LOTS 601-603 BALANNUP ROAD &
200-202 SKEET ROAD, HARRISDALE

STRUCTURE PLAN

HARRISDALE NORTH



Prepared by
Hex Design & Planning

August 2023

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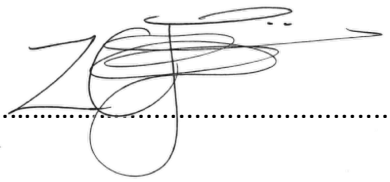
ENDORSEMENT PAGE

This Structure Plan is prepared under the provisions of the City of Armadale Scheme No. 4

It is certified that Harrisdale North Structure Plan was approved by resolution of the Western Australian Planning Commission on:

02 November 2023

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



.....

An officer of the Commission duly authorised by the Commission pursuant to section 24 of the Planning and Development Act 2005 for that purpose, in the presence of:

Witness: .....

Date: 03 November 2023

Date of Expiry: 03 November 2033

TABLE OF AMENDMENTS

Amendment No.	Summary of Amendment	Amendment Type	Date approved by WAPC

EXECUTIVE SUMMARY

Structure Plan – North Harrisdale

This report represents an application to the City of Armadale to consider a proposed Structure Plan comprising Lots 601-603 Balannup Road & 200-202 Skeet Road, Harrisdale, herein referred to as the 'subject land'.

The subject lots have a combined area of 21.18 hectares and are located in the northern area of Harrisdale.

The subject land is situated approximately 19.0 km south of Perth and 7.5km west of Armadale Town Centre. The site is located at the junction of Skeet and Ranford Road, with the land subject of this submission bound by Ranford, Balannup, Reilly and Skeet Road, Harrisdale.

The Structure Plan has been prepared concurrently with a Local Scheme Amendment to rezone the land within the 'Urban Development'. The subject land was zoned 'Urban' under the MRS in June 2021 (MRS 1383/27), with the local zoning of 'General Rural' required to change to 'Urban Development' to be consistent with urban development.

The Harrisdale North Structure Plan will facilitate future subdivision and development of residential lots at Residential 25 and Residential 30 density and accommodate an area for Commercial land uses on Ranford Road.

The Structure Plan Summary Table below details the nature and key outcomes of the Structure Plan.

Structure Plan Summary Table

ITEM	DATA	Structure Plan REF (section no.)
Total area covered by the Structure Plan	21.18 ha	Section 1.2.2, 1.2.3, 3.1.1
Area of each land use proposed: - Residential - Local Centre	 10.47 ha (53.4 %) 0.8 ha	Section 3.4.1
Total estimated lot yield	280 lots	Section 1.1
Estimated number of dwellings	280 dwellings	Section 3.4.1
Estimated population	728 persons	Section 3.4.1
Estimated residential site density	26.7 dwellings per site hectare	Section 3.4.1
Estimated area and percentage of Public Open Space given over to: - Regional open space - Local parks	 Nil 4.46 ha (21%)	Section 3.2

Part One - Implementation

Part One - Implementation

Structure Plan – North Harrisdale

1. Structure Plan Area

This Structure Plan shall apply to Lots 601-603 Balannup Road & 200-202 Skeet Road, Harrisdale. The Structure Plan area is defined by the line denoting the Structure Plan boundary on the Structure Plan Map (Plan 1).

2. Operation

The date the Structure Plan comes into effect is the date the Structure Plan is approved by the WAPC.

3. Subdivision and Development Requirements

3.1 Subdivision within the Structure Plan area is to be in accordance with the residential density code prescribed by the Structure Plan.

3.2 Land use permissibility within the Structure Plan area shall be in accordance with the corresponding zone or reserve under the Scheme.

3.3 At the time of subdivision, the following strategies and plans may be required via conditions of subdivision approval:

a) Urban Water Management Plan;
b) Fauna Management Plan;
c) Landscape and Streetscape Plan;
d) Foreshore Management and Improvement Plan / Detailed Wetland and Buffer Management Plan;
e) Midge and Mosquito Management Plan;
f) Bushfire Management Plan; and
g) Noise Assessment.

3.4 Residential density targets applied under Perth and Peel @3.5million and the Southern Metropolitan Peel Sub-Regional Structure Plan of 26 dwellings per residential site hectare are to be achieved.

3.5 The structure plan is to provide a minimum 10 percent of the area as public open space in accordance with the WAPC policy requirements. The provision of public open space is to be provided generally in accordance with the structure plan map.

4. Local Development Plans

The preparation and implementation of a Local Development Plan may be required as a condition of subdivision approval where deemed necessary for land comprising the following:

a) Lots affected by road and/or kennel noise;
b) Lots where specific vehicle access and egress control is required (dual frontage); and
c) Lots within the Local Centre zone;

5. Other Requirements

5.1 Bushfire Management

This structure plan is supported by a bushfire management plan (Appendix 6). Site-specific bushfire management plans may be required to support future subdivision of land within the structure plan. Future development is required to be in accordance with the recommendations of the bushfire management plan and comply with the requirements of Australian Standards 3959.

5.2 Notifications on Title

As a condition of subdivision approval, a notification on the certificate of title may be required to advise prospective purchasers of the following:

- Lots deemed to be within a bushfire prone area and additional development standards may apply.
- Lots deemed to be affected by road/kennel noise and additional development standards may apply.
- Lots deemed to be impacted by mosquitos.

5.3 Restrictive Covenants

Restrictive Covenants restricting access from Skeet Road and Ranford Road shall be placed on the Certificate(s) of Title(s) of those sites with direct frontage to Skeet Road and Ranford Road.

5.4 Development Contributions

The structure plan is subject to a contribution to the cost of common infrastructure in accordance with a Development Contribution Plan and Cost Apportionment Schedule prepared pursuant to Part 5A and Schedule 9B Development Contribution Plans of Town Planning Scheme No.4

5.5 Infrastructure Arrangements

Upgrades to the existing road network will be required through subdivision/development with detailed engineering plans required to be submitted to the City of Armadale for:

- The construction of Reilly Road adjacent to the Structure Plan area;
- The upgrading of Balannup Road to provide a full movement roundabout to the Structure Plan area; and
- The upgrading of Balannup Road to provide the proposed left-in/left-out intersection.

5.6 Protection and Management of Environmental Features

An environmental management plan will be required as a condition of subdivision/development approval to address the management, retention and rehabilitation of the identified Banksia Woodland proposed to be retained. The environmental management plan is to be consistent with Schedule 8 of Town Planning Scheme No.4.

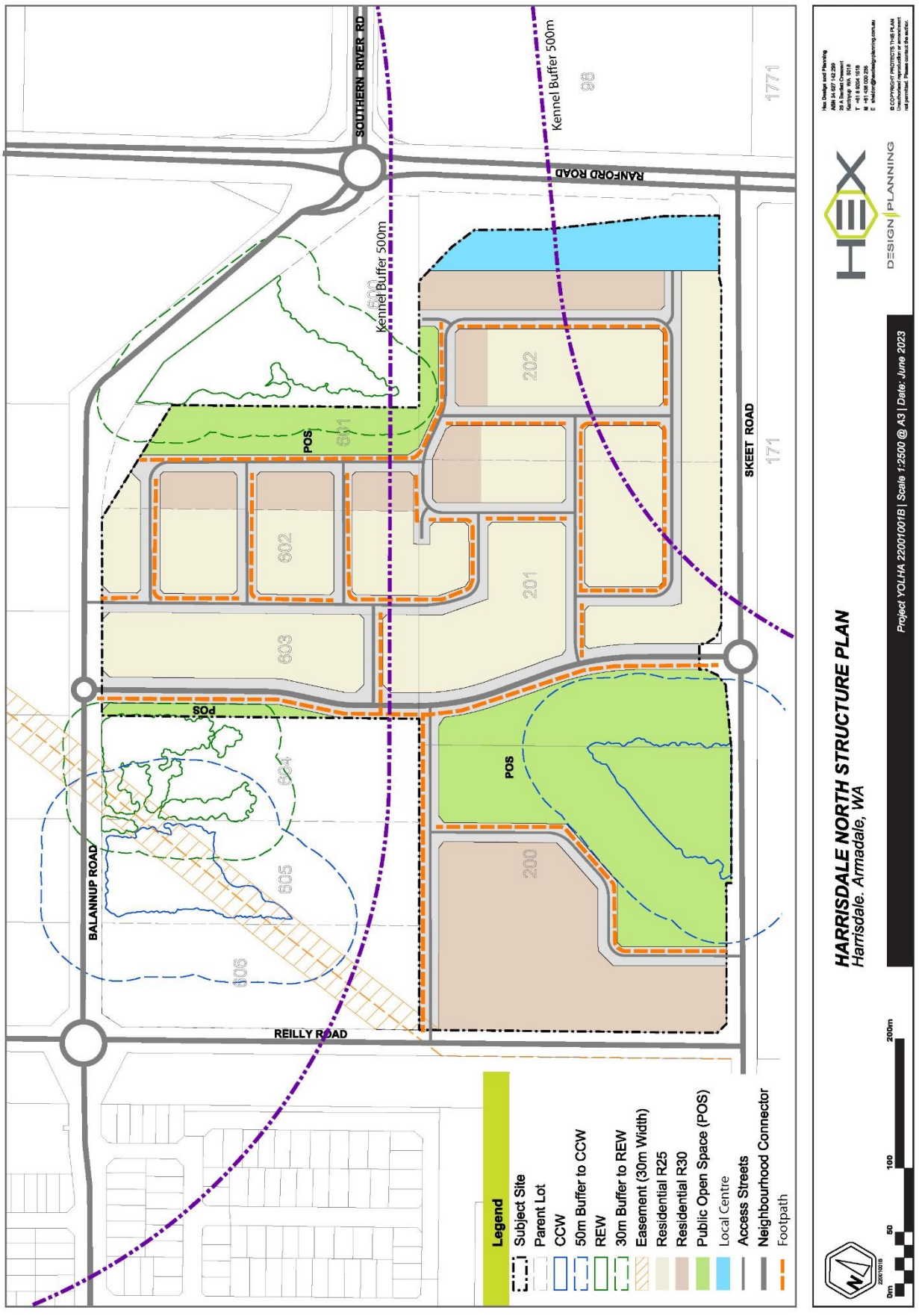
6. Additional Information

As a condition of subdivision or development approval within the structure plan area, conditions pertaining to the following may be imposed;

- Acid Sulphate Soil Assessment.
- Noise Wall Design
- Environmental Management Plan
- Soil Contamination Assessment
- Site Remediation and Validation Report
- Access Arrangements from Ranford Road and Skeet Road for the proposed Local Centre

Plan 1

Structure Plan Map



Part Two–Explanatory Report

Document Summary

VERSION	Ref	COMMENT	PREPARED BY	REVIEWED BY	REVIEW DATE	APPROVED BY	ISSUE DATE
Revision 1-6	YOLHALSP	Draft	SLD			SLD	
Revision 7	YOLHALSP	Final Submitted CoA	SLD	SY	1/8/2021	SLD	3/8/2022
Revision 7a	YOLHALSP	EPA/DWER/CoA Rev	SLD	SY	5/2/2022	SLD	
Revision 8	YOLHALSP	Final	SLD	SY	19/2/2022	SLD	31/5/2022
		Submit CoA	SLD				30/5/2022
Revision 9	YOLHALSP	SPC Modifications	SLD		31/8/23	SLD	31/8/23

Prepared for: ***Yolk Sky No.15 Pty Ltd. (Yolk Property Group)***

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All of the information details included in this report are based upon the existing land area conditions and research provided and obtained at the time the Consultant conducted its analysis.

Please note that the information in this report may not be directly applicable to another client. The Consultant warns against adapting this report's strategies/contents to another land area which has not been researched and analysed by the Consultant. Otherwise, the Consultant accepts no liability whatsoever for a third party's use of, or reliance upon, this specific document.

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1 PLANNING BACKGROUND

1.1 INTRODUCTION AND PURPOSE

This submission has been prepared by Hex Design and Planning on behalf of the landowners of Lots 601-603 Balannup Road & 200-202 Skeet Road, Harrisdale.

The site is located at the junction of Skeet and Ranford Road, with the land subject of this submission bound by Ranford, Balannup, Reilly and Skeet Road, Harrisdale ('the subject land'). The Structure over the subject land is intended to guide future subdivision and development in accordance with the provisions of the City of Armadale's Town Planning Scheme No.4 (TPS4) and The Structure Plan and is intended to be considered concurrently with an Amendment to the City of Armadale's Town Planning Scheme No. 4 (TPS 4) to rezone the subject land to 'Urban Development'.

The ultimate objective of this proposal is to facilitate the subdivision and development of the land for a range of residential land uses in a manner that interacts appropriately with the development that has occurred in the locality.

The intended land uses within the Structure Plan include:

- Approximately three hundred (300) residential lots, with residential density coding of R25 and R30;
- Area of Commercial on Ranford Road;
- Three (3) areas of open space (POS), both restricted and unrestricted, incorporate a Conservation and Resource Enhancement Category Wetland, wetland buffers, and drainage associated with the development of the subject land.

This submission is accompanied by a Structure Plan Map (Plan 1) prepared in accordance with the *Planning and Development (Local Planning Scheme) Regulations, 2015* which is included in Part One of this Report.

The Explanatory Section of this Structure Plan Report includes a detailed description of the proposal, provides an evaluation of the relevant town planning, environmental, fire management, local water management and servicing considerations applicable to the land, and details the rationale supporting the proposed Structure Plan.

The Structure Plan has been developed having regard to the physical features of the land, surrounding development, recommendations from technical reports and discussions with technical staff at the City of Armadale.

The Structure Plan has been prepared by Hex Design in collaboration with a team of specialist consultants, who have provided input in relation to matters as follows:

Hex Design and Planning	-	Urban Design, Town Planning
Emerge Associates	-	Environmental Report / Land Capability
Emerge Associates	-	Bushfire Management Plan
Emerge Associates	-	Landscape
Porters Engineering	-	Engineering Services Report
Emerge Associates	-	Local Water Management Strategy
Porters Engineering	-	Transport Assessment
Urbis	-	Economic Report

Copies of the relevant consultant reports are included as Appendices in this report, with key findings from the respective reports incorporated within the core of this report.

A Local Water Management Strategy (LWMS) has been prepared to support the Structure Plan and has been submitted concurrently to the Structure Plan Report by Emerge Associates for approval by the Department of Water. The Consultants' Reports confirm there are no significant constraints to progressing urban development of the land and is capable of being supported by the Council.

Once the concurrent Scheme Amendment has been gazetted and the Structure Plan endorsed, it will be possible for urban development and subdivision to proceed in a coordinated manner as envisaged by the earlier rezoning of the site by the MRS to Urban.

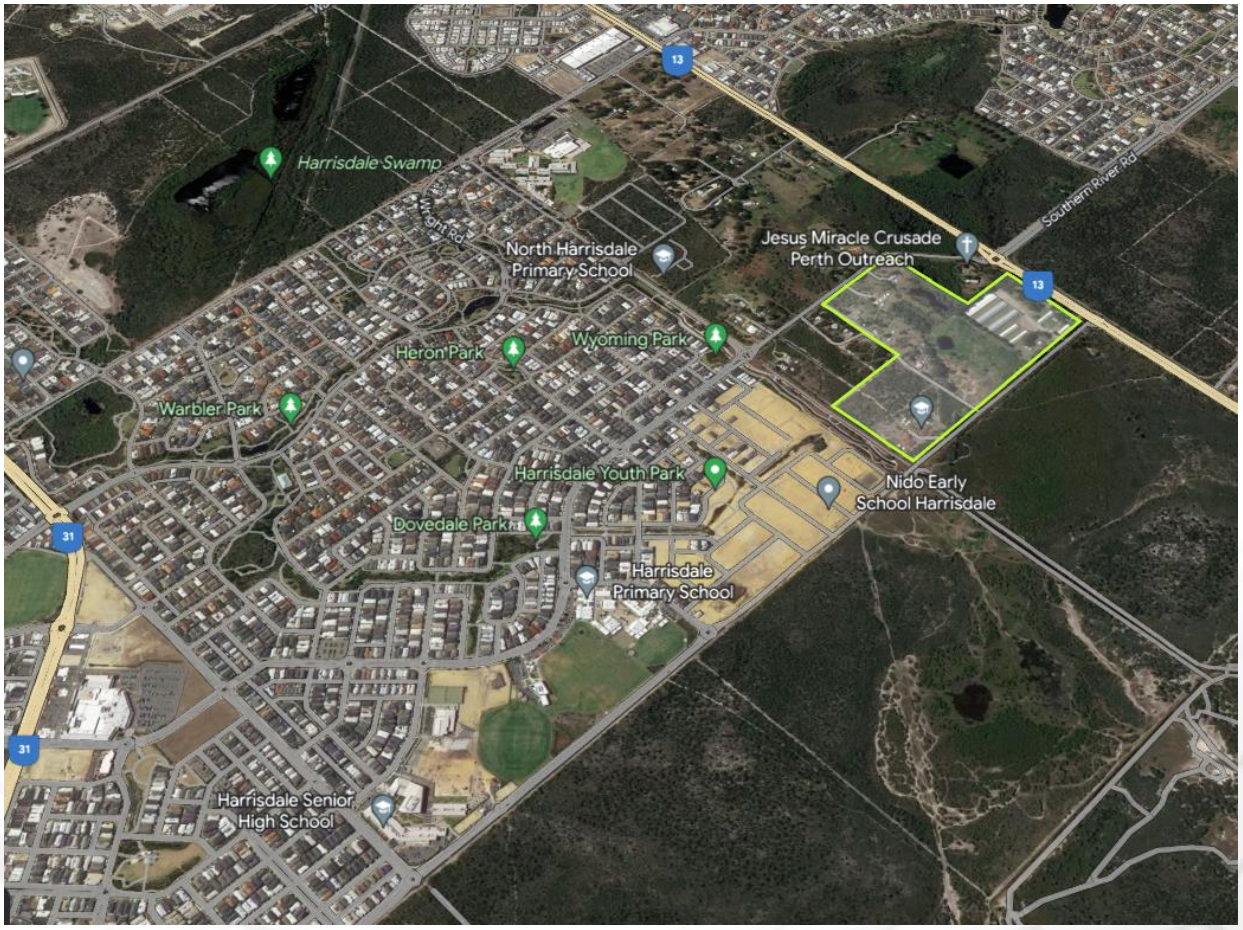
1.2 LAND DESCRIPTION

1.2.1 Location

The subject land is approximately 20 kilometres south of the Perth CBD and approximately 7.5km west of the Armadale Town Centre. The site fronts Ranford Road to the north, which is classified 'Other Regional Road' by the provisions of the Metropolitan Region Scheme (MRS), and links with the Primary Regional Road network via Armadale Road to the south. (refer ***Figure 1 – Regional Context Plan*** *and* ***Location Plan***).

Access to the subject land is best afforded via Kwinana Freeway which is located circa 8km west and provides a north-south link between Yanchep to the north and Bunbury via the Forrest Hwy to the south.

The subject land is predominantly surrounded by a mix of medium and low-density residential development, comprising the recent development of Fairhaven Estate and Heron Park to the south. With the development of Harrisdale Primary School and High School 1km south of the subject land (as part of Heron Park Estate), the subject land is a natural progression of the urban front northward.



Location Plan (Source: Google Earth)

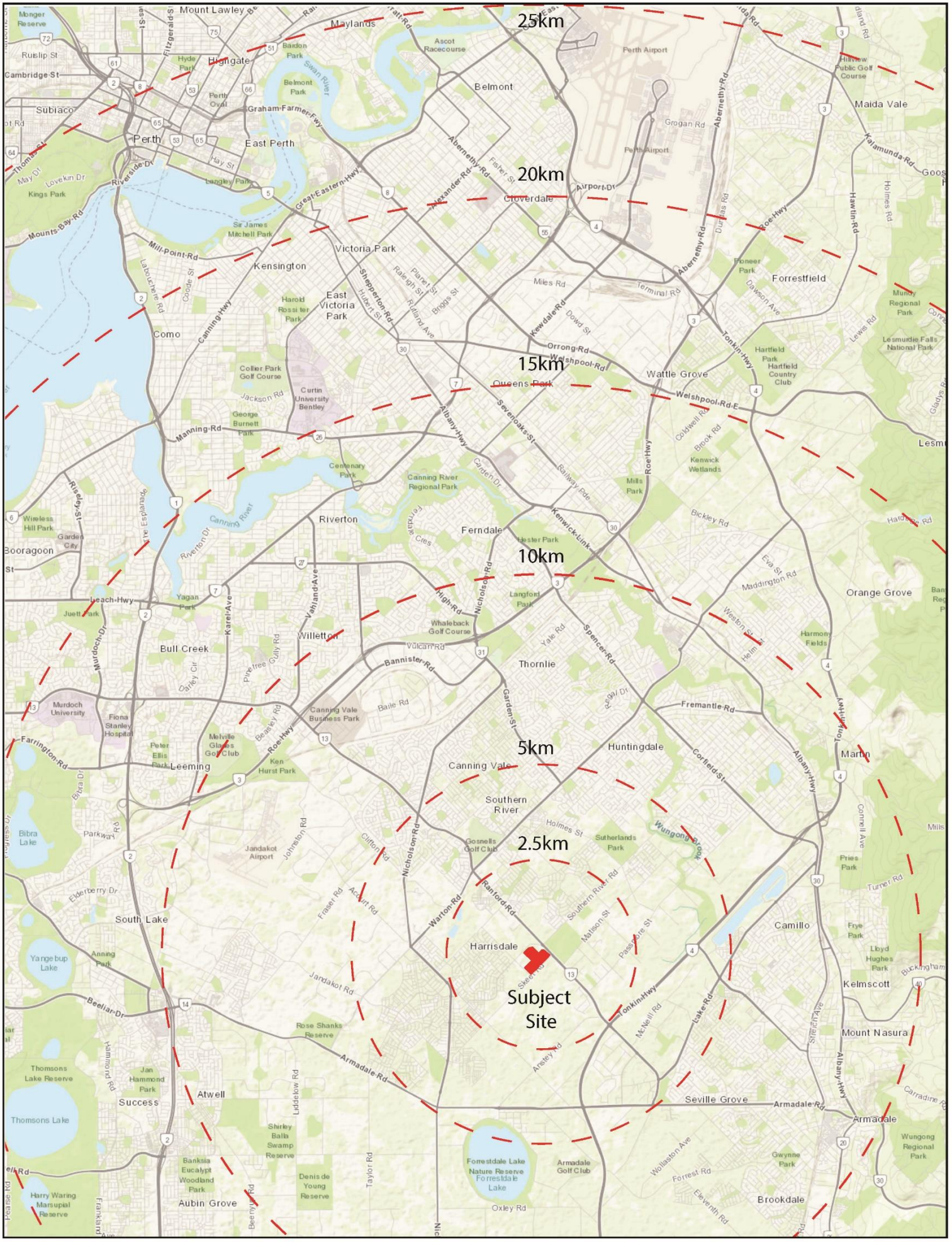


Figure 1 - Regional Context Plan

0 2.5km 5km

Scale 1:80,000@A4 I Date JANUARY 2021 I Project YPGHAMRS-1-001

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1.2.2 Area and Land Use

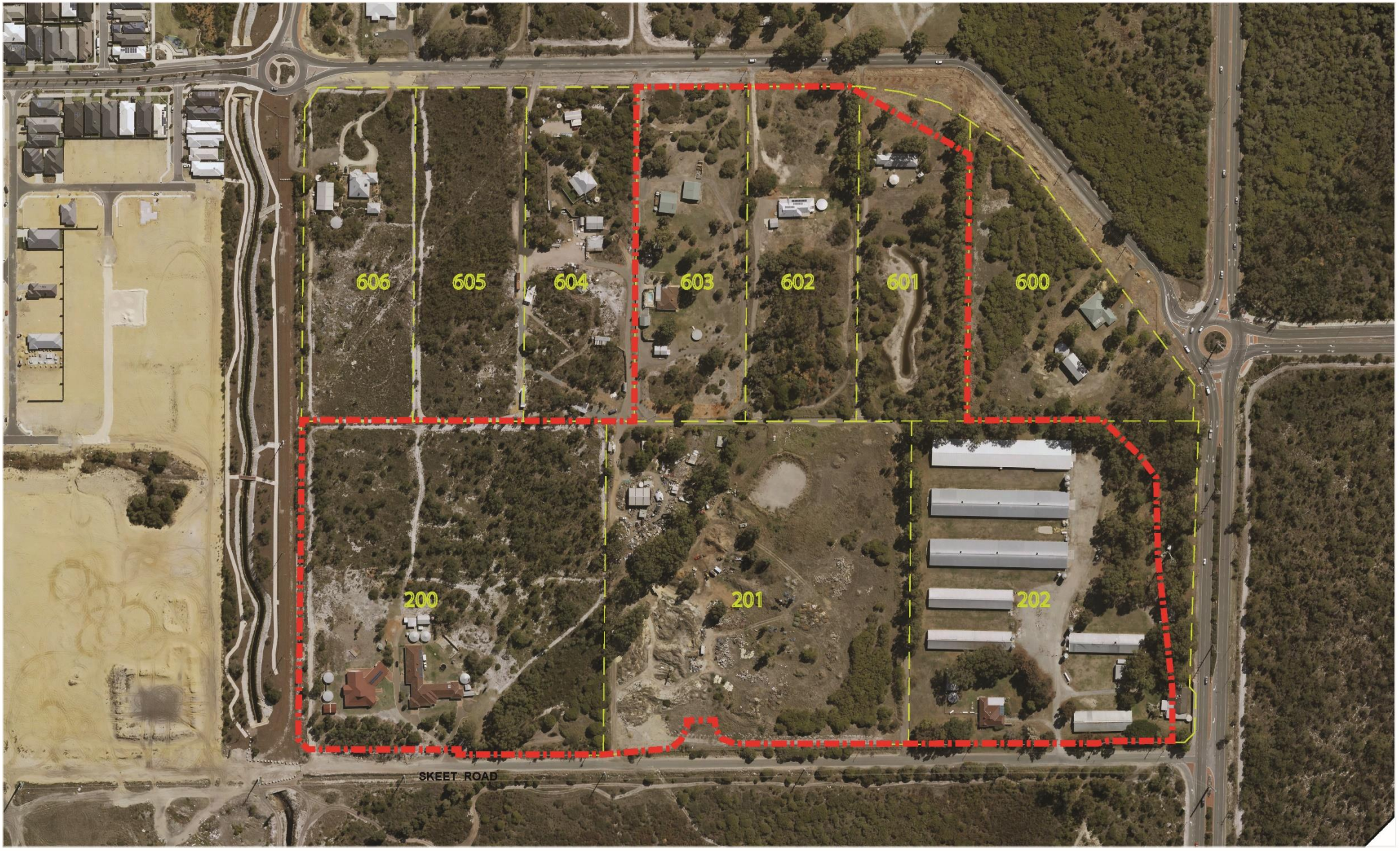
The subject land comprises six (6) lots totalling 21.18 ha in area and is located within the City of Armadale and bound by Ranford, Balannup, Reilly and Skeet Road, Harrisdale ('the subject land').

Land uses within the subject land reflect the previous 'General Rural' zoning under TPS4 and generally comprise rural living and a poultry farm located on Lot 202 Skeet Road. The Aerial Photograph (**over page**) shows the current state of the subject land.

Lot 202 is currently occupied by a poultry farm, operated by Wirraway Holdings Pty Ltd. The operation of this land use has resulted in the sterilization of the surrounding land from residential development, with an odour buffer currently being in place. It is noted that occupancy of residential dwellings within the poultry buffer is not permissible until the operation has ceased, and the buffer removed.

With the surrounding area having been developed over the past two decades and zoned Urban, the subject land has been constrained due to an operating poultry farm on Lot 202 Skeet Road.

The structure plan area is subject of Amendment 121 to the City of Armadale's Town Planning Scheme No.4 (see section 1.3.1 of this report), with residential development to be the primary land use proposed by the structure plan, with a small commercial area fronting Ranford Road.



Harrisdale
Subject Site Structure Plan

0 50 100 250

CONCEPT PLAN FOR DISCUSSION PURPOSES ONLY

Scale 1:2500@A3 I Date May 2021 I Project YOLHAFEA-1-021

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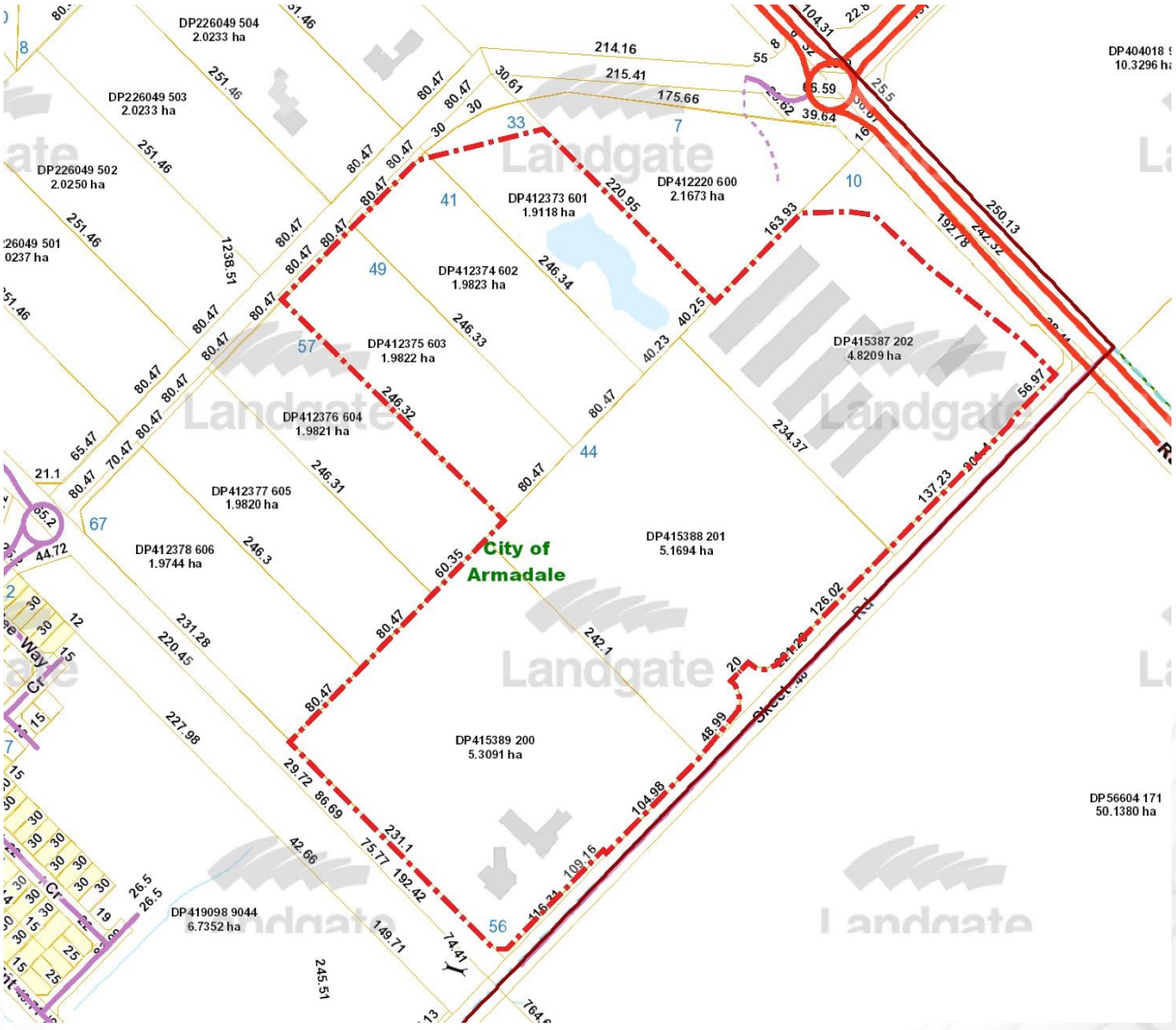
1.2.3 Legal Description, Ownership

The subject land comprises six (6) lots. ***Table 1*** below provides details of the constituent lots.

Table 1 - Lot Details

Lot / Address	Lot No.	Deposited Plan	Volume	Folio	Area / Ha
33 Balannup Road	601	412373	2950	114	1.9118
41 Balannup Road	602	412374	2948	542	1.9823
49 Balannup Road	603	412375	2948	499	1.9822
56 Skeet Road	200	415389	2957	595	5.3091
44 Skeet Road	201	415388	2957	594	5.1694
10 Skeet Road	202	415387	2958	419	4.8209
Total Lot Area					27.1757

Copies of the applicable Certificates of Title listed above are included in ***Appendix 1*** of this submission.



Subject Land – Landgate

1.3 PLANNING CONSIDERATIONS

1.3.1 Zoning and Reservations

1.3.1.1 Metropolitan Region Scheme (MRS)

The MRS is the statutory land use planning scheme for the Perth Metropolitan Area. The primary purpose of the MRS is to reserve and zone land and control development on reserved and zoned land at the regional level.

The subject land is zoned 'Urban' under the provisions of the MRS, pursuant to MRS Amendment 1383/27 which was gazetted in August 2021.

Ranford Road, which abuts the subject land's northern boundary, is identified as 'Other Regional Road' under the MRS. The final area required for Ranford Road is currently being assessed by DPLH/WAPC, with portions of Lot 202, 601 and 602 having been excluded from the Urban zone until this has been resolved. These areas excluded remain Urban Deferred under the MRS and do not form a part of the structure plan area. A further MRS amendment is required for the lifting of Urban Deferment.

The structure plan complies with the MRS zoning/objectives.

1.3.1.2 City of Armadale Town Planning Scheme No. 4 – Amendment 121

The subject land is currently zoned 'General Rural' under the City of Armadale Town Planning Scheme No.4 (TPS4), however, is in the process of being rezoned 'Urban Development' by way of an Amendment to TPS4. Amendment No.121 to the City of Armadale Town Planning Scheme (TPS4) seeks to amend the zoning of the subject site, which will bring it in line with the underlying Urban MRS zoning.

Amendment 121 was the subject of a detailed review by the City of Armadale in conjunction with government agencies including EPA and DWER, which saw the rezoning progress for the site.

The Urban Development zone requires a Structure Plan to be prepared in accordance with the Planning and Development (Local Planning Schemes) Regulations, 2015, being the most appropriate and flexible mechanism to progress subdivision and development, having regard to the following objectives of the zone:

a) *"To provide for the orderly planning of large areas of land for residential and associated purposes through a comprehensive Structure Plan which is able to respond to changing circumstances throughout the developmental stages of the area; and*

b) *To promote the sustainable development of new urban communities in accordance with the social, environmental and economic goals of the City of Armadale."*

The proposed Structure Plan has been prepared having regard to the relevant provisions of the Scheme and it is understood that the City of Armadale will require the adoption of subdivision and development provisions in the process of approval of the Structure Plan.

1.3.2 Sub-Regional Planning Framework - Perth and Peel @ 3.5 Million Framework

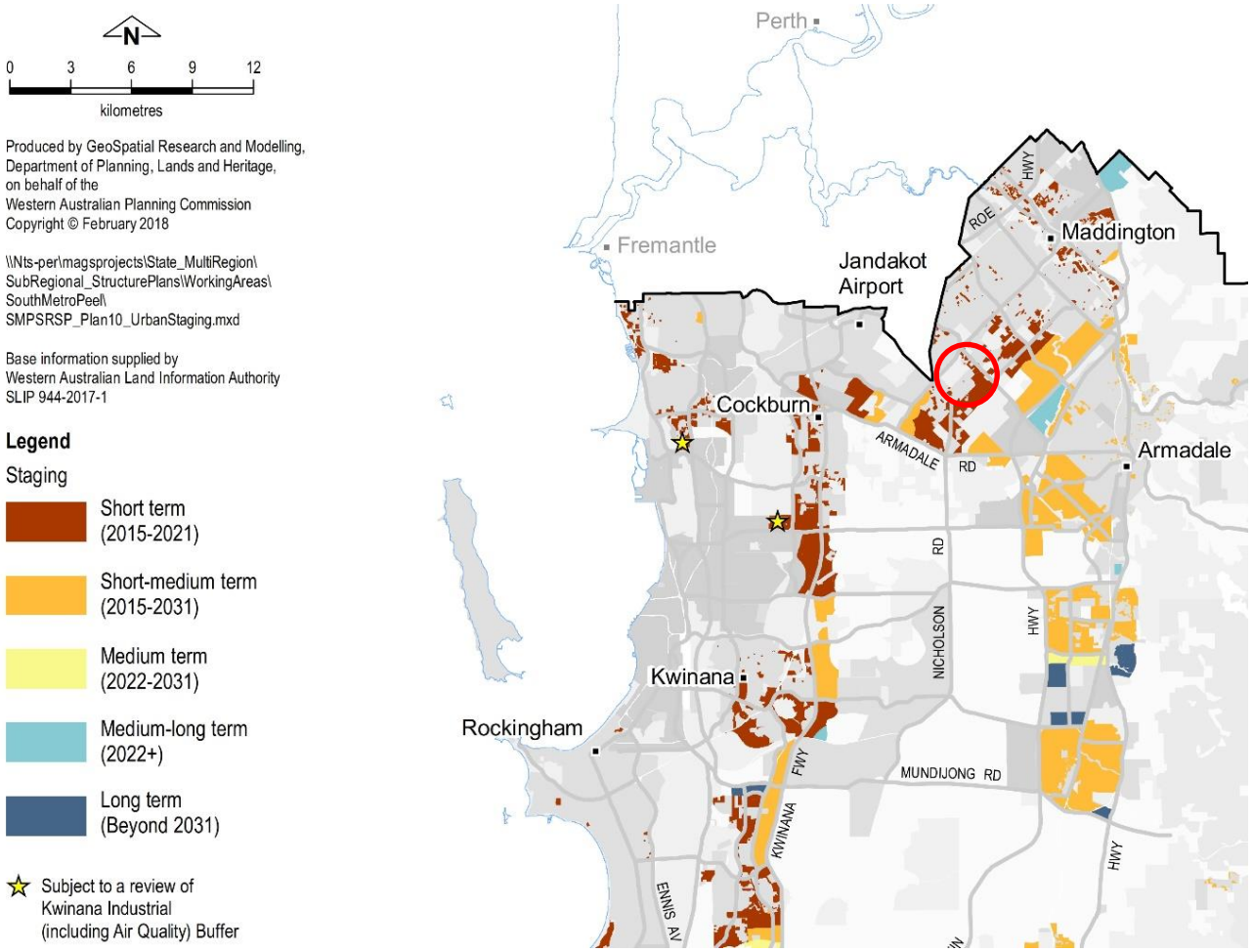
The Western Australian Planning Commission's Sub-regional Planning Frameworks, released in early 2018, establish the vision for future growth of the Perth and Peel Metropolitan Regions and provide a framework to guide the delivery of housing, infrastructure and services necessary to accommodate anticipated population growth over the next 35 years.

The subject land is included in the South Metropolitan Peel Region Planning Framework and identified as short-term development (2015-2021), acknowledging that it has an environmental impediment that has restricted development to date.

Consistent with the draft Perth and Peel @ 3.5 million document, the Sub-Regional Planning Frameworks seek to achieve a residential density target equivalent to 26 residential dwellings per residential site hectare and requires a residential density target of 15 dwellings per urban site hectare.

The subject land is situated within the South Metropolitan Peel Sub-Regional Planning Framework, which identifies the land as 'Urban Deferred'. Development of the subject land for residential land use is consistent with the South Metropolitan Peel Sub-Regional Planning Framework and will facilitate planned residential development in the locality.

The structure plan meets the objectives/requirements of the frameworks.



South Metropolitan Peel Region Planning Framework

1.3.3 City of Armadale Local Planning Strategy

The City of Armadale Local Planning Strategy was prepared in January 2014 to support TPS 4 and is intended to set out the long-term planning direction for the City. The Strategy envisages the progression of Structure Plans in the area on a sub-precinct basis according to the conclusions of the necessary environmental and servicing investigations.

The proposed Structure Plan is consistent with the intention of the Local Planning Strategy and has been prepared having regard to the above considerations, and hence is consistent with the Local Planning Strategy.

1.3.4 Planning Policies and Guidelines

1.3.4.1 State Planning Policy 3.7 – Planning in Bushfire Prone Areas

State Planning Policy 3.7 (SPP 3.7) seeks to guide the implementation of effective risk-based land use planning and development to preserve life and reduce the impact of bushfire on property and infrastructure. SPP 3.7 applies to strategic planning proposals, including Structure Plans, overland designated as bushfire

prone by the Map of Bushfire Prone Areas prepared by the Department of Fire and Emergency Services.

The subject land is designated as Bush Fire Prone, and SPP 3.7 is applicable to the Structure Plan area. The requirements of SPP 3.7 are addressed by a Bushfire Management Plan prepared in support of the Structure Plan.

Further details are provided in section 2.6 and **Appendix 3** of this Report.

1.3.4.2 State Planning Policy 5.4 – Road and Rail Transport Noise and Freight Considerations in Land Use

State Planning Policy 5.4 (SPP 5.4) includes the following objectives which are relevant to the proposed Scheme Amendment:

- *Protect people from unreasonable levels of transport noise by establishing a standardised set of criteria to be used in the assessment of proposals;*
- *Protect major transport corridors and freight operations from incompatible urban encroachment;*
- *Encourage best-practice design and construction standards for new development proposals and new or redeveloped transport* infrastructure proposals;

Given the subject land abut Ranford, resulting in the potential to exceed the noise limit specified by SPP 5.4, Noise Assessment was considered appropriate.

Further details addressing SPP 5.4 are included in section 2.9 and **Appendix 2** of this Report.

1.3.4.3 Liveable Neighbourhoods

The WAPC's Liveable Neighbourhoods is an operational policy that guides the design and assessment of structure plans (regional, district and local) and subdivision of new urban neighbourhoods in the metropolitan area and country centres, on greenfield and large urban infill sites.

Liveable Neighbourhoods includes the following Principle Aims that are particularly relevant to the Study Area:

- *To foster a sense of community and strong local identity and sense of place in neighbourhoods and towns.*
- *To ensure the avoidance of key environmental areas and the incorporation of significant cultural and environmental features of a site into the design of an area.*
- *To provide for a more integrated approach to the design of open space and urban water management.*
- *To ensure cost-effective and resource-efficient development to promote affordable housing.*
- *To maximise land efficiency wherever possible.*
- *To provide a variety of lot sizes and housing types to cater for the diverse housing needs of the community at a density that can ultimately support the provision of local services.*

Liveable Neighbourhoods outlines that Local Structure Plans should depict:

- *walkable neighbourhood catchments of approximately 400m–450m radii around proposed commercial centres;*
- *density targets expressed as dwellings per hectare;*
- *existing and proposed commercial centres;*
- *natural features to be retained;*
- *proposed street block layout;*
- *proposed street network, including street types and path networks;*
- *proposed transportation corridors, public transport networks and cycle and pedestrian networks;*

- *proposed land uses, including distribution of higher, medium and lower density residential;*
- *proposed schools and community facilities;*
- *public parkland; and*
- *proposed urban water management measures.*

The structure plan has been prepared and given due consideration/regard to all the above.

1.3.4.4 City of Armadale Local Planning Policies

Relevant Local Planning Policies prepared by the City of Armadale have been considered during the preparation of the proposed Structure Plan design and documentation.

1.3.5 Other Approvals and Decisions

1.3.5.1 Concurrent Scheme Amendment

This Structure Plan is to be considered in conjunction with a Local Scheme Amendment to the City of Armadale Town Planning Scheme No. 4 (proposing to rezone the subject land from 'General Rural' to 'Urban Development').

1.3.5.2 Scheme Amendment – Amendment 121 to City of Armadale TPS4.

An application for a Local Scheme Amendment is currently underway for the subject land, which will see the site rezoned from 'General Rural' to "Urban Development'. This rezoning will align the Scheme with the MRS, which at the regional level zones the subject land 'Urban'.

1.3.6 Pre-Lodgement Consultation

Co-ordinated planning for subject land has been the subject of consultation with the City of Armadale, through 2020/2021 and early 2022. The City's preliminary comments from those consultations are reflected in the Structure Plan Report and have been incorporated into the design of the Structure Plan.

Pre-consultation has also included extensive site investigations and site inspections with state government agencies, including the Environmental Protection Agency (EPA) and the Department of Water and Environment Regulation (DWER) which occurred through the rezoning process, which has further led to the refinement of the structure plan prior to submission.

From these meetings with technical staff at the City of Armadale, it was generally agreed;

- *Road layout considered appropriate for the site;*
- *Land uses are considered appropriate for the site; and*
- *Open space configuration and bushland retention areas. (These areas were subject to detailed discussions with DWER and EPA through the rezoning process).*

In accordance with a request from the City of Armadale to confirm that the proponent of the Harrisdale North Structure Plan, Yolk Property Group, has consulted with the other landowners within the precinct, Table 2 below confirms the timing and extent of these consultations:

Table 2 – Landowner and Agency Consultation

Lot No.	*Landowners*	*Consultation undertaken*
Lot 200	ABORIGINAL CHRISTIAN CHURCH TEACHING CENTRE OF W.A. INC	Consultation with the landowner has been undertaken over the past 12-18 months, with access having been granted to enable technical consultants to access the landholding and prepare documentation required for the structure plan.
Lot 201	LUIGI DECAMPO & JUDITH DECAMPO	No consultation was required as Yolk Sky No.15 Pty Ltd has entered an unconditional Contract of Sale with the current landowners (settlement pending).
Lot 202	BRIAN ARTHUR CHESTER & DELORES VERONICA CHESTER	No consultation was required as Yolk Sky No.15 Pty Ltd has entered an unconditional Contract of Sale with the current landowners (settlement pending).
Lot 601	ALLAN STANLEY PASHBY & THELMA MAVIS PASHBY	Yolk Property Group contacted the landowners in 2020 and subsequently through the start of 2021 and met with them for a preliminary discussion. Consultation has been ongoing as the Structure Plan preparation progressed, with access to the landholding having been granted to technical consultants to advance reports required for the Structure plan.
Lot 602	THOMAS MARTIN KAVANAGH	No consultation was required as Yolk Sky No.15 Pty Ltd has entered an unconditional Contract of Sale with the current landowners (settlement pending).
Lot 603	LIZA FOWLER	Yolk Property Group contacted the landowners in 2020 and subsequently through the start of 2021 and met with them for a preliminary discussion. Contact between Yolk Property Group and the landowner was ongoing as the Structure Plan preparation progressed, with access to the landholding having been granted to technical consultants to advance reports required for the Structure plan.
Lot 604	RICHARD ALAN HENDERSON	Yolk Property Group contacted the landowners in 2020 and subsequently through the start of 2021 and met with them for a preliminary discussion. Consultation had been ongoing as the Structure Plan preparation progressed, with access to the landholding having been granted to technical consultants to advance reports required for the Structure plan.
Lot 605	BERNARD ANTHONY BLAKE	Yolk Property Group contacted the landowners in 2020 and subsequently through the start of 2021 for preliminary discussions. Consultation had been ongoing as the Structure Plan preparation has progressed, with access to the landholding having been granted to technical consultants to advance reports required for the Structure plan.
Lot 606	KENNETH BEAUMONT MCKAY & AILEEN SYLVIA MCKAY	Yolk Property Group contacted the landowners in 2020 and subsequently through the start of 2021. Consultation had been ongoing as the Structure Plan preparation progressed, with access to the landholding having been granted to technical consultants to advance reports required for the Structure plan.

Table 2 – Landowner and Agency Consultation (cont.)

Lot No.	*Landowners*	*Consultation undertaken*
All	Department of Water and Environmental Regulation (DWER)	Site investigations and visits were undertaken by DWER through 2021/2022 to confirm vegetation mapping and water bodies. This was undertaken as part of the rezoning consideration process.
All	Environmental Protection Agency (EPA)	Site investigations and visits were undertaken by EPA through 2021/2022 to confirm vegetation mapping and water bodies. This was undertaken as part of the rezoning consideration process.
All	City of Armadale	Yolk Property Group had various meetings with the City of Armadale (and technical staff) to discuss the structure plan layout and supporting documentation throughout 2020-2022.

2 SITE CONDITIONS AND CONSTRAINTS

Site conditions and constraints have been ascertained through the site-specific Environmental Assessment (EAMS) undertaken by Emerge Associates. (**Appendix 2**).

The following is a summary of the main environmental characteristics of the subject land.

2.1 BIODIVERSITY AND NATURAL AREA ASSETS

An Environmental Assessment and Management Strategy (EAMS) prepared by Emerge Associates (Emerge) in Appendix 2 has investigated and reported on the environmental characteristics of the land within and outside the Structure Plan area.

The study area is bound by Reilly Road to the south, Skeet Road to the east, Ranford Road to the north and Balannup Road to the west.

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

- Historical land uses across the study area comprised an informal salvage yard, a poultry farm and rural residential-style dwellings.
- The topography of the study area ranges from 21 m in relation to the Australian Height Datum (mAHD) up to 23 mAHD.
- Based on the Geological Survey of Western Australia (Gozzard 1986), the western portion of the study area is underlain with sand, whereas the eastern is underlain with peaty sand and peat-rich sand. Geotechnical investigations found the ground condition to be a mixture of sand, sandy clay and clayey sand.
- The north/northeast portion of the study area has a 'High to Moderate' risk of acid sulfate soils (ASS) occurring within 3 m of the natural soil surface. The remainder of the study area is classified as having a 'Moderate to Low' risk of ASS occurring within 3 m of the natural soil surface.
- Based on a recent survey undertaken by Emerge Associates (2022), approximately 11 ha or 40.3% of the study area supports native plant communities. The remainder of the study area (15 ha or 57.13% of the study area) comprises cleared or non-native vegetation with buildings, bare soil, weeds, or planted vegetation. The condition of the vegetation across the study area was determined to range from 'Completely Degraded' to 'Excellent', with the most intact native vegetation located in the south-western half of the study area.
- A total of 6.13 ha of 26.3 ha (or 24%) of vegetation within the study area is in 'Good' or better condition, which is considered to be intact native vegetation.
- Emerge Associates (2022) confirmed the composition of plant communities BaBm, BKg and BaMpKg located within the study area are representative of the federally listed 'banksia woodlands of the Swan Coastal Plain' 'Threatened Ecological Community' (TEC) (herein referred to as the 'banksia woodland TEC') as well as the state listed 'Priority Ecological Community' (PEC). Therefore, a total of 7.64 ha of the Banksia woodland TEC/PEC occurs within the study area.
- Three priority flora species were recorded within the study area, Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026) (P1), Verticordia lindleyi subsp. lindleyi (P4) and Jacksonia gracillima (P3).
- While the threatened flora species, Drakaea elastica was not identified during flora surveys conducted over the appropriate survey window, a potentially suitable habitat for this species, plant community BKg, occurs within the study area.
- Emerge Associates (2021a) recorded a total of 18 native and three introduced fauna species within the,

study area including one species of conservation significance, Isoodon fusciventer (quenda) (P4). In addition, four threatened, six priority, three migratory and one specially protected fauna species were considered to possibly occur within the site, including three species of black cockatoos; Calyptorhynchus latirostris (Carnaby's cockatoo), Calyptorhynchus baudinii (Baudin's cockatoo) and Calyptorhynchus banksii naso (forest red-tailed black cockatoo) (referred to herein collectively as 'black cockatoos'). No black cockatoos were observed during the survey and no evidence of roosting was recorded. The study area is located within the expected range of all three species and suitable habitat occurs within the local area, so it is possible that all three species may utilise the study area at varying times. None of the potential habitat trees present within the study area contain hollows that would be suitable for use for breeding by black cockatoos.

- An Environmentally Sensitive Area is present over the entirety of the study area.
- A wetland assessment prepared by Emerge Associates (2021g) delineated the on-ground wetland values of the study area and concluded that the study area supports two conservation category wetlands (CCWs)(within the site) and a nearby resource enhancement wetland (REW) within the northern adjacent lot (i.e. not within the site). The Department of Biodiversity Conservation and Attractions (DBCA) have subsequently reviewed the Emerge wetland assessment against the existing Geomorphic Wetlands of the Swan Coastal Plain dataset and confirmed revisions to the wetland mapping are generally in line with the Emerge assessment.
- No registered Aboriginal or non-indigenous heritage sites have been historically identified within the study area.
- No registered contaminated sites are located within the site, however Lot 202 (which contains a currently operational poultry farm) and Lot 201 (which contains an informal salvage yard) support land uses with the potential to cause contamination. All other lots have historically been used for rural residential purposes.
- Ranford Road is located along the northern boundary of the site and is identified as a 'strategic freight and/or major traffic route', hence the State Planning Policy 5.4 Road and Rail Noise (SPP 5.4) applies to the site.
- Parts of the site are located within the City of Armadale's Kennel Buffer zone and a number of registered kennels within both the City of Armadale and the City of Gosnells are located within a 500 m radius of the site.
- Bushfire hazards associated with bushfire-prone vegetation have been identified within and outside the site, associated with the vegetated portions of the various wetlands and unmanaged vegetation within existing private landholdings, particularly to the south of the site.

The urban layout of the Structure Plan has been developed with consideration of the identified environmental values of the site. A number of design responses have been incorporated into the Structure Plan in this regard, including:

- Provision of a 50 m buffer to the CCW's and a 30m buffer to REW's, to avoid impacts on the hydrology of the wetland.
- Preparation of the LWMS, which outlines the groundwater and surface water management strategy for the SP.
- Preparation of the BMP, which outlines how the SP responds to the bushfire protection criteria specified in the Guidelines for Planning in Bushfire Prone Areas.
- Contiguous areas of remnant vegetation and wetland communities for viable retention.

The EAMS also outlines the environmental framework to be implemented across the site as part of the future subdivision and development phases of the residential development process, including:

- Where future subdivision stages incorporate or are located directly adjacent to a POS area, an Environmental Management Plan (or similar) will be prepared. This document will identify environmental management requirements and specify management actions to be implemented within POS areas and the wetland buffer zone. This will consider factors such as vegetation and fauna habitat retention and improvement, potential revegetation and general POS management.
- Preparation of an Urban Water Management Plan to support each stage of subdivision.

- Completion of detailed bushfire attack level (BAL) assessment and imposition of determined BAL ratings on affected lots.
- The potential requirement for an Acid Sulfate Soil and Dewatering Management Plan (ASSDMP) is based on future investigations if required.

Overall, the environmental attributes and values identified can be accommodated within the Structure Plan design or can be managed appropriately through the future subdivision and development phases in line with the relevant state and local government legislation, policies and guidelines

2.1.1 Flora and vegetation

Three areas of POS (approximately 4.46ha or 23% of the site) are proposed within the Structure Plan, including a large area of 3.36ha which retains a wetland and remnant vegetation, enhancing the environmental retention within the estate and consolidating these areas to mitigate edge effect and weed infestation opportunity.

The structure plan contains vegetation that is deemed 'Good' or better condition, proposed to be retained within POS, whilst other areas of vegetation that fall outside this classification are also to be retained in addition to this.

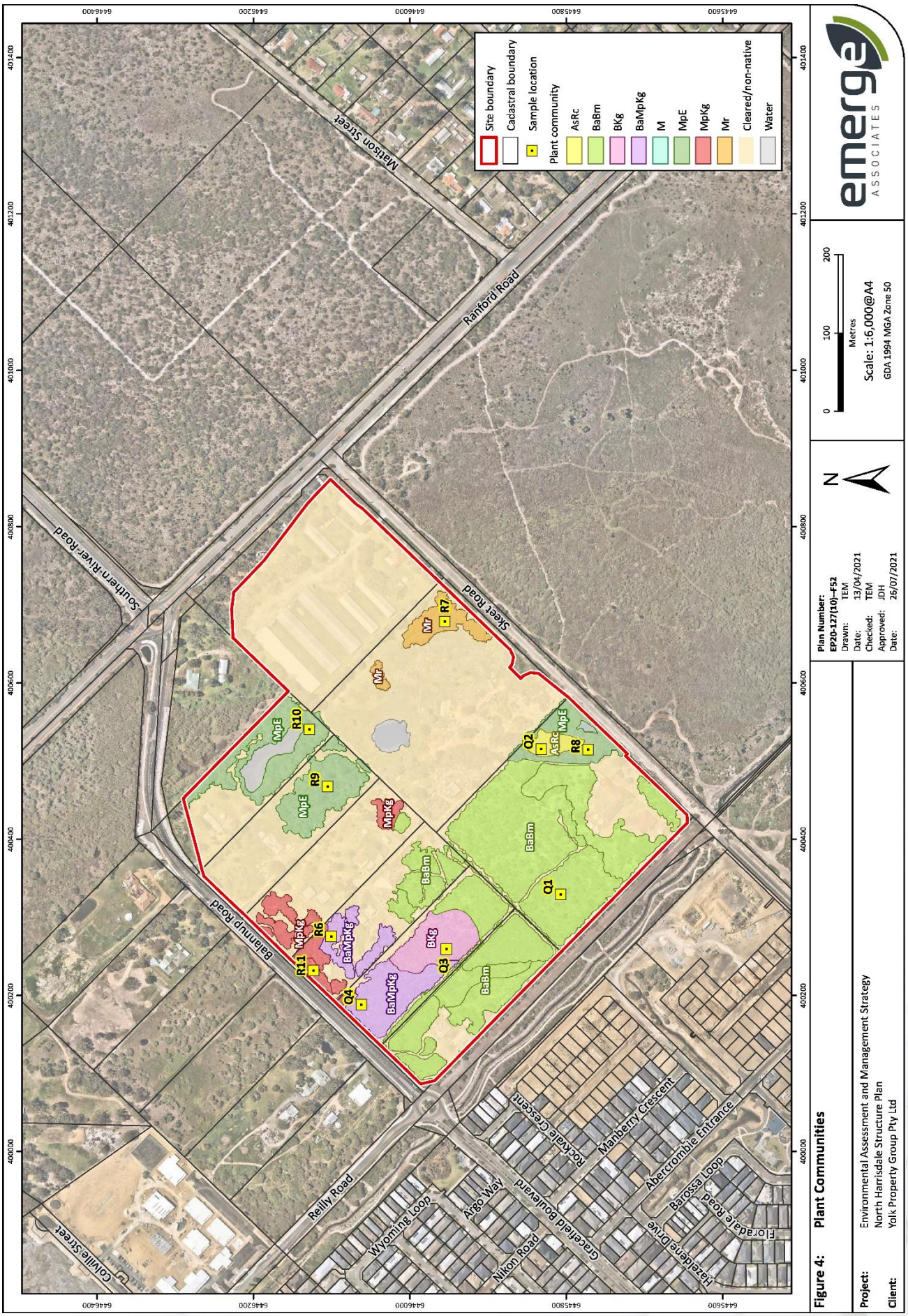
The POS areas have been strategically located to retain portions of the Banksia Woodland TEC/PEC occurring within the site.

Opportunities to retain these areas of native vegetation across the development will be possible in the areas of POS and will be confirmed during the final development design and bulk earthworks requirements.

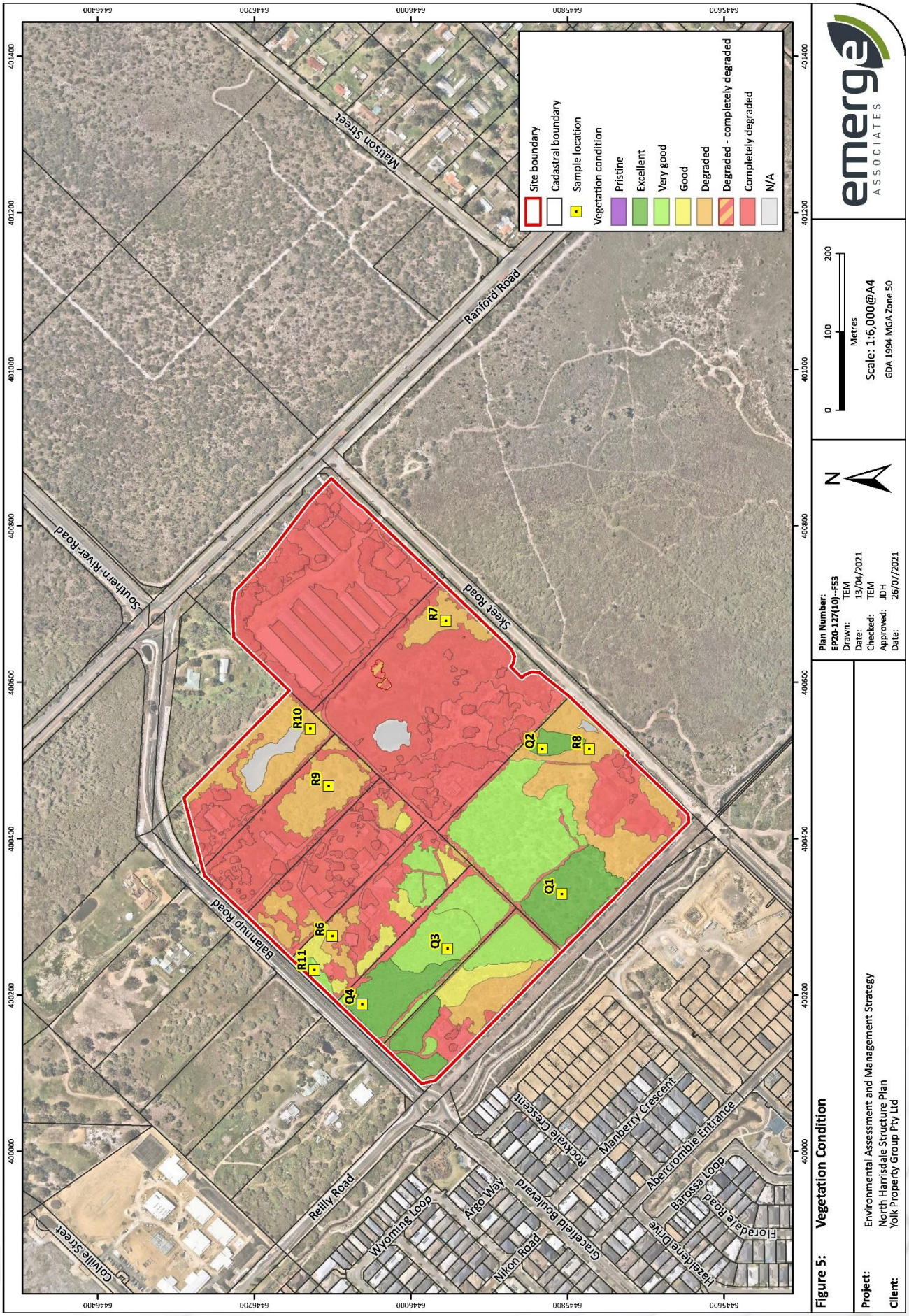
A native vegetation clearing permit will not be required if clearing is done in accordance with subdivision approval.

Individual proponent(s) will therefore need to consider their obligations under the EPBC Act in relation to the potential impacts arising out of their proposed action (i.e. development which may require assessment and potential offsets) on the Banksia Woodland TEC.

A vegetation and flora management plan(s) (or similar) should be required to be prepared to mitigate any potential impacts on flora and vegetation associated with construction and development works. This can be applied as a condition of subdivision.



EAMS – Plant Communities



EAMS - Vegetation Condition.

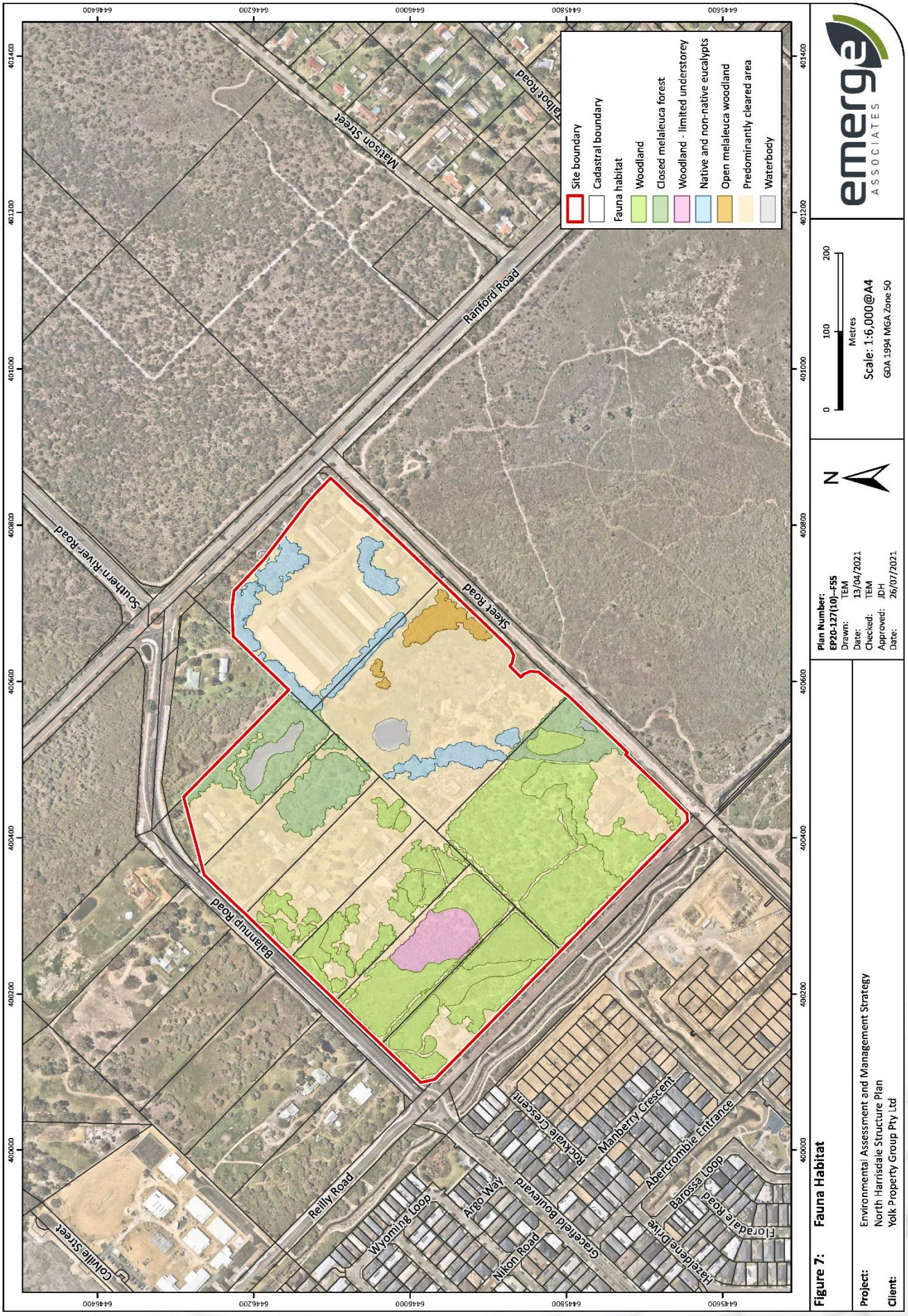
2.1.2 Terrestrial Fauna

The Structure Plan provides three POS areas (totalling 4.46ha) which will retain identified intact fauna habitats, predominately 'Woodland' and 'Closed Melaleuca Forests' habitat types.

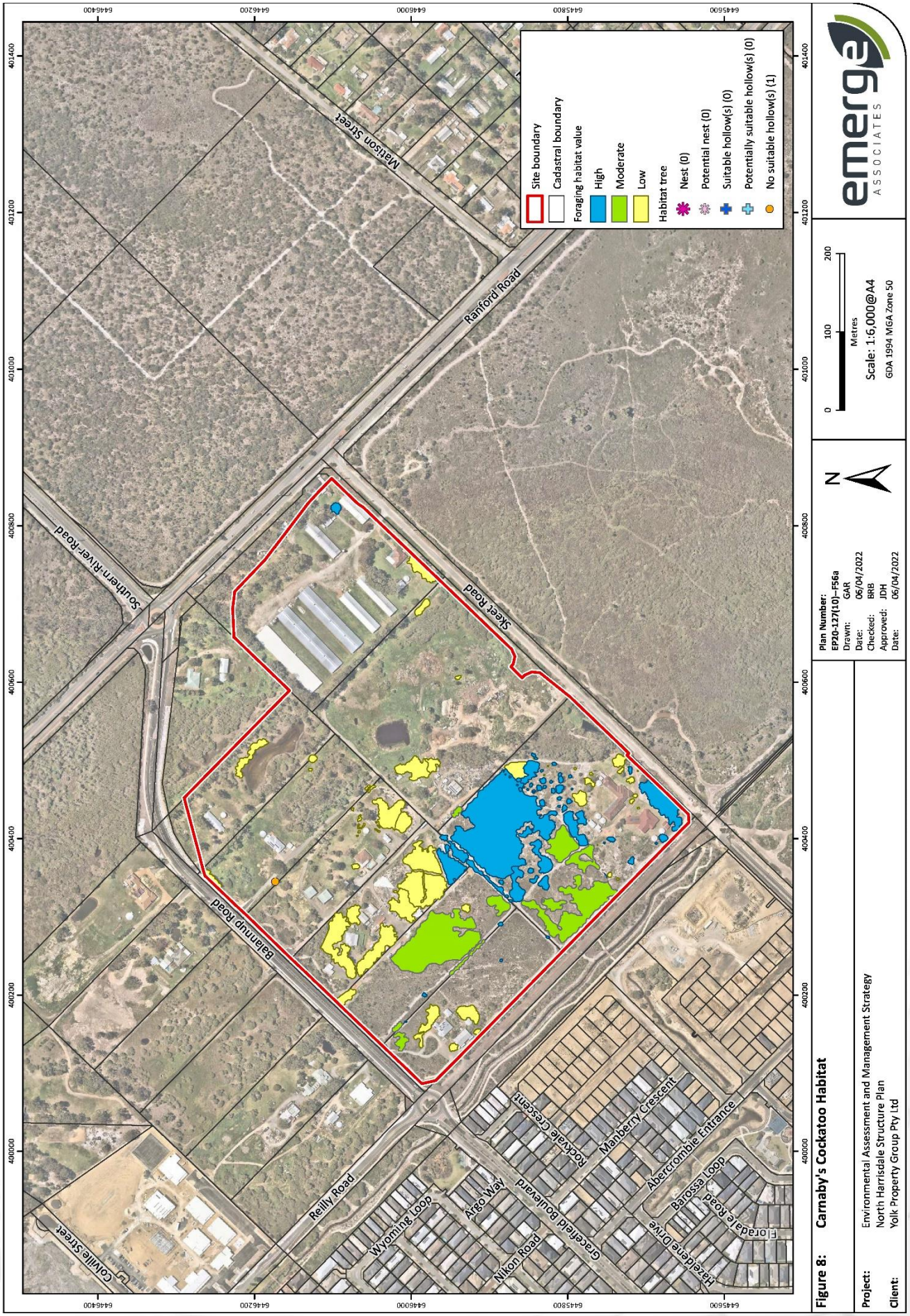
The Structure Plan would also facilitate the retention of black cockatoo foraging habitat within POS areas, in particular, Carnaby's Cockatoo foraging habitat (of the total of 4.12 ha, or 46.11%).

The vegetation proposed to be retained supports a dense cover of remnant native understorey vegetation, known to provide suitable habitat for several conservation significant fauna species. In addition, the wetland buffer areas will provide separation from the urban land uses, limiting the potential impacts on the fauna associated with the wetland areas.

As part of future subdivision and development, Fauna Management Plan(s) should be required to further mitigate the potential impacts on fauna during construction. Landform and Soils



EAMS – Fauna Habitat Mapping



EAMS – Carnaby Cockatoo Habitat Mapping

2.2 LANDFORM / SOIL / GEOLOGY

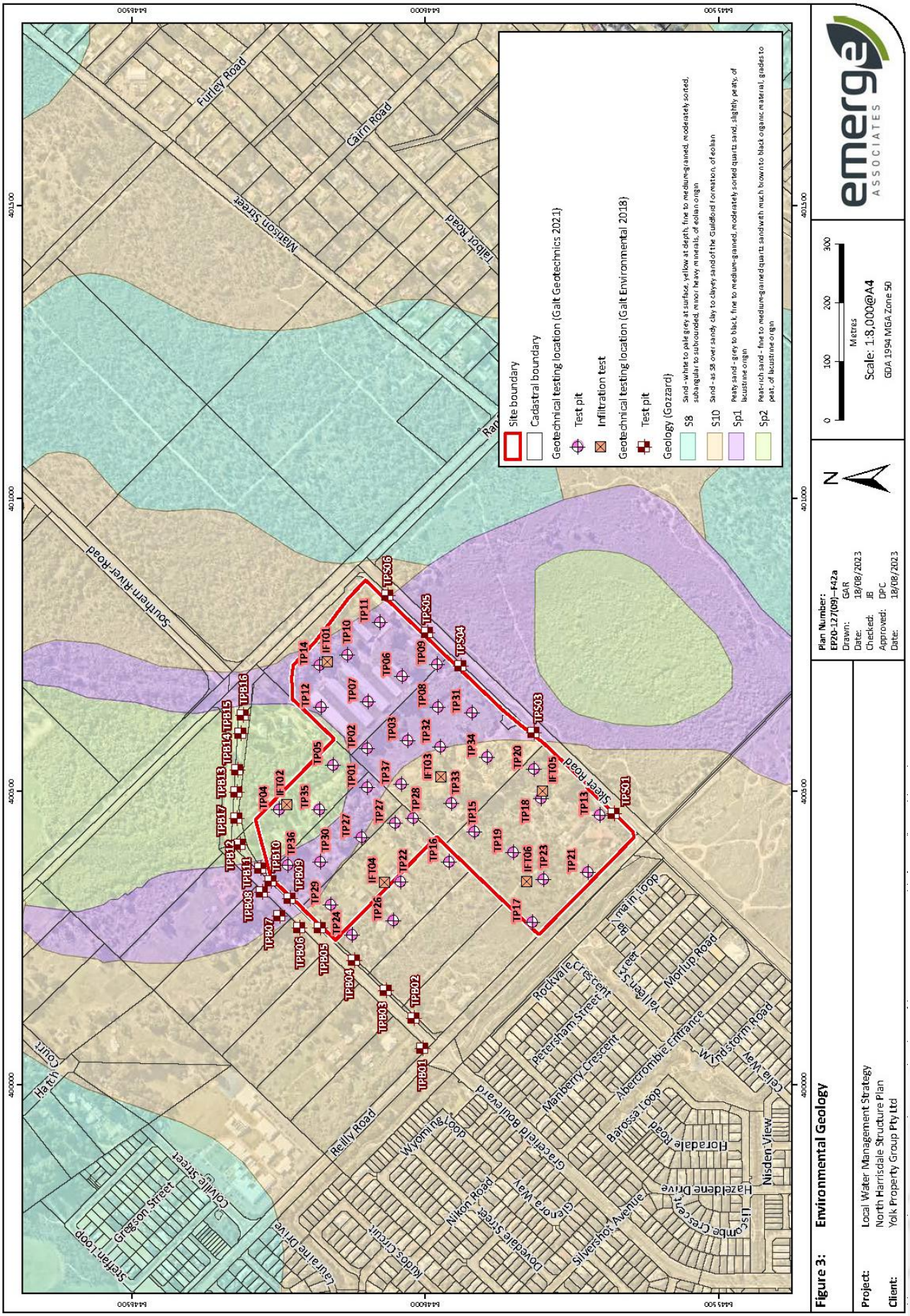
The EAMS prepared by Emerge in **Appendix 2** has investigated and reported on the landform and soils of the land within the Structure Plan area.

The site is generally flat, with elevations ranging from 21 m Australian Height Datum (mAHD) in the central portion of the site (associated with a man-made dam) to 23 mAHD across the majority of the site (DoW 2008). The topographical characteristics of the site are shown in Figure 2 of **Appendix 2.**

The site is located along the eastern margin of the Swan Coastal Plain which is roughly bound by the Indian Ocean to the west and the Darling Scarp to the east. Examination of broad-scale soil mapping places the site within the Southern River association. The Southern River association comprises of 'sandplain with low dunes and many intervening swamps; iron and humus podzols, peats and clays' (Churchward and McArthur 1980).

Environmental geology for the site has been mapped by the Geological Survey of Western Australia (Gozzard 1986). The site consists of:

- S10. Sand - as S8 (Sand) over sandy clay to clayey sand of the Guildford Formation, of eolian origin.
- Sp1. Peaty sand - grey to black, fine to medium-grained, moderately sorted quartz sand, slightly peaty, of lacustrine origin.
- Sp2. Peat-rich sand - fine to medium-grained quartz sand with much brown to black organic material, grades to peat, of lacustrine origin.



EAMS - Geology Mapping

2.3 GROUNDWATER / SURFACE WATER / WETLANDS

The EAMS prepared by Emerge in **Appendix 2** has investigated and reported on the groundwater and surface water within the Structure Plan area. Additional Wetland Assessment Report is included as **Appendix 4**.

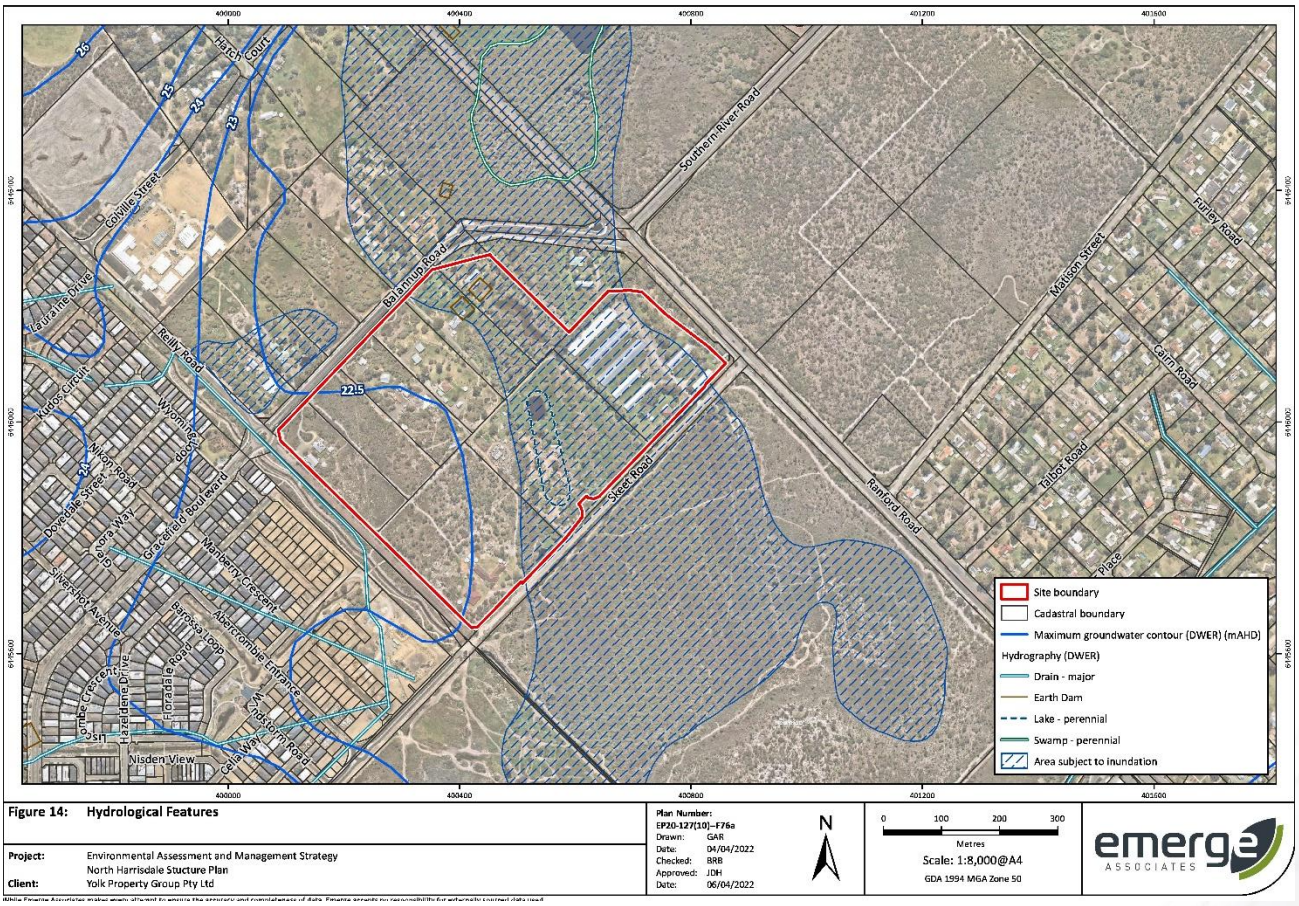
2.3.1 Groundwater

A review of the regional groundwater contours shown in the Perth Groundwater Map (DWER 2021) indicates that the maximum and minimum groundwater contour is within the west/southwest portion of the site and is approximately 2 m AHD from the existing surface.

2.3.2 Surface Water

The Department of Water and Environmental Regulation (DWER) hydrography dataset (DWER 2018) shows a perennial lake present within Lot 201 and two earth dams present within Lots 601 and 602. These three features are located within a larger area that is mapped as an 'area subject to inundation' that extends over most of the eastern portion of the site (DWER 2018) (Figure 14).

The site is also located within the surface water drainage catchment of the Forrestdale Main Drain (FMD), which has a total catchment area of 5,400 ha (JDA 2014). This catchment contains various local authority open and piped drainage, overland flow paths and Water Corporation open drains (JDA 2014).



EAMS – Hydrology

2.3.3 Wetlands

In the context of environmental impact assessment, the EPA's objective for inland waters is 'to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected' (EPA 2018).

The findings of the Wetland Assessment (Emerge Associates 2021g) delineated the on-ground wetland boundaries of the study area as shown in the following figure. Due to the significant environmental values associated with these wetlands, they need to be retained and protected.

The Structure Plan provides for the separation of the CCWs/REW from residential development through the provision of wetland buffers.

A review of the wetland dataset (DBCA 2020a) indicated that the site supports the following geomorphic wetlands:

- One CCW (UFI 14880) occurs in a small area in the south-eastern portion of the site and extends across Skeet Road to the southeast of the site.
- Two MUWs (UFI 14879 and UFI 13347) are present within the western half of the site, and an additional MUW (UFI 14404) is present over the eastern half of the site.
- Two REWs (UFI 16164/16165 and UFI 15946) also exist within Lot 602 and Lot 600 (i.e. not within the site) and extend into Balannup Road.

The neighbouring lots to the structure plan (Lots 604 and 605) contain a REW and CCW as mapped by DBCA, with the buffer being taken into consideration in the structure plan.

- One CCW (UFI 16166) occurs on the other portion of Lot 600 (i.e. not within the site).
- One REW (UFI 16163) exists within Lot 604 (i.e. not within the site) and extends into Balannup Road.

DBCAs evaluation of the Wetland Assessment (Emerge Associates 2021f) confirmed that the REW within Lot 602, although acknowledged its marginal condition and limited values (see correspondence provided in Appendix G).

Both Emerge and DBCA concurred that the Lot 602 REW (UFI 16164/16165) area is disturbed, historically modified, and comprises low ecological values compared to the other wetlands within the site. Restoration of these areas would require intensive works over an extended period of time.

Based on the findings, the geomorphic wetland boundaries that align with the on-ground values and incorporate DBCAs comments are shown in the following mapping. Formal Geomorphic Wetlands of the Swan Coastal Plain dataset.

For the CCW buffers, a minimum of 50 m will allow for the retention of existing native vegetation and revegetation. For the REW buffer, a minimum of 30 m will allow for the retention of existing native vegetation and revegetation. Whilst POS areas surrounding the wetlands generally provide larger buffers reflective of the minimum distances, a reduced buffer surrounding the neighbouring Resource Enhancement Wetland (REW) on Lot 603 as it abuts Lot 604 has been applied due to existing clearing and quality of remanent vegetation on Lot 603. An existing crossover through this area exists, and the main connector road to Balannup as identified by the City of Armadale runs within this cleared area/alignment and will provide a hard edge to the wetland and associated buffer.

Preparation of a Wetland Management Plan(s) should be required to outline specific strategies for the preservation of the wetlands and their associated buffer areas.

EAMS - Geographic Wetland Boundaries

DBCA - Geographic Wetland Boundaries (DBCA-019)



30/08/2023, 15:29:41

Cadastre Address (LGATE-002) - Large Scale

Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)

- Conservation
- Multiple Use
- Not Applicable
- Not Assessed
- Resource Enhancement

Others

- Laneway, Sealed
- Laneway, Unsealed
- Mall, Sealed
- Track, Unsealed
- Other

Minor Roads

- Minor, Sealed

0 0.07 0.15 0.3 km

Esri, HERE, Garmin, USGS, METI/NASA, LANDGATE/SLIP, SLIP/LANDGATE, Landgate / SLIP

powered by SLIP

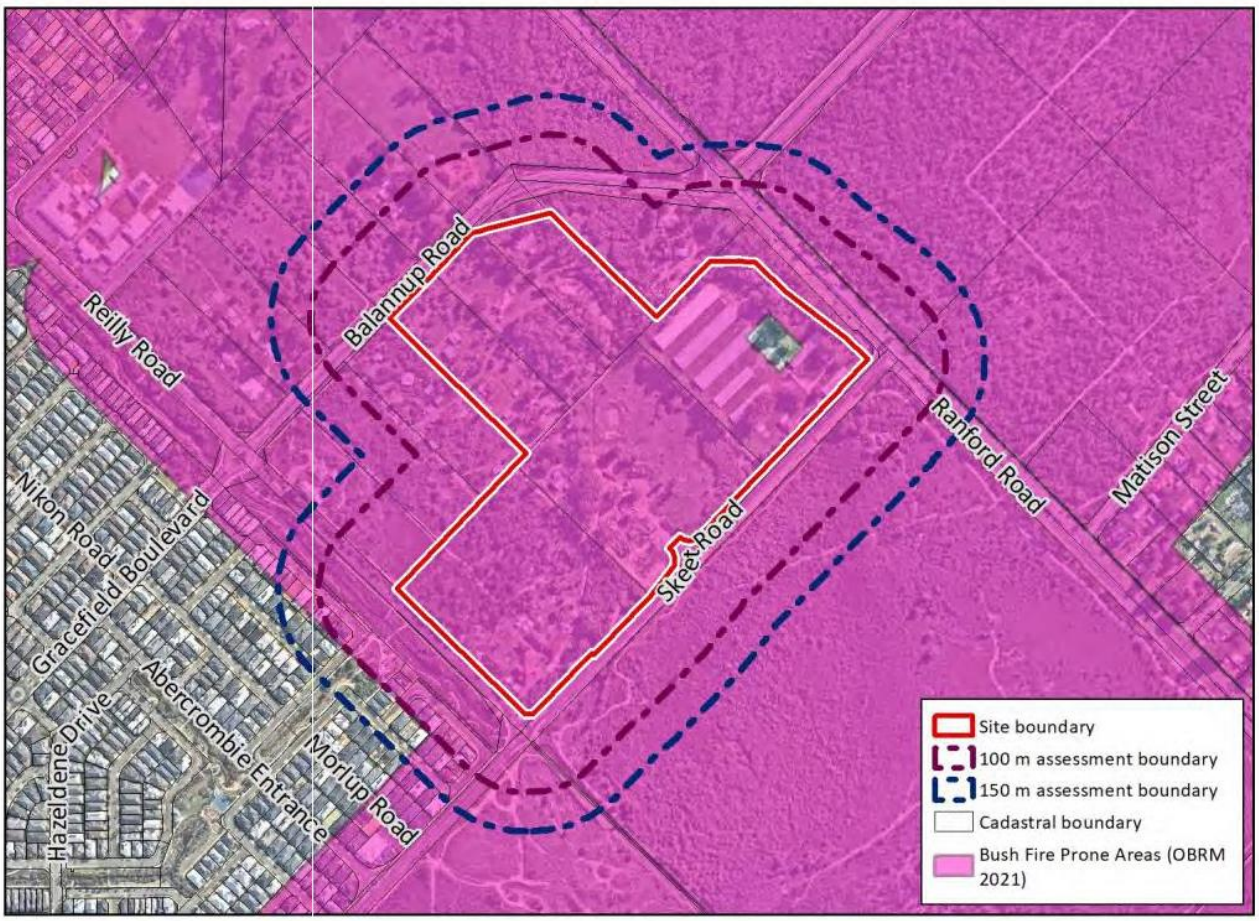
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2.4 BUSHFIRE HAZARD

A Bushfire Management Plan (BMP) prepared by Emerge Associates (Emerge) in **Appendix 6** has identified the Structure Plan area as a 'bushfire prone area' and reported on management measures required to enable the development of the land for primarily residential purposes.

The Structure Plan will involve the majority of the bush fire hazard within the site to be removed, due to the construction of residential lots and the road network. Hazards will remain however within the three areas of POS associated with retained native vegetation and the significant environmental values within these areas.

The bushfire hazards within the POS would also increase with the revegetation of buffer areas, although the risks associated with this and necessary mitigation measures have been outlined within the North Harrisdale Bushfire Management Plan (Emerge Associates 2021f), which has been prepared to support the Structure Plan.



DFES Bushfire Mapping

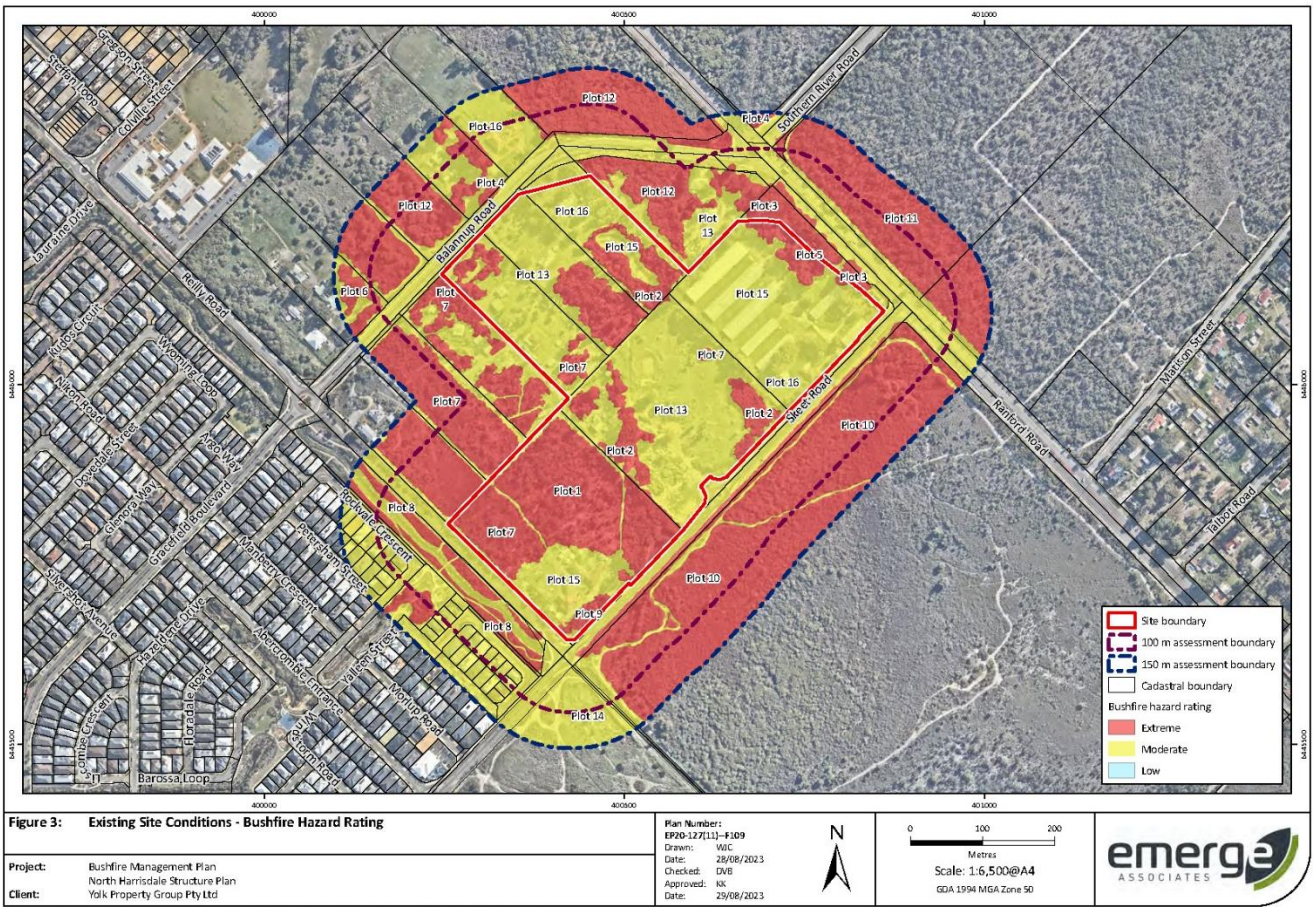
The findings of the BMP demonstrate that as development progresses, it will be possible for an acceptable solution to be adopted for each of the applicable bushfire protection criteria outlined in the Guidelines. This includes:

- ***Location:*** future development can be balanced with the conservation of ecological assets whilst achieving required measures within an area that will, on completion, be subject to a low or moderate bushfire hazard level, based on the removal or management of existing classified vegetation within the site.
- ***Siting and Design***: In the long-term, the main bushfire hazard to the site will be the existing remnant vegetation that is proposed to be retained within the identified wetlands (and any associated revegetation) and classified vegetation outside the site. The minimum setback distances can be used to inform future proposed development layout at structure planning and subsequent subdivision, particularly for areas adjacent to any future conservation

reserves. The proposed rezoning would not prevent existing or future development from achieving BAL-29 or lower.

- ***Vehicular Access:*** the site is located adjacent to Ranford Road to the north-east, Skeet Road to the south-east, Reilly Road to the south-west and Balannup Road north-west, which provides egress to the north, east south and west. Future detailed planning will need to ensure that an interconnected road network within the site connects to the existing broader road network.
- ***Water***: the development can be provided with a permanent and reticulated water supply to support onsite firefighting requirements.

The measures to be implemented through this structure plan and associated future subdivision processes have been outlined as part of this BMP and can be used to support future planning and development approval processes.



BMP – Bushfire Hazard Assessment Mapping

2.5 SURROUNDING ZONING AND LAND USES

As previously noted, the City of Armadale has considered the integrated planning of this area with the neighbouring residential area, with the site having been included in the Development Contribution Area (DCA) within the municipality.

Land to the south and west of the subject land has historically been developed for residential purposes, with the land having been zoned Urban Development and subsequential Residential by the provisions of TPS4. The subject area has been constrained due to an operating poultry farm on Lot 202 Skeet Road, and hence not been zoned Urban Development until recently.

Land to the east (adjacent to the subject land) is zoned Parks and Recreation Reserve and will be retained indefinitely as a bushland reserve.

2.6 ODOUR

The subject land is impacted by the existing Poultry Farm operation located on Lot 202 Skeet Road.

- Other than the current odour buffer which remains for the time being to protect the poultry farm as it winds down its operations and transitions to permanent closure, there are no identified hazard issues in relation to this land use.
- Removal of the poultry farm as detailed in Section 3.4 removes this issue and enables residential development and occupation of the subject land. This land use is also detailed in the local scheme amendment provisions for the subject land.

2.7 NOISE

Noise impact considerations (i.e. Ranford Road and nearby registered kennels) associated with the proposed residential development have been addressed through a specific noise impact assessment that forms part of the EAMS (**Appendix 2** and **Appendix 5**).

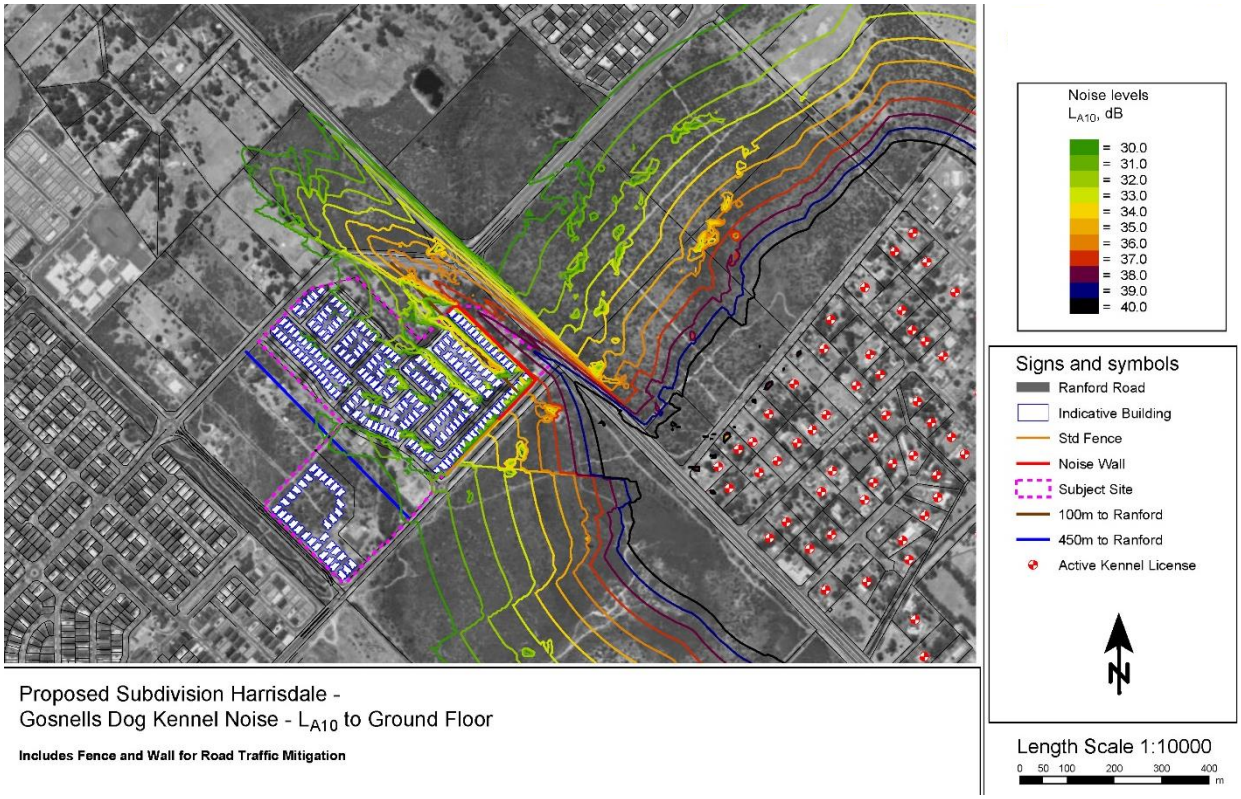
2.7.1 Kennel Zone

The site is located within the CoA's Kennel Buffer, as identified in Special Control Area Map 1 of TPS 4. The Kennel Buffer extends in a 500 m radius around designated kennel areas to allow for consideration of noise from barking dogs in relation to any proposed land uses within proximity to existing kennels.

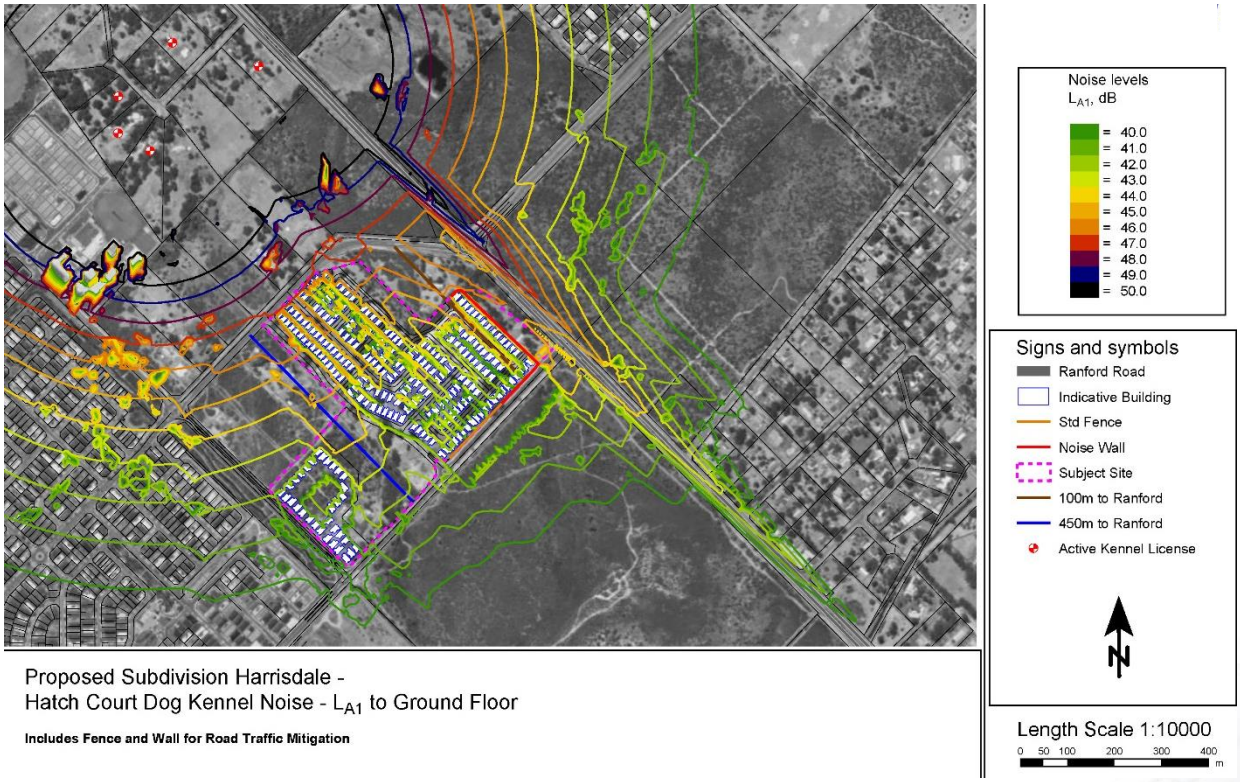
Within the City of Gosnells (located north of Ranford Road), there are also registered kennels located within a 500 m radius of the site (located towards the east). Due to the range and proximity of registered kennels as well as Ranford Road noise considerations, a noise impact assessment has been undertaken to address any noise impact considerations and mitigation requirements necessary.

The acoustic modelling and assessment undertaken by Lloyd George Acoustics identifies the impact that the kennel has on future residential dwellings and confirms that suitable mitigation measures can be undertaken to facilitate development.

Notification on titles will be placed on all future residential lots that are located within 500 m of a property with a current Kennel Licence (as currently occurs) unless a subsequent noise study at the structure planning phase determines an alternative buffer, or before the development of lots the Kennel Licence ceases to be current and the relevant kennel premises ceases operation.



Acoustic Modelling Gosnells Kennels – Lloyd George



Acoustic Modelling Hatch Court Kennels – Lloyd George



Kennel Acoustic Mitigation Measures – Lloyd George

2.7.2 Road & Rail Noise

Ranford Road is identified by State Planning Policy 5.4 – Road and Rail Noise as a 'strategic freight and/or major traffic route'.

The purpose of SPP 5.4 is to minimise the adverse impact of road and rail noise on noise-sensitive land use and/or development within the specified trigger distance of strategic freight and major traffic routes and other significant freight and traffic routes.

A Transportation Noise Assessment of Armadale Road adjacent to the Structure Plan area was conducted by Lloyd George Acoustics to inform a road traffic noise assessment of the Structure Plan area where it abuts Ranford Road.

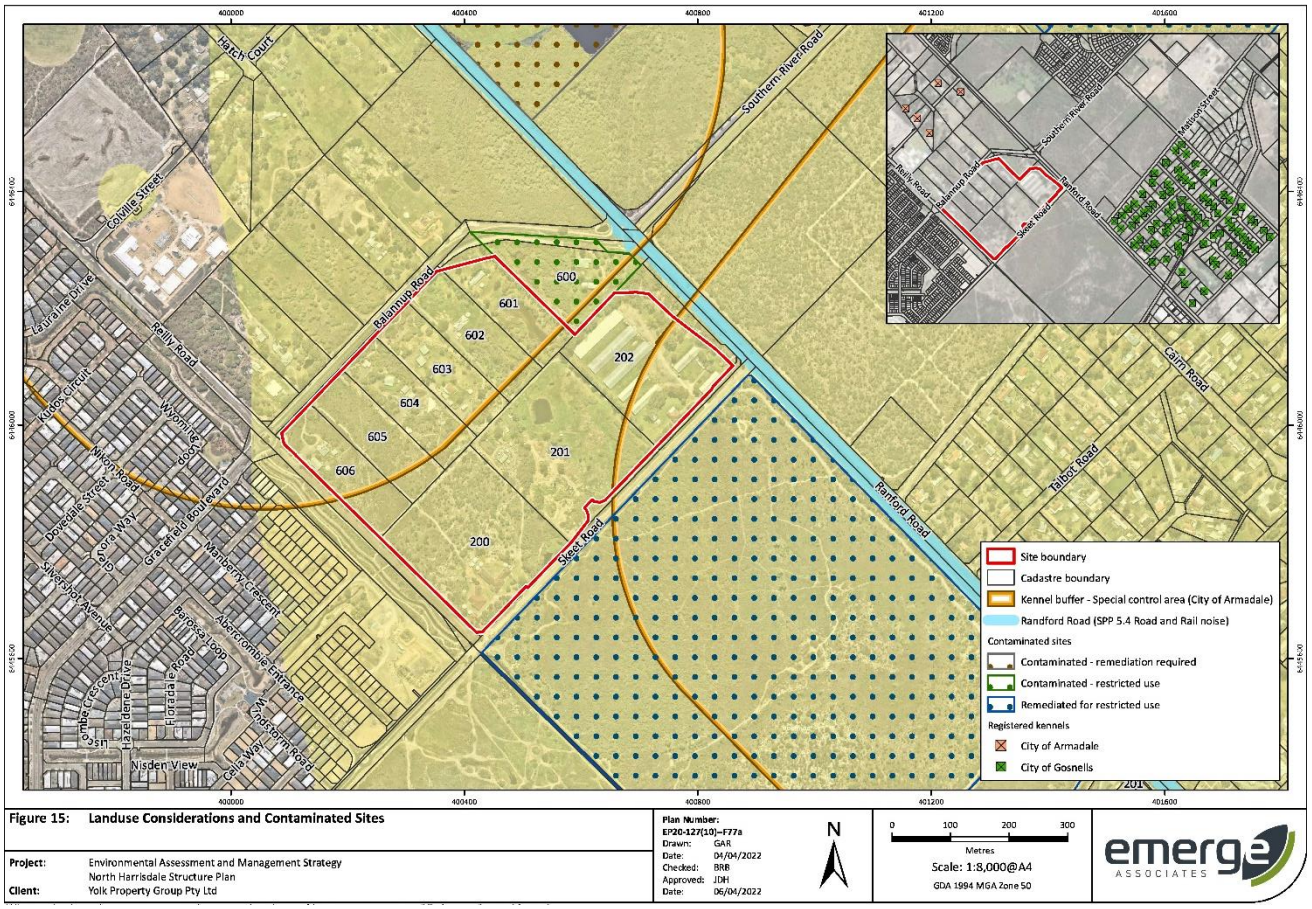
A copy of the Transportation Noise Assessment report is included in the EAMS (**Appendix 2** and **Appendix 5**).

The report indicates that it will be practicable for the proposed Structure Plan to satisfy the requirements of State Planning Policy (SPP) 5.7: Road and Rail Transport Noise and Freight Considerations in Land Use Planning. The recommended noise control requirements consist of:

- A noise wall of varying height (between 2 m to 2.4 m) is proposed to mitigate both the Ranford Road noise considerations and the registered kennel noise considerations.
- With the use of a noise wall, exposure levels will be significantly reduced with expected exposure levels predicted as follows:
- Quiet home architectural packages will therefore be required for a range of dwellings. Architectural packages ranging from 'Package A' to 'Package C' will be required for a range of dwellings towards the north-eastern portion of the site, and residential lots created within the site will be located within the affected area.
- Alternative treatment to the 'deemed to satisfy' provisions can be accepted if supported by a report by a suitably qualified acoustical engineer (member firm of the Association of Australasian Acoustical Consultants);

The noise mitigation requirements are to be finalised once the subdivision design is complete along with finished lot

levels and will be applied through conditions imposed on the affected homesites by way of a Local Development Plan.



EAMS – Surrounding Land Use Considerations

2.8 CONTAMINATED SITES

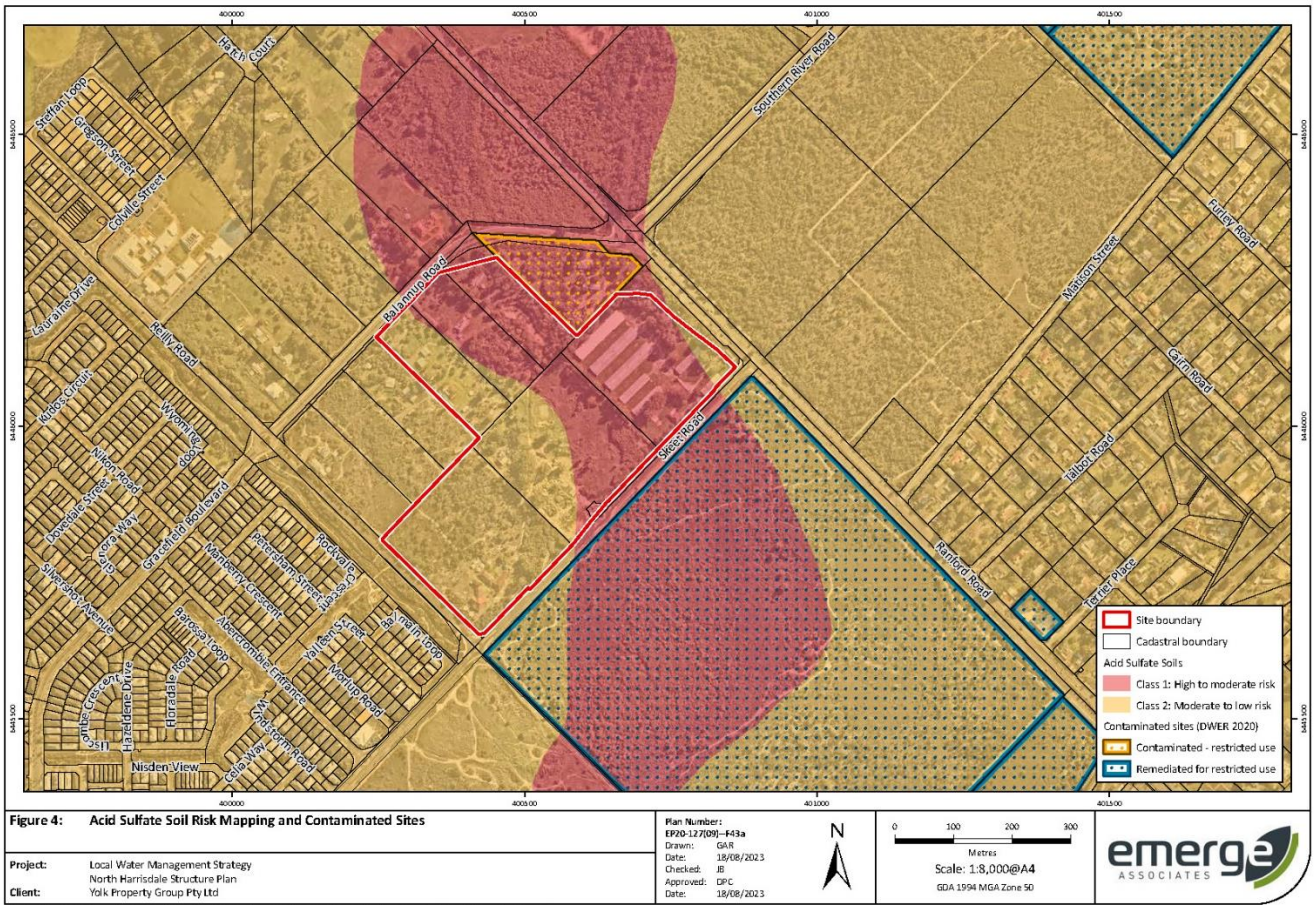
The majority of the lots that comprise the subject land (Lots 601, 602 and 603) have been used for rural residential purposes, which are not identified by the DWER as potentially contaminating land use. The exception to this is Lot 201, which has been used for non-residential purposes including a stockpile yard/stockpiling and storage of various materials, and Lot 202, which is a currently operational poultry farm.

Any likelihood of contamination risk is therefore limited to Lot 201 and Lot 202 however does not require a spatial or land-use response within the Structure Plan. Further investigations for Lot 201 and 202 should be undertaken as part of the subdivision process.

2.9 ACID SULFATE SOILS

Acid Sulphate Soil Mapping confirms a high-risk area covers part of the site. Ground disturbing works including dewatering will require the management of acid sulphate. This can be done via standard construction techniques.

Regional ASS risk mapping identifies the north/northeast portion of the site (associated with the soil units Sp1 and Sp2 (Peaty sand)) as having a 'high to moderate' risk of ASS occurring within 3 m of the natural soil surface (DWER 2021b). The remainder of the site is classified as having a 'Moderate to Low' risk of ASS occurring within 3 m of the natural soil surface.



Acid Sulfate Soil Mapping – DWER – 049

2.10 HISTORIC LAND USE

A review of historical aerial imagery (Landgate 2020) available from 1953 onwards shows the following:

- The site was uncleared in 1953 and the eastern half of the site was part of a large wetland.
- By 1961 several roads are present surrounding the site.
- By 1974 Lots 201 and 202 were cleared and a large body of water is present across these lots (see Plate 1). By 1977 Lot 200 was almost entirely cleared, except for the southeast corner.
- Between 1965 and 1989 various small-scale clearing events are visible across Lots 604-606 and Lot 601 is entirely cleared.
- Between 1987 and 1989 (see Plate 2) several buildings were constructed, including the poultry farm in Lot 202.
- By 1989 much of Lot 600 and half of Lot 602 was cleared.
- In 1991 a large fire scar was visible over the western portion of the site.
- Since 2008 most of the site has been subject to limited clearing, and areas of regrowth of native vegetation are visible, particularly in Lots 200 and 600.

2.11 UNEXPLODED ORDINANCE (UXO)

The subject land is not an area identified as having substantial, slight or other UXO potential.

2.12 ABORIGINAL HERITAGE

In accordance with the Aboriginal Heritage Due Diligence Guidelines (DAA 2013), a search of the AHIS online database (DAA 2021) was undertaken. The results of this search indicated that the site is not mapped within any identified Registered Aboriginal Heritage Sites or Other Heritage Places.

2.13 EUROPEAN HERITAGE

A desktop search of the Australian Heritage Database (DAWE 2021), the State Heritage Office database (Heritage Council 2021) and the City of Armadale Heritage List (City of Armadale 2008) has indicated there are no registered heritage sites located within the site.

2.14 BUSH FOREVER

No Bush Forever sites are present within the site. Bush Forever Site 413 (Balannup Lake and Adjacent Bushland, Southern River/Forestdale) is present to the north of the site. Bush Forever Site 342 (Anstey/Keane Dampland and Adjacent Bushland, Forestdale) is present to the southeast of the site.

3 LAND USE AND SUBDIVISION REQUIREMENTS

3.1 LAND USE

3.1.1 Design overview

The Structure Plan design has been developed having regard to the site-specific environmental assessment, detailed engineering investigation, local water management and fire planning requirements.

The Structure Plan has been prepared to guide the development of the 21.18 ha site for residential subdivision and associated commercial land uses. The Structure Plan will facilitate the development of a high-quality, liveable urban precinct offering a diversity of lot product, and hence housing choice, with access to the full range of urban services and facilities in the area.

The design is based upon the existing perimeter network of roads defining the precinct and access point and taking into account access required for the commercial area fronting Ranford Road, located in the northern portion of the Structure Plan area.

A concept subdivision plan has been prepared to demonstrate the potential yield of circa 280 dwellings for the subject land (**Appendix 7**).

Detailed structure planning has been informed by an integrated approach with inputs from specialist consultants to appropriately address planning, water management environmental and bushfire management objectives. Collectively, these factors have influenced the proposed road and lot layout, as depicted in the Structure Plan included as Plan 1 in **PART ONE** of this document

3.1.2 Integration with Adjoining Lots

The Structure Plan is bound by existing road reserves on all boundaries, with an existing road network in place.

With land to the south having already been zoned and developed for residential purposes, the proposed structure plan aligns with the development intent of the Harrisdale area.

With a Parks and Recreation Reserve to the north and east of the subject land, there is an existing road interface that provides a defined boundary. The precinct is essentially standalone, with its main road access being a recently constructed roundabout intersection on Skeet Road for residential development, with it planned that the road connection will be provided through to Balannup Road to the west.

Direct access to Skeet and Balannup Road for residential purposes will be limited/restricted, given the higher-order nature of the road.

3.2 PUBLIC OPEN SPACE

The Structure Plan proposes open space that retains wetlands identified within the subject land, and respects areas of remnant vegetation located throughout the site.

The open space has been derived from extensive site visits and analysis undertaken in conjunction with the Environmental Protection Authority (EPA) and the Department of Biodiversity Conservation and Attractions (DBCA). Areas were subject to detailed review during the lifting of urban deferment process to the Metropolitan Region Scheme which resulted in extensive areas of open space being identified throughout the subject land.

The Structure Plan provides predominantly for one(1) large area of open space in the southern/central area of the site. Two (2) additional areas of open space are provided and will form part of a larger open space network when neighbouring landholdings, which are not subject to this structure plan, are progressed in the planning framework in the future.

These open space areas serve different functions, though have resulted due to the requirements of the site (i.e., drainage etc.) and also environmental aspects that exist which the structure plan must reflect.

The third open space area has been proposed at the northeast corner of the site which accommodates a buffer associated with a mapped Resource Enhancement Wetland (REW) that is located on abutting Lot 600 (which does not form part of this structure plan).

Whilst there is a statutory requirement to provide 10% of the land area as open space, due to these aspects, 23% of the gross site area has been identified as 'green space' and is to be vested as open space in a combination of credited and uncredited areas.

The structure plan provides for 10 percent of the area as public open space in accordance with the WAPC policy requirements. The provision of public open space is to be provided generally in accordance with the structure plan map.

The design and location of Public Open Space with the Structure Plan area are reflective of the following requirements;

- Retention of one Conservation Category Wetland (CCW) and associated 50m buffers;
- Core or CCW's located on Lot 200;
- Acknowledgment of Resource Enhancement Wetlands (REW) on Lot 604 and associated buffer;
- Incorporation of 30m REW Buffer, with wetland core located on Lot 600 Balannup Road which abuts the subject land;
- Consolidation of drainage, vegetation, and wetland areas to maximise available areas for a range of uses and functions, as well as achieving improved efficiencies in terms of maintenance and management;
- Be compatible with local water management requirements and accommodate drainage integrated with landscaping to improve useability and amenity for residents;
- Retention of powerline corridor and associated easement (acknowledging existing ground-level requirements);
- Encourage maximum surveillance of POS areas to discourage opportunities for anti-social behaviour.

A total of 4.46 ha of green space is provided by the structure plan. This area is made up of a combination of various open space categories as detailed in the table below. It is acknowledged that there are several 'green areas' that are not credited as open space, though form part of the overall open space network.

		Credited Open Space		***Uncredited Open Space***			
POS	***Total***	***Restricted Wetland Buffer***	***Unconstrained Open Space***	***1:1 Drainage***	***Drainage 1:1-1:5***	***Wetland Core***	***Wetland Buffer***
1	*3.36*	*0.27*	*0.87*	*0.10*	** Within buffer area*	*0.69*	*1.51*
2	*0.20*	*0.02*	*0.06*	*0.01*	** Within buffer area*	*0.00*	*0.11*
3	*0.90*	*0.08*	*0.38*	*0.03*	** Within buffer area*		*0.44*
	4.46	***0.37***	***1.31***	***0.14***	***0.00***	***0.69***	***1.95***

** Areas in hectares (ha)*
** Areas taken from LWMS*
** Credited buffer and drainage area allocated on a pro-rata basis of 16%*
** 1:1 and 20% event drainage contained within buffer areas (refer LWMS)*



Landscape Masterplan

POS 1

POS 1 incorporates a Conservation Category Wetland (CCW) and the associated 50m buffer. There is also vegetation retention and drainage basins/storage within this central open space.

POS 2

POS 2 incorporates the buffer of the neighbouring Resource Enhancement Wetland (REW), which has been identified by DWER and the wetland mapping, and also site investigations undertaken by DWER and the EPA. A reduced buffer on the eastern boundary of the REW has been applied due to existing clearing and quality of remanent vegetation on Lot 603.

POS 3

POS 3 incorporates a 30m buffer attributed to the Resource Enhancement Wetland located in Lot 600 which abuts the subject land. These will be rehabilitated in accordance with a Wetland Management Plan that will be prepared as a condition of subdivision.

The retention of the wetlands, buffers and remanent vegetation is reflected in the concept landscape plan for the subject site, as per the included masterplan (**Appendix 8**).

Table 3: Land Use Table (all areas in ha)

Developable Area			
Lots	**200**	5.31	
	201	5.17	
	202	4.82	
	601	1.91	
	602	1.98	
	603	1.98	
	Total		***21.17***
Deductions	1:1 Year Drainage (1.5% of GLA)	0.14	
	Easement	0.05	
	Non-Credited CCW/REW Buffer	1.95	
	Non-Credited CCW/REW Core	0.69	
	Road Widening / Non-Urban	0.75	
	Commercial	0.80	
	Total Deductions		***4.38***
Gross Subdivisible Area (GSA):			**16.79**

Public Open Space Requirement			
	10% of Gross Subdivisible Area		1.68
	80% Unrestricted		1.30
	20% Restricted		0.37
Open Space Provided			
	Unrestricted	**8%**	**1.31**
	POS 1		0.87
	POS 2		0.06
	POS 3		0.38
	Restricted	**2%**	**0.37**
	POS 1 Wetland Buffer / 1:2-1:5 Drainage		**0.27**
	POS 2 Wetland Buffer / 1:2-1:5 Drainage		**0.02**
	POS 3 Wetland Buffer / 1:2-1:5 Drainage		**0.08**
	Total	**10%**	**1.68**
	*** Surplus / Shortfall**		**0.00**
	*** Area may be reduced at the time of detailed design**		

Notes

1. *In accordance with Liveable Neighbourhoods: the area subject to inundation more frequently than a one-year average recurrence interval rainfall event is not included as restricted or unrestricted open space and is a deduction from the net site area (LN R33); areas for the detention of stormwater for a greater than one-year average recurrence interval up to the five-year recurrence interval is restricted open space; areas for the detention of stormwater for a greater than five-year average recurrence interval is within unrestricted open space (LN R25)*

2. *Buffer to Category Conservation Wetland has been taken as forming restricted open space in accordance with Liveable Neighbourhoods (LN R33)*

As detailed in the above and following table an area of 1.68 ha of creditable Public Open Space has been provided, some of which also serves a drainage function as detailed in the LWMS (including Engineering Plans) prepared to support the Structure Plan. The POS Schedule and Calculations in Table 2 illustrate the subject land is required to provide 1.63 ha of land for public open space, in accordance with the 10% site contribution required by Liveable Neighbourhoods.

The drainage swale areas are included as restricted open space and have been calculated from the 1 in 5 yr Top of Water (ToW) level area but exclude the 1:1-year ToW for all proposed swales. These drainage areas are within the buffer areas of the identified wetlands and hence have been grouped together and classified as restricted open space.

The drainage areas are detailed in the Local Water Management Strategy (LWMS) at **Appendix 6**. And have informed the Landscape Concept Plans in **Appendix 5**.

Table 4: Greenspace Provision

Summary of Public Open Space (Revised Gross Subdivisible Area)			
Green Space Required (POS + Drainage)	**Uncredited**		**2.78**
	Drainage 1:1	0.14	** Outside buffer area*
	Drainage 1:1-1:5	0.00	** Within buffer area*
	CCW Core	0.69	
	CCW Buffer in excess of credited restricted POS	1.84	
	REW Buffer in excess of credited restricted POS	0.11	
	Restricted POS		**0.37**
	Credited Drainage 1:1 – 1:5 (Restricted POS) *	0.00	** Within buffer area*
	CCW Buffer	0.35	
	REW Buffer	0.02	
	Unrestricted POS		**1.31**
	Unrestricted POS	1.31	
	**Vegetation retention has been included as unconstrained given the nature of the site/structure plan.*		
**23% of Gross Site Area (excluding commercial)*			**4.46**

** Areas in hectares (ha)*

Table 5: Apportionment of POS between landholdings

	Other	***Buffer***	***Core***	***Total***
POS 1				***3.36***
200	*0.69*	*0.96*	*0.65*	*2.30*
201	*0.28*	*0.74*	*0.04*	*1.06*
POS 2				***0.20***
603	*0.07*	*0.13*		*0.2*
POS 3				***0.90***
202	*0.07*	*0.05*		*0.12*
601	*0.33*	*0.45*		*0.78*
Total	***1.44***	***2.33***	***0.69***	***4.46***

** Areas in hectares (ha)*

** Credited buffer and drainage area allocated on a pro-rata basis of 16%*

** 20% event drainage contained within wetland buffer areas (refer LWMS)*

3.3 LANDSCAPE CONCEPT

An indicative Landscape Concept prepared by landscape architects Emerge in **Appendix** 8 demonstrates a proposed landscape outcome that respects the natural attributes of the site and its surrounds while delivering a quality urban outcome.

The structure plan provides a minimum of 10 percent of the area as public open space in accordance with the WAPC policy requirements. The provision of public open space is to be provided generally in accordance with the structure plan map.

The LSP provides for a well-connected open space network that will provide the local community with safe parklands, supporting various open space functions whilst facilitating significant environmental outcomes through the retention and protection of existing conservation category wetlands (CCW). The landscape master plan for the proposal includes the retention of existing vegetation and the revegetation of buffers for the CCW as well as the resource enhancement wetland (REW) to the north of the site.



Landscape Masterplan

3.3.1 POS Central

This POS is located centrally within the proposed development providing a concentrated suite of amenities and POS functions accessible to the wider community. It incorporates the CCW to the south adjacent to Skeet Road.

- POS 1 – 3.36ha
- Informal active recreation uses on open grassed areas
- Gathering nodes with picnic / BBQ facilities
- Playground associated with picnic and BBQ facilities
- Stormwater retention and conveyance through a vegetated and stabilized swale
- Retention and protection of CCW and revegetation of associated buffer
- Retention of existing significant trees and vegetation where possible
- Path network which links into the greater development
- Manicured landscape areas fully irrigated outside buffer areas
- All areas outside of wetland, vegetated wetland buffer areas and bioretention areas are to be “low threat vegetation” in accordance with AS3959:2018.

This POS is located centrally within the proposed development providing a concentrated suite of amenity and POS function accessible to the wider community. It incorporates the CCW to the south adjacent Skeet Road.

- Informal active recreation uses on open grassed areas
- Gathering nodes with picnic and shelter facilities
- Opportunity for informal walking trails through controlled access points through the POS. Location and alignment of trails to avoid disturbance of areas of significant vegetation.
- Stormwater retention and conveyance through a vegetated and stabilized swale
- Retention and protection of CCW and revegetation of associated buffer
- Retention of existing Banksia Woodland areas
- Opportunity for nature play nodes to existing areas of clearing
- Path network which links into the greater development
- Manicured landscape areas fully irrigated outside buffer and retained vegetation areas
- All areas outside of wetland, vegetated wetland buffer area and bioretention areas to be “low threat vegetation” in accordance with AS3959:2018.











3.3.2 POS West

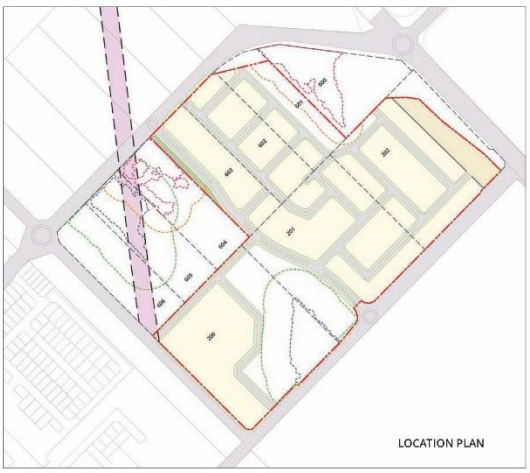
This POS is located within the western corner of the proposed structure plan and will perform a buffer to the abutting wetlands located in Lots 604 and 605. Whilst this area is small in area, it is acknowledged that it will serve the function of open space and drainage, and hence needs to be included in the land use strategy for the structure plan.

The open space area accommodated the reduced buffer area of the REW that abuts the western boundary of Lot 604.

- POS 2 – 0.20ha
- Vegetation retention and revegetation of associated buffer to REW
- Opportunity for informal walking trails through controlled access points through the POS. Location and alignment of trails to avoid disturbance of areas of significant vegetation
- Path network which links into the greater development Retention of existing significant trees and vegetation where possible
- Opportunity for education of the site and its environmental assets through signage or other means along walking trails
- The majority of this POS will be classified as vegetation and therefore a bushfire hazard in accordance with AS3959:2018

This POS is located within the western corner of the proposed LSP along the central entry road off Balannup Road . It includes the REW buffer to the west of the site.

- Vegetation retention and revegetation of associated buffer to REW
- Opportunity for informal walking trails through controlled access points through the POS. Location and alignment of trails to avoid disturbace of areas of significant vegetation
- Path network which links into the greater development Retention of existing significant trees and vegetation where possible
- Opportunity for education of the site and its environmental assets through signage or other means along walking trails
- Majority of this POS will be classified vegetation and therefore a bushfire hazard in accordance with AS3959:2018











3.3.3 POS East

This POS is located in the northeast corner of the site. It provides for a revegetated buffer to the REW to the north of the site. It is linear in shape and will provide a north-south greenspace connection through the development.

- POS 3 – 0.90ha
- Gathering nodes with seating along the footpath network
- Stormwater retention and conveyance through a vegetated and stabilised swale
- Vegetation retention and revegetation of associated buffer to REW
- Retention of existing significant trees and vegetation where possible
- Path network which links into the greater development
- Manicured landscape areas fully irrigated outside buffer areas
- All areas outside of the wetland, vegetated wetland buffer and bio-retention areas are to be "low-threat vegetation" in accordance with AS3959:2018

This POS is located in the north east corner of the site. It provides for a revegetated buffer to the REW to the north of the site. It is linear in shape and will provide a north-south greenspace connection through the development.

- Gathering nodes with seating along footpath network
- Stormwater retention and conveyance through a vegetated and stabilised swale
- Vegetation retention and revegetation of associated buffer to REW
- Retention of existing significant trees and vegetation where possible
- Path network which links into the greater development
- Manicured landscape areas fully irrigated outside buffer areas
- All areas outside of the wetland, vegetated wetland buffer and bio retention areas to be " loe threat vegetation" in accordance with AS3959:2018








3.3.4 Stormwater Strategy

All stormwater from the development will be directed into bio-retention treatment areas constructed along the edges of the POS. These will be sized to treat the flows from the small rainfall event in accordance with the principles of water-sensitive urban design. Storm events in excess of these will be directed into flood storage areas typically located within CCW and REW buffer areas. Flood storage areas will be revegetated with native species. Bio-retention areas will be located outside of CCW and REW buffer areas.

3.3.5 Streetscape

The streetscape planting strategy design will be translated through different palettes of street trees providing legibility through the development.

Tree species selected are Waterwise, fast-growing, reliable and readily available whilst providing shade and amenity to each street. The proposed species below offer consistencies in appearance with differences in size and scale. Larger, taller trees are shown around POS areas and along north-south roads as the major connector roads through the development. Smaller trees are shown on east-west roads as minor local roads.

3.4 RESIDENTIAL

3.4.1 Land Use and Residential Density

The Structure Plan reflects the intended use of the subject land for primarily residential purposes and land uses permissible within the associated zone. Whilst the residential zoning will permit primarily single and grouped housing development, the development of an aged care facility/strata-grouped housing is also contemplated for Lot 200, which would be undertaken as a strata development.

The proposed residential density is consistent with the strategic direction of the WAPC's Sub-Regional Planning Frameworks which promote higher densities in undeveloped areas zoned for urban use, particularly in areas close to transit corridors and high amenity. The Sub-Regional Planning Frameworks encourage new urban development to use an average residential density target of 15 dwellings per gross hectare of urban-zoned land and 26 dwellings per residential site hectare to guide the allocation of residential densities.

Given the location of the subject land to education facilities and playing fields in the immediate locality, development is proposed at an underlying density code of R25, with R30 over the large, grouped housing site in the southern corner. The base coding of R25 will facilitate the creation of a range of lot product, which will also address the affordability aspect of residential development, with a range of family dwellings able to accommodate sufficient open space on the smaller lot product, without compromising the house design.

The proposed densities achieve an appropriate residential density of 26.7 dwellings per net site hectare (as defined by Urban Growth Monitor). Based on 2016 ABS statistics and an expected dwelling yield of 280 dwellings, the estimated population of the Structure Plan area is 728 persons at 2.6 persons per dwelling.

3.4.2 Residential Lot Layout

The road network has been designed to facilitate the creation of regular shaped lots, capable of accommodating standard residential dwellings, with direct access to a public street. A suitable mix of lot types is able to be accommodated by the structure plan, including a standard 20m, 25m and 30m lot product. To demonstrate the potential subdivision pattern, refer to the preliminary Subdivision Concept in **Appendix 7**.



Concept Subdivision Layout

Orientation towards all areas of open space has been maximised, allowing for passive surveillance of these areas. All POS areas within the Structure Plan area shall be provided with passive surveillance from surrounding lots, and in turn aims to promote the use of these areas by residents.

3.4.3 Residential Lot Size

The Structure Plan proposes a road network that results in the creation of standard street blocks that are robust and adaptable to accommodate a variety of lot sizes. Density coding of R25 and R30 is proposed, which can accommodate standard lot depths ranging from 20m – 30m. Standard R25 coded lots would be 300-350m^2 in area, with standard R30 lots being 200-240m^2 in area.

3.5 MOVEMENT NETWORKS

3.5.1 Existing Movement Network

A Transport Impact Assessment (TIA) prepared by transport professionals Porters in **Appendix 10** has investigated movement networks around the subject land and has forecast future transport impacts from the development and occupancy of the Structure Plan area.

3.5.1.1 Regional Road Network

The subject land is well connected to the Metropolitan and wider regional road network, given its proximity to Ranford Road, with its connections to the Tonkin Highway and the Kwinana Freeway. The regional road network provides efficient access to the wider Perth Metropolitan Region including commercial and employment centres, notably Armadale to the east and Cockburn Central to the west.

Ranford Road is designated as an Other Regional Road under the Metropolitan Region Scheme (MRS)

3.5.1.2 Local Road Network

The subject land has direct frontage to Skeet Road, Balannup Road and Reilly Road.

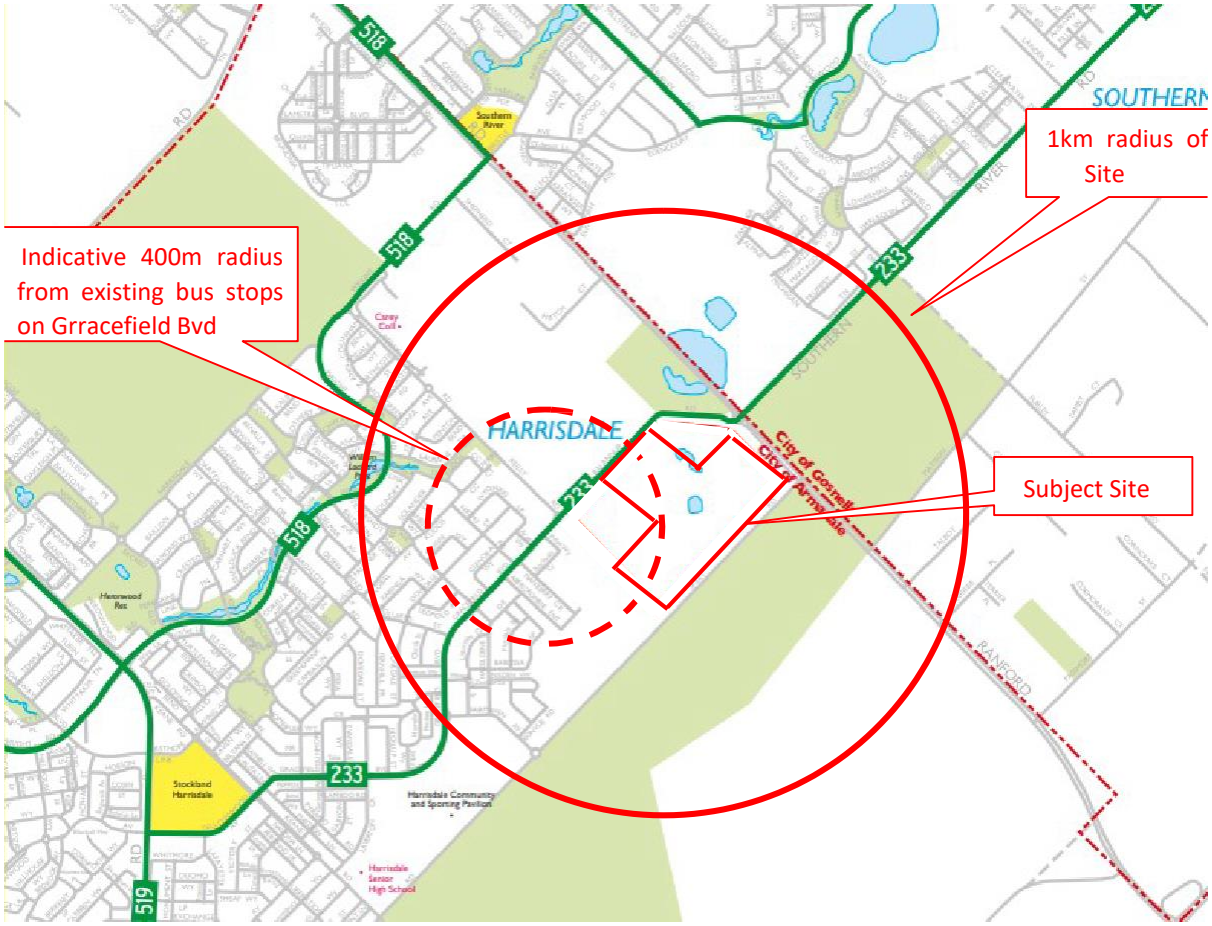
3.5.1.3 Public Transport Network

Route 233 is currently the closest service for the development. Public Transport Authority (PTA) has advised that this service is likely to be the only option until the local area expands and demand increases.

Route 233 operates between Gosnells Station and Cockburn Central Station via Balannup Rd/ Gracefield Bvd. This service commenced at the beginning of 2021 with a service every 15 minutes in the peak and every 60 minutes at all other times and operates 7 days a week.

The nearest operational stops for Route 233 are Stops 28333 / 28335 on Gracefield Bvd. Only a portion of the Structure Plan falls within a 400m radius of these stops with the majority of this being Public Open Space. PTA has indicated that new additional stops could be considered with the development of the Structure Plan.

In the longer term, PTA advises the future Route 260 is planned to operate along Ranford Rd along the northeastern boundary of the site. This route would operate between Armadale Station and Murdoch Station via the future Ranford Station.



Existing Public Transport Routes Surrounding the Site (PTA Network Maps)

3.5.1.4 Cycle & Cycle Network

The recently constructed Skeet Road includes a 2.5m path on the same side as in the Structure Plan whilst on Balannup Road a path is provided on the opposite side to the Structure Plan. Appropriate path links and crossing facilities should be included within the detailed design to allow pedestrians and cyclists to access this existing path network.

On-road cycle lanes are provided along both Skeet Road and Balannup Road.

3.5.2 Proposed Movement Network

The Site does not currently have any existing roads located within it. The Site abuts Ranford Road to the northeast, Balannup Road to the northwest, Skeet Road to the southeast and an unconstructed road reserve for Reilly Road to the southwest.

Four new road network connections from the Structure Plan are proposed as follows:

- Balannup Road, – new T-junction, full movements, roundabout;
- Balannup Road – new T-junction, left in and left out only;
- Skeet Road, – new T-junction, full movements, roundabout;
- Skeet Road – new T-junction, left in left out; and
- Reiley Road (yet to be constructed) – new T-junction, left in and left out only.

All roads within the new internal road network would be designated as local access roads (i.e. <3,000 vehicles per day). The main northwest-southeast spine road connecting Balannup Road (to the northwest) and Skeet Road (to the southeast) both under roundabout control will facilitate full vehicular movements onto the existing external road network. This main northwest-southeast spine road will carry the highest volume of traffic (1,300 vehicles per day) with each internal access road progressively carrying less as traffic is distributed along the internal network.

The road reserve widths for the new internal road network are proposed to range from 13m to 20m as shown in Figure 4.2 of the TIA. The widths adhere to those documented within the Liveable Neighbourhoods (WAPC, 2009) which outline a range of acceptable road reserve widths for various categories of access roads.

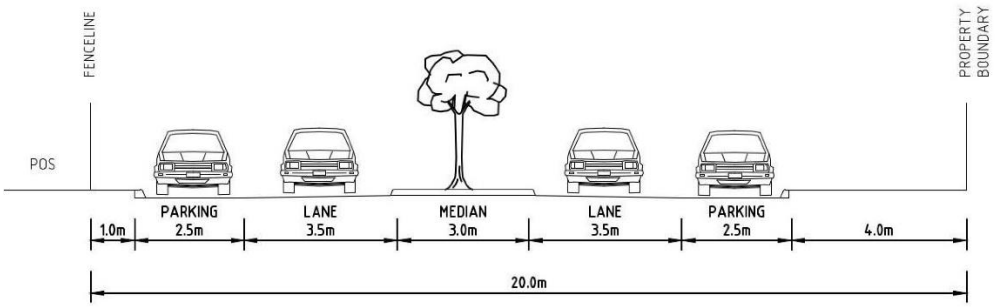


Proposed Road Classification – Liveable Neighbourhoods (TIA)

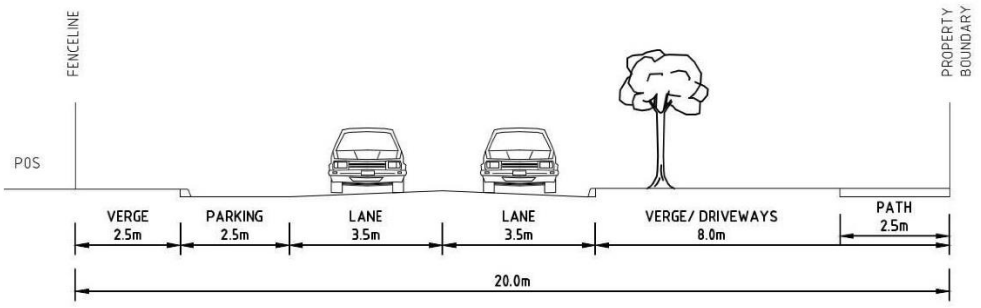
All new internal roads are considered to be defined as "access roads". Road cross-sectional elements that need to be provided on this category of road include:

- 5.5-7.2m wide pavement with respect to the category of access road i.e. the lower the traffic volumes the narrower the pavement width may be;
- on-street parking embayments to be installed adjacent to POS areas where there is likely to be a parking demand (i.e. near active spaces, playground);
- path provided on at least one side of the road; and
- sufficient verge width for the provision of utility services and infrastructure.

The cross sections as derived from Liveable Neighbourhoods are contained within the TIA included as Appendix 10, with the cross-section of the higher function Access Road (20m) being shown on the next page.



Indicative Cross Section: Access Street A, Avenue, <3,000 vpd, Skeet Road to first access road.



Indicative Cross Section: Modified Access Street parking embayments on one side only, <3,000 vpd, Balannup Road to last side road before Skeet Road

Local Access Road Connection Skeet and Balannup Roads – TIA/Liveable Neighbourhoods.

The 20m road reserve is envisaged to provide on-street parking adjacent to the POS and rear access properties between Skeet Road and the first internal side road as shown in Figure 4.3. On-road cycle lanes are not envisaged with traffic volumes estimated to be less than 3,000 vpd. Where on-street parking is not provided on both sides of the road it is envisaged that the cross-section will revert to a single carriageway as shown in Figure 4.4 of the TIA with parking embayments provided adjacent to the POS only. The 20m reserve width creates the opportunity for occasional traffic islands for traffic calming and/or landscaping subject to detailed design.

All other internal roads (other than the main spine road) have a road reserve width of 15m or 13m where abutting POS as shown in Figure 4.2 of the TIA. The widths adhere to those documented within the Liveable Neighbourhoods (WAPC, 2009) which outline a range of acceptable road reserve widths for various categories of access roads.

3.5.3 Traffic Generation

Detailed traffic modelling and SIDRA analysis have been undertaken and are detailed within the TIA (**Appendix 10**).

The Structure Plan makes provision for 280 residential dwellings. A small parcel of land abutting Ranford Road is proposed to be developed as a local centre commercial zone. For the Structure Plan, the indicative land uses are assumed to be general low-use commercial such as showrooms.

Adopting trip generation rates detailed in Table 6.1 of the TIA, the proposed local Structure Plan will generate in the order of 3,320 vehicle trips per weekday with approximately 258 and 346 vehicle trips during the am and pm peak hours respectively as summarised in Table 6.2 of the TIA.

Residential Lots

The residential trips will typically comprise various trip purposes including work, education, shopping and recreational/social. Therefore the traffic distribution patterns consider the following:

- workforce catchment area (based on data for the existing City of Armadale workforce),
- surrounding educational facilities (i.e. North Harrisdale Primary School, Harrisdale Senior High School, Carey Baptist College),
- shopping centres (i.e. Stockland Harrisdale Shopping Centre, Southern River Shopping Centre),
- recreational/social facilities (i.e. Harrisdale Community Oval, Sutherlands Park).

The resulting trip distribution patterns have subsequently been estimated to be as follows:

- Ranford Road (north) 35%
- Ranford Road (south) 35%
- Southern River Road (east) 10%
- Skeet Road (west) 10%
- Balannup Road (west) 10%

The peak hour traffic distribution for residential trips is typically split 20% inbound and 80% outbound during the am peak hour with the reverse during the pm peak hour which is reflective of the dominant arrival and departure patterns of residents travelling to/from work.

The City of Armadale traffic model indicates that traffic volumes may potentially increase to 7,000 vehicles per day in 2031 on Balannup Road, west of Reilly Road. At present traffic volumes are in the order of 5,700 vehicles per day (Aug 2020). These traffic volumes are likely to decrease in the short term with the re-opening of Skeet Road at Ranford Road before they start to gradually increase again with development-generated traffic growth.

Lots bounding Skeet Road do not require direct road access as the internal lot layout includes frontage to an internal road.

Commercial Zone

A small commercial zone (8,000m2) is proposed within the Structure Plan on the corner of Skeet Road and Ranford Road. Access to this lot is proposed via the following:

- Left turn ingress only from Ranford Road
- Left egress to Skeet Road.

The commercial trips (indicatively a showroom) are typically split 70% inbound and 30% outbound during the am peak hour with 48% inbound/52% outbound during the pm peak hour.

Ranford Road is currently signposted at 80km/h. Recommendations within the Ranford Road Reservation Study include the reduction of the speed limit to either 70km/h or 60km/h. It is acknowledged that any speed reduction is not imminent and therefore at this stage access arrangement on Ranford Road should be based on a design speed of 80km/h.

The existing distance along Ranford Road between Skeet Road and Balannup Road/Southern River Road is in the order of 270m and is adequate length to provide a dedicated left-turn deceleration lane from Ranford Road into the proposed commercial zone.

A left turn-only ingress/egress is proposed at 50m-60m along Skeet Road from Ranford Road. Whilst this is the preferred option from Ranford Road and a left out from Skeet Road, this will require further investigation at the detailed design stage and development application stage.

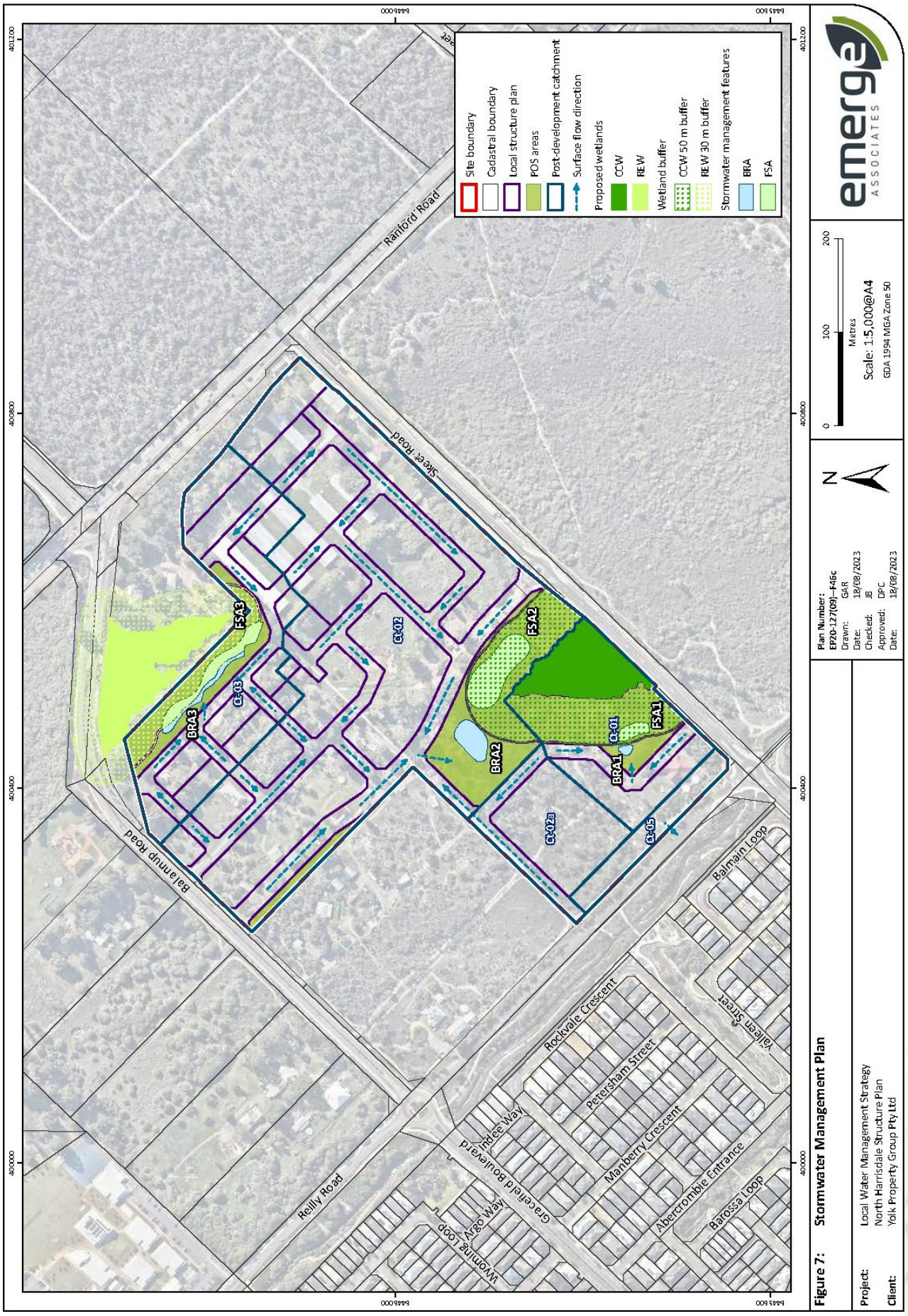
3.6 WATER MANAGEMENT

The WAPC's Better Urban Water Management (BUWM) document identifies the requirement to prepare a Local Water Management Plan (LWMS) to support Structure Plan proposals. The LWMS for this Structure Plan has been prepared by Emerge Associates in accordance with the requirements of the BUWM and reflects the District Urban Water Management Strategy (DWMS) that has been approved for the wider area.

The complete LWMS is included in **Appendix 9**.

The drainage areas identified in the LWMS reflect the open space areas and road network that are proposed by the Structure Plan.

Implementation of the LWMS will be facilitated by an Urban Water Management Plan (UWMP), which will be required through a WAPC condition of subdivision.



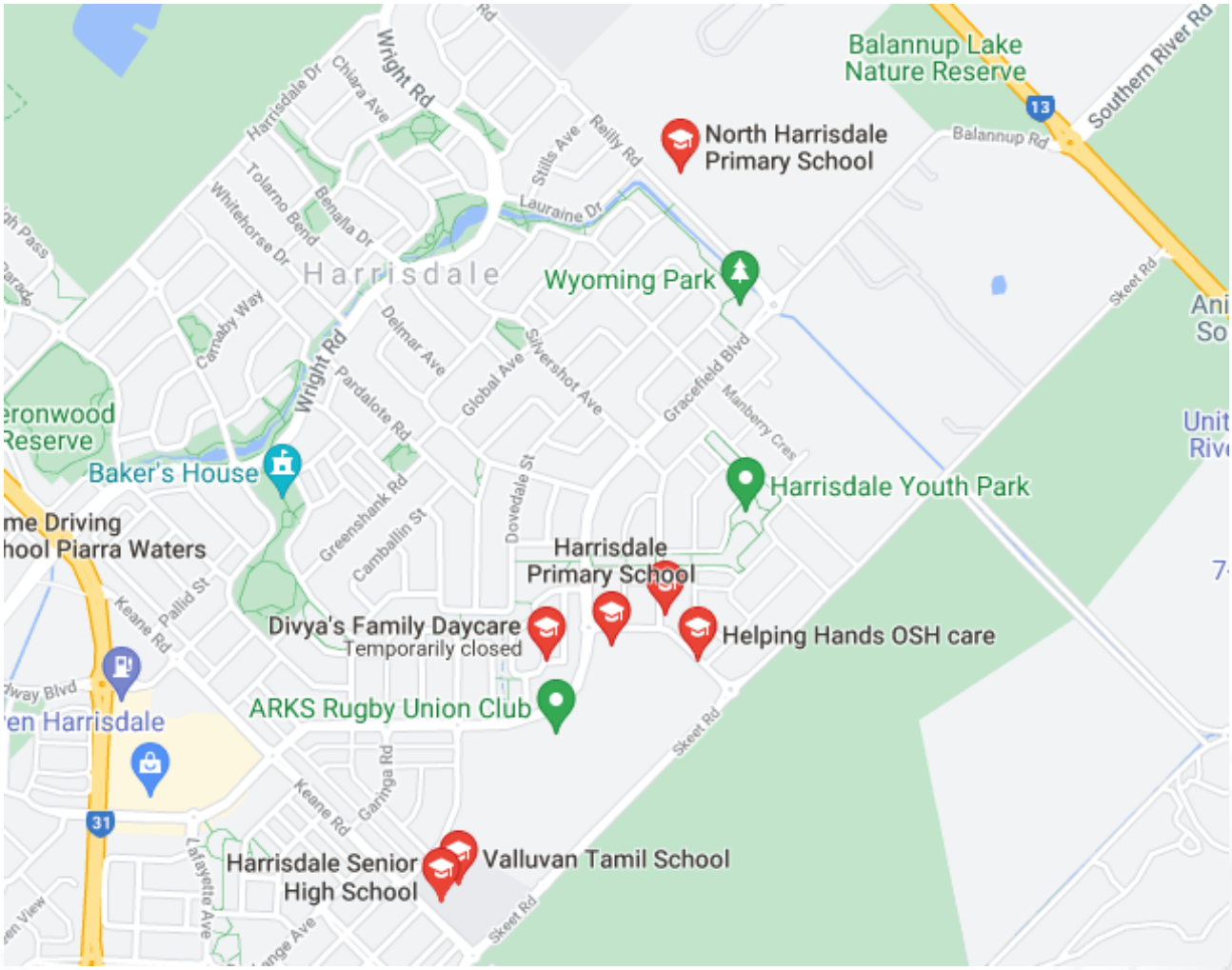
Water Strategy and Catchments

3.7 EDUCATION FACILITIES

The subject land is located within an area comprising a range of established school sites, public utilities, and community facilities. Schools located within 2.0 km of the subject land include:

- Bletchley Park Primary School
- Harrisdale Primary School
- Carey Baptist College
- North Harrisdale Primary School
- Harrisdale Primary School
- Harrisdale Senior High School

There are numerous areas of public open space, playing fields and reserved land within close proximity to the subject land. The established range of schools, public utilities and community facilities are considered to be adequate with no additional facilities required within the subject land.



Local School Locations

3.8 ACTIVITY CENTRES AND EMPLOYMENT

The Harrisdale Shopping Centre is located 2.2km south of the subject land, with the employment centre of Southern River which includes commercial and light industrial land uses being 1.4km north on Ranford Road. Several schools are also located in the immediate locality of the subject land.

An economic analysis of the subject land has been undertaken by Urbis (economics) and is attached as **Appendix 11**.

The Structure Plan proposes a commercial area along the Ranford Road frontage to take advantage of the high traffic volumes and passing traffic. In order to ensure demand, an analysis has been undertaken based on an 8000sqm site, and its suitability in the context of the Council's activity centre policy.

The key findings of the report are summarised below;

- **High Exposure / Visibility**: This corner site is located on Skeet Road and Ranford Road which currently experiences more than 29,000 daily vehicle movements. Exposure is expected to increase as the wider urban area develops.
- **Ease of Accessibility**: With the proposed left-in-left-out access at Ranford Road and left-in on Skeet Road, the site will be easily accessible. These roads are major connections to existing and planned residential areas as well as other key arterial roads including Nicholson Road and Southern River Road.
- **Large and Growing Catchment**: The surrounding area has an established population of 30,800 residents (2016). Urban development around the area will see an increase in the population to approximately 74,000 residents (2036).
- **Lot Attributes**: The site supports suitable floorplates and flexible configuration that can accommodate a range of commercial uses.
- **Community Benefit**: The 8,000 sqm scale supports a local provision of road-based uses which complements the activity centre hierarchy.

Overall, the site is well-positioned to help meet a need for commercial uses and can complement other activity centres and industrial/light commercial areas within the broader area.

3.9 INFRASTRUCTURE COORDINATION, SERVICING AND STAGING

An Engineering Servicing Report prepared by Porter Consulting Engineer is included in **Appendix 12**.

This report has been based on the civil engineering aspects of the primarily residential land uses. The report covers the engineering infrastructure requirements to service the proposed development. The engineering review has covered earthworks, roads, stormwater drainage and utility services with a particular emphasis on outlining how all major utility services will be available once the structure planning of the landholding has been completed.

The investigations and preparation of the report are largely based on preliminary advice from the various service authorities. The information is current as of July 2021 and is subject to change as development proceeds in the Perth southeast corridor. The key findings are as follows:

3.9.1 Groundwater

The site is characterised by high groundwater levels which will require a combination of subsoil drainage and fill in order to achieve adequate separation between finished lot levels and groundwater.

The Perth Groundwater Atlas confirms the groundwater level is typically shallow and flows from the north down to the south. Emerge has completed the LWMS, refer to this document for the maximum groundwater level contours. The maximum groundwater level for this site is 22.7m.

The site will require filling and is likely to require subsoil drains to achieve minimum groundwater separation.

It is expected dewatering will be required during elements of the construction development and will be at its most critical point during the winter months. Dewatering will have a temporary drawdown effect on the local groundwater, and at certain locations will present a risk of exposing Acid Sulphate Soils (ASS). This will need to be considered and managed concurrently with any ASS requirements for the site.

All dewatering must be carried out in accordance with Department of Parks and Wildlife (DPaW) and DoW regulations. It is currently envisaged that dewatering will be limited to deep service trenches given the expectation of imported fill across the site based on the current earthworks concept.

3.9.2 Geological Conditions

A detailed geotechnical investigation is being completed by Galt Geotechnical at the time of writing this report. Advice from Galt confirms approximately 200mm of topsoil was found over clean sand. Clay was found at a depth (+1.5m) however this will have no impact on the development. It is expected the topsoil will be stripped, screened, blended and then used as structural fill.

Uncontrolled fill was found across parts of the site however Galt indicated this can be used as structural fill at depth with only a small portion (5%) requiring disposal off-site.

The existing ground surface generally consists of grass cover with minimal topsoil (0.1m). The Armadale Geology Sheet indicates that the site is underlain by a white to pale grey Sand forming part of the Bassendean Sand geological unit over alluvial Silty Sand (Guildford Formation). The site is classified as a Class A site, in accordance with AS 2870 – 2011. It is recommended that a preliminary design Californian Bearing Ratio (CBR) of 10% is applicable.

3.9.3 Acid Sulphate Soils.

Acid Sulphate Soil mapping compiled by the Department of Environment and Conservation indicates that the development site has a combination of low to moderate & moderate to high risk of ASS occurring within 3m of the natural soil surface.

The majority of the site is classified as “moderate to low” risk occurring within 3m of the surface.

Given there will be some fill importation proposed for the site it is expected ASS management will only be restricted to deep service excavations greater than 2m depth i.e., sewer and drainage services. These works may require the treatment of both soils and water associated with dewatering.

3.9.4 Demolition & Clearing

All scattered vegetation, with the exception of those marked for retention, will need to be removed prior to undertaking earthworks on the site.

Any scrap material or rubbish located on the site will need to be removed and disposed of at an approved tipping location prior to work on site. Asbestos Containing Material (ACM) will require removal in accordance with applicable standards or a Remediation and Validation Plan (RVP) and disposed of at licensed facilities.

As part of the Development works, existing asbestos dwellings or sheds will need to be removed and disposed of offsite in accordance with applicable standards and disposed of at licensed facilities. In particular, ACM shall be removed by a licensed asbestos contractor in accordance with the Health (Asbestos) Regulations 1992.

3.9.5 Earthworks and Retaining Walls

Based on preliminary geotechnical and hydrogeological advice for the site, it is expected structural fill will be required as typical with development in this area. The filling criteria include:

- 1% AEP flood separation,
- site classification requirements,
- separation to groundwater, and
- sewer servicing requirements.

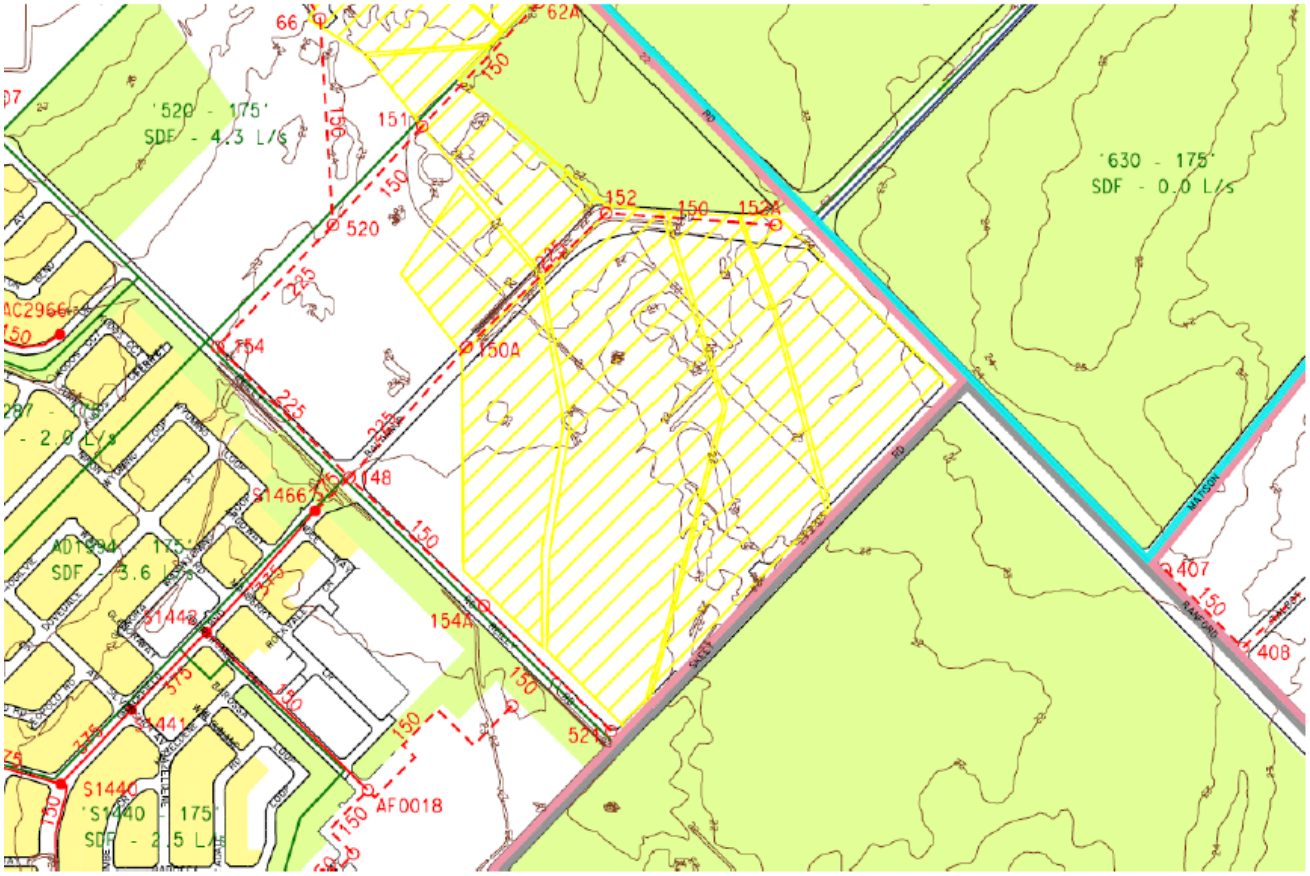
The filling will also have to tie in with the site's perimeter including Skeet and Balannup Roads.

It is expected fill will be sourced from local sand extraction pits as typical with other development sites in the area.

Retaining will be required in between the commercial and residential to allow at grade Ranford Road frontage for the commercial lot. Based on lot configurations and engineering detail, it is probable retaining walls will be required to manage level differences. Internal retaining is expected to be minimal however perimeter retaining may be more substantial

3.9.6 Sewer Reticulation

The Water Corporation owns and maintains all sewerage reticulation systems in the area. Any sewer connection point provided to the development site will need to be designed and constructed in accordance with Water Corporation requirements.



The Water Corporation Wastewater Planning

The point of connection is at the intersection of Balannup and Reilly Roads. The gravity sewer network extends out to service the site. The filling is required to enable a gravity sewer service.

A request has been made with the Water Corporation for a flatter-grade sewer prior to the site. This will save a significant quantity of fill which has many added benefits including environmental, traffic impact, aesthetic, and cost. The specifics of this request will be resolved at the detailed design stage.

This information is subject to confirmation from the WC planning branch during the subdivision approval process and detailed design, in accordance with conceptual planning provided by the Water Corporation.

3.9.7 Roadworks

Balannup and Skeet Roads have recently been upgraded by the City of Armadale. Ranford Road was upgraded in 2009. It is not anticipated this development will require any upgrade works here.

The unmade Reilly Road reserve separates the Balannup Drain and the site. It is expected Reilly Road will be constructed by the developer of the lots adjacent to this or the Council.

An internal road network will be required to provide frontage to each of the proposed lots. Standard subdivision requirements are expected.

It is noted the final Ranford Road land resumption has not been resolved yet. A conservative boundary has been shown for the lifting of urban deferment purposes. The final land take will be resolved in due course which will result in the commercial lot increasing in size.

It is expected a left turn pocket will be provided off Ranford Road for an entry-only crossover to the commercial lot. It is expected the pocket will be in the order of 100-120m long which places the crossover clear of the existing communications tower. A crossover on Skeet Road is needed to facilitate both entry and exit movements.

Intersections, sweeps/corners, and roundabouts will be designed for vehicle turning movements defined in AUSTROADS design guidelines. Upon handover, all internal roads will be owned and maintained by the City of Armadale.

3.9.8 Stormwater Drainage

The Perth Groundwater Atlas confirms the groundwater level is typically shallow and flows from the north down to the south. Emerge has completed the LWMS, refer to this document for the maximum groundwater level contours. The maximum groundwater level for this site is 22.7m.

The site will require filling and is likely to require subsoil drains to achieve minimum groundwater separation.

Parallel to Reilly Road is the Balannup Drain. The Forrestdale Main Drain Arterial Drainage Strategy (November 2009) completed a detailed investigation of the greater catchment and confirmed 1% AEP drain flood levels including those of the Balannup Drain.

This was further refined in the LWMS to determine the 1% AEP flood levels for the site.

Stormwater drainage management is a major component of an overall Urban Water Management Plan (UWMP) strategy for which achievement of the principles of the plan may be facilitated through the application of Water Sensitive Urban Design (WSUD) techniques during the planning, design and construction of urban development projects. Objectives of WSUD include but are not limited to the following:

- Detention of stormwater rather than rapid conveyance to maintain predevelopment flows for quantity management Use of vegetation for filtering purposes and nutrient stripping for quality management;
- Use of stormwater to conserve potable water; and
- Water-efficient landscaping.

The stormwater drainage from the development area will need to be designed and constructed in accordance with the City of Armadale Guidelines. The current drainage strategy for the site is based on advice currently developed in conjunction with Emerge (LWMS).

The site generally drains in a north-to-south direction.

It is proposed to manage drainage runoff via a pit and pipe system for minor events with infiltration and treatment of 1-year storm events through biofiltration media in the drainage swales. In addition to the pit and pipe system, major events will be managed through the road network with overflow directed into POS/wetland areas.

The design philosophy for the development site will need to demonstrate that post-development flows and volumes

do not exceed predevelopment flows for both 1- and 100-year ARI events. Preliminary design levels have assumed outflow of the drainage lines into the POS areas will have a free-flowing outlet with the headwall outlet set at the top of the swale/basin.

3.9.9 Subsoil Drainage

The road network will contain a typical pit and pipe network to collect stormwater and convey it to drain disposal areas. Depending on the extent of filling, lot connection pits may be required if onsite disposal cannot be achieved.

Drainage disposal areas will be required throughout the site. These will be positioned within the strategic public open spaces. It is likely part of the site will have a direct connection to the Balannup Drain, water quality improvement techniques need to be implemented to ensure clean water leaves the site.

Depending on the extent of filling, it is probable parts of the site will require subsoil drains to manage groundwater separation. The level of the subsoil drains needs to be set to ensure they daylight to their basin or the Balannup Drain.

Subsoil drains have been detailed along Skeet Road. These are based on the Balannup Drain levels and extend to the extent that minimum cover can be achieved. Due to the extent of fill, it is likely some lots will hold and dispose of runoff on-site.

The LWMS details the drainage philosophy for the subject land.

3.9.10 Water Reticulation

The Water Corporation owns and maintains the existing water reticulation system adjacent to the development site.

Water Corporation planning advice confirms the site can be serviced off the existing water infrastructure in the adjoining road network. The proposed water main network will be reticulated through the site such that all lots will have a service. Refer to Appendix E of the Servicing Report (Appendix 9 – Servicing Report) for the Concept Water Servicing Plan. The exact layout of the larger diameter water main will be resolved at the detailed design stage.

3.9.11 Power Supply

Western Power mapping confirms the site has in the order of 15-20MVA spare capacity (2021 forecast). This is more than sufficient to serve the site.

There are large overhead high-voltage power lines that traverse the western portion of the site (shown in Plan 1). These overheads will remain and be protected via POS. It is possible Western power will require this asset to be placed within an easement.

There are large overhead high-voltage power lines that run on the southern verge of Skeet Road. These will remain.

There is existing high and low-voltage infrastructure in the road network surrounding the site. It is expected high voltage connections will be made to this network to power new transformers and switch gears. A low-voltage network will then service each lot plus the street lighting and any POS furniture.

As the development can potentially be supplied from the existing surrounding infrastructure, it is foreseen that the supply of electrical power to this development is not a major constraint.

3.9.12 Gas

Reticulated gas is not considered to be an essential service and as such is not required as a condition of subdivision, however, it is usual practice to install gas reticulation network for the subdivision within a common civil trench at no cost to the developer.

The surrounding road network contains existing gas infrastructure, which may be extended throughout the estate. If there is an extension required to connect to the nearest high-pressure gas main, the developer will be required to pay for the trenching to the gas main as a headworks cost.

3.9.13 Telecommunications

General communication services for the development will consist of the installation of a standard pit and pipe network in accordance with NBN Co guidelines and standards. The current design practice for road reserves, pavement and verge provisions will make adequate allowance for services including broadband in accordance with the agreed Utilities Service Providers handbook. There will be some local land requirements for equipment sites, similar to current provisions which will be accommodated at the detailed subdivision stage.

3.10 DEVELOPER CONTRIBUTION ARRANGEMENTS

Part 6B – Development Contributions Areas of the City of Armadale's TPS 4 provides for a cost contribution scheme to be established, to ensure the equitable sharing of costs between owners towards infrastructure required as a result of the subdivision and development of land within the Developer Contribution Area (DCA).

The subject land is situated within DCA No.3, which ensures equitable development contributions across all developments within the DCA area with respect to proposed Primary School sites, the District Playing Fields site and other costs which accord with the requirements of State Planning Policy 3.6 'Development contributions for infrastructure'.

3.11 OTHER REQUIREMENTS

3.11.1 Bushfire Management

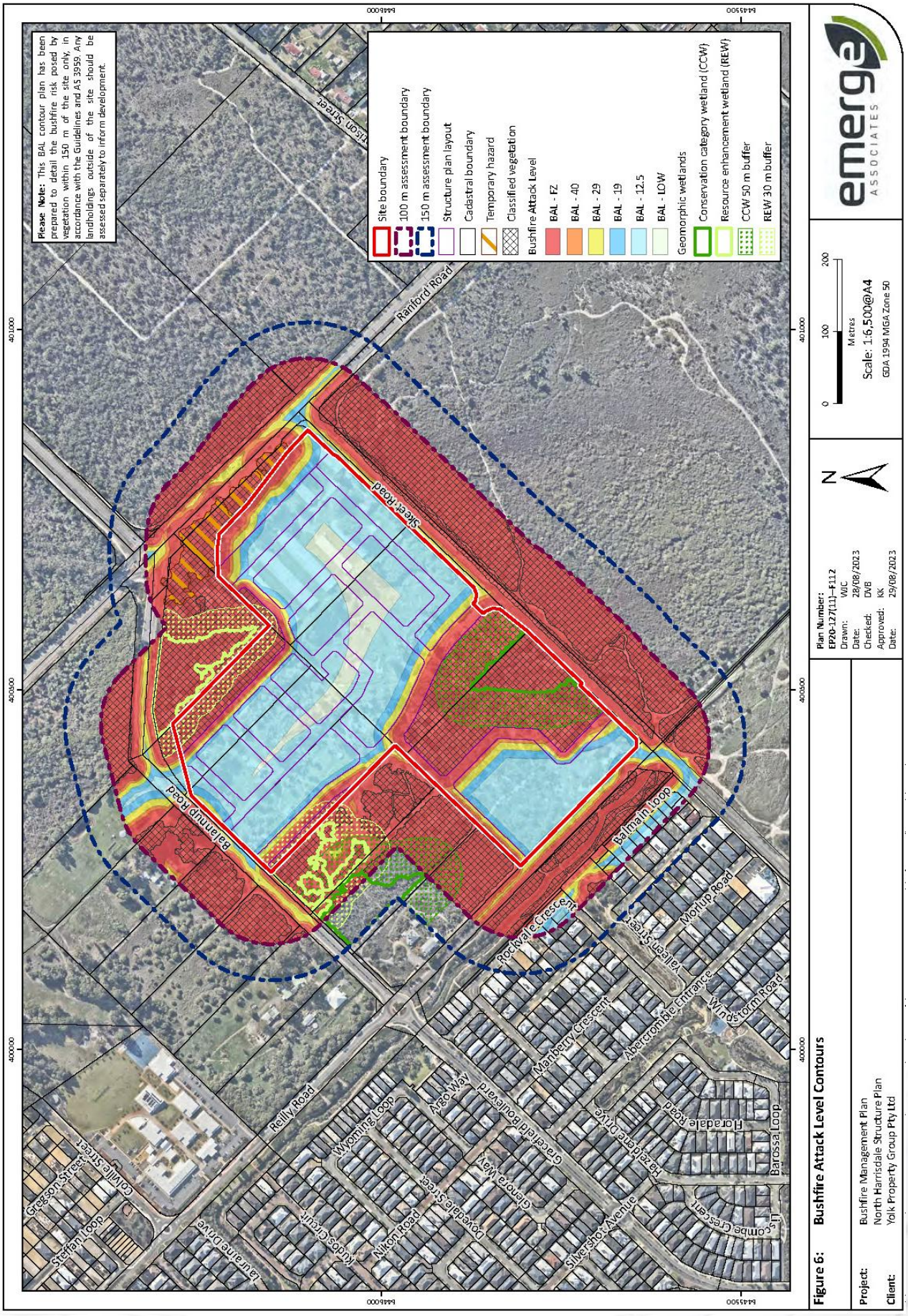
The Structure Plan has been informed by the Bushfire Management Plan in **Appendix 3**.

The Structure Plan will allow for the removal of the majority of bushland hazards within the site, which will remove the classified vegetation and therefore hazard across the site due to the construction of lots and the road network. Hazards will remain however within the three areas of POS associated with the retention of native vegetation and significant environmental values within these areas.

As shown in the landscaping masterplan, revegetation will be possible within the three areas of POS. Bushfire hazards, therefore, are assumed to increase within POS areas, and the risks associated with this and mitigation measures required to respond to them, have been outlined within the North Harrisdale Bushfire Management Plan (Emerge Associates 2021f), which has been prepared to support the Structure Plan.

There are several areas (i.e. Lot 604-606) that through the preparation of the structure plan have been identified as being suitable for investigation for residential development. Whilst these areas are currently impacted by remnant vegetation bushfire areas, these have been included to be further investigated at the respective subdivision / detailed design phase of the lots. The inclusion of these lots for development facilitates the creation of the open space and provides some development potential for the existing parent lots.

The subject land has been identified as suitable for development, provided that risk management strategies and designs are incorporated into the development as detailed in the Bushfire Management Plan.



BMP – Bushfire Attack Levels (BAL)

3.11.2 Environmental Management

The Structure Plan has been informed by the Environmental Assessment and Management Strategy in **Appendix 2**.

This EAMS also outlines the environmental framework to be implemented across the site as part of the future subdivision and development phases of the residential development process, including:

- Where future subdivision stages incorporate or are located directly adjacent to a POS area, an Environmental Management Plan (or similar) will be prepared. This document will identify environmental management requirements and specify management actions to be implemented within POS areas and the wetland buffer zone. This will consider factors such as vegetation and fauna habitat retention and improvement, potential revegetation, and general POS management.
- Preparation of an Urban Water Management Plan (UWMP) to support each stage of subdivision.
- Wetland Management Plan(s) (WMPs) should be prepared and implemented as a condition of subdivision approval. The WMP(s) will detail the management of any potential impacts of the proposed development on the wetlands and the management of buffer areas.
- With subdivision approvals, a condition requiring the preparation and implementation of a Fauna Relocation Management Plan(s) (or similar), which would aim to minimise the risk of fauna interactions during construction is minimised, should be applied.
- Application of a subdivision condition may be appropriate for Lot 201 and Lot 202 where potentially contaminating activities have been identified. The remaining lots within the site have not been subject to a potentially contaminating land use and therefore an investigation for potential contamination is not warranted.
- Prepare a new/revised BMP in accordance with SPP 3.7, the Guidelines and AS 3959 to support future subdivision applications, based on the proposed subdivision layout and in consideration of existing bushfire hazards or those that will be present following development. In addition, if the assumptions regarding the treatment of the POS and public road reserves change as part of future detailed design stages, a revised BMP will be required.
- The potential requirement for an Acid Sulfate Soil and Dewatering Management Plan (ASSDMP) based on future investigations, if required.

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

EAMS - Environmental Feature Response

3.12 IMPLEMENTATION

The proposed Structure Plan has been prepared in accordance with the requirements of the Planning and Development (Local Planning Schemes) Regulations 2015. Further, the Structure Plan complies with the applicable State and Local Planning Policy Framework as set out in **section 1.3** of this Report.

The Planning and Development (Local Planning Schemes) Regulations 2015 stipulate the manner by which the Structure Plan will be processed by the City of Armadale and thereafter, the Western Australian Planning Commission to enable final approval.

Development and subdivision of the Structure Plan Area is dependent on the finalisation of the Scheme Amendment and Structure Plan.

4 TECHNICAL APPENDICES INDEX

Appendix			
1	Certificates of Title	N/A	N/A
2	Environmental Assessment & Management Strategy	LA/DWER	N/A
3	Basic Fauna and Targeted Black Cockatoo Assessment	DBCA	For Assessment
4	Wetland Assessment	EPA/DBCA	For Assessment
5	Acoustic Report	LA/WAPC	For Assessment
6	Bushfire Management Plan	LA/DFES	For Assessment
7	Open Space Plan & Subdivision Concept	LA/WAPC	For Information
8	Landscape Concept	LA	For Information
9	Local Water Management Strategy	DoW	For Information
10	Transport Impact Assessment	LA	For Information
11	Economic Report	LA	For Information
12	Engineering Report	LA/ WP/ WC	For Information

Abbreviations:

LA: Local Authority

DWER: Department of Water and Environmental Regulation

DFES: Department of Fire and Emergency Services

WAPC: Western Australian Planning Commission

DBCA: Department of Biodiversity, Conservation and Attractions

DoW: Department of Water

WP: Western Power

WC: Water Corp

WAPC: Western Australian Planning Commission

APPENDIX 1 – CERTIFICATES OF TITLE

WESTERN AUSTRALIA

REGISTER NUMBER	
603/DP412375	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	23/5/2018

VOLUME 2948 FOLIO 499

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 603 ON DEPOSITED PLAN 412375

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

LIZA FOWLER OF 49 BALANNUP ROAD HARRISDALE WA 6112

(AF N886296) REGISTERED 1/5/2018

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. N436962 MORTGAGE TO BANK OF QUEENSLAND LTD REGISTERED 19/9/2016.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	DP412375
PREVIOUS TITLE:	1729-578
PROPERTY STREET ADDRESS:	49 BALANNUP RD, HARRISDALE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF ARMADALE

LANDGATE COPY OF ORIGINAL NOT TO SCALE 08/01/2021 04:47 PM Request number: 61474740

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
602/DP412374	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	23/5/2018

VOLUME 2948 FOLIO 542

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 602 ON DEPOSITED PLAN 412374

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

THOMAS MARTIN KAVANAGH OF UNIT 7 43 PRESTON POINT RD , EAST FREMANTLE WA 6158
(AF N886303) REGISTERED 1/5/2018

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. *O531233 CAVEAT BY YOLK SKY NO 15 PTY LTD LODGED 21/10/2020.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: DP412374
PREVIOUS TITLE: 1759-287
PROPERTY STREET ADDRESS: 41 BALANNUP RD, HARRISDALE.
LOCAL GOVERNMENT AUTHORITY: CITY OF ARMADALE

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Landgate
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WESTERN AUSTRALIA

REGISTER NUMBER	
601/DP412373	
DUPLICATE EDITION **1**	DATE DUPLICATE ISSUED **27/6/2018**

VOLUME **2950** FOLIO **114**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 601 ON DEPOSITED PLAN 412373

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ALLAN STANLEY PASHBY
THELMA MAVIS PASHBY
BOTH OF LOT 509 BALANNUP ROAD, FORRESTDALE
AS JOINT TENANTS

(AF N916283) REGISTERED 11/6/2018

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. H470188 MORTGAGE TO PERPETUAL TRUSTEES AUSTRALIA LTD REGISTERED 12/6/2000.
N327951 TRANSFER OF MORTGAGE H470188, MORTGAGEE NOW MEMBERS EQUITY BANK LTD REGISTERED 16/5/2016.

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----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

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SKETCH OF LAND:	DP412373
PREVIOUS TITLE:	2105-443
PROPERTY STREET ADDRESS:	33 BALANNUP RD, HARRISDALE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF ARMADALE

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WESTERN AUSTRALIA

REGISTER NUMBER	
201/DP415388	
DUPLICATE EDITION **1**	DATE DUPLICATE ISSUED **7/11/2018**

VOLUME **2957** FOLIO **594**

RECORD OF CERTIFICATE OF TITLE

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 201 ON DEPOSITED PLAN 415388

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

LUIGI DECAMPO
JUDITH DECAMPO
BOTH OF 7 BUNTER COURT LEEMING WA 6149
AS JOINT TENANTS

(AF O012026) REGISTERED 19/10/2018

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. *O531228 CAVEAT BY YOLK SKY NO 15 PTY LTD LODGED 21/10/2020.

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SKETCH OF LAND:	DP415388
PREVIOUS TITLE:	1289-796
PROPERTY STREET ADDRESS:	44 SKEET RD, HARRISDALE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF ARMADALE

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WESTERN AUSTRALIA

REGISTER NUMBER	
200/DP415389	
DUPLICATE EDITION **2**	DATE DUPLICATE ISSUED **23/11/2018**

VOLUME **2957** FOLIO **595**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 200 ON DEPOSITED PLAN 415389

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ABORIGINAL CHRISTIAN CHURCH TEACHING CENTRE OF W.A. INC OF 56 SKEET ROAD HARRISDALE WA 6112

(AN O034673) REGISTERED 21/11/2018

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. *O531234 CAVEAT BY SIXPACK NOMINEES PTY LTD LODGED 21/10/2020.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
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STATEMENTS:

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SKETCH OF LAND:	DP415389
PREVIOUS TITLE:	1814-483
PROPERTY STREET ADDRESS:	56 SKEET RD, HARRISDALE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF ARMADALE

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WESTERN AUSTRALIA

REGISTER NUMBER	
202/DP415387	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	27/11/2018

VOLUME 2958 FOLIO 419

RECORD OF CERTIFICATE OF TITLE

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 202 ON DEPOSITED PLAN 415387

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

BRIAN ARTHUR CHESTER
DELORES VERONICA CHESTER
BOTH OF 10 SKEET ROAD HARRISDALE WA 6112
AS JOINT TENANTS

(AF O026644) REGISTERED 9/11/2018

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. G514013 MORTGAGE TO WESTPAC BANKING CORPORATION REGISTERED 27/6/1997.
2. J269402 LEASE TO HUTCHISON 3G AUSTRALIA PTY LTD OF BUILDING A, 207 PACIFIC HIGHWAY, ST LEONARDS, NEW SOUTH WALES EXPIRES: SEE LEASE. AS TO PORTION ONLY. REGISTERED 2/5/2005.
3. *J769661 CAVEAT BY H3GA PROPERTIES (NO.3) PTY LTD AS TO PORTION ONLY LODGED 1/6/2006.
4. K239601 LEASE TO TELSTRA CORPORATION LTD OF LEVEL 34 242 EXHIBITION STREET MELBOURNE VIC 3000 EXPIRES: SEE LEASE. AS TO PORTION ONLY. REGISTERED 25/6/2007.
   N690790 EXTENSION OF LEASE K239601. REGISTERED 8/8/2017.
5. *O531222 CAVEAT BY YOLK SKY NO 15 PTY LTD LODGED 21/10/2020.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
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STATEMENTS:

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SKETCH OF LAND:	DP415387
PREVIOUS TITLE:	2726-259
PROPERTY STREET ADDRESS:	10 SKEET RD, HARRISDALE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF ARMADALE

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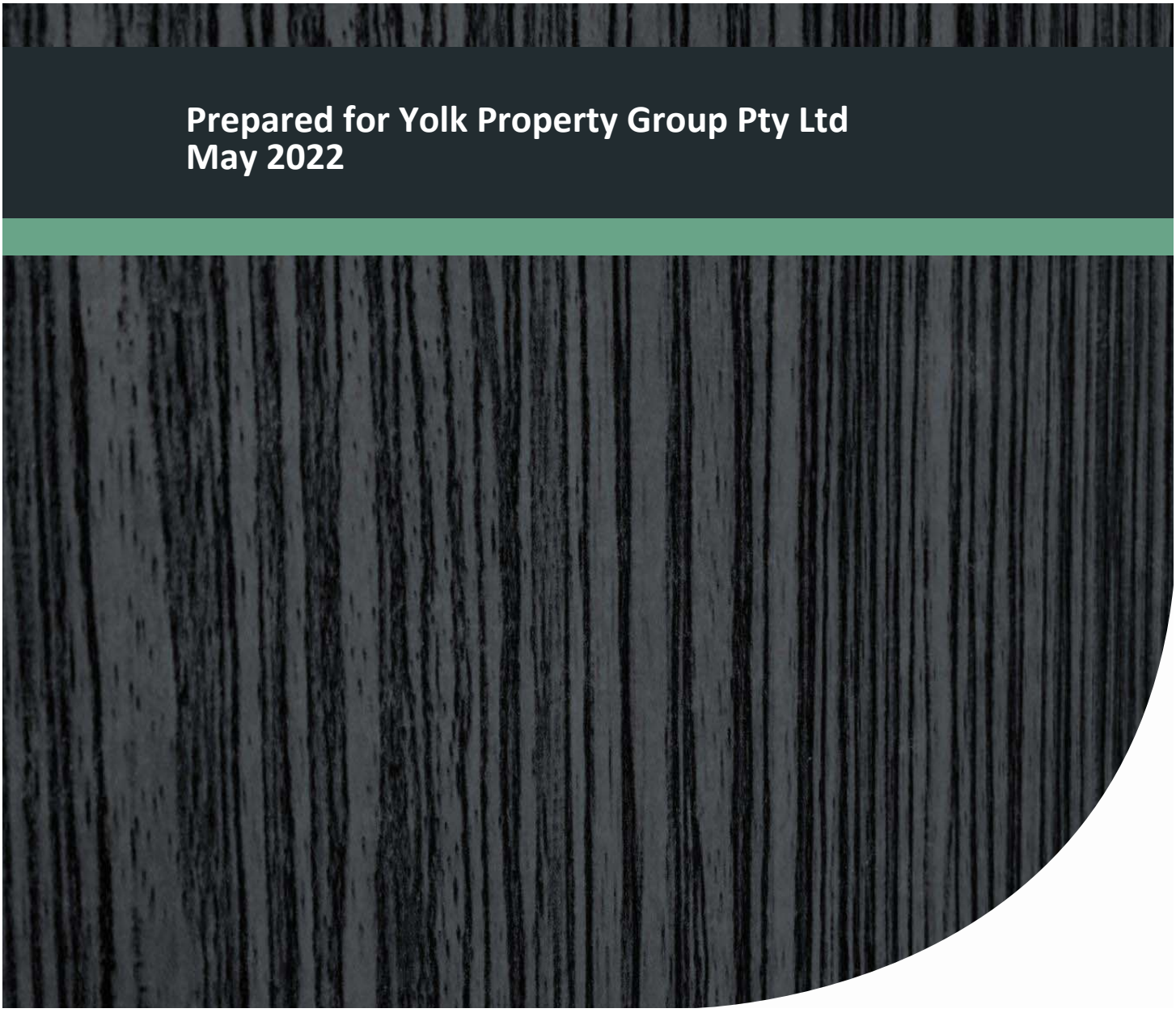
APPENDIX 2 – ENVIRONMENTAL ASSESSMENT MANAGEMENT STRATEGY

Environmental Assessment and Management Strategy

North Harrisdale Local Structure Plan

Project No: EP20-127(10)--011

Prepared for Yolk Property Group Pty Ltd
May 2022



Document Control

Doc name:	Environmental Assessment and Management Strategy North Harrisdale Local Structure Plan				
Doc no.:	**EP20-127(10)—011A TEM**				
Version	**Date**	**Author**		**Reviewer**	
1	July 2021	Tess Mcallister	TEM	Jason Hick	JDH
	Report issued to client for review.				
A	April 2022	Bianca Bertelli	BRB	Jason Hick	JDH
	Modifications to address EPA public comments arising from local scheme amendment				
B	May 2022	Bianca Bertelli	BRB	Jason Hick	JDH
	Updated to in response to revised supporting documentation.				

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Executive Summary

Hex Design and Planning (Hex) on behalf of various landowners (which include Yolk Property Group Pty Ltd) are progressing the North Harrisdale Structure Plan (herein referred to as the 'Structure Plan') incorporating part Lot 601 Balannup Road, Lots 602-606 Balannup Road, Lots 200 and 201 Skeet Road, and part Lot 202 Skeet Road, Harrisdale ('the site').

Located within the City of Armadale, the site is approximately 26 hectares (ha) in size and is bound by Ranford Road to the north-east, Skeet Road to the south-east, Reilly Road to the south-west and Balannup Road to the north-west.

This *Environmental Assessment and Management Strategy* (EAMS) has been prepared to support the Structure Plan and address the requirements of the Western Australian Planning Commission's (WAPC) *Structure Plan Framework* (WAPC 2015b) to support the preparation, approval and future implementation of the Structure Plan, subdivision and development. It also responds to advice provided to the City of Armadale by the Environmental Protection Authority (EPA) on Amendment 121 to the City of Armadale Town Planning Scheme No. 4 pursuant to section 48A(1)(a) of the *Environmental Protection Act 1986* (EP Act).

The EAMS provides a synthesis of information regarding the environmental values and attributes of the site, obtained from a range of sources such as local and regional reports, databases, mapping and site-specific investigations. The following documents were relevant for and provided support to the preparation of this EAMS:

- *District Water Management Plan – Lots 172, 515 and 516 Skeet Road, Harrisdale* (JDA 2014)
- *Due Diligence Environmental and Geotechnical Study - Proposed Road Widening Balannup Road and Skeet Road Harrisdale* (Galt Environmental 2018)
- *Detailed Flora and Vegetation Assessment – Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale* (Emerge Associates 2022b)
- *Basic Fauna and Targeted Black Cockatoo Assessment – Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale* (Emerge Associates 2021a)

The following have been prepared in parallel with the EAMS to support the Structure Plan:

- *Local Water Management Strategy* (LWMS) (Emerge Associates 2022c)
- *Wetland Assessment* (Emerge Associates 2021c)
- *Bushfire Management Plan – Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale* (Emerge Associates 2022a)

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

- Historical land uses across the site comprised of an informal salvage yard, a poultry farm and rural residential stye dwellings.
- Topography of the site ranges from 21 m in relation to Australian Height Datum (mAHD) up to 23 mAHD.
- Based on the *Geological Survey of Western Australia* (Gozzard 1986), the western portion of the site is underlain with sand, whereas the eastern is underlain with peaty sand and peat-rich sand.

Geotechnical investigations found ground condition to be a mixture of sand, sandy clay and clayey sand.

- The north/northeast portion of the site has a 'High to Moderate' risk of acid sulfate soils (ASS) occurring within 3 m of the natural soil surface. The remainder of the site is classified as having a 'Moderate to Low' risk of ASS occurring within 3 m of the natural soil surface.
- Based on a recent survey undertaken by Emerge Associates (2022b), approximately 11 ha or 40.3% of the site supports native plant communities. The remainder of the site (15 ha or 57.13% of the site) comprises cleared or non-native vegetation with buildings, bare soil, weeds, or planted vegetation. The condition of the vegetation across the site was determined to range from 'Completely Degraded' to 'Excellent', with the most intact native vegetation located in the south-western half of the site.
- A total of 6.13 ha of 26.3 ha (or 24%) of vegetation within the site is in 'Good' or better condition, which is considered to be intact native vegetation.
- Emerge Associates (2022b) confirmed the composition of plant communities **BaBm, BKg** and **BaMpKg** located within the site are representative of the federally listed 'banksia woodlands of the Swan Coastal Plain' 'Threatened Ecological Community' (TEC) (herein referred to as the 'banksia woodland TEC') as well as the state listed 'Priority Ecological Community' (PEC). Therefore, a total of 7.64 ha of the Banksia woodland TEC/PEC occurs within the site.
- Three priority flora species were recorded within the site, *Acacia lasiocarpa* var. bracteolata long peduncle variant (G.J. Keighery 5026) (P1), *Verticordia lindleyi* subsp. *lindleyi* (P4) and *Jacksonia gracillima* (P3).
- While the threatened flora species, *Drakaea elastica* was not identified during flora surveys conducted over the appropriate survey window, potentially suitable habitat for this species, plant community **BKg**, occurs within the site.
- Emerge Associates (2021a) recorded a total of 18 native and three introduced fauna species within the site, including one species of conservation significance, *Isoodon fusciventer* (quenda) (P4). In addition, four threatened, six priority, three migratory and one specially protected fauna species were considered to possibly occur within the site, including three species of black cockatoos; *Calyptorhynchus latirostris* (Carnaby's cockatoo), *Calyptorhynchus baudinii* (Baudin's cockatoo) and *Calyptorhynchus banksii naso* (forest red-tailed black cockatoo) (referred to herein collectively as 'black cockatoos'). No black cockatoos were observed during the survey and no evidence of roosting was recorded. The site is located within the expected range of all three species and suitable habitat occurs within the local area, so it is possible that all three species may utilise the site at varying times. None of the potential habitat trees present within the site contain hollows that would be suitable for use for breeding by black cockatoos.
- An Environmentally Sensitive Area is present over the entirety of the site.
- A wetland assessment prepared by Emerge Associates (2021c) delineated the on-ground wetland values of the site and concluded that the site supports two conservation category wetlands (CCWs) and one Resource Enhancement Wetland (REW) (within the site) and one nearby REW within the northern adjacent lot (i.e. not within the site). The Department of Biodiversity Conservation and Attractions (DBCA) have subsequently reviewed the Emerge wetland assessment against the existing Geomorphic Wetlands of the Swan Coastal Plain dataset and confirmed revisions to the wetland mapping generally in line with the Emerge assessment.
- No registered Aboriginal or non-indigenous heritage sites have been historically identified within the site.

- No registered contaminated sites are located within the site, however Lot 202 (which contains a currently operational poultry farm) and Lot 201 (which contains an informal savage yard) support land uses with the potential to cause contamination. All other lots have historically been used for rural residential purposes.
- Ranford Road is located along the northern boundary of the site and is identified as a 'strategic freight and/or major traffic route', hence the State Planning Policy 5.4 *Road and Rail Noise* (SPP 5.4) applies to the site.
- Parts of the site are located within the City of Armadale's Kennel Buffer zone and a number of registered kennels within both the City of Armadale and the City of Gosnells are located within a 500 m radius of the site.
- Bushfire hazards associated with bushfire prone vegetation have been identified within and outside the site, associated with the vegetated portions of the various wetlands and unmanaged vegetation within existing private landholdings, particularly to the south of the site.

This EAMS provides an outline of the specific structure plan responses and management requirements that will need to be considered as part of as part of the future subdivision and development process and responds to the EPA public advice provided when Amendment 121 was referred pursuant to section 48A of the EP Act. It is important to note that the draft Structure Plan provided to the EPA for information as part of the referral of Amendment 121 has been modified (now referred to as the 'Structure Plan') to respond to the EPA public comments. The EAMS has been updated to detail the environmental responses of the Structure Plan.

The key environmental considerations are summarised as follows.

Acid Sulfate Soils

The sewage network that is proposed to service the site will ultimately be gravity fed to an existing connection network at the intersection of Balannup Road and Reilly Road.

The preliminary earthworks strategy for the site indicates that sewer levels will be installed above the existing natural surface elevations (i.e. within fill) in areas shown as 'High to Moderate' risk of ASS, which will assist in mitigating the potential extent of ASS disturbance during construction.

Towards the western portion of the site particularly at the lowest connection point, the sewage network may need to be installed below the groundwater table where ASS may therefore be encountered, and temporary dewatering may be required. This can be appropriately mitigated and managed through an ASS and Dewatering Management Plan (ASSDMP) for the construction of the deep sewer network, via the application of the model subdivision condition on the subdivision approval.

There is no requirement for further consideration of ASS required at the structure planning stage.

Flora and vegetation

Three large areas of POS (approximately 8.26 ha or 31.37% of the site) are proposed within the Structure Plan, including 4.6 ha specifically for conservation purposes. The POS have been strategically located to retain 3.82 ha of 7.64 ha (or 50%) of the Banksia Woodland TEC/PEC occurring within the site. In addition, the Structure Plan would facilitate the retention of three priority flora

species: *Acacia lasiocarpa var. bracteolata* long peduncle variant (P1), *Jacksonia gracillima* (P3) and *Verticordia lindleyi subsp. Lindleyi* within the south western POS.

Although the threatened flora species, *Drakaea elastica* was not identified during flora surveys, 0.56 ha of potentially suitable habitat, plant community **BKg,** was identified within the site and the Structure Plan would allow for this plant community to be fully retained within the western POS area (referred to as POS West).

Opportunities to retain additional areas of native vegetation across the development will also be possible in other areas of POS and will be confirmed during final development design and bulk earthworks requirements.

A native vegetation clearing permit will not be required if clearing is done in accordance a subdivision approval.

Further management requirements should include flora and vegetation management plan(s) (or similar) to further mitigate potential impacts to flora and vegetation during construction and development.

Terrestrial fauna

The Structure Plan provides three large POS areas (totalling 8.26 ha) which will retain 5.52 ha (of 12.27 ha, or 45%) of identified intact fauna habitats, predominately 'Woodland' and 'Closed Melaleuca Forests' habitat types.

The Structure Plan would also retain 2.17 ha of black cockatoo foraging habitat (of 7.27 ha) within POS areas, in particular, 1.90 ha of Carnaby's Cockatoo foraging habitat (of the total of 4.12 ha, or 46.11%).

The vegetation proposed to be retained supports dense cover of remnant native understorey vegetation, known to provide suitable habitat for a number of conservation significant fauna species including the Quenda. In addition, the wetland buffer areas will provide separation from the urban land uses, limiting the potential impacts on fauna associated with the wetland areas.

As part of future subdivision and development, Fauna Management Plan(s) should be required to further mitigate the potential impacts to fauna during construction.

Wetlands

As a result of DBCA's revision of the Geomorphic Wetlands mapping, the site is now known to support two CCWs (i.e. within the site), a nearby REW within the northern adjacent lot (i.e. not within the site), and two additional but marginal REWs within the site. The three POS areas within the Structure Plan have been strategically located to retain these wetland values. The Structure Plan provides for the separation of the two CCWs, one of the marginal REWs, and the adjacent REW from residential development through the provision of wetland buffers. For the CCW buffers, a minimum of 50 m will allow for the retention of existing native vegetation and revegetation. For the REWs, buffers of up to 30 m will allow for the retention of existing native vegetation and revegetation. The POS areas surrounding the wetlands generally provide larger buffers than the minimum distances. One additional (newly classified) REW area has been retained entirely within POS. Given the marginal

wetland values associated with this wetland, the entire 30 m REW buffer area is not contained within a POS area.

Preparation of Wetland Management Plan(s) should be required to outline specific strategies for the preservation of the wetlands and their associated buffer areas.

Hydrology

A Local Water Management Strategy has been prepared by Emerge Associates (2021d) to support the Structure Plan. The overarching objective for the site is to retain and treat all runoff up to the major event within the development. Treatment will be provided via vegetated bio-retention areas, which will minimise nutrient loading to downstream wetlands and groundwater. Infiltration features such as flood storage areas (FSAs) will be located within POS areas or wetland buffer areas and will be designed to retain the major rainfall event on-site.

The use of treatment and infiltration features within the POS will assist in recharging the superficial aquifer and maintaining the overall health of the nearby wetlands and groundwater dependent ecosystems.

During successive subdivision, Urban Water Management Plan(s) will be required to support the detailed design and demonstrate how the principles established through the LWMS are to be implemented.

Potential site contamination

The majority of the lots that comprise the site (Lots 601, 602, 603, 604, 605 and 606) have been used for rural residential purposes, which are not identified by the DWER as a potentially contaminating land use. The exception to this is Lot 201, which has been used for non-residential purposes including a stockpile yard/stockpiling and storage of various materials, and Lot 202, which is a currently operational poultry farm.

Any likelihood of contamination risk is therefore limited to Lot 201 and Lot 202 however does not require a spatial or land-use response within the Structure Plan. Further investigations for Lot 201 and 202 should be undertaken as part of the subdivision process.

Bushfire management

The Structure Plan will involve the majority of the bush fire hazard within the site to be removed, due to the construction of residential lots and the road network. Hazards will remain however within the three areas of POS associated with retained native vegetation and the significant environmental values within these areas.

The bushfire hazards within the POS would also increase with revegetation of buffer areas, although the risks associated with this and necessary mitigation measures have been outlined within the *North Harrisdale Bushfire Management Plan (Emerge Associates 2022a)*which has been prepared to support the Structure Plan.

Noise considerations

Noise impact considerations (i.e. Ranford Road and nearby registered kennels) associated with the proposed residential development has been addressed through a specific noise impact assessment. To mitigate noise impacts, a noise wall of varying heights (between 2 m to 2.4 m) will be required along the north-eastern corner joining to a solid fence which will interface with Skeet Road.

The assessment also concluded that quiet home architectural packages ranging from 'Package A' to 'Package C' will be required for a range of dwellings towards the north-eastern portion of the site, and residential lots created within the site that will be located within the Kennel Buffer – Special Control Area (CoA 2005), should be subject to a notification on title.

Additional details in this regard will be further outlined in Noise Management Plan(s), undertaken as part of future subdivision and development of the site.

Conclusions

Overall, the environmental attributes and values of the site have been accommodated within the Structure Plan or can be managed appropriately through future subdivision and development in line with the relevant state and local government legislation, policies and guidelines and current management practices. The Structure Plan also responds to the public advice provided by the EPA when the associated Amendment 121 was referred to the EPA.

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Appendices

Appendix A

Harrisdale Local Structure Plan (Hex Design and Planning 2022)

Appendix B

Detailed Flora and Vegetation Assessment – Lots 600 - 606 Balannup Road and 200-202 Skeet Road, Harrisdale (Emerge Associates 2022b)

Appendix C

Fauna and Detailed Black Cockatoo Assessment – Lots 600 - 606 Balannup Road and 200-202 Skeet Road, Harrisdale (Emerge Associates 2021)

Appendix D

DPAW advice pertaining to wetland mapping review (DPaW 2015)

Appendix E

Wetland Assessment (Emerge Associates 2021)

Appendix F

DBCA Wetland Correspondence pertaining to relation to the Wetland Assessment (2021)

Appendix G

MRA Amendment 1274/57 EPA Advice Letter (2014)

Appendix H

North Harrisdale Structure Plan Landscape Report (Emerge Associates 2022)

Appendix I

Noise Impact Assessment (Lloyd George Acoustics 2021)

List of Abbreviations

Table A1: Abbreviations – General terms

General terms	
AHD	Australian Height Datum
AHIS	Aboriginal Heritage Inquiry System
ASS	Acid Sulfate Soil
ASSDMP	Acid Sulfate Soil and Dewatering Management Plan
EAMS	Environmental Assessment and Management Strategy
ESA	Environmentally Sensitive Area
FCT	Floristic community type
LWMS	Local Water Management Strategy
PEC	Priority Ecological Community
PDWSA	Public Drinking Water Source Area
TEC	Threatened Ecological Community
UWMP	Urban Water Management Plan

Table A2: Abbreviations – Legislation and policies

Legislation and policies	
AH Act	*Aboriginal Heritage Act 1972*
BC Act	*Biodiversity Conservation Act 2016*
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*

Table A3: Abbreviations – Organisations

Organisations	
CoA	City of Armadale
DBCA	Department of Biodiversity Conservation and Attractions
DoW	Department of Water (now known as Department of Water and Environmental Regulation)
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
WAPC	Western Australian Planning Commission

Table A4: Abbreviations – Planning and building terms.

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

1 Introduction

1.1 Background

Hex Design and Planning (Hex) on behalf of various landowners (which include Yolk Property Group Pty Ltd) are progressing the North Harrisdale Structure Plan (herein referred to as the 'Structure Plan') (provided in **Appendix A**) for part Lot 601 Balannup Road, Lots 602-606 Balannup Road, Lots 200 and 201 Skeet Road, and part Lot 202 Skeet Road, Harrisdale (herein referred to as 'the site').

Located within the City of Armadale, the site is approximately 26.3 hectares (ha) in size and is bound by Ranford Road to the north-east, Skeet Road to the south-east, Reilly Road to the south-west and Balannup Road to the north-west (see **Figure 1**).

1.2 Planning context

Following the historical Metropolitan Regional Scheme (MRS) Amendment 1274/57, which sought to rezone the Balannup/Skeet Road Precinct, the site was rezoned from 'Rural' to 'Urban Deferred'.

An MRS Amendment request for the lifting of the 'Urban Deferred' zone (which applies across the entire site) was also progressed to facilitate future residential subdivision and development under the MRS 'Urban' zone.

The site is currently zoned 'General Rural' under the City of Armadale Town Planning Scheme No. 4 (TSP 4). The rezoning of the affected land under the provisions of the City of Armadale's TPS 4 to 'Urban Development' zone (Amendment 121) is also progressing in parallel with the preparation of the Structure Plan.

Amendment 121 to TPS 4 was referred to the EPA pursuant to Section 48A of the *Environmental Protection Act 1986* (EP Act). The EPA determined that Amendment 121 did not require assessment by the EPA but the EPA provided publicly available advice as to the various environmental considerations that would need to be resolved as part of the future planning and development process.

1.3 Purpose of this report

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

- Identifies the existing environmental values and attributes of the site (**Section 2**).
- Discusses the land use and environmental planning context for the site (**Section 3**).
- Discusses how the Structure Plan layout responds to the existing environmental features and values, and future environmental management requirements as part of the future planning and development process (**Section 4**).

- Provides an implementation framework for future environmental management requirements as part of the future planning and development process (**Section 4.8.3**).
- Summarises the Structure Plan's response to the existing environmental values and attributes of the site (**Section 6**).

The EAMS is the key supporting environmental document for the Structure Plan, enabling the consideration of relevant environmental issues by the local government and various state government agencies and authorities. It is consistent with the requirements for environmental reporting as outlined in the Western Australian Planning Commission's (WAPC's) *Structure Plan Framework* (WAPC 2015b), and responds to the public advice provided by the EPA on Amendment 121.

1.4 Assessment scope

Emerge Associates (Emerge) was engaged to undertake this environmental assessment to document the existing environmental attributes and values of the site and ensure that any relevant environmental values can be accommodated within the Structure Plan, and/or managed through future subdivision and development of the site. This involved utilising a range of information sources including local and regional reports, and technical surveys.

The following documents were prepared as part of MRS Amendment 1274/57, and were used to inform the EAMS:

- *District Water Management Plan – Lots 172, 515 and 516 Skeet Road, Harrisdale* (JDA 2014)
- *Due Diligence Environmental and Geotechnical Study - Proposed Road Widening Balannup Road and Skeet Road Harrisdale* (Galt Environmental 2018)
- *Bushfire Management Plan – Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale (Emerge Associates 2022a)*
- *Environmental Assessment Report - Lots 600-606 Balannup Road & 200-202 Skeet Road, Harrisdale* (Emerge Associates 2021b).

The following documents have also informed the EAMS, including investigations undertaken by Emerge to support the proposed Structure Plan include:

- *Detailed Flora and Vegetation Assessment – Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale* (Emerge Associates 2022b)
- *Basic Fauna and Targeted Black Cockatoo Assessment – Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale* (Emerge Associates 2021a)
- *Local Water Management Strategy* (LWMS) – *North Harrisdale* Structure Plan (Emerge Associates 2022c)
- *Wetland Assessment – North Harrisdale* Structure Plan (Emerge Associates 2021c)

2 Existing Environment

2.1 Historical and current land uses

A review of historical aerial imagery (Landgate 2021) available from 1953 onwards shows the following:

- The site was vegetated and undisturbed/undeveloped in 1953 and appears to support a large wetland.
- By 1961 several roads are present surrounding the site and by 1965 clearing associated with a power transmission line across Lots 604-606 can be seen.
- By 1974 Lots 201 and 202 were cleared of mature vegetation and what appears to be a large body of water is present across these lots (see **Plate 1**). By 1977 Lot 200 was almost entirely cleared, except for the south east corner.
- Between 1965 and 1989 various small-scale vegetation clearing events are visible across Lots 604-606 and Lot 601 is entirely cleared.
- Between 1987 and 1989 (see **Plate 2**) several buildings were constructed, including what appears to be the poultry farm in Lot 202.
- By 1989 much of Lot 600 and half of Lot 602 was cleared.
- In 1991, what appears to be a large fire scar is visible over the western portion of the site.
- Since 2008 areas of regrowth of native vegetation are visible, particularly in Lots 200, 600 and 604-606.



Plate 1: Site circa 1974 (Landgate, 2021)



Plate 2: Site circa 1989

Current land uses within the site comprise of rural residential dwellings, an informal salvage yard and materials storage (Lot 201), and a poultry farm (on Lot 202).

2.2 Landform and soils

2.2.1 Topography

Topographic contours across the site indicate that the site is relatively flat, with an elevation of approximately 23 m relative to Australian height datum (mAHD) across the site. It is noted that there are several spot heights with an elevation up to 24 mAHD just outside the site boundary, perpendicular to Skeet Road on the western boundary and along Ranford Road to the east. Regional topographic contours are shown in **Figure 2**.

2.2.2 Landform, soils, and geology

The site is located along the eastern margin of the Swan Coastal Plain which is roughly bound by the Indian Ocean to the west and the Darling Scarp to the east. Examination of broad-scale soil mapping places the site within the Southern River association. The Southern River association comprises of *'sandplain with low dunes and many intervening swamps; iron and humus podzols, peats and clays'* (Churchward and McArthur 1980).

Environmental geology for the site has been mapped by the *Geological Survey of Western Australia* (Gozzard 1986). The site consists of:

- S10. Sand - as S8 (Sand) over sandy clay to clayey sand of the Guildford Formation, of eolian origin.

- Sp1. Peaty sand - grey to black, fine to medium-grained, moderately sorted quartz sand, slightly peaty, of lacustrine origin.
- Sp2. Peat-rich sand - fine to medium-grained quartz sand with much brown to black organic material, grades to peat, of lacustrine origin.

Environmental geology across the site is shown in **Figure 2**.

Two site-specific geotechnical investigations have been conducted across portions of the site. Galt Environmental (2018) conducted an investigation in relation to the proposed widening of Skeet and Balannup Road, and a further investigation was constructed by Galt Geotechnics (2021) to support the Structure Plan and detailed design. Soils encountered during the surveys were predominately fine to medium grained sand overlying clayey sand/sandy clay and are generally consistent with the regional mapping.

2.2.3 Acid sulfate soils

Acid Sulfate Soils (ASS) is the name commonly given to naturally occurring soils and sediment containing iron sulphide (iron pyrite) materials. In their natural state, ASS are generally present through disturbed waterlogged anoxic conditions and do not present any risk to the environment. When oxidised, ASS produce sulphuric acid, which can pose risks to the surrounding environment, infrastructure, and human health.

Regional ASS risk mapping identifies the north/north east portion of the site (associated with the soil units Sp1 and Sp2 (Peaty sand)) as having a 'high to moderate' risk of ASS occurring within 3 m of the natural soil surface (DWER 2021b). The remainder of the site is classified as having a 'Moderate to Low' risk of ASS occurring within 3 m of the natural soil surface. Regional ASS mapping is shown in **Figure 3**.

2.3 Biodiversity and natural assets

2.3.1 Flora and vegetation

2.3.1.1 Regional context

Native vegetation can be described and mapped at different scales in order to illustrate patterns in its distribution. At a continental scale the *Interim Biogeographic Regionalisation of Australia* (IBRA) divides the Swan Coastal Plain into two floristic subregions (Environment Australia 2000). The site is contained within the 'SWA02' or Perth subregion, which is characterised as mainly containing *Banksia* low woodland on leached sands with *Melaleuca* swamps where ill-drained; and woodland of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah) and *Corymbia calophylla* (marri) on less leached soils (Beard 1990). This subregion is recognised as a biodiversity hotspot and contains a wide variety of endemic flora and vegetation types.

Regional variations in native vegetation can be further classified based on regional vegetation associations. Heddle *et al.* (1980) mapping shows the site as comprising the 'Southern River Complex', which is described as comprising open woodland of *Corymbia calophylla - Eucalyptus marginata - Banksia* spp. with fringing woodland of *Eucalyptus rudis - Melaleuca rhaphiophylla* along creek beds. This complex was determined to have 18.43% remaining in 2018, of which 1.37% is under formal protection (Government of Western Australia 2019).

More recent Beard *et al.* (2013) mapping shows the site comprises vegetation association 'Bassendean_1001'. This association is described as 'low forest, woodland or low woodland with scattered trees' of '*Eucalyptus marginata*, *Banksia* spp., *Allocasuarina* spp.' (Beard *et al.* 2013). 'Bassendean_1001' association has 22% of its pre-European extent remaining on the Swan Coastal Plain with 2.8% protected for conservation purposes (Government of Western Australia 2018).

Studies have indicated that the loss of biodiversity caused by habitat fragmentation is significantly greater once a habitat type falls below 30% of its original extent (Miles 2001). The national objectives and targets for biodiversity conservation established an objective of retaining 30% of the original extent of each vegetation complex (Environment Australia 2001). However, a lower objective of 10% is applied in 'constrained urban areas' such as the Swan Coastal Plain (Ministry for Planning 1995; EPA 2008). The percentage remaining of the 'Southern River Complex' and the 'Bassendean_1001' association fall below the 30% retention objective, but above the 10% applied in constrained areas.

2.3.1.2 Plant communities

A flora and vegetation assessment to the standard required of a 'detailed' survey in the Environmental Protection Authority's (EPA's) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) was undertaken by Emerge Associates on 15 October and 4 December 2020 and 6 August, 6 September, 5 October and 3 November 2021 (Emerge Associates 2022b) (**Appendix B**) across the site. Vegetation within the site was determined to be representative of eight plant communities including cleared/planted vegetation, as described in **Table 1** and shown in **Figure 4**.

The total area of the identified native plant communities is approximately 11 ha or 42.3% of the site. The remainder of the site (15 ha or 57.7% of the site) comprises cleared or non-native vegetation with buildings, bare soil, weeds, or planted vegetation. An additional 0.45 ha (2%) comprises open water and was not mapped as a plant community.

Table 1: Description and extent of plant communities identified within the site

Plant community	Description	Area (ha)
BaBm	Low open woodland of *Banksia spp., Eucalyptus todtiana* and *Nuytsia floribunda* over shrubland of *Kunzea glabrescens, Xanthorrhoea spp, Macrozamia riedlei* and *Melaleuca thymoides* over low shrubland of *Scholtzia involucrata*, *Adenanthos obovatus, Bossiaea eriocarpa* and *Eremaea pauciflora* var. *pauciflora* over forbland of *Phlebocarya ciliata, Patersonia occidentalis, Lyginia* spp., *Dasypogon bromeliifolius, Lomandra* spp. and **Ursinia anthemoides* over open to closed tussock grassland **Ehrharta calycina* and **Briza maxima*.	6.12
KgB	Low open woodland of *Banksia* spp. and closed tall shrubland of *Kunzea glabrescens* over low sparse shrubland of *Xanthorrhoea brunonis, Hibbertia subvaginata* and *Bossiaea eriocarpa* over open forbland of *Dasypogon bromeliifolius, Patersonia occidentalis, Lyginia imberbis* and *Phlebocarya ciliata*.	0.57
KgBM	Open woodland *Banksia attenuata* and *Melaleuca preissiana* over tall shrubland of *Kunzea glabrescens* over shrubland of *Xanthorrhoea* spp., *Regelia ciliata, Melaleuca trichophylla, Hypocalymma angustifolium* and *Pericalymma ellipticum* over forbland of *Phlebocarya ciliata, Lyginia* spp., *Hypolaena exsulca, Evandra pauciflora* and *Dasypogon bromeliifolius*.	0.96
MKg	Low open woodland of *Melaleuca preissiana* over tall shrubland *Kunzea glabrescens* over low shrubland *Hypocalymma angustifolium*, *Regelia ciliata*, *Verticordia lindleyi* subsp. *lindleyi* (P4), *Boronia dichotoma* and *Euchilopsis linearis* over open forbland *Stylidium brunonianum, Hypolaena pubescens* and *Schoenus efoliatus* (or understorey absent in degraded areas).	0.61
AsRc	Sparse woodland of *Melaleuca preissiana* and **Eucalyptus camaldulensis* over closed shrubland of *Astartea scoparia*, *Regelia ciliata* and *Melaleuca teretifolia* with open vineland of *Cassytha racemosa* over sparse low shrubland of *Latrobea tenella* and *Euchilopsis linearis* over sparse forbland *Pterostylis vittata* and *Hypolaena exsulca.*	0.16
Mr	Open to closed tall shrubland of *Melaleuca rhaphiophylla* and *Melaleuca teretifolia* with open vineland of *Cassytha racemosa* over closed tussock grassland of *Typha domingensis* and pasture weeds.	0.38
ME	Open forest of *Melaleuca preissiana, Eucalyptus rudis* and/or **Eucalyptus camaldulensis* over open to closed shrubland of *Melaleuca rhaphiophylla, M. lateritia* and *M. teretifolia* over grassland to closed grassland of pasture weeds.	2.25
Cleared/Planted	Heavily disturbed areas comprising weeds with occasional native shrubs and forbs and planted vegetation**.**	15.0

2.3.1.3 Vegetation condition

In accordance with the methodologies outlined by Keighery (1994), the condition of the vegetation across the site was determined to range from 'completely degraded' to 'excellent', with the most intact native vegetation located in the south-western half of the site. The extent of vegetation by condition category is detailed in **Table 2** and shown in **Figure 5**.

Table 2: Vegetation condition categories within the site

Condition category (Keighery (1994))	Size (ha)
Pristine	0
Excellent	2.02
Very good	3.62
Good	0.76
Degraded	4.44
Degraded – completely degraded	0.49
Completely degraded	15.0

As shown in **Table 2**, 6.4 ha of 26.3 ha (or 24%) of vegetation within the site is in 'Good' or better condition.

2.3.1.4 Threatened and Priority Ecological Communities

An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a unique habitat. An ecological community's structure, composition and distribution are influenced by environmental factors such as soil type, position in the landscape, altitude, climate, and water availability (DAWE 2020b).

A 'Threatened Ecological Community' (TEC) is an ecological community that is recognised as rare or under threat and therefore warrant special protection. Selected TECs are afforded statutory protection at a Commonwealth level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). TECs listed under the EPBC Act are categorised as either 'critically endangered', 'endangered' or 'vulnerable'.

Within Western Australia, state listed TECs are statutorily protected through the Biodiversity Conservation Act 2016 (BC Act) and BC Regulations. While no TECs are currently listed for protection under the BC Act, it is likely they will be listed at a future date, requiring future Ministerial authorisation where a proposed development is likely to disturb or modify an identified TEC. In the meantime, TECs are determined from a ministerial list for the purposes of Part IV and and Part V of the EP Act.

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

A detailed Floristic Community Type (FCT) analysis and assessment against the specific diagnostic criteria has confirmed that the structure and composition of plant communities **BaBm, BKg** and **BaMpKg** within the site are representative of the 'Banksia Woodlands of the Swan Coastal Plain' TEC, (herein referred to as the 'Banksia woodland TEC') listed as 'endangered' under the EPBC Act. The location of the banksia woodland TEC within the site is shown in **Figure 6**.

In addition, the Department of Biodiversity and Attraction (DBCA's) list of priority ecological communities (PEC's) indicates that the description, area and condition thresholds that apply to the Commonwealth-listed TEC also apply to the 'banksia woodlands of the Swan Coastal Plain' PEC (DBCA 2020b). Therefore, a total of 7.64 ha of this PEC occurs within the site. The location of the banksia woodland PEC within the site is shown in **Figure 6**.

2.3.1.5 Significant flora

Certain flora species that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, flora species may be listed as 'threatened' pursuant to the EPBC Act. At a State level, plant species may also be classed as 'threatened' under the BC Act. Species that are potentially rare or threatened meet the criteria for near threatened; or have recently been removed from the threatened species list are classed as 'priority' flora species. However, priority flora species are not afforded specific statutory protection.

No threatened flora species were recorded within the site, and given the extent of survey now undertaken there are not expected to be any threatened flora species occurring within the site. As noted in the *Flora and Vegetation Assessment* (Emerge Associates 2022b) the survey was expended to coincide with the optimal survey period for one threatened flora species, *Drakaea elastica. D. elastica* is listed as 'critically endangered' in Western Australia and 'endangered' under the EPBC Act. Whilst *D. elastica* flowers in late September to October or November, the optimal survey period is when the bright green leaf is visible in July and/or August (DEC 2009). Potential suitable habitat for *D. elastica* occurs within the site in plant community **BKg** (refer **Section 2.3.1.2**). Multiple DBCA records for *D. elastica* occur in the wider region, with the closest being approximately 3 km northeast of the site. Based on the additional survey this species was not identified within the site where suitable habitat occurs that is likely to be disturbed by development.

Three priority flora species were recorded within the survey area, *Acacia lasiocarpa* var. bracteolata long peduncle variant (G.J. Keighery 5026) (P1), *Verticordia lindleyi* subsp. *lindleyi* (P4) and *Jacksonia gracillima* (P3). All were located within the western portion of the site in relatively intact native vegetation (**Figure 6**).

2.3.2 Terrestrial Fauna

2.3.2.1 Desktop assessment

A total of 523 fauna species were identified from database searches as occurring or potentially occurring within 10 km of the site as listed in Appendix D of the *Basic Fauna and Targeted Black Cockatoo Assessment* (Emerge Associates 2021a) provided in **Appendix C.**

Of these species, 78 are conservation significant, including 33 threatened, 17 priority, 26 migratory fauna and 2 other specially protected species as listed in Appendix E of the *Basic Fauna and Targeted Black Cockatoo Assessment* (**Appendix C**).

2.3.2.2 Field survey

A terrestrial vertebrate fauna assessment to the standard required of a 'basic' fauna survey and a 'targeted' black cockatoo survey was undertaken by Emerge Associates (**Appendix C**) across the site.

The assessment was carried out in accordance with the EPA's technical guidance (EPA 2020) and the *Environment Protection and Biodiversity Conservation Act* black cockatoo referral guidelines (DSEWPaC 2012b).

Seven fauna habitats have been identified within the site during the assessment (Emerge Associates 2021a), with the highest value habitat being in the south western portion due to the presence of relatively intact native vegetation. A description and the area of each habitat is provided in **Table 3**, with locations shown in **Figure 7**.

Table 3: Fauna habitats identified within the site

Fauna habitat classification	Description	Area (ha)
Woodland	Low open woodland generally consisting of overstorey trees of *Banksia* spp., *Eucalyptus todtiana*, *Nuytsia floribunda*, *Melaleuca preissiana*, **Eucalyptus camaldulensis*, over shrubland of *Kunzea glabrescens, Xanthorrhoea spp, Macrozamia riedlei* and *Melaleuca thymoides* and forbland species including *Dasypogon bromeliifolius* and *Hypolaena exsulca* (or understorey absent in degraded areas).	7.84
Woodland – limited understorey	Low open woodland of *Banksia* spp. and closed tall shrubland of *Kunzea glabrescens* over low sparse shrubland of *Xanthorrhoea brunonis, Hibbertia subvaginata* and *Bossiaea eriocarpa* over open forbland of *Dasypogon bromeliifolius, Patersonia occidentalis, Lyginia imberbis* and *Phlebocarya ciliata*.	0.57
Open melaleuca woodland	Open to closed tall shrubland of *Melaleuca rhaphiophylla* and *Melaleuca teretifolia* with open vineland of *Cassytha racemosa* over closed tussock grassland of *Typha domingensis* and pasture weeds.	0.38
Closed melaleuca forest	Open forest of *Melaleuca preissiana, Eucalyptus rudis* and/or **Eucalyptus camaldulensis* over open to closed shrubland of *Melaleuca rhaphiophylla, M. lateritia* and *M. teretifolia* over grassland to closed grassland of pasture weeds.	2.25
Native and non-native eucalypts	Scattered native eucalypts including *Eucalyptus rudis* and planted non-native eucalypts including *E. camaldulensis* and *E. botryoides.*	1.39
Waterbody	Temporary or permanent areas of water within wetlands.	0.45
Predominantly cleared area	Heavily disturbed areas comprising weeds with occasional native shrubs and forbs and planted vegetation.	13.65

2.3.2.3 Conservation significant fauna

Certain fauna taxa that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, fauna taxa may be listed as 'threatened' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

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

A total of 18 native and three introduced fauna species were recorded during the field survey, including one species of conservation significance, *Isoodon fusciventer* (quenda) (P4). In addition, four threatened, six priority, three migratory and one specially protected fauna species were considered to possibly occur within the site as listed in **Table 4**.

The remainder of the conservation significant fauna species identified in the desktop assessment (63 species) are considered unlikely to occur in the site due to lack of suitable habitat or because the site lies outside of the species known distribution.

Table 4: Summary of conservation significant fauna species recorded or deemed possible or likely to occur within the site

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
Birds					
Apus pacificus	Pacific swift	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Johnstone and Storr 1998).	**Possible:** May opportunistically occur in or fly over the site on commute or while searching for prey.
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU	Eucalypt and Corymbia forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding *Corymbia calophylla*, *Eucalyptus mar*ginata, introduced **Melia azedarach* and *Eucalyptus* spp. trees (Johnstone and Storr 1998).	**Likely:** Several records of the species in close proximity (<2 km) to the site and there is foraging habitat within the site.
Calyptorhynchus baudinii	Baudin's cockatoo	EN	EN	Mainly eucalypt forests. Attracted to seeding *Corymbia calophylla*, *Banksia* spp., *Hakea* spp., and to fruiting apples and pears (Johnstone and Storr 1998).	**Possible:** Species known to occur within the broader area and there is limited foraging habitat within the site.
Calyptorhynchus latirostris	Carnaby's cockatoo	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of *Pinus* spp. Attracted to seeding *Banksia* spp., *Dryandra* spp., *Hakea* spp., *Eucalyptus* spp., *Corymbia calophylla, Grevillea* spp., and *Allocasuarina* spp. (Johnstone and Storr 1998).	**Likely:** Historical records within and adjacent to the site and there are areas of foraging habitat within the site.
Falco peregrinus	*Peregrine falcon*	OS	-	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	**Possible:** May opportunistically occur in or fly over the site on commute or while searching for prey.
Oxyura australis	*Blue-billed duck*	P4	-	Mainly deeper freshwater swamps and lakes; occasionally saltlakes and estuaries freshened by flood waters (Johnstone and Storr 1998).	**Possible:** May utilise the wetlands within the site whilst water is present.

Table 4: Summary of conservation significant fauna species recorded or deemed possible or likely to occur within the site (continued)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
Birds					
Plegadis falcinellus	*Glossy Ibis*	MI	MI	Well-vegetated wetlands, wet pasture, ricefields, floodwaters, floodplains, brackish or occasionally saline wetlands, mangroves, mudflats and occasionally dry grassland (Pizzey & Knight 2012).	**Possible:** May utilise the wetlands within the site whilst water is present.
Tringa hypoleucos	*Common sandpiper*	MI	MI	Edge of sheltered waters salt or fresh, e.g. estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations where low perches are available (Johnstone & Storr 1998).	**Possible:** Small numbers of occasional transient individuals may utilise the site when wetlands have water.
Invertebrates					
Idiosoma sigillatum	*Swan Coastal Plain shield-backed trapdoor spider*	P3	-	Widely distributed in sandy areas on the Swan Coastal Plain and on Rottnest Island (Prince 2003).	**Possible:** Suitable habitat present
Leioproctus contrarius	*A short-tongued bee*	P3	-	Life history and habits are poorly documented/ unknown. It has been recorded only on flowers of Goodeniaceae and possibly Lechenaultia stenosepala (Bamford 2003).	**Possible:** Historic records within the broader area and one Goodeniaceae species present within the site
Neopasiphae simplicior	*A short-tongued bee*	EN	CR	This species of native bee has been collected on flowers of *Goodenia filiformis, Lobelia tenuior, Angianthus preissianus* and *Velleia* sp. (Houston 2000).	**Possible** Historic records within the broader area, and *Lobelia tenuior* present within the site
Mammals					
Isoodon fusciventer	Quenda	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012).	Recorded
Notamacropus irma	*Western brush wallaby*	P4	-	Dry sclerophyll forest, *Banksia* spp. woodlands and shrublands, typically favouring dense low vegetation that provides dense cover (Christensen and Strahan 1983).	**Possible** Recent records of a population within the broader area

Table 4: Summary of conservation significant fauna species recorded or deemed possible or likely to occur within the site (continued)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
Reptiles					
Lerista lineata	Perth slider	P3	-	Sandy coastal heath and low scrubland. *Banksia* spp. woodland, *Eucalyptus gomphocephala* open woodland over deep sands, and coastal dunes immediately adjacent to the beach.	**Possible:** Historic records adjacent to the site and there is potentially suitable habitat within the site.
Neelaps calonotos	Black-striped snake	P3	-	Coastal and near-coastal dunes, sandplains supporting heathlands and *Banksia* spp. woodlands.	**Possible:** Historic records adjacent to the site and there is habitat within the site.

2.3.2.4 Quenda

One species of conservation significance, quenda, was recorded within the site. This species is likely to persist in the **woodland** habitat where the understorey shrubland layer is present, as it provides suitable cover for the species. This species is likely to utilise the site as part of a larger home range, extending to the south-east where areas of contiguous native vegetation are present.

2.3.2.5 Black cockatoo habitat

The Swan Coastal Plain is known to provide habitat for three threatened species of black cockatoo, including *Calyptorhynchus latirostris* (Carnaby's cockatoo), *Calyptorhynchus baudinii* (Baudin's cockatoo) and *Calyptorhynchus banksii naso* (forest red-tailed black cockatoo) (referred to herein collectively as 'black cockatoos').

Important black cockatoo habitat includes the following:

- Foraging habitat: Vegetation that contains known foraging plant species for black cockatoos.
- Breeding habitat: Trees that contain hollows that are suitable for breeding black cockatoos. These must generally be located within 7 km of food and water resources (Saunders 1990).
- Roosting habitat: Groups of large trees that are located within 6 km of water and food resources, with overlapping foraging ranges within 12 km (Shah 2006; Le Roux 2017).

While black cockatoos were not actually observed within the site, their likelihood of occurrence within the site is likely or possible, and therefore requires more detailed consideration.

Foraging habitat

Foraging habitat was identified by assessing vegetation in the site for plant species known to provide food for black cockatoos (Davies 1966; Saunders 1980; Johnstone and Storr 1998; Johnstone and Kirkby 1999; Groom 2011; Johnstone *et al.* 2011; DSEWPaC 2012a).

Foraging habitat was classified as providing a 'high', 'moderate' or 'low' value resource based on the proportion of 'primary' or 'secondary' food plants present as outlined in **Table 5**. A detailed description of the methodology of the value is found in Section 3.2.2.3 of the *Basic Fauna and Targeted Black Cockatoo Assessment* (Emerge Associates 2021a).

Table 5: Foraging value categories

Value	Definition
High	Greater than 50% primary food plants
Moderate	Greater than 10% to 50% primary food plants
Low	10% or less primary food plants^
Nil	No primary or secondary food plants

^includes areas with 1-100% secondary food plants

The extent of foraging habitat by value classification is detailed in **Table 6**. In summary, a total of 4.12 ha of foraging habitat was identified for Carnaby's cockatoo (see **Figure 8**), 3.90 ha for Baudin's cockatoo (see **Figure 9**) and 4.36 ha for forest red-tailed black cockatoo (see **Figure 10**). The amount of 'High' or 'Moderate' foraging value mapped within the site was very low (less than 0.1 ha) for both Baudin's cockatoo and forest red-tailed black cockatoo (see **Figure 9** and **Figure 10**).

Table 6: Foraging habitat value

Foraging value	Black cockatoo species and foraging habitat area (ha)		
	Carnaby's	Baudin's	Forest red-tailed
High	1.57 (38%)	0	0.08 (2%)
Moderate	1.18 (28%)	0	0
Low	1.37 (34%)	3.97 (100%)	4.28 (98%)
Total	**4.12**	**3.97**	**4.36**

Breeding habitat

One black cockatoo habitat tree was recorded within the site as shown in **Figure 8**. The habitat tree was a *Eucalyptus rudis* (flooded gum) and did not contain hollows suitable for breeding by black cockatoos.

Roosting

No black cockatoos were observed during the survey and no evidence of roosting was recorded. The site is located within the expected range of all three species and suitable habitat occurs within the site and local area, so it is possible that all three species may utilise the site at varying times. Therefore, the key black cockatoo habitat value/consideration within the site is the occurrence of suitable foraging habitat for Carnaby's black Cockatoo.

2.3.3 Bush Forever

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

No *Bush Forever* sites are present within the site. *Bush Forever* Site 413 (Balannup Lake and Adjacent Bushland, Southern River/Forestdale) is present to the north of the site. *Bush Forever* Site 342 (Anstey/Keane Dampland and Adjacent Bushland, Forestdale) is present to the south-east of the site. The location of *Bush Forever* Sites 413 and 342 are shown in **Figure 11**.

2.3.4 Ecological linkages

Ecological or biodiversity linkages are described as areas of native vegetation which provide a corridor or linkage (typically linear) between patches of vegetation to allow movement of flora and fauna and their genetic material through the landscape, helping to maintain metapopulations.

Ecological linkages are often continuous or near continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

The Perth Biodiversity Project, supported by the Western Australia Local Government Association (WALGA), has identified, and mapped regional ecological linkages within the Perth Metropolitan Region (PBP 2007).

As shown in **Figure 11**, no ecological linkages are present near the site.

2.3.5 Environmentally sensitive areas

Environmentally Sensitive Areas (ESAs) are prescribed under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* and have been identified to protect native vegetation values of areas surrounding significant, threatened, or scheduled flora, vegetation communities or ecosystems.

Within an ESA none of the exemptions under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* apply and would indicate that the site is likely to support significant environmental values. However, exemptions under Schedule 6 of the *Environmental Protection Act 1986* (EP Act) still apply, including any clearing in accordance with a subdivision approval under the *Planning and Development Act 2005* (a recognised exemption under the Schedule 6 of the EP Act 1986).

One ESA is present over the entirety of the site (see **Figure 11**), and it is unclear what environmental value this is associated with. The ESA is unlikely to pose an issue for the future development of the site for residential purposes as any clearing would occur under subdivision exceptions; but notwithstanding this, detailed flora and vegetation and fauna surveys have established the key values within the site.

2.4 Wetlands

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

2.4.1 Historical wetland assessment

As part of a historical MRS Amendment 1274/57 (discussed further in **Section 3.1**), a request was referred to the Department of Parks and Wildlife (DPAW) to review the wetland mapping of the *Geomorphic Wetlands Swan Coastal Plain dataset* (DBCA 2020a) (the *wetland dataset*) upon advice from 360 Environmental.

DPAWs advice pertaining to this historical assessment is provided in **Appendix D**. At the time of this assessment, Lots 601 and 200, as well as part lot; 602, 201 and 200 were identified as a resource enhancement category wetland (REW) (UFI 14404) and Lots 603-606 and part lots; 602, 200 and 201 were identified as a Multiple Use Category Wetland (MUW) (UFI 14879) (refer to Figure 1 of **Appendix E**).

DPAW concluded that there was sufficient information to warrant modification of the *wetland dataset*. In summary, DPAW concluded the following:

- The majority of the REW (UFl 14404) should be reclassified to a MUW.
- The vegetated portion in the western portion of UFI 14404, dominated by *M. rhaphiophylla* and *M. preissiana* low open woodland over *Melaleuca teretifolia, Melaleuca viminea, Kunzea micrantha* subsp. *micrantha* and *Regelia ciliata* shrubland over *Lepidosperma londitudinale* and *Chaetanthus aristatus* open sedgeland, was commensurate with a REW.
- The vegetated portion in the southern portion of UFI 14404, dominated by *M. preissiana* low woodland over *R. ciliata* and *A. scoparia* heath over *L.ongitudinale* open sedgeland, was commensurate with a conservation category wetland (CCW) and will be incorporated into UFI 14880 (located east of Skeet Road).

The *wetland dataset* (DBCA 2020a) was subsequently updated to reflect the above and is reflective of the currently available *wetland dataset* as discussed below in **Section 2.4.2**.

2.4.2 Current wetland mapping

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

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

The Ramsar site 'Forrestdale and Thomsons Lakes' (ID 246) is located 14 km south of the site.

A review of the *wetland dataset* (DBCA 2020a) indicated that the site supports the following geomorphic wetlands:

- One CCW (UFI 14880) occurs in a small area in the south-eastern portion of the site and extends across Skeet Road to the south east of the site.
- Two MUWs (UFI 14879 and UFI 13347) are present within the western half of the site, and an additional MUW (UFI 14404) is present over the eastern half of the site.
- One REW (UFI 15946) also exists within Lot 600 (i.e. not within the site) and extends into Balannup Road.

The extent of the currently mapped geomorphic wetlands and their management categories in the vicinity of the site are shown in **Figure 12**.

2.4.3 Proposed wetland mapping

As part of the MRS amendment request for the lifting of the 'Urban Deferred' zone, the DBCA reviewed the *Detailed Flora and Vegetation Assessment* undertaken for the site (Emerge Associates 2021c). DBCA indicated the current DBCA (2020a) *Geomorphic Wetlands of the Swan Coastal Plain* dataset may not align with on-ground values, notwithstanding their recent review and reclassification at the original MRS amendment stage.

At the request of DBCA, representatives from the wetlands branch and an ecologist from Emerge conducted a site visit in March 2021. Following the site visit, DBCA requested that a detailed 'wetland survey and evaluation' was undertaken across four areas of interest within the site. The findings from the evaluation are discussed further in **Section 2.4.3.1**.

2.4.3.1 Wetland survey and evaluation

Ecologists from Emerge visited the survey area in May 2021 to conduct further field surveys. The survey consisted of flora and vegetation sampling and wetland data collection.

The wetland survey and evaluation (**Appendix E**) concluded the following in relation to on-ground wetland values:

- Southern CCW - An existing CCW (UFI 14880) mapped within the southern portion of the site within Lot 200 was confirmed to occur, albeit with a minor extension to its boundary recommended.
- Western CCW - An additional CCW (not currently mapped under the *Wetland dataset* (DBCA 2020a)) is located in the western portion of the site within Lot 605.
- Northern REW - An existing REW (UFI 15946) is located outside of the site to the north, within Lot 600. Minor remapping of this wetland boundary was recommended.
- Two 'potential REWs' were identified within parts of Lots 600,601, 602 and 604.

The *Wetland Assessment* (Emerge Associates 2021c) is provided in **Appendix E**.

DBCAs evaluation of the *Wetland Assessment* (Emerge Associates 2021c) confirmed that the 'potential REW' within Lots 600 and 601 is considered to be a MUW. DBCA confirmed the 'potential REWs' within Lot 602 and 604 to be REW, although acknowledged their marginal condition and limited values (see correspondence provided in **Appendix F**).

Both Emerge and DBCA concur that the potential REW areas are disturbed, historically modified and comprise low ecological values compared to the other wetlands within the site. Restoration of these areas would require intensive works over an extended period of time.

Based on the aforementioned, the proposed geomorphic wetland boundaries that align with the on-ground values and incorporate DBCAs comments are shown in **Figure 13**. It is expected that the formal Geomorphic Wetlands of the Swan Coastal Plain dataset will be updated to reflect these modifications in due course.

2.5 Hydrology

2.5.1 Groundwater

The *Water Register* (DWER 2021c) indicates that aquifers beneath the site are the Superficial Swan (unconfined), the Leederville (confined) and the Yarragadee north (confined).

A review of the regional groundwater contours shown in the *Perth Groundwater Map* (DWER 2021) indicates that groundwater flows in an easterly direction across the site, from approximately 22.7 m AHD, down to 22.2 m AHD (i.e. within 0 to 2 m below the natural surface) as shown in **Figure 14**.

Groundwater level monitoring was undertaken across the site by 360 Environmental (2015) in 2014-2015 and again by Emerge in 2021. Results were calibrated to a nearby Department of Water and Environmental Regulation (DWER) bore. The calibrated maximum groundwater levels (MGL) within the site were calculated to be 22.25 mAHD to 22.68 mAHD (i.e. 0.65 m to 1 m below the natural surface) and MGL contours are shown in **Figure 14**.

2.5.2 Surface water

The Department of Water and Environmental Regulation (DWER) hydrography dataset (DWER 2018) shows a perennial lake present within Lot 201 and two earth dams present within Lots 601 and 602. These three features are located within a larger area that is mapped as an 'area subject to inundation' that extends over most of the eastern portion of the site (DWER 2018) (**Figure 14**).

The site is also located within the surface water drainage catchment of the Forrestdale Main Drain (FMD), which has a total catchment area of 5,400 ha (JDA 2014). This catchment contains various local authority open and piped drainage, overland flow paths and Water Corporation open drains (JDA 2014).

2.5.3 Public Drinking Water Source Areas

Public Drinking Water Source Areas (PDWSAs) are proclaimed by DWER to protect identified drinking water sources, including surface water and groundwater sources (DoW 2009). They are proclaimed

under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* or the *Country Areas Water Supply Act 1947* as Water Reserves, Catchment Areas or Underground Water Pollution Control Areas.

The site is not located within a proclaimed PDWSA.

2.6 Heritage

2.6.1 Aboriginal heritage

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

In accordance with the *Aboriginal Heritage Due Diligence Guidelines* (DAA 2013), a search of the AHIS online database (DAA 2021) was undertaken. The results of this search indicated that the site is not mapped within any identified Registered Aboriginal Heritage Sites or Other Heritage Places.

Overall, given the extent of historic disturbance within the site (including removal of native vegetation and construction) and the predominantly 'built' nature of the site, the risk of disturbing Aboriginal heritage sites is low.

2.6.2 Non-indigenous heritage

A desktop search of the Australian Heritage Database (DAWE 2021), the State Heritage Office database (Heritage Council 2021) and the City of Armadale Heritage List (City of Armadale 2008) has indicated there are no registered heritage sites located within the site.

2.7 Potential site contamination

A review of the DWER *Contaminated Sites Database* (DWER 2021) confirms that none of the properties located within the site are shown on the Database (DWER 2021). Lot 600 Balannup Road (located directly adjacent to the north of Lot 601) is shown on the data base and is classified as '*Contaminated - restricted use*' due to the presence of asbestos containing material (ACM) in the soil (see **Figure 15**). This property is located outside of the site and information available for this property has identified no evidence of contamination that would impact upon the contamination status of site.

The majority of the properties that comprise the site (Lots 601, 602, 603, 604, 605 and 606) have been used for rural residential purposes and are therefore not identified as supporting a potentially contaminating activity.

Lot 201 has been used for non-residential purposes which has included stockpiling and storage of various materials. Whilst no evidence of contamination has been observed within Lot 201 the presence of various stockpiles of unknown materials could pose a potential risk of contamination which needs to be further considered.

Lot 202 is a currently operational poultry farm. This land use is identified by the DWER as a potentially contaminating land use.

2.8 Surrounding land use considerations

2.8.1 Ranford Road Traffic Noise

Ranford Road is situated to the north of Lot 202 and 600, and is identified as a 'strategic freight and/or major traffic route' (see **Figure 15**) and therefore State Planning Policy 5.4 *Road and Rail Noise* (SPP 5.4) applies to the site.

The purpose of SPP 5.4 is to minimise the adverse impact of road and rail noise on noise-sensitive land use and/or development within the specified trigger distance of strategic freight and major traffic routes and other significant freight and traffic routes.

2.8.2 Kennel Buffer Special Control Area

Within the City of Armadale, registered kennels are located within a 500 m radius of the site, hence most of the site is located within the City of Armadale's Kennel Buffer, as identified in Special Control Area Map 1 of TPS 4 (see **Figure 15**). The Kennel Buffer extends in a 500 m radius around designated kennel areas to allow for consideration of noise from barking dogs in relation to any proposed land uses within close proximity to existing kennels.

Within the City of Gosnells (located north of Ranford Road), there are also registered kennels located within a 500 m radius of the site (located towards the east) (see **Figure 15**).

Due to the range and proximity of registered kennels as well as Ranford Road noise considerations, a noise impact assessment has been undertaken to address any noise impact considerations and mitigations requirements necessary. This is discussed further in **Section 4.7.3**.

2.9 Bushfire hazards

The entirety of the site is located within a 'bushfire prone area' under the state-wide *Map of Bush Fire Prone Areas* prepared by the Office of Bushfire Risk Management (OBRM 2019) and is shown in **Plate 3** below. The identification of a site within an area declared as bushfire prone necessitates that further assessment of the determined bushfire risk of the proposed development is to be undertaken in accordance with *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) (WAPC 2015a) and the *Guidelines for Planning in Bushfire Prone Areas Version 1.4* (the Guidelines) (DPLH & WAPC 2021). This has been addressed through the preparation of a *Bushfire Management Plan* (Emerge Associates 2022a)

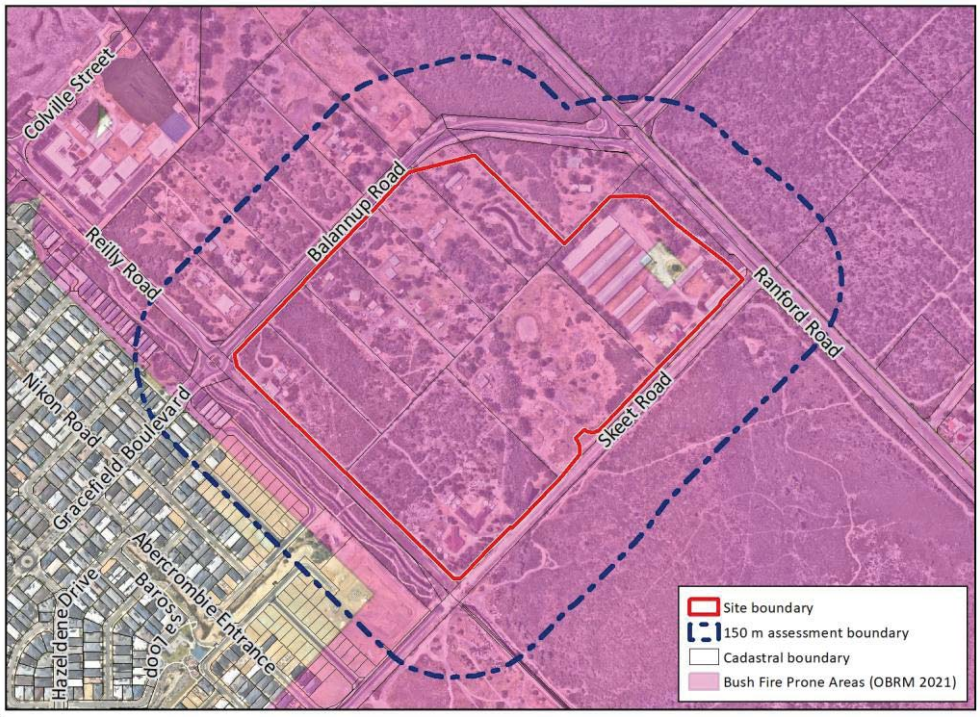


Plate 3: Areas within and surrounding the site identified as 'bushfire prone areas' (as indicated in purple) under the state-wide Map of Bush Fire Prone Areas (OBRM 2021).

All areas within the site and surrounding 150 m have been assessed for the presence of bushfire prone vegetation and have been classified as per Table 2.5 of *Australian Standard 3959:2018 Construction of buildings in bushfire prone areas* (AS 3959) (Standards Australia 2018) to determine the associated bushfire hazard rating levels and bushfire risk.

Whilst the majority of the site has historically been cleared, bushfire hazards within the site exist predominantly within the southern and northern lots (associated with remnant vegetation), as well as moderate to large patches within the remaining lots (**Figure 16**).

3 Historic planning and environmental assessment context

3.1 Historical planning context

Yolk Property Group has entered into a contract of sale with the owners of Lot 202 (the poultry farm operator), which confirms that the poultry farm will be permanently closed prior to any future dwellings on the site being occupied. On this basis, a request was submitted to the WAPC to lift the 'Urban Deferred' zone (which applies across the whole site) to allow the further planning for residential subdivision and development to proceed.

Transferring land from the 'Urban Deferred' zone to the 'Urban' zone does not constitute an amendment to a region planning scheme to which the environmental assessment of amendments under section 48A of the *Environmental Protection Act 1986* apply; therefore, the lifting of Urban Deferment was not referred to the EPA.

However, MRS Amendment 1274/57, which sought to rezone the Balannup/Skeet Road Precinct (including the site) from 'Rural' to 'Urban deferred' was referred to the EPA. The EPA determined that the amendment did not require formal assessment but provided advice and recommendations regarding the environmental and planning issues to be considered prior to any future lifting of the 'Urban Deferred' zone. These recommendations are discussed further in **Section 3.4.1.1**.

More recently, the City of Armadale initiated Amendment 121 which was referred to the EPA. The EPA determined that the amendment did not require assessment and was comfortable with the scheme provisions that were proposed by the City of Armadale to be included in the scheme for the site. This is discussed further below in **Section 3.4.1.1**.

3.2 Proposed Structure Plan

A draft structure plan Hex Design and Planning (2021) was provided to the EPA initially for information as part of the referral of Amendment 121 and has since been modified (now referred to as the 'Structure Plan') to respond to the EPA public comments. Modifications to the draft structure plan have resulted in the retention of vegetation specifically the banksia woodland TEC and priority flora species and finalisation of wetland boundaries, as currently depicted in the revised Structure Plan, provided in **Appendix A.**

The Structure Plan prepared by (Hex Design and Planning 2022) extends over part Lot 601 Balannup Road, Lots 602-606 Balannup Road, Lots 200 and 201 Skeet Road, and part Lot 202 Skeet Road, Harrisdale. The Structure Plan proposes the following urban land uses and/or accommodates for the following:

- Residential lots/dwellings
- Commercial development fronting Ranford Road
- Public open space (approximately 8.26 ha)
- Recreational facility
- Retirement facility
- Retention of various wetlands, including the provision of wetland buffers
- Western Power easement

- Internal road networks.

The landscape report is provided in **Appendix H**, and demonstrates how the three large areas of POS (with a combined area of 8.26 ha) would be treated and managed to respond to the site's environmental values.

For ease of reference, under the Structure Plan the three areas of POS have been referred to as 'POS west', 'POS Central' and 'POS North', and is shown in **Figure 17**. The largest POS area (4.06 ha), POS west, will be allocated solely to conservation, which will enable the retention/enhancement of a number of significant environmental values outlined in **Section 2** (this is discussed further in **Section 4**).

3.3 Future planning and approvals

Following the lifting of the 'Urban Deferred' zone, the progression of the local scheme amendment (Amendment 121 as discussed further in **Section 3.4.1.1**) and the endorsement and approval of the final Structure Plan by the WAPC, urban development of the site would be progressed through subdivision and/or development approvals (collectively referred to as 'future planning stages').

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

- Acid sulfate soils
- Flora and vegetation
- Native fauna
- Wetlands
- Hydrology
- Potential site contamination
- Bushfire risks
- Noise impacts.

The WAPC can impose conditions on subdivision applications to ensure subdivision incorporates all the appropriate environmental management measures. These conditions are usually determined in accordance with WAPC's *Model Subdivision Conditions Schedule* (WAPC and DPLH 2021) and include those relating to environmental considerations. It is envisaged that there would be future subdivision conditions applied for any subdivision within the site, that would me the mechanism to manage environmental, hydrological and bushfire related requirements identified through the state planning process.

3.4 Environmental approvals

3.4.1 Environmental Protection Act 1986

3.4.1.1 Part IV - Section 48A and Section 38

As outlined in **Section 3.1**, MRS Amendment 1274/57 which sought to rezone the Balannup/Skeet Road Precinct (including the site) from 'Rural' to 'Urban Deferred' was referred to the EPA. The EPA

determined that the amendment did not require formal assessment but provided advice and recommendations prior to any future lifting of the 'Urban Deferred' zone. The environmental considerations outlined by the EPA are outlined in **Table 7**, along with the contextual site attributes (which were known at the time of the MRS Amendment proposal) and the associated recommendation by the EPA. A copy of the notice from the EPA is provided in **Appendix G**.

Table 7: Environment Protection Authority's environmental considerations regarding MRS Amendment 1274/57

Environmental factors to be addressed	EPA objective	Site context	EPA's specific recommendations	Factor discussed and mitigated
Human Health	The EPA has regard to noise, soil contamination, dust and odour in relation to human health across the proposed development.	• The majority of the site is within two district kennel buffer zones which extends 500 m. • The existing poultry industry may have environmental considerations such as noise, dust, odour and nutrients.	The EPA advises that arrangements to close the poultry farm and appropriate buffers to the kennels and Balannup Lake are to be finalised.	Refer to **Section 4.6** and **Section 4.8**
Hydrological Processes	The EPA's objective is to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.	• The Balannup Lake is located north of the subject land.	The EPA recommends that additional management measures be required to ensure that that there are no negative impacts to the surrounding Balannup Lake reserve.	Refer to **Section 4.5**
Flora and Vegetation	The EPA's environmental objective in regard to flora and vegetation is to protect and maintain biological diversity and ecological integrity.	• Bush Forever Site 413 is located north and Bush Forever Site 342 is located to the south and east of the subject land. • Remnant vegetation is located within the site.	The EPA recommends that additional management measures be required to ensure that that there are no negative impacts to the surrounding Bush Forever sites.	Refer to **Section 4.4** and **Section 4.5**
Terrestrial Fauna	The EPA's environmental objective in regard to terrestrial fauna is to protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	• State and commonwealth listed conservation significant fauna species were identified as potentially occurring within the site. • An ESA is located over a portion of the site.	No specific recommendations regarding terrestrial fauna were outlined by the EPA.	Refer to **Section 4.3** and **Section 4.4**

An assessment regarding how these impacts and other relevant environmental considerations can be addressed and mitigated in the proposed Structure Plan are discussed in **Section 4**.

A request for the rezoning of the affected land under the provisions of the City of Armadale TPS 4 from the 'Rural' zone to the 'Urban Development' zone has also been initiated (Amendment 121) and was referred to the EPA pursuant to Section 48A of the EP Act. The EPA determined that it did not need to assessment Amendment 121 and was comfortable with the scheme provisions proposed to be included by the City of Armadale to address the various environmental considerations.

The currently proposed scheme provisions are listed below in **Table 8**.

Table 8: Additional provisions applicable to subdivision and development associated with Amendment 121

Provision	Land Additional Provisions applicable to subdivision and development
72.1	Subdivision and development of land is to generally be in accordance with a structure plan prepared and approved pursuant to Part 4 of the Deemed Provisions of the *Planning and Development (Local Planning Schemes) Regulations 2015* (as amended).
72.2	In addition to standard requirements, the following plans are to be prepared by the applicant and approved by the City of Armadale as part of the Structure Plan: • Local Water Management Strategy, prepared in accordance with any relevant District Water Management Strategy, in consultation with the Department of Water and Environmental Regulation and Department for Biodiversity Conservations and Attractions and shall demonstrate to the satisfaction of the City that surface water drainage and groundwater conditions within the subject land will be managed in a manner that does not adversely impact significant wetlands or groundwater dependant ecosystems either within or surrounding the site; • An Acoustic assessment shall be prepared to address noise from traffic along Ranford Road, future commercial development and kennel noise; • An Environmental Management Plan shall be prepared, in consultation with the Department of Biodiversity, Conservation and Attractions to the satisfaction of the City of Armadale. The Environmental Management Plan shall address as a minimum, actions to prevent and manage impacts of urban development on vegetation identified for retention within the site and adjacent Bush Forever Sites, and be informed by a botanical survey undertaken during optimal flowering period to assess the potential presence of conservation significant flora.
72.3	The Structure Plan shall provide design and management responses for implementation through subdivision and development, addressing: • Acid sulphate soils; • Site contamination; • Identification and protection of significant landscape trees and features as per Local Planning Policy PLN 2.4 Landscape Feature and Tree Preservation, where possible; • Suitable wetland buffer distances that do not impact existing dwelling and outbuilding on Lot 606 Balannup Road, in accordance with the Environmental Management Plan; • Maximised retention of banksia woodland species within POS areas and within the area identified as excellent condition on Lot 200 Skeet Road, where possible. Any bushland POS area identified as being below excellent condition must be improved by the landowner to an excellent condition at the time the POS is vested to the City. In addition, the Environmental Management Plan must specify how the condition of the banksia woodland will be improved and managed at an excellent condition category to the satisfaction of the City. • Visual impact of noise attenuation measures. • Create an appropriate link between significant wetland and POS areas within the Structure Plan area.
72.4	At the subdivision stage, applications are to be prepared with, but not limited to the following plans: • Detailed Wetland and Buffer Management Plan (where applicable), consistent with provision 72.2(c) and prepared in consultation with the Department of Biodiversity, Conservation and Attractions and the Environmental Protection Authority to the satisfaction of the City of Armadale. The Detailed Wetland and Buffer Management Plan shall address as a minimum: o Buffers for sites subject of, and/or adjacent to, a Wetland and/or a Threatened Ecological Community; and, o How potential impacts to the wetlands from adjacent urban development will be managed. • A Midge and Mosquito Management Plan demonstrating how larvae will be kept to a minimum (non-nuisance levels) during and after development to the satisfaction of the City. • Prior to undertaking any earthworks or development of the land, the landowners shall demonstrate to the satisfaction of the City and the WAPC that primary production or filling has not occurred on the subject land, or, undertake a Soil Contamination Assessment of the land, at the landowner's cost to determine the presence or absence of soil contamination to the satisfaction of DWER. • Should any soil contamination be identified in the soil contamination assessment, a Site Remediation and Validation Report for the subject land shall be prepared at the landowner's cost by the developer/subdivider and remediation works shall be undertaken at the landowner's cost for all identified

	contamination and should be validated as being free of contamination above acceptance guidelines to the satisfaction of the DWER, prior to undertaking any earthworks or development of the land. • An Urban Water Management Plan, consistent with the approved Local Water Management Strategy and prepared in consultation with the Department of Water and Environmental Regulation and the Department for Biodiversity, Conservation and Attractions to the satisfaction of the City of Armadale, will specify site drainage and fill details to prevent adverse impacts on significant wetlands or groundwater dependent ecosystems, either within or surrounding the site. • A fauna management plan, prepared in consultation with the Department of Biodiversity Conservations and Attractions to the satisfaction of the City of Armadale, which specifies measures to avoid impacts to significant fauna including: o traffic calming and/or signage measures where fauna may conflict with vehicle movements.
72.5	Subdivision or development may be permitted within the SCA Map 3 Poultry farm buffer subject to the following: • The amalgamation of lots or part lots; • For the efficient provision of utilities and infrastructure that would not prejudice future residential development outcomes outside of the buffer area; • In accordance with SPP 2.5 – Rural Planning, the WAPC may support subdivision within the buffer subject to demonstration that land use will not result in unacceptable impacts to sensitive land uses, such as odour, dust, noise and vibrations associated with the Poultry Sheds on Lot 202 Skeet Road, Harrisdale to the satisfaction of the WAPC on advice from the City / DWER. • The WAPC may defer final endorsement of diagram of surveys until satisfactory arrangements are made that confirms usage of the Poultry Sheds on Lot 202 Skeet Road, Harrisdale has ceased on the advice of the City / DWER.
72.6	Subdivision or development that intensifies residential development on Lot 606 Balannup Road within the 50m Balannup Road CCW wetland buffer, will not be permitted unless it is development to: • replace a like for like existing structure, or portion of existing dwelling; or • enable work related to maintenance of any existing structures or dwelling.

The Structure Plan process has run concurrently with (and slightly ahead) of Amendment 121 in order to inform the amendment process. Given the historical referral of the MRS Amendment 1274/57 and the referral of Amendment 121 to the EPA, it is not envisaged that it will be necessary to refer any future subdivision proposal to the EPA pursuant to Section 38 of the EP Act. It is important to note, however, that as a result of the EPA referral there have been layout modifications made to the draft Structure Plan (now referred to as the Structure Plan) in order to address the public comments provided by the EPA.

3.4.1.2 Part V – Native Vegetation Clearing Permit

A native vegetation clearing permit will not be required if clearing is undertaken in accordance with subdivision approval. If works are undertaken on-site prior to /separate to the subdivision approval process, then a clearing permit is likely to be required pursuant to Part V of the EP Act, unless a valid exemption applies.

3.4.2 Environment Protection and Biodiversity Conservation Act 1999

The EPBC act provides statutory protection for listed Matters of National Environmental Significance (MNES). The most relevant MNES considerations within the site are the Banksia Woodland TEC and Carnaby's black cockatoo.

The structure plan has specifically considered the MNES and has sought to facilitate the retention of 50% of the extent of the Banksia Woodland TEC, and 46% of the Carnaby's black cockatoo foraging habitat.

Notwithstanding this, there is likely to be residual impacts on both the Banksia Woodland TEC and Carnaby's black cockatoo associated within future residential development of the land parcels within the Structure Plan. The extent which impacts on MNES would occur and therefore the need to address EPBC Act obligations (i.e. the need to refer) will depend on the extent and characteristics of the individual proposed actions (i.e. individual developments) within the Structure Plan area, and there is no need or ability to refer the Structure Plan as a whole.

Once the Structure Plan is endorsed and subdivision/development proceeds, each landowner will need to consider and resolve any EPBC Act requirements but would do so while acknowledging the impact avoidance measures that have been accommodated into the Structure Plan.

3.4.3 Biodiversity Conservation Act 2016

The BC Act affords statutory protection to listed threatened species and ecological communities. However, under the current arrangements, it is unlikely that BC Act authorisation would be required for development associated with the implementation of the Structure Plan.

4 Environmental Assessment and Management Strategy

This section outlines any layout considerations within the Structure Plan to respond to environmental attributes and values within the site, and any future environmental management requirements that will need to be accommodated within future planning and development stages. Only those environmental values and attributes that require specific consideration based on their presence within the site, and/or the applicable legislation and policy requirements have been addressed in this section. This section also gives consideration to the proposed provisions associated with Amendment 121.

4.1 Acid sulfate soils

4.1.1 Policy framework, site context and management objectives

Management of ASS is guided by the DWER guidelines *Identification and Investigation of Acid Sulfate Soils and Acidic Landscape* (DER 2015) and *Treatment and Management of Soil and Water in Acid Sulfate Soil Landscapes* (DWER 2015).

A review of the regional mapping produced by DWER indicates that majority of the site is within a 'Moderate to Low' risk of ASS occurring within 3 m of the natural soil surface, with an area of 'High to Moderate' risk through the northern portion of the site, as shown in **Figure 4**.

Management objectives for ASS are to prevent adverse effects on soil and groundwater through neutralisation of disturbed ASS and appropriate treatment of dewatering effluent. The ASS disturbance required for typical residential subdivision such as that associated with the Structure Plan are considered to be readily manageable during the construction process. This is considered during the subdivision approval process typically with the application of the appropriate model environmental condition which requires the completion of an ASS Self-Assessment Form, and where required, an ASS investigation and the preparation of an ASS and Dewatering Management Plan (ASSDMP). These documents are typically reviewed by the DWER as the clearing authority for the subdivision condition, and where required, management of ASS and dewatering is addressed through the implementation of the ASSDMP during construction works.

4.1.2 Structure Plan layout considerations for acid sulfate soils

ASS management does not require any spatial consideration within the Structure Plan, and any ASS risk can be appropriately managed in future planning stages.

4.1.3 Future acid sulfate soils management requirements

As discussed in the LWMS (Emerge Associates 2022c) the conceptual sewer design relies on the connection to the existing network at the intersection of Balannup Road and Reilly Road (refer to Appendix B of the LWMS for the conceptual civil designs). This sewage network will ultimately be gravity fed, and hence, will dictate the finished levels across the site (i.e. fill levels).

The preliminary earthworks strategy for the site (as show in Appendix B of the LWMS), indicates that sewer levels will be installed above the existing natural surface elevation in areas shown as 'High to Moderate' risk of ASS, which will assist in mitigating the extent of ASS risk during construction.

At the lowest point of the site (i.e. around the sewage connection), the sewage network will likely be installed around 19.9 mAHD in areas classified as a 'Moderate to Low' risk of ASS. At this location, MGL is approximately 22.5 mAHD, hence (depending on the groundwater levels at the time), the sewage network may need to be installed below the groundwater table where ASS may be encountered. This can be appropriately mitigated and managed through an ASSDMP, via the application of the model subdivision condition on the subdivision approval.

There is no requirement for further consideration at the structure planning stage.

4.2 Flora and vegetation

4.2.1 Policy framework, site context and management objectives

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

- **Avoid** impacts
- **Minimise** impacts
- **Offset** impacts.

The site comprises vegetation in 'completely degraded' condition (57.1%), however, 7.64 ha of the Banksia Woodland TEC/PEC was found within Lots 603, 604, 605, 606 and 200 along with three priority listed species (as discussed in **Section 2.3**).

4.2.2 Structure Plan layout considerations for flora and vegetation

The Structure Plan has sought to retain areas of Banksia Woodland TEC/PEC within POS West and POS Central. The Structure Plan will allow for the retention of retain 3.82 ha of 7.64 ha (or 50%) of the Banksia Woodland TEC/PEC while 3.82 ha falls within the developable area. The areas proposed to be retained are shown in **Figure 17**. Overall, of the 6.40 ha of vegetation within the site that is in 'Good' or better condition, 3.49 ha (or 54.5%) is proposed to be retained within areas of POS.

The Structure Plan would facilitate the retention of three priority flora species, one individual of *Acacia lasiocarpa* var. *bracteolata* long peduncle variant (P1) two individuals of *Jacksonia gracillima* (P3) and 38 individuals of *Verticordia lindleyi subsp. Lindleyi* within the south western POS.

Although the flora survey did not identify the presence of the threatened flora species, *Drakaea elastica*, the Structure Plan has allowed for the full retention of its suitable habitat, plant community **BKg** (0.56 ha) which occurs within the site. This plant community will be retained within the POS West.

The Structure Plan also provides for the retention of the two CCWs one REW and a nearby REW, and their wetland buffer areas. There is the opportunity to revegetate the buffer areas, and this will facilitate flora and vegetation retention and enhancement outcomes.

Opportunities to retain additional remnant native vegetation will also be possible, within the broader POS areas, and will be confirmed during final development design and bulk earthworks requirements.

4.2.3 Future flora and vegetation management requirements

Where native vegetation is required to be cleared within the site, this will likely be undertaken in accordance with a subdivision approval and associated authorised subdivision works, which will provide an exemption from the requirements for a clearing permit.

As previously outlined, 3.82 ha of the federally listed Banksia Woodland TEC will likely be impacted by the development. Individual proponent(s) will therefore need to consider their obligations under the EPBC act in relation to the potential impacts arising out of their proposed action (i.e. development which may require assessment and potentially offsets) on the Banksia Woodland TEC.

A vegetation and flora management plan(s) (or similar) should be required to be prepared to mitigate any potential impacts to flora and vegetation associated with construction and development works. This can be applied as a condition of subdivision.

4.3 Native fauna

4.3.1 Policy framework, site context and management objectives

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

The EPBC Act also provides protection for listed 'threatened' species, including black cockatoos, for which the site contains foraging for Carnaby's black cockatoo. Any proposed action which is considered likely to result in a 'significant' impact upon these species (identified as MNES), needs to be referred to the Commonwealth DAWE.

A total of 18 native and three introduced fauna species were recorded during the field survey, including one species of conservation significance, *Isoodon fusciventer* (quenda).

One potential habitat tree for black cockatoo breeding was identified within the site but did not contain suitable hollow(s). No black cockatoos were observed during the survey and no signs of use, such as chew marks, droppings or moulted feathers within any of the trees with hollow(s) in the site. As discussed in **Section 2.3.2.5**, approximately 11.1 ha of foraging habitat was mapped within the site, however this habitat is patchily distributed and is interspersed with plant species not used for black cockatoo foraging (see **Figure 8, Figure 9** and **Figure 10**).

Overall, the habitat values within the site (and the sites location) would suggest that the Carnaby's black cockatoo is the most relevant fauna consideration.

The potential foraging habitat for Carnaby's black cockatoo mapped within the site is unlikely to represent critical foraging or breeding habitat given its limited extent and quality.

Nevertheless, the Structure Plan has demonstrated how areas of potential foraging habitat can be retained, namely for Carnaby's black cockatoo due to its 'moderate' to 'high' foraging habitat value.

4.3.2 Structure Plan layout considerations for terrestrial fauna

The Structure Plan provides three large POS areas (totalling 8.26 ha) which will retain 5.52 ha (of 12.27 ha, or 45%) of identified intact fauna habitats, predominately 'Woodland' and 'Closed Melaleuca Forests' habitat types.

The Structure Plan will also facilitate the retention of 2.17 ha of black cockatoo foraging habitat (of 7.27 ha) within POS areas, in particular, 1.90 ha of Carnaby's Cockatoo foraging habitat (of the total of 4.12 ha, or 46.11%).

4.3.3 Future terrestrial fauna management requirements

Approval under the EPBC Act is required if a proposal is likely to have a significant impact on MNES, as defined in the EPBC Act. The most relevant native fauna MNES considerations within the site is the Carnaby's black cockatoo. Therefore, any significant clearing of Carnaby's black cockatoo habitat will need to be considered by each proponent(s) in the context of potential referral requirements in accordance with the EPBC Act.

As part of the future subdivision approval process, a condition requiring the preparation and implementation of Fauna Relocation Management Plan(s) (or similar), which would aim to minimise the risk of fauna interactions during construction is minimised, should be applied.

4.4 Wetlands

4.4.1 Policy framework, site context and management objectives

In the context of environmental impact assessment, the EPA's objective for inland waters is *'to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected'* (EPA 2018).

The findings of the *Wetland Assessment* (Emerge Associates 2021c) delineated the on-ground wetland boundaries of the site as shown in

The site supports two CCWs, one mapped CCW (UFI 14880) located towards the south-east, and one additional CCW (not currently mapped under the *Geomorphic Wetlands of the Swan Coastal Plain* dataset) located within the south-west portion of the site. Due to the significant environmental values associated with these wetlands they need to be retained and protected.

4.4.2 Structure Plan considerations for wetlands

The Structure Plan provides for the retention and protection of the important wetlands within the site.

The western CCW has been incorporated into POS West, which is intended for conservation purposes. The POS area provides a wetland buffer that varies in width, and is a minimum of 50 m, however the entire buffer area is intended for native vegetation retention and revegetation. A portion of POS west will be utilised for stormwater management, however all features including bioretention areas (BRA) and flood storage areas (FSA) will be located external to the CCW 50m wetland buffer.

The southern CCW has been incorporated into POS Central, which is intended for both conservation and passive recreation purposes. POS Central provides a wetland buffer that varies in width and treatments, of which the immediate 50 m surround the wetland will be intended for vegetation retention and revegetated, with a portion of the buffer area allocated as a FSA. Outside of this in some locations are complementary open space areas to provide further setback from roads and residential lots, further adding to the total wetland buffer provided by POS Central.

A northern REW is located within Lot 600 (i.e. not within the site), however has been accommodated within the Structure Plan. POS East provides a buffer for this wetland and would ensure that up to 30 m from the wetland boundary can accommodate native vegetation retention and revegetation. Beyond this, complementary open space areas provide further setback from roads and residential lots, further adding to the total wetland buffer provided by POS East. The POS East will contain some stormwater quality treatment features within 30 m of the wetland boundary.

The marginal REW area located within Lot 604 is completely contained within POS West, accommodated within the retention/revegetation area surrounding the Western CCW. Given the marginal wetland values associated with this wetland, the entire 30 m REW buffer area is not contained within POS. The other marginal REW area located within Lot 602 is not located within a POS area and is therefore not proposed to be retained.

The landscaping report contained in **Appendix H**, and specifically the landscape masterplan shows how the wetland areas and their buffer areas are proposed to be treated through future development.

The implementation of the LWMS (discussed in **Section 4.5**) will also manage the threat of water quality impacts to the adjacent CCWs/REW via the use of water sensitive urban design (WSUD) measures, and also ensure that the existing hydrological regime is maintained.

4.4.3 Future management requirements

Wetland Management Plan(s) (WMPs) should be prepared and implemented as a condition of subdivision approval. The WMP(s) will detail the management of any potential impacts of the proposed development on the wetlands, and the management of buffer areas.

The WMP(s) will facilitate the enhancement of the wetland core habitat, vegetation and function, including the reduction of weed species, and the revegetation of wetland buffer areas.

Surface water and groundwater impacts to the CCWs/REW can be avoided through appropriate stormwater management approaches in the preparation and implementation of future water management plans. The requirement to undertake the preparation of more detailed water management plans to support the development can be imposed as a condition of development.

4.5 Hydrology

4.5.1 Policy framework, site context and management objectives

In the context of environmental impact assessment, the EPA's objective for inland waters is *'to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected'.* The application of the mitigation hierarchy should be applied to avoid or minimise impacts to inland waters where possible.

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

4.5.2 Structure Plan layout considerations for hydrology

Emerge prepared a Local Water Management Strategy (LWMS) (Emerge Associates 2022c) to support the preparation of the Structure Plan, which provides a framework for the future delivery of a best practice approach to integrated water cycle management utilising WSUD principles. The Structure Plan can accommodate the stormwater management requirements outlined in the LWMS, with adequate storage available for detention and treatment of stormwater within areas of POS and road reserves, while responding to the wetland areas within the site.

The principal elements of the LWMS are summarised below:

- The efficient use of water resources will be promoted through lot scale water conservation measures and the use of waterwise gardening principles.
- Wastewater and potable water supply will be serviced via a reticulated network, serviced by the Water Corporation.
- Back of lots (which accounts for 75% of the lot) will retain and treat the small rainfall event utilising WSUD measures.
- Runoff from the front of lots (which accounts for 25% of the lot) as well as the road reserve, will be conveyed to downstream bio-retention areas, located within the POS. Bioretention areas will not be located within wetland buffer areas.
- Major rainfall event runoff will be retained on-site via flood storage areas, located within the POS areas.
- The above management approach will ensure the resilience of nearby wetlands and groundwater dependent ecosystems.

4.5.3 Future management requirements

In accordance with *Better Urban Water Management*, an Urban Water Management Plan will be required to support future subdivision. As such, it is anticipated that WAPC will impose model subdivision condition D2 on future subdivision approvals within the site, which requires:

Prior to the commencement of subdivisional works, an urban water management plan is to be prepared and approved, in consultation with the Department of Water, consistent with any approved Local Water Management Strategy. (Local Government).

The UWMP will provide for the implementation of the water management strategies approved through the LWMS, specifically addressing the following considerations:

- The detailed stormwater design.
- Imported fill specifications and requirements
- Implementation of water conservation strategies
- Water quality improvement measures
- Management and maintenance requirements
- Monitoring and evaluation program, namely within wetland areas.

4.6 Potential site contamination

4.6.1 Policy framework, site context and management objectives

Contaminated sites in Western Australia are managed by DWER under the *Contaminated Sites Act 2003* with consideration in the planning process to trigger investigations where there is a change of land use for a property where a potentially contaminating activity has been undertaken or where a site has been identified as a known or suspected contaminated site. This is typically achieved through the application of the appropriate model subdivision condition on the subdivision approval for specific lots which have been subject to a potentially contaminating activity. This condition will trigger the requirement for investigations in line with the DWER's Contaminated Sites Guidelines which is a separate, and well-defined process.

The objective of the investigations is to ensure that the portions of the site are suitable for the intended residential land use without significant risk to human health or the environment.

Application of a subdivision condition is considered be an appropriate approach where the potentially contaminating activity is such that the property could be made suitable for the intended future land use. This would only be appropriate specifically for Lot 201 and Lot 202 where potentially contaminating activities have been identified (see **Section 2.7**). The remaining lots within the site have not been subject to a potentially contaminating land use and therefore an investigation for potential contamination is not warranted.

4.6.2 Structure Plan layout considerations for site contamination

There is no available information to indicate that the properties within the site could not be made suitable for the intended land use indicated in the structure plan.

The consideration of contamination is limited to just Lot 201 and Lot 202 and does not require a spatial or land-use response with respect to the Structure Plan.

4.6.3 Future management requirements

Investigation of potential contamination risk is only relevant for Lot 201 and Lot 202 where potentially contaminating activities have been identified. Potential contamination associated with these two lots can be appropriately investigated and managed at the subdivision stage via the application of the model subdivision condition.

4.7 Bushfire management

4.7.1 Policy framework, site context and management objectives

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

- Classification of existing vegetation types within the site and surrounding 100 m, in accordance with *Australia Standard 3959:2018 Construction of buildings in bushfire-prone areas* (AS 3959) (Standards Australia 2018).
- Assessment of bushfire hazard levels within the site and surrounding 150 m, in accordance with the *Guidelines for Planning in Bushfire Prone Areas* (the Guidelines) (DPLH & WAPC 2021)
- Assessment of effective slope under areas of classified vegetation.
- Completion of an indicative Bushfire Attack Level (BAL) assessment and preparation of an associated BAL contour plan.
- Assessment of the Structure Plan design against the bushfire protection criteria, in accordance with the Guidelines.

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

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

This policy objective ensures that future development appropriately considers the bushfire risks and provides appropriate separation from any identified risks without negatively impacting existing environmental values. The principal management objective for bushfire risk for the site is to ensure that the risk to future dwellings is appropriately minimised without negatively impacting on environmental values within or surrounding the site that are required to be retained.

A BMP has been prepared to assess the bushfire hazards, both within and nearby the site, and identify the 'management' strategies required to ensure the development of the land is consistent with the intent of the *State Planning Policy* (SPP) 3.7.

Further discussion in this regard is provided in the BMP (Emerge Associates 2022a).

4.7.2 Structure Plan layout considerations for bushfire management

The principal management objective for bushfire risk within the site is to ensure the risk is appropriately mitigated without negatively impacting on environmental values within or surrounding the site.

The Structure Plan will allow for the removal of majority of bushland hazard within the site, which will remove the classified vegetation and therefore hazard across the site due to the construction of lots and the road network. Hazards will remain however within the three areas of POS associated with the retention of native vegetation and significant environmental values within these areas.

As shown in the landscape masterplan provided in **Appendix H**, revegetation will be possible within the three areas of POS. Bushfire hazards therefore are assumed to increase within POS areas, and the risks associated with this and mitigation measures required to respond to them, have been outlined within the *North Harrisdale Bushfire Management Plan* (Emerge Associates 2022a) which has been prepared to support the Structure Plan.

4.7.3 Future bushfire management requirements

The BMP (Emerge Associates 2022a) demonstrates that SPP 3.7 and the bushfire protection criteria (outlined within the Guidelines (WAPC and DFES 2021)) can be satisfied through an 'acceptable solution' approach, without compromising on the key environmental values within or immediately surrounding the site for the majority of the structure plan area.

Future residential lots located between Reilly Road and the western CCW POS (within current lot 606) are located partially within BAL-40 and BAL-FZ and therefore it is unlikely that future dwellings within these would be able to satisfy the 'acceptable solution' for Element 2: Siting and design. This area is adjacent to the western CCW POS which is proposed to be revegetated to enhance and conserve the values of the wetland and has been classified as Scrub (Class D) vegetation in a post development scenario. Given it is unlikely that there would be proposed fuel reduction works within the western CCW POS, it has been assumed to remain a bushfire threat to these lots in perpetuity. It is noted that these residential lots were specifically requested to be included within the Structure Plan by the City of Armadale.

4.8 Noise considerations

4.8.1 Policy framework, site context and management objectives

Registered kennels are located within a 500 m radius of the site, either within the City of Armadale, or the City of Gosnells (see **Figure 15**). Hence the site is also located within the City of Armadale's Kennel buffer, as identified in Special Control Area Map 1 of TPS 4.

Ranford Road is also identified as a 'strategic freight and/or major traffic route' (see **Figure 15**) and therefore State Planning Policy 5.4 *Road and Rail Noise* (SPP 5.4) applies to the site.

4.8.2 Structure Plan layout considerations for acoustic impacts

The noise considerations for the proposed development do not have any considerations on the layout of the Structure Plan.

Nevertheless, the Structure Plan has allowed for the commercial area, the REW (within Lot 600) and its associated buffer to interface Ranford Road (**Appendix A**). In doing so this will provide horizontal separation between proposed residential dwellings and the noise sources (i.e. the registered kennels and Ranford Road).

The Structure Plan has also ensured that adequate space for the provision of a noise wall can be accommodated where required (discussed further in **Section 4.8.3**).

4.8.3 Future noise impact management requirements

Based on the noise impact assessment (see **Appendix I**), a noise wall of varying height (between 2 m to 2.4 m) is proposed to mitigate both the Ranford Road noise considerations and the registered kennel noise considerations and would be located along the north-eastern corner joining to a solid fence which will interface with Skeet Road. With the use of a noise wall, exposure levels will be significantly reduced with expected exposure levels predicted as follows:

- The ground floor of a small number of dwellings will likely experience a noise 'Exposure A' level (see Figure 4-3 of **Appendix I**).
- The upper floors of dwellings within the northern portion of the site will likely experience noise levels up to 'Exposure C' (See Figure 4-4 of **Appendix I**).

Quiet home architectural packages will therefore be required for a range of dwellings, refer to Figure 4-5 and 4-6 in **Appendix I** for packages required for both ground and upper floor lots within the north-eastern portion of the site. Furthermore, residential lots created within the site that will be located within the Kennel Buffer – Special Control Area (CoA 2005), should be subject to a notification on title, alerting residential lot owners to the presence of nearby registered kennels and associated noise.

5 Implementation Framework

A summary of how the Structure Plan responds to the environmental values and attributes within the site is provided in **Table 9**. The table also outlines the proposed future management required as part of the subdivision and development process.

Table 9: Environmental management framework implementation table

Factor	Structure Plan phase	Subdivision phase	Part of development works
Acid sulfate soils	• No spatial response in Structure Plan required.	• If required, preparation of an Acid Sulfate Soil Management Plan, primarily for the installation of the southern portion of the sewage network.	• Implementation of an Acid Sulfate Soil and Dewatering Management Plan, if required.
Flora and vegetation	• The Structure Plan allows for retention retain 3.82 ha of 7.64 ha (or 50%) of the Banksia Woodland TEC/PEC occurring within the site. • Full retention of plant community **BKg,** which is suitable habitat for the threatened flora species *Drakaea elastica.*	• Preparation of vegetation management plan(s) to satisfy subdivision conditions. • Each proponent consider the need for referral of proposed impacts pursuant to EPBC Act. • Consideration of requirement for Clearing Permit(s).	• Incorporation of vegetation and retained trees in POS landscaping works. • Implementation of vegetation management plan(s).
Native fauna	• Retention of 5.52 ha (of 12.27 ha, or 45%) of identified intact fauna habitats, predominately 'Woodland' and 'Closed Melaleuca Forests' habitat types. • Retention of 2.17 ha of black cockatoo foraging habitat (of 7.27 ha) within POS areas, in particular, 1.90 ha of Carnaby's Cockatoo foraging habitat (of the total of 4.12 ha, or 46.11%).	• Preparation of Fauna Management Plan(s) where required. • Each proponent to consider the need for referral of proposed impacts pursuant to EPBC Act.	• Implementation of fauna management actions(s), where required.
Wetlands	• The western CCW has been incorporated into POS West (4.06 ha), which will be allocated solely to conservation. • The southern CCW has been incorporated into POS Central. • The northern REW located within Lot 600 (outside of the site) has been accommodated within the Structure Plan. POS East provides a buffer for this wetland. • The Structure Plan provides for the separation of the CCWs/REW from residential development through the provision of wetland buffers. • The marginal REW area located within Lot 604 is entirely contained within POS West.	• Preparation of Wetland Management Plan(s).	• Implementation of Wetland Management Plan(s).

Table 6: Environmental management framework implementation table(continued)

Factor	Structure Plan phase	Subdivision phase	Part of development works
Hydrology	• Preparation of a Local Water Management Strategy. • Providing for stormwater management features to accommodate stormwater (i.e. bioretention areas) within the Structure Plan layout.	• Preparation of Urban Water Management Plan(s).	• Implementation of Urban Water Management Plan(s).
Potential site contamination	• The consideration of contamination is limited to just Lot 201 and Lot 202 and does not require a spatial or land-use response with respect to the Structure Plan.	• Preparation of detailed site investigation(s) (for Lots 201 and 202) to support subdivision.	• Any remediation required.
Bushfire risk	• Bushfire Management Plan prepared to mitigate bushfire risk without negatively impacting on environmental values within or surrounding the site.	• Prepare Bushfire Management Plans for each subdivision application.	• N/A
Noise considerations	• Preparation of a full acoustic assessment, including detailed noise modelling.	• Installation of noise walls.	• Acoustic mitigation measures including but not limited to: acoustic walling and architectural packages for dwellings.

6 Conclusions

This *Environmental Assessment and Management Strategy* (EAMS) has been prepared to support the Structure Plan (**Appendix A**) for part Lot 601 Balannup Road, Lots 602-606 Balannup Road, Lots 200 and 201 Skeet Road, and part Lot 202 Skeet Road, Harrisdale to enable future residential development. The EAMS provides a synthesis of information regarding the environmental values and attributes of the site, obtained from a range of sources such as local and regional reports, databases, mapping and site-specific investigations.

The following documents were relevant for and provided support to the preparation of this EAMS:

- *District Water Management Plan – Lots 172, 515 and 516 Skeet Road, Harrisdale* (JDA 2014)
- *Due Diligence Environmental and Geotechnical Study - Proposed Road Widening Balannup Road and Skeet Road Harrisdale* (Galt Environmental 2018)
- *Detailed Flora and Vegetation Assessment – Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale* (Emerge Associates 2022b)
- *Basic Fauna and Targeted Black Cockatoo Assessment – Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale* (Emerge Associates 2021a)
- *Environmental Assessment Report - Lots 600-606 Balannup Road & 200-202 Skeet Road, Harrisdale* (Emerge Associates 2021b).

The following have been prepared in parallel with the EAMS to support the Structure Plan:

- *Local Water Management Strategy* (LWMS) (Emerge Associates 2022c)
- *Wetland Assessment* (Emerge Associates 2021c)
- *Bushfire Management Plan – Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale (Emerge Associates 2022a)*

Acid Sulfate Soils

The sewage network that services the site will ultimately be gravity fed to an existing connection network at the intersection of Balannup Road and Reilly Road.

The preliminary earthworks strategy for the site indicates the sewage network may need to be installed below the groundwater table where ASS may be encountered, however this can be appropriately mitigated and managed through an ASS and Dewatering Management Plan (ASSDMP).

There is no requirement for further consideration at the structure planning stage.

Flora and vegetation

Three large areas of POS (approximately 8.26 ha or 31.37% of the site) are proposed within the Structure Plan, including 4.06 ha specifically for conservation purposes. The POS have been strategically located to retain a significant extent (3.82 ha of 7.64 ha (or 50%)) of the Banksia Woodland TEC/PEC occurring within the site.

In addition, the Structure Plan would facilitate the retention of three priority flora species: *Acacia lasiocarpa var. bracteolata* long peduncle variant (P1), *Jacksonia gracillima* (P3) and *Verticordia lindleyi subsp. Lindleyi* within the south western POS.

A native vegetation clearing permit will not be required if clearing is done in accordance with the subdivision approval process.

Vegetation and flora management plan(s) (or similar) should be required to mitigate any potential impacts to flora and vegetation associated with construction and development works.

Terrestrial fauna

The Structure Plan provides three large POS areas (totalling 8.26 ha) which will retain 5.52 ha (of 12.27 ha, or 45%) of identified intact fauna habitats, predominately 'Woodland' and 'Closed Melaleuca Forests' habitat types.

The Structure Plan will also facilitate the retention of 2.17 ha of black cockatoo foraging habitat (of 7.27 ha) within POS areas, in particular, 1.90 ha of Carnaby's Cockatoo foraging habitat (of the total of 4.12 ha, or 46.11%)

As part of the future subdivision approval process, Fauna Relocation Management Plan(s) (or similar), should be prepared to minimise the risk of fauna interactions during construction.

Wetlands

The site support two Conservation Category Wetlands (CCWs) and one Resource Enhancement Wetland (REW) (i.e. within the site) and one nearby REW is located within the northern adjacent lot (i.e. not within the site). The three POS areas within the Structure Plan have been strategically located to retain these wetlands. The Structure Plan also provides for the separation of the CCWs/REW from residential development through the provision of wetland buffers.

Preparation of Wetland Management Plan(s) will be required to outline specific strategies for the preservation of the wetlands and their associated buffer areas.

Hydrology

The Structure Plan can accommodate the stormwater management features outlined in the *Local Water Management Strategy* (LWMS) (Emerge Associates 2022), with adequate storage available for retention and treatment of stormwater within POS areas.

During successive subdivision, Urban Water Management Plan(s) will be required to support the detailed design and demonstrate how the principles established through the LWMS are being implemented.

Potential site contamination

Majority of the lots that comprise the site have been used for rural residential purposes, which are not identified by DWER as a potentially contaminating activity. The exception to this is Lot 201, which has been used for non-residential purposes including stockpiling and storage of various materials, and Lot 202, which is a currently operational poultry farm.

The consideration of contamination risk is therefore limited to Lot 201 and Lot 202 and does not require a spatial or land-use response within the Structure Plan. Further investigations for Lot 201 and 202 should be undertaken as part of the subdivision process.

Bushfire management

The Structure Plan will involve majority of the bush fire hazard within the site to be removed, due to the construction of residential lots and the road network. Hazards will remain however within the three areas of POS associated with the retention of native vegetation and significant environmental values within these areas.

The bushfire hazards would also increase within POS areas due to revegetation, although the risks associated with this and necessary mitigation measures have been outlined within the *North Harrisdale Bushfire Management Plan* (Emerge Associates 2022a) which has been prepared to support the Structure Plan.

Noise consideration

Noise impact considerations (i.e. Ranford Road and nearby registered kennels) associated with the proposed residential development has been addressed in a noise impact assessment. To mitigate noise impacts, a noise wall of varying heights (between 2 m to 2.4 m) will be required along the north-eastern corner joining to a standard fence which will interface with Skeet Road. Quiet home architectural packages will also be required for a range of lots towards the north-eastern portion of the site, and residential lots created within the site that will be located within the Kennel Buffer – Special Control Area (CoA 2005), should be subject to a notification on title.

Additional details in this regard will be further outlined in Noise Management Plan(s), undertaken as part of future subdivision and development of the site.

Conclusions

Overall, the environmental attributes and values of the site have been accommodated within the Structure Plan, or can be managed appropriately through future subdivision and development in line with the relevant state and local government legislation, policies and guidelines and current management practices.

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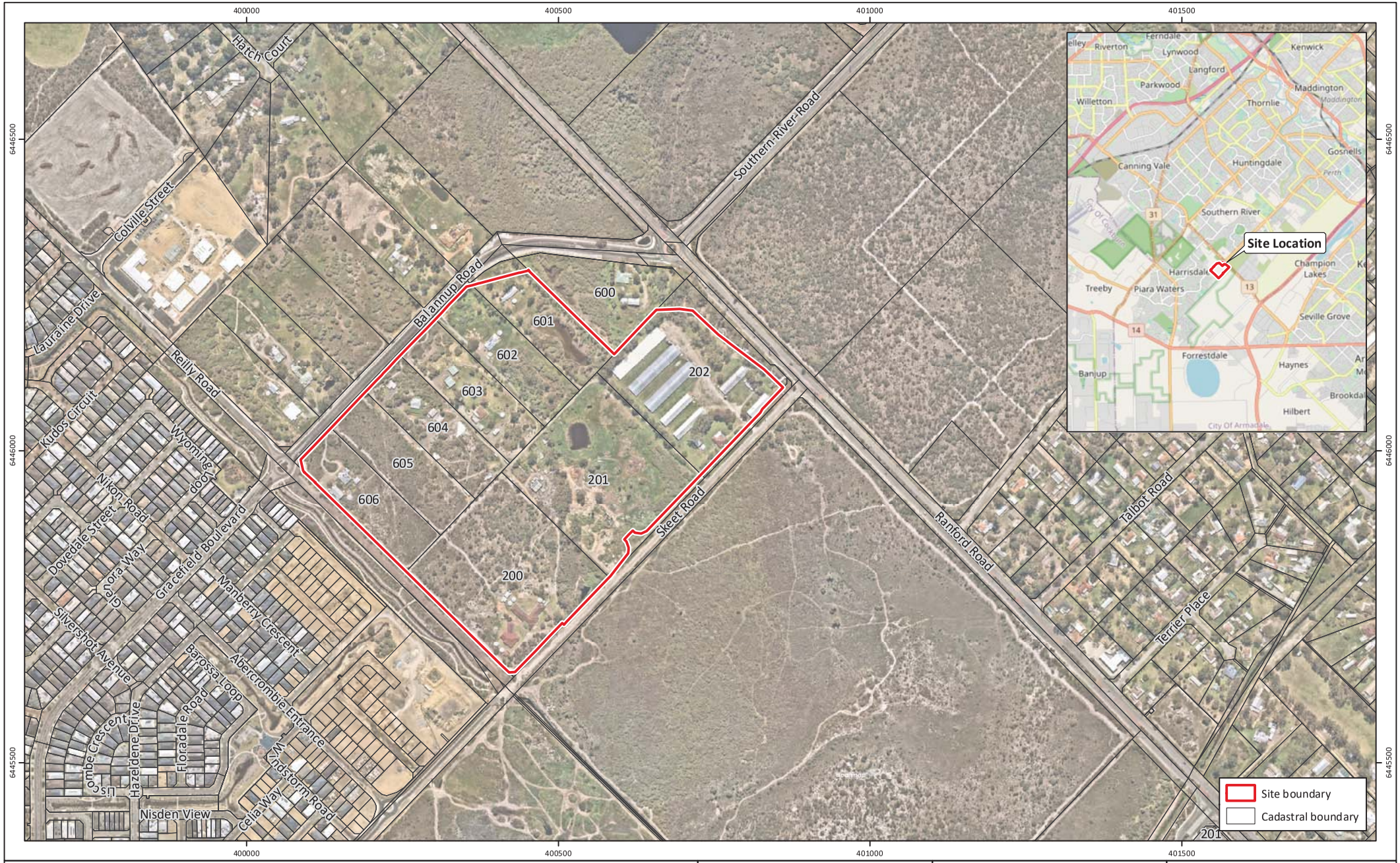


Figure 1: Site Locality

Project:	Environmental Assessment and Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F49

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Date:	13/04/2021
Checked:	TEM
Approved:	JDH
Date:	23/07/2021

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Scale: 1:8,000@A4

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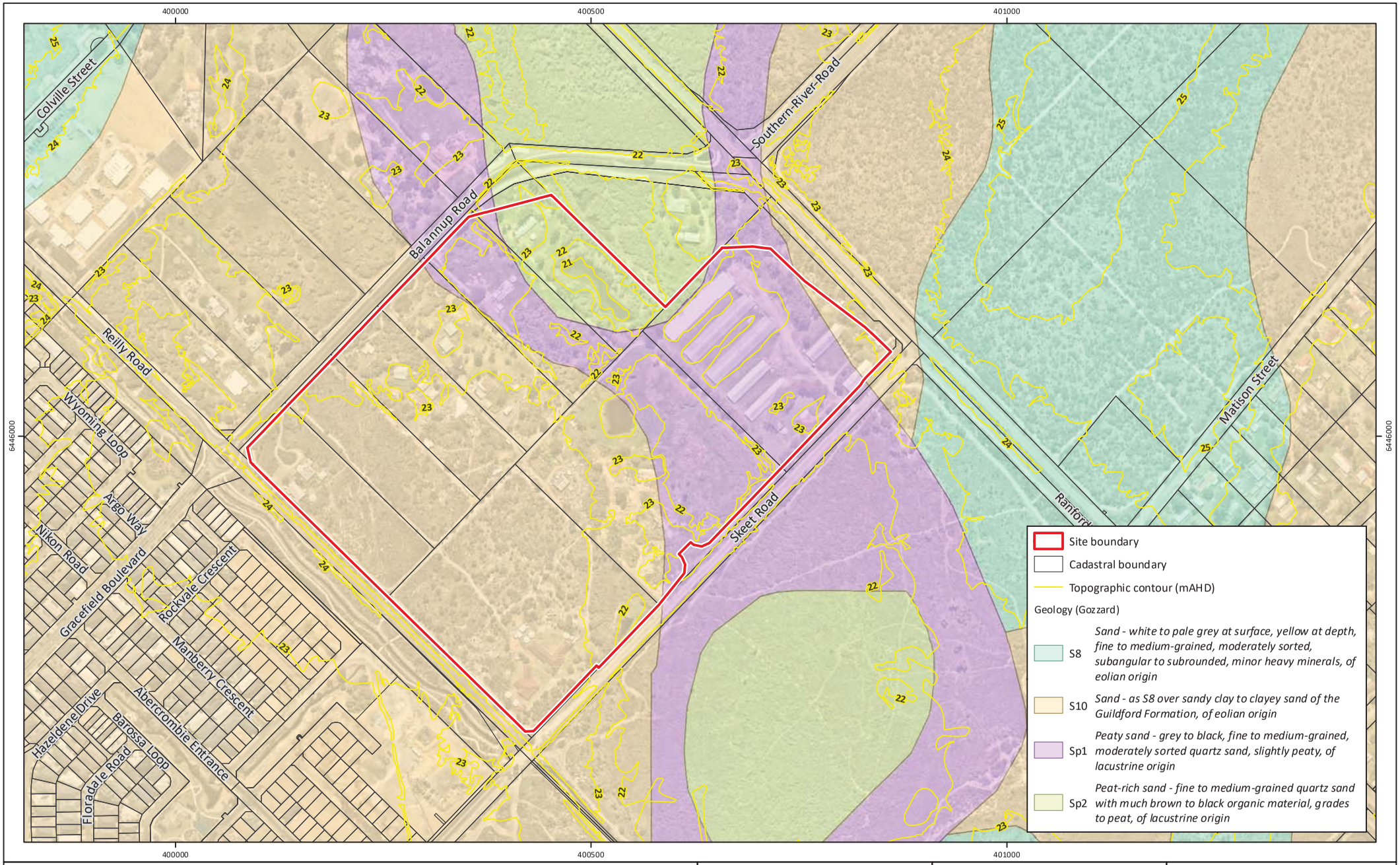


Figure 2: Topography and Environmental Geology

Project: Environmental Assessment and Management Strategy
North Harrisdale Structure Plan
Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F50
Drawn: TEM
Date: 13/04/2021
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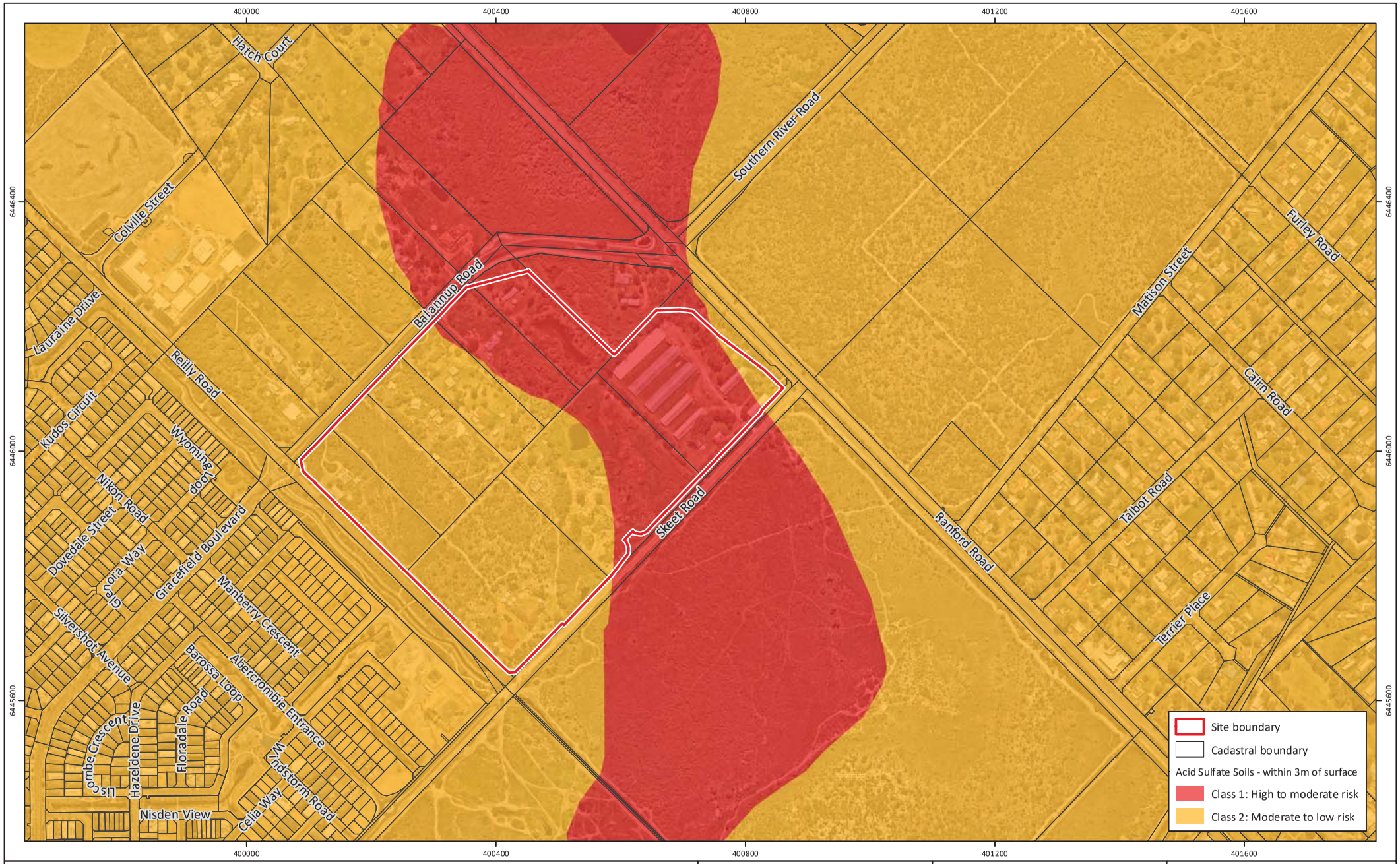


Figure 3: Acid Sulfate Soil Risk Mapping and Contaminated Sites

Project: Environmental Assessment and Management Strategy
North Harrisdale Structure Plan
Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F51
Drawn: TEM
Date: 13/04/2021
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Approved: JDH
Date: 26/07/2021

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Figure 4: Plant Communities

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Plan Number:
EP20-127(10)--F52

Drawn:	TEM
Date:	13/04/2021
Checked:	TEM
Approved:	JDH
Date:	26/07/2021

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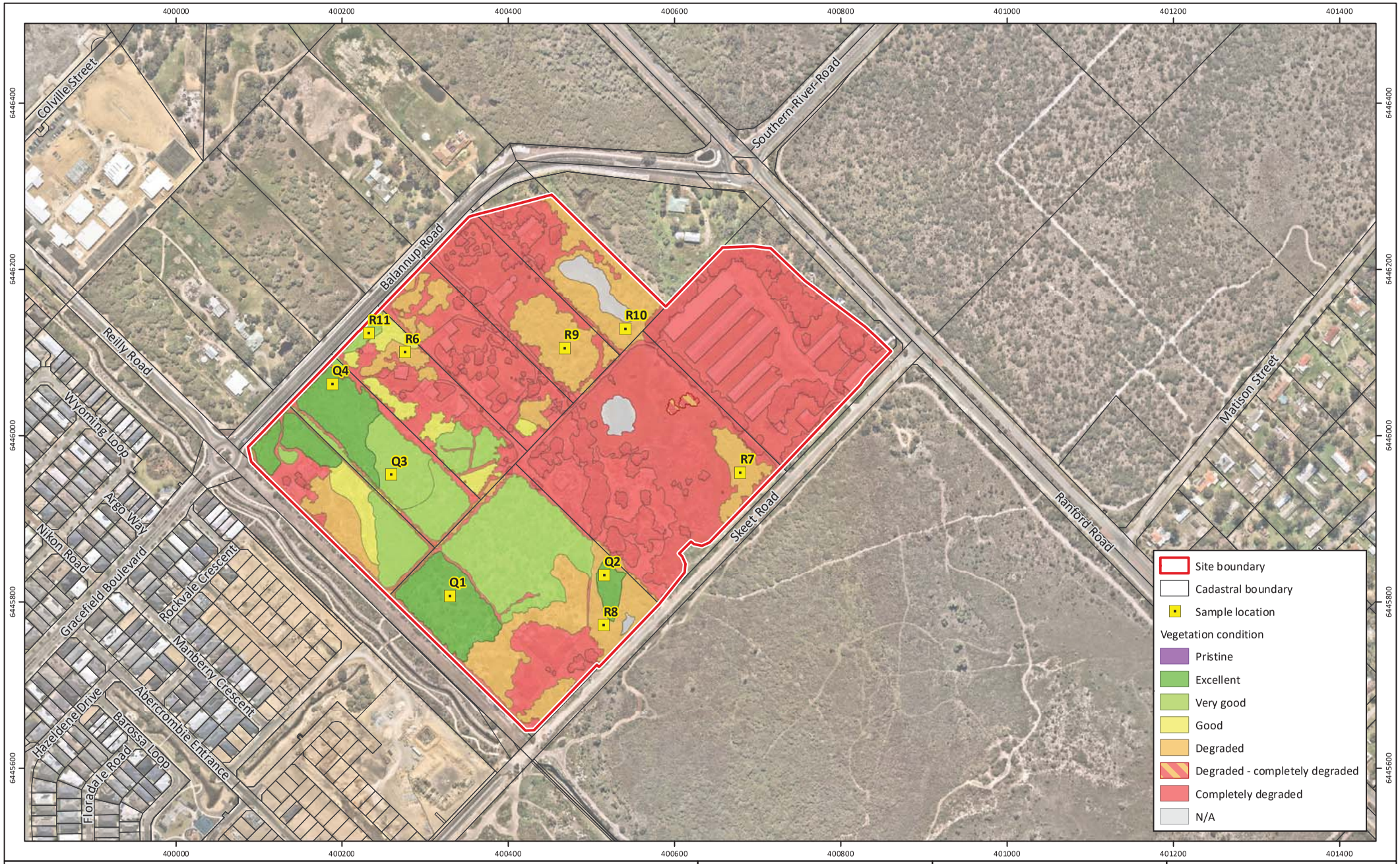


Figure 5: Vegetation Condition

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North Harrisdale Structure Plan
Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F53
Drawn: TEM
Date: 13/04/2021
Checked: TEM
Approved: JDH
Date: 26/07/2021

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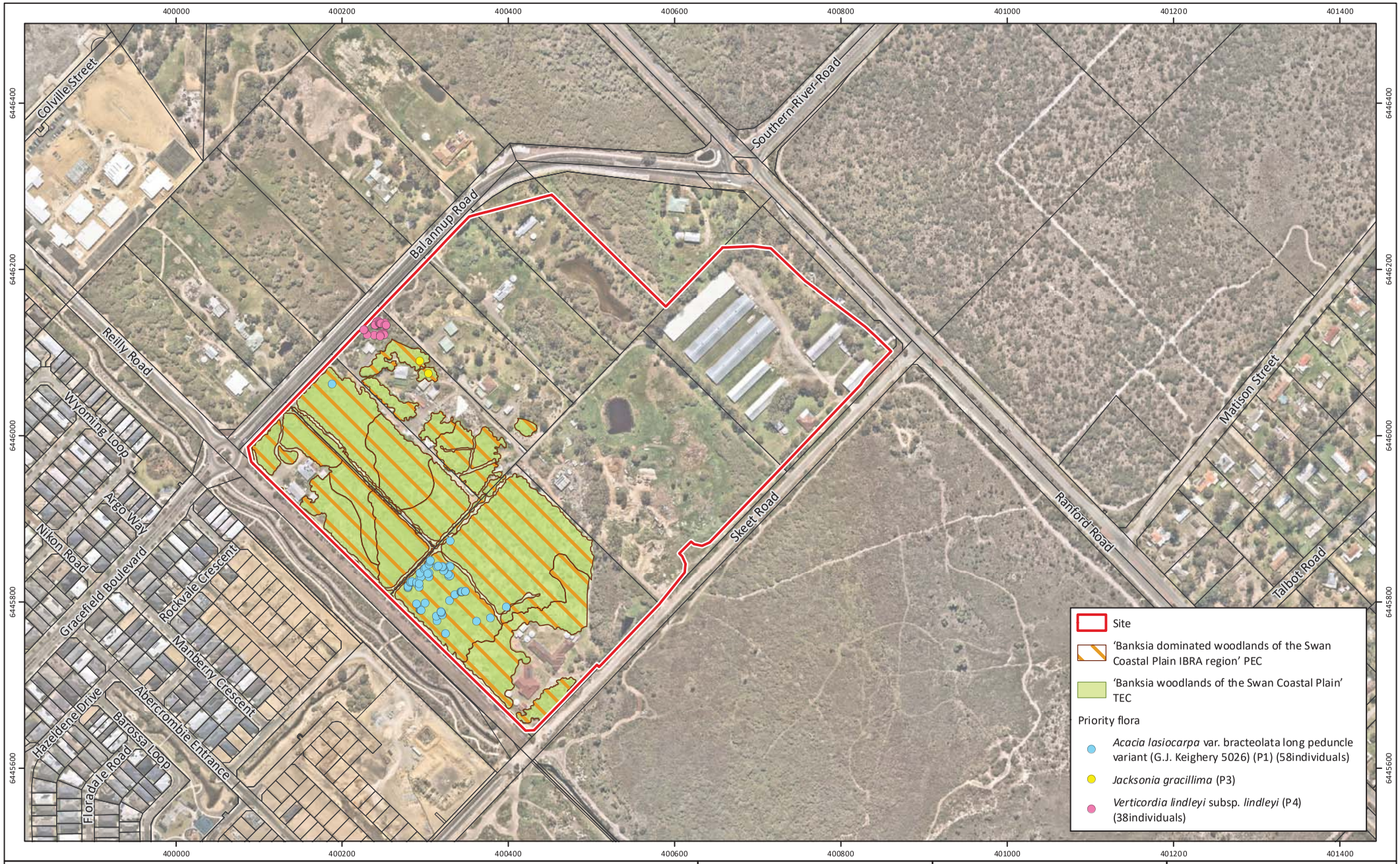


Figure 6: Conservation Significant Flora and Vegetation Values

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Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F54a

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Date:	04/04/2022
Checked:	BRB
Approved:	JDH
Date:	06/04/2022

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Figure 7: Fauna Habitat

Project:	Environmental Assessment and Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F55

Drawn:	TEM
Date:	13/04/2021
Checked:	TEM
Approved:	JDH
Date:	26/07/2021

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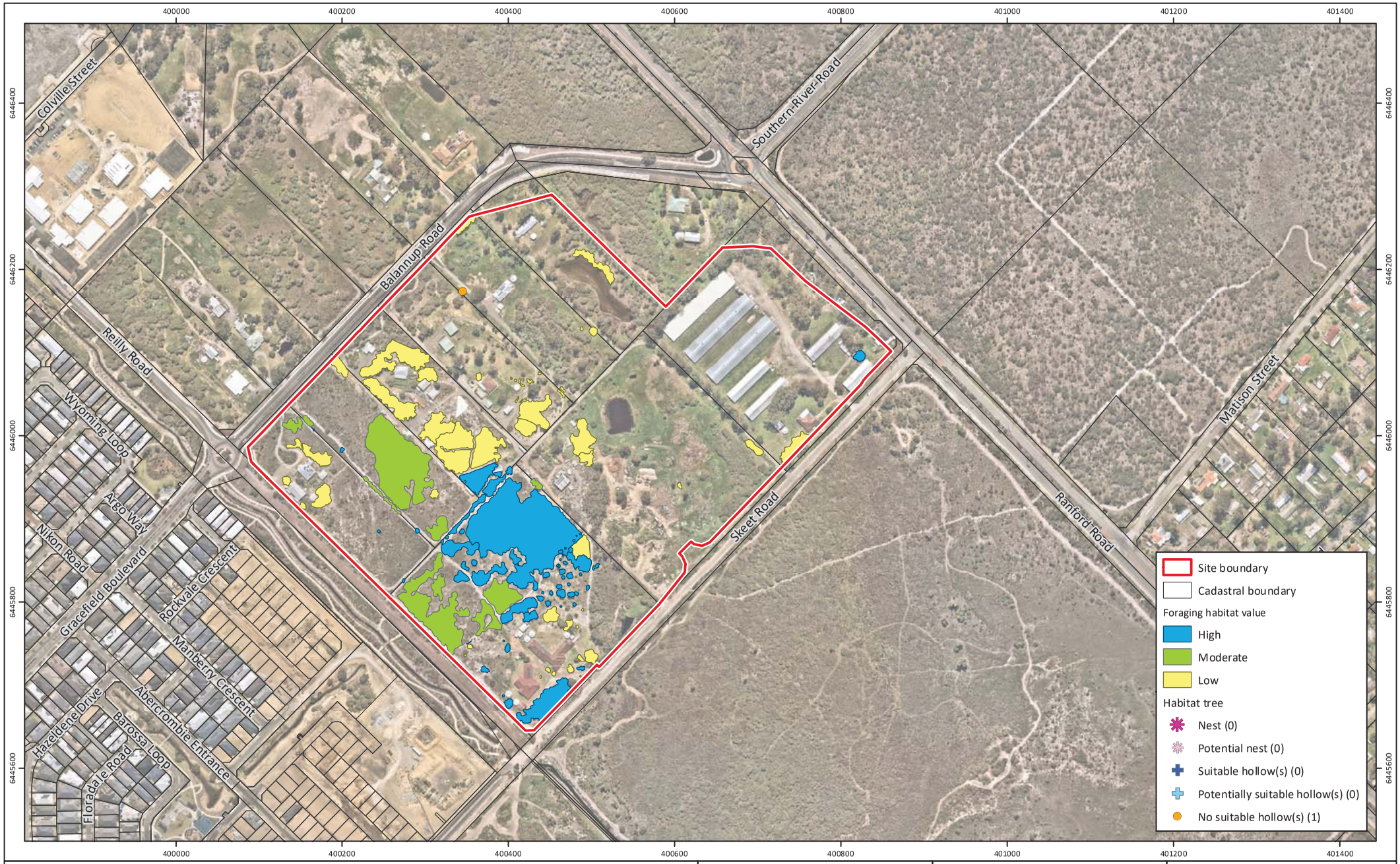


Figure 8: Carnaby's Cockatoo Habitat

Project:	Environmental Assessment and Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F56a

Drawn:	GAR
Date:	06/04/2022
Checked:	BRB
Approved:	JDH
Date:	06/04/2022

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Scale: 1:6,000@A4

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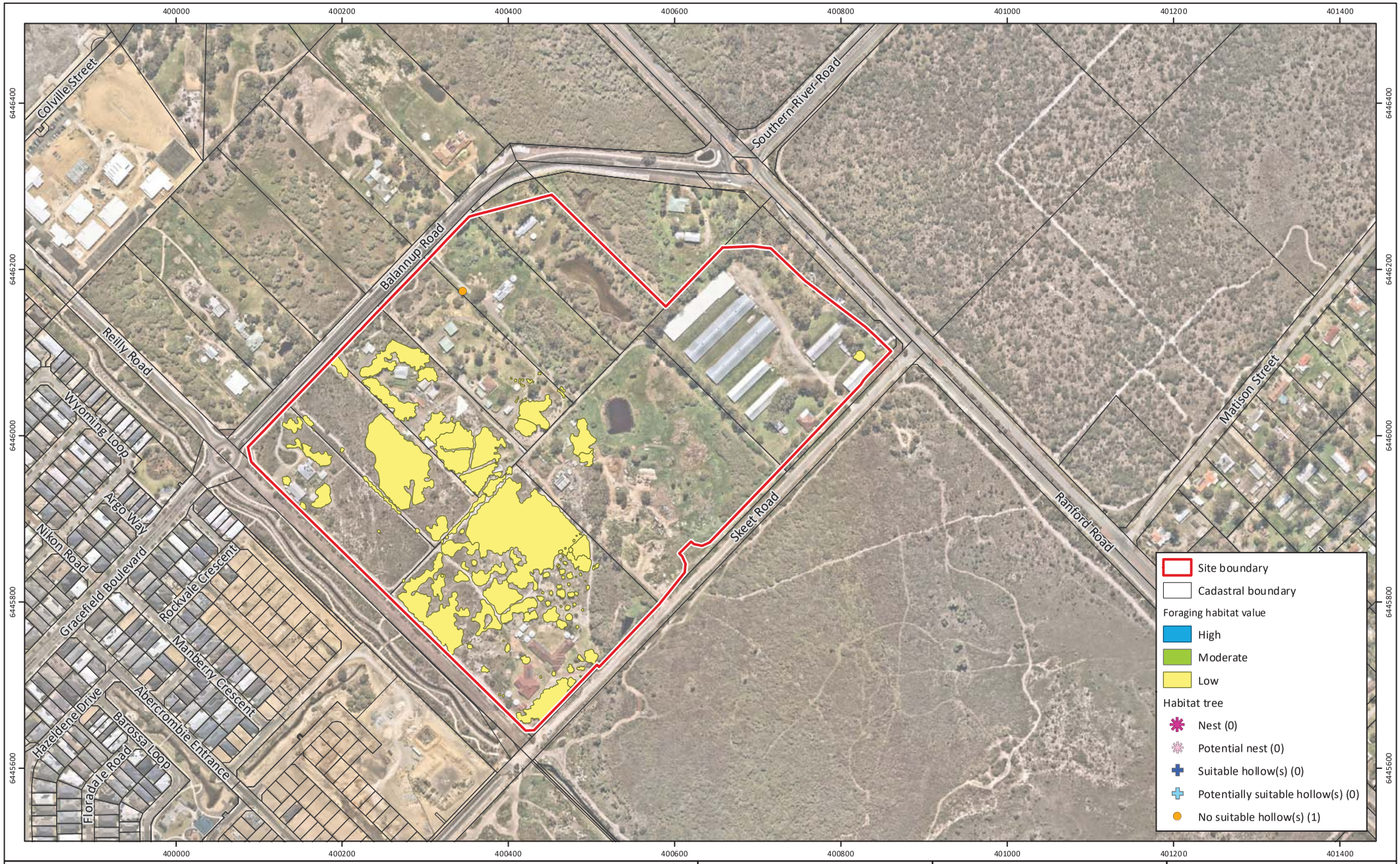


Figure 9: Baudin's Cockatoo Habitat

Project:	Environmental Assessment and Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F57a

Drawn:	GAR
Date:	06/04/2022
Checked:	BRB
Approved:	JDH
Date:	06/04/2022

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Scale: 1:6,000@A4

GDA 1994 MGA Zone 50

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Figure 10: Forest Red-tailed Black Cockatoo Habitat

Project:	Environmental Assessment and Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F58a

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Date:	13/04/2021
Checked:	TEM
Approved:	JDH
Date:	26/07/2021

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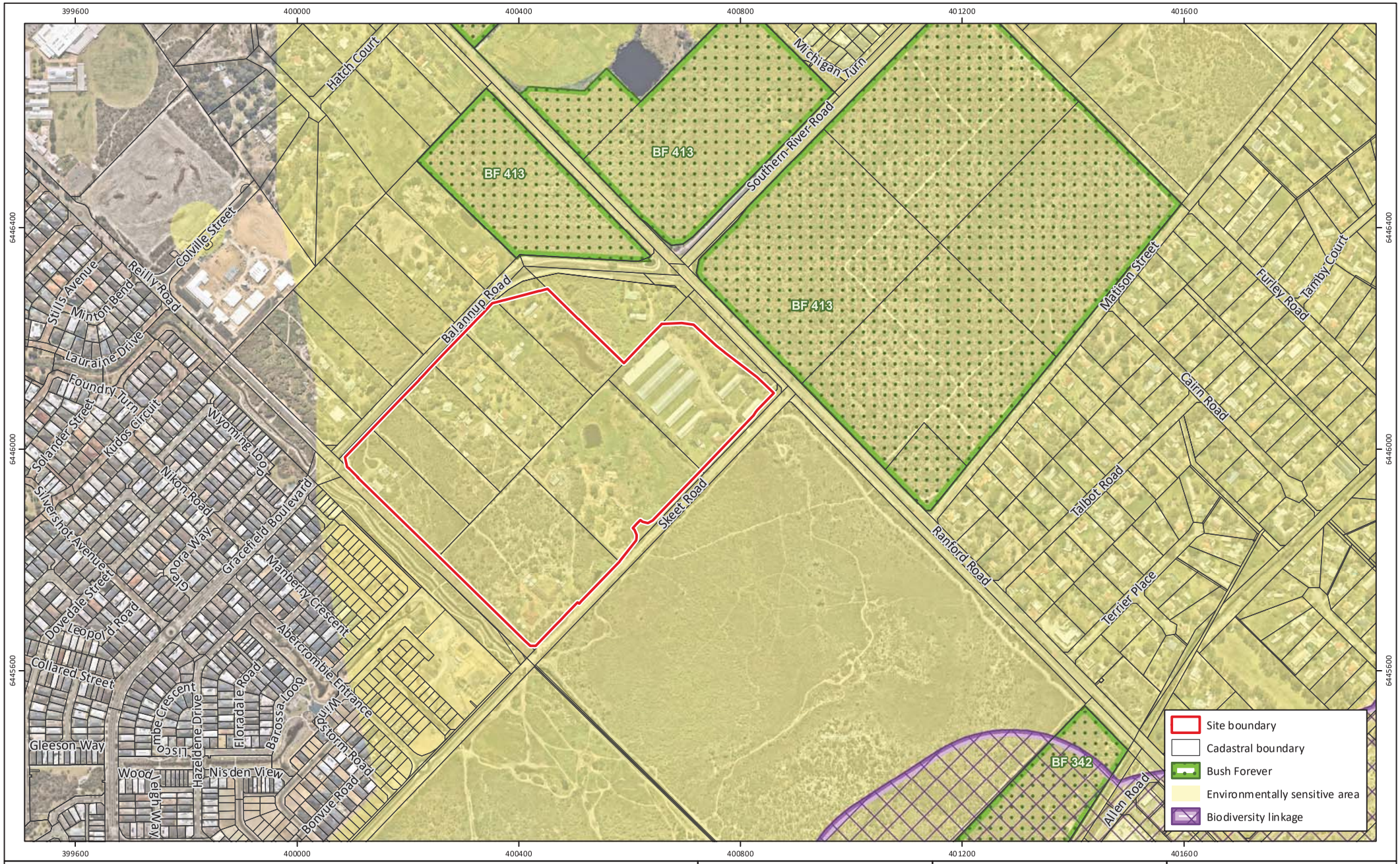


Figure 11: Bush Forever, Ecological Linkages and Environmentally Sensitive Areas

Project:	Environmental Assessment and Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F59a

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Checked:	BRB
Approved:	JDH
Date:	06/04/2022

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Metres

Scale: 1:9,000@A4

GDA 1994 MGA Zone 50

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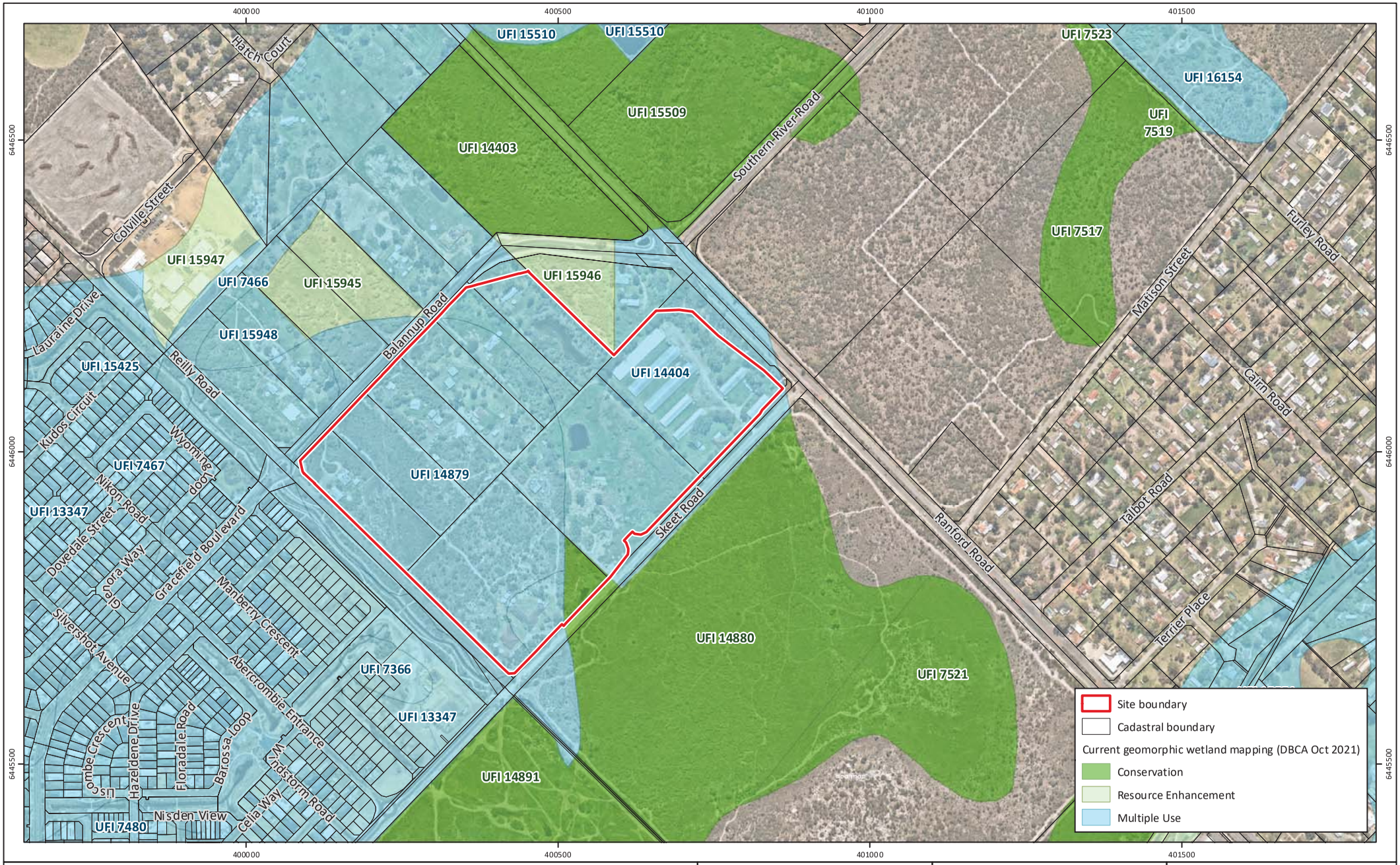


Figure 12: Current Geomorphic Wetland Mapping

Project:	Environmental Assessment and Management Strategy North Harrisdale Local Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F60a

Drawn:	GAR
Date:	04/04/2022
Checked:	JDH
Approved:	BRB
Date:	06/04/2022

N

0 160 320
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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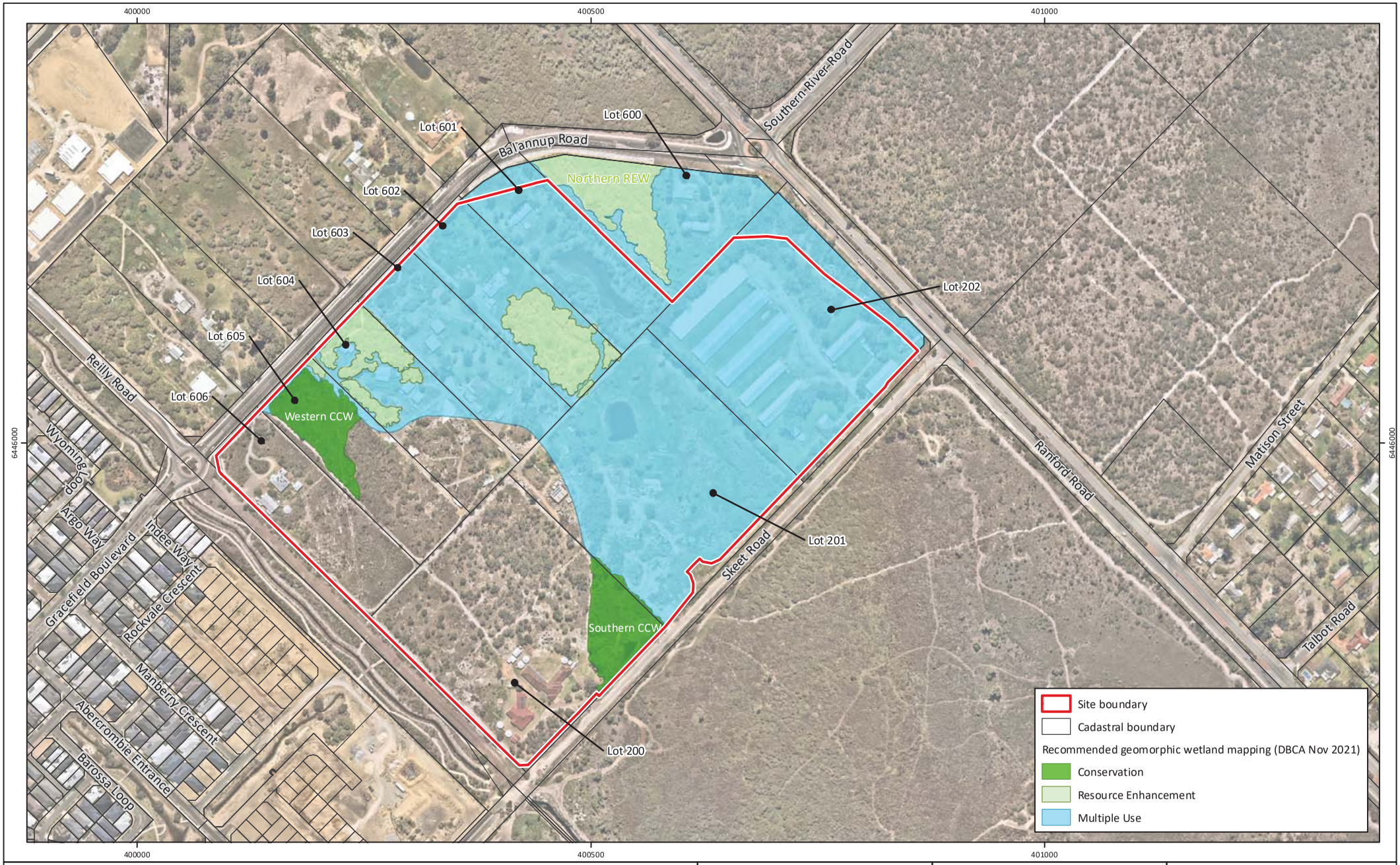


Figure 13: Proposed Geomorphic Wetland Mapping

Project:	Environmental Assessment and Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F75a

Drawn:	GAR
Date:	06/04/2022
Checked:	BRB
Approved:	JDH
Date:	06/04/2022

N

0 90 180
Metres

Scale: 1:5,500@A4

GDA 1994 MGA Zone 50

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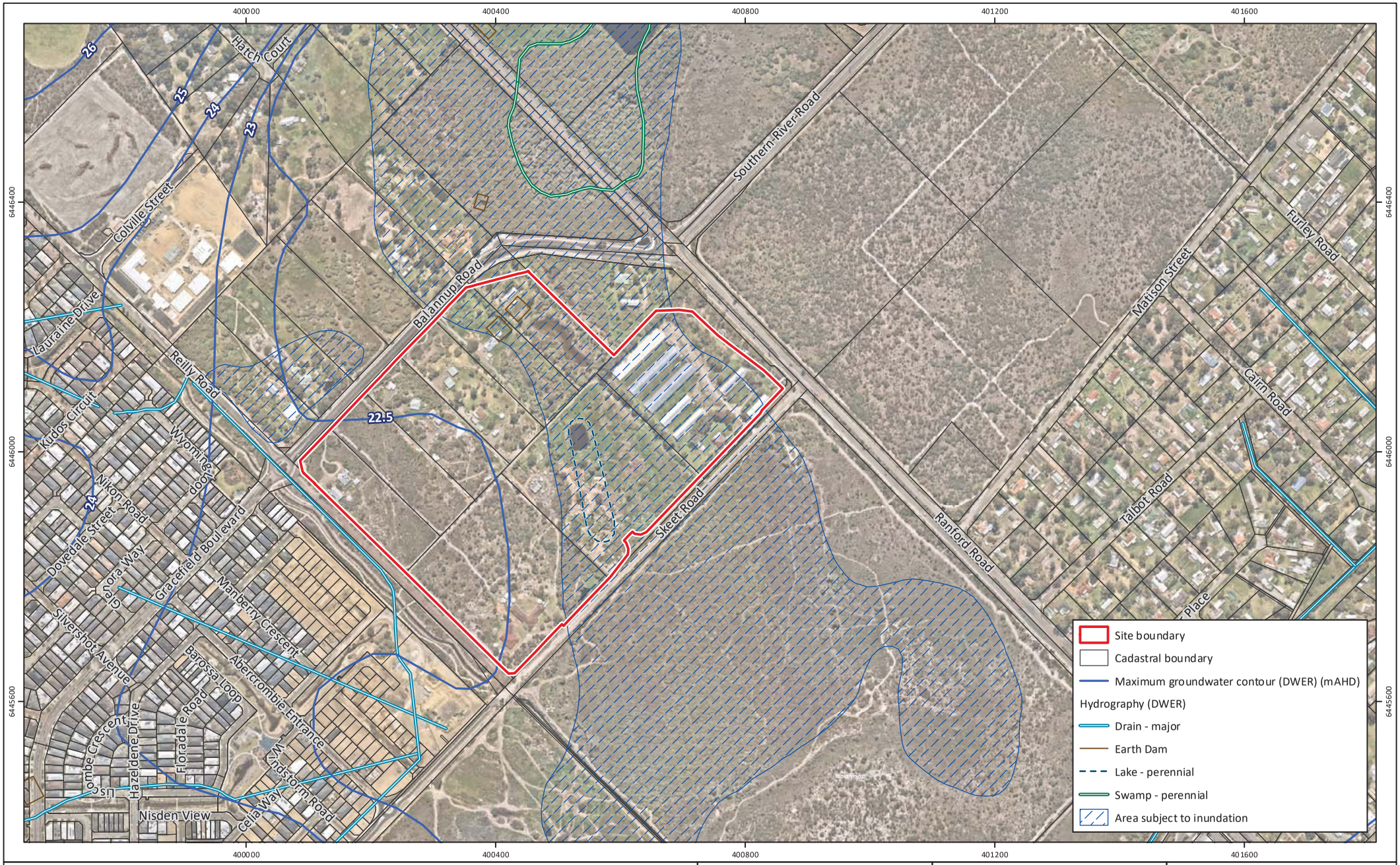


Figure 14: Hydrological Features

Project:	Environmental Assessment and Management Strategy North Harrisdale Stucture Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F76a

Drawn:	GAR
Date:	04/04/2022
Checked:	BRB
Approved:	JDH
Date:	06/04/2022

N

0 100 200 300
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

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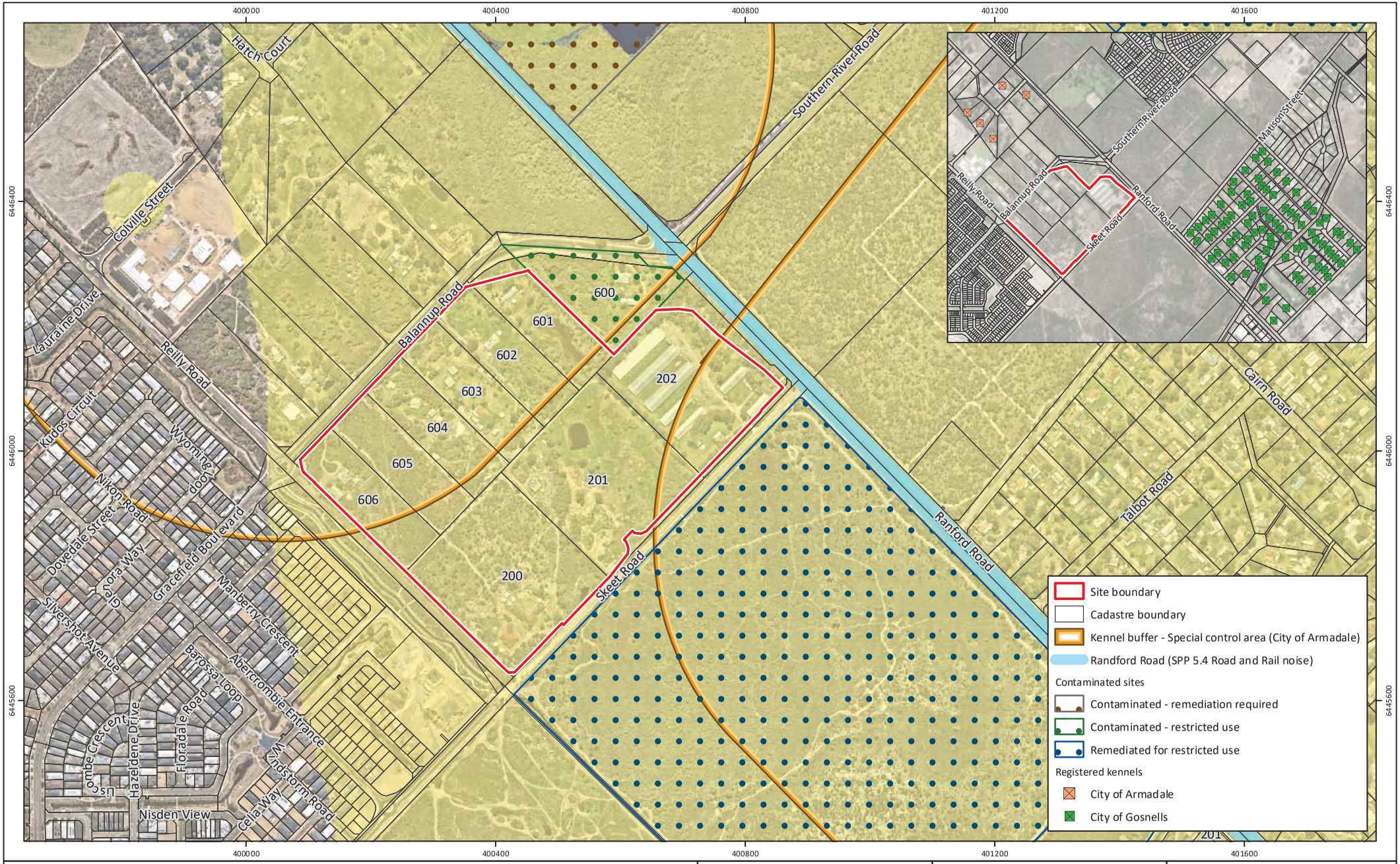


Figure 15: Landuse Considerations and Contaminated Sites

Project:	Environmental Assessment and Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F77a

Drawn:	GAR
Date:	04/04/2022
Checked:	BRB
Approved:	JDH
Date:	06/04/2022

N

0 100 200 300
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

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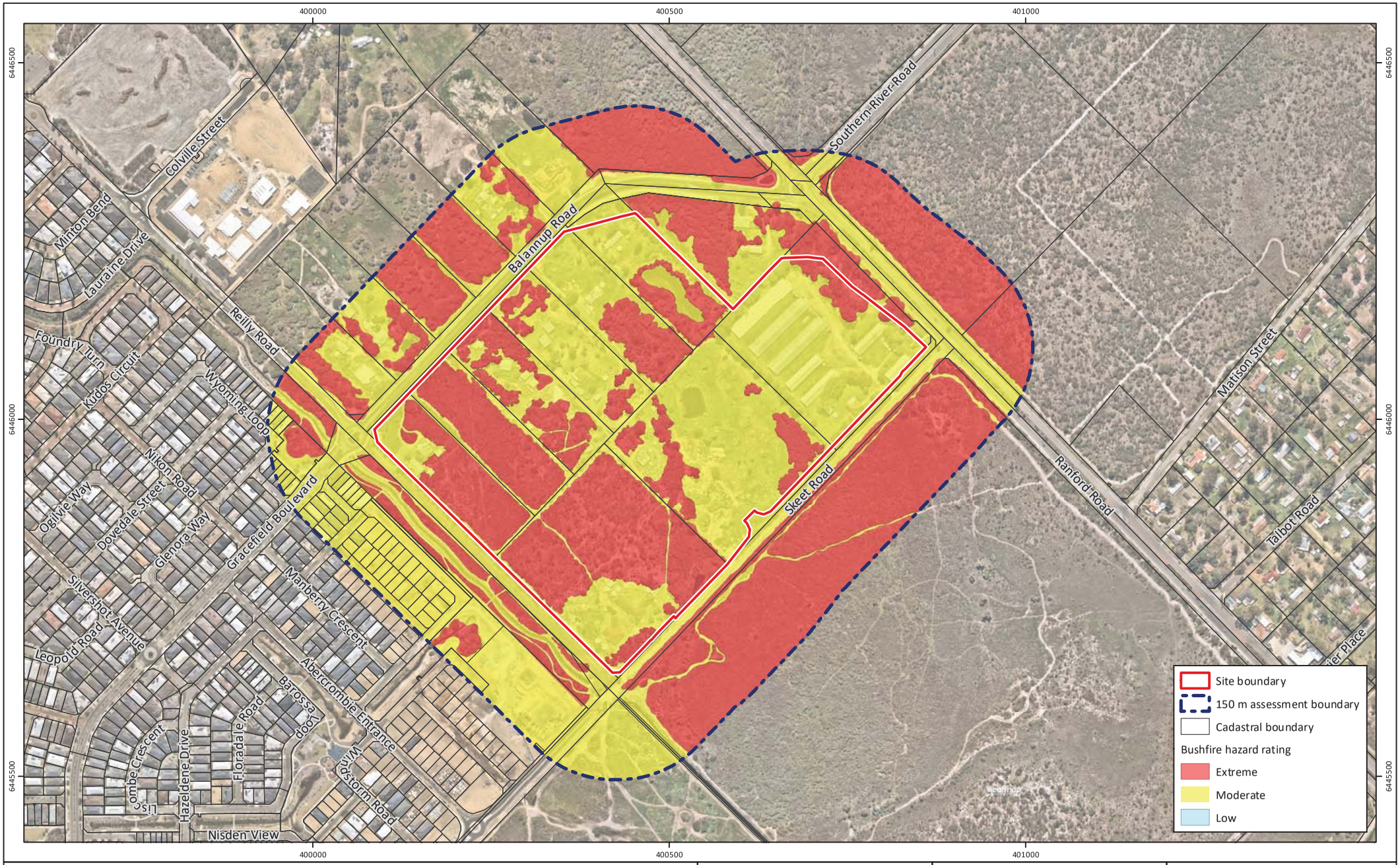


Figure 16: Existing Site Conditions - Bushfire Hazard Assessment

Project:	Environmental Assessment and Management Strategy North Harrisdale Stucture Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F78a

Drawn:	GAR
Date:	04/04/2022
Checked:	BRB
Approved:	JDH
Date:	06/04/2022

N

0 100 200
Metres

Scale: 1:7,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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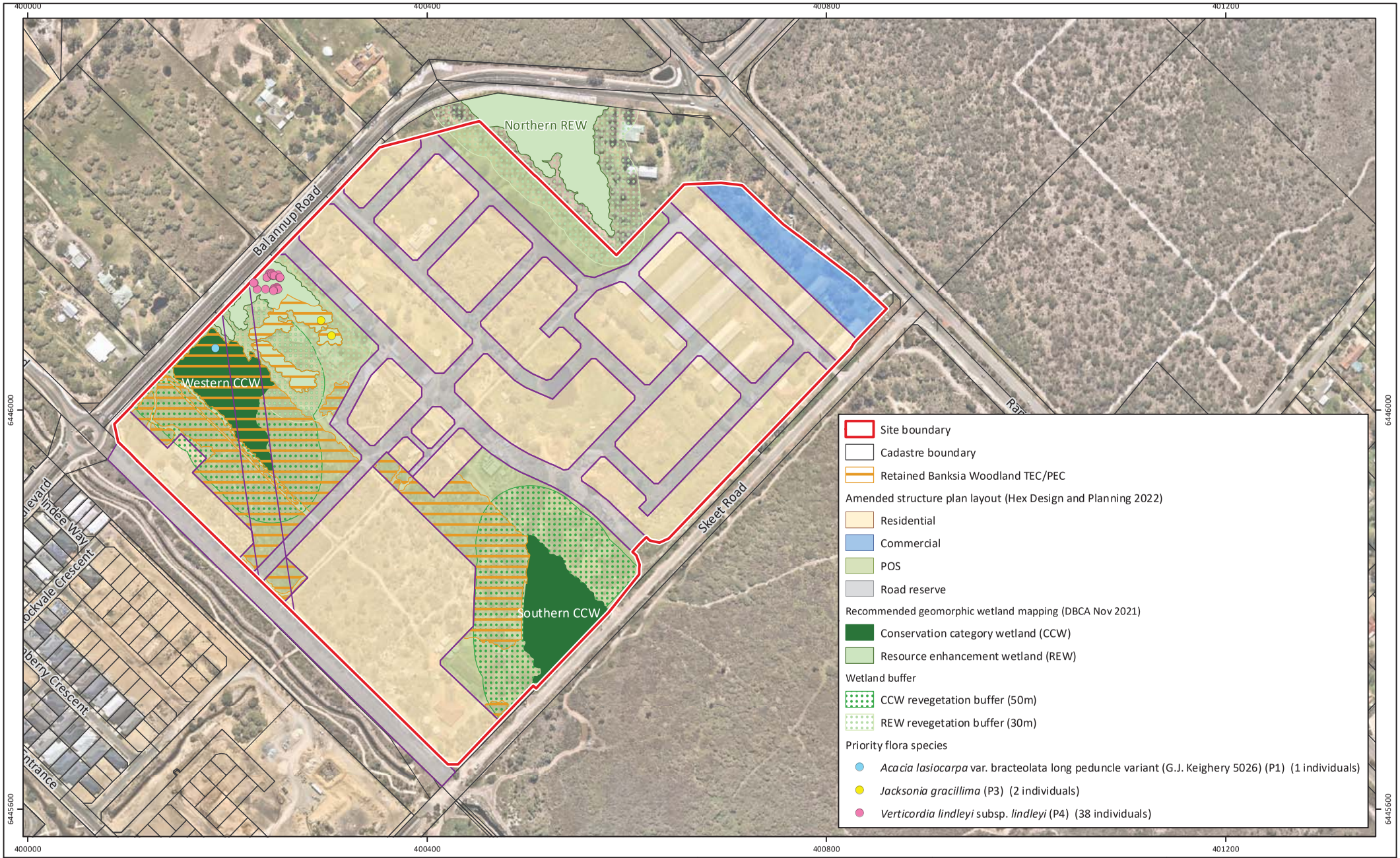


Figure 17: Structure Plan Response to Key Environmental Features

Project:	Environmental Assessment and Management Strategy North Harrisdale Stucture Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(10)--F79a

Drawn:	GAR
Date:	04/04/2022
Checked:	BRB
Approved:	JDH
Date:	06/04/2022

N

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Metres

Scale: 1:5,000@A4

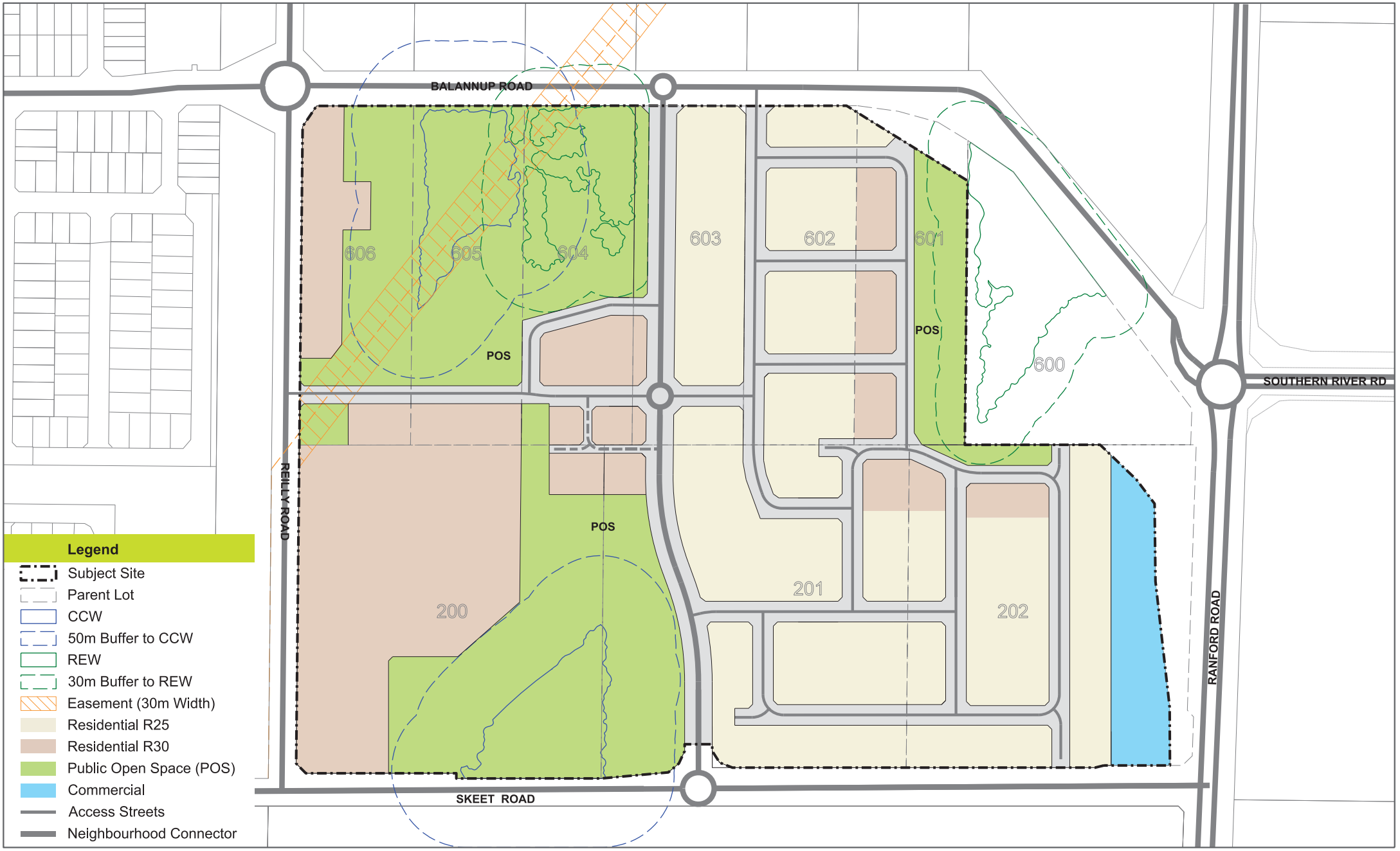
GDA 1994 MGA Zone 50

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Appendix A

Harrisdale Local Structure Plan (Hex Design and Planning 2022)



22-001-001A

0m 50 100 200m

HARRISDALE NORTH STRUCTURE PLAN

Harrisdale. Armadale, WA

Project YOLHA | Scale 1:2500 @ A3 | Date: March 2022

HEX DESIGN | PLANNING

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Appendix B

Detailed Flora and Vegetation Assessment – Lots 600 - 606 Balannup Road and 200-202 Skeet Road, Harrisdale (Emerge Associates 2022b)

Detailed Flora and Vegetation Assessment

Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Project No: EP20-127(02)

Prepared for Yolk Property Group Pty Ltd
March 2022



Document Control

Doc name:	Detailed Flora and Vegetation Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale				
Doc no.:	**EP20-127(02)--003A SKP**				
Version	**Date**	**Author**		**Reviewer**	
1	January 2021	Sarah Paul	SKP	Rachel Weber	RAW
	Report prepared for client review				
A	March 2022	Arielle Fontaine	ASF	Rachel Weber	RAW
	Report updates following additional targeted surveys. Prepared for client review				

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Executive Summary

Emerge Associates (Emerge) were engaged to undertake a 'detailed' flora and vegetation survey for Lots 600-606 Balannup Road and Lots 200-202 Skeet Road, Harrisdale (referred to herein as 'the site'). The purpose of this survey was to provide technical documentation to support the future development of the site for residential purposes.

As part of the assessment, a desktop review of relevant background information was completed and a primary flora and vegetation field survey was undertaken on 15 October and 4 December 2020. During the field survey an assessment was made on the type, condition and values of vegetation across the site. Additional targeted surveys were undertaken within Lots 200 and 602 on 6 August, 6 September, 5 October and 3 November 2021.

Outcomes of the survey include the following:

- Non-native vegetation is present across 16.96 ha (58% of the site).
- Remnant native vegetation is present across 11.88 ha (41% of the site).
- Open water (dams) is present across the remaining 0.45 ha (2% of the site).
- A total of 123 native and 42 non-native (weed) species were recorded in the site.
- No threatened flora species were recorded within the site. One threatened flora species, *Drakaea elastica*, is considered to have potential to occur. Targeted surveys within suitable habitat during the optimal survey period for this species would be required to confirm if this species occurs in Lot 605.
- Three priority flora species were recorded in the site: *Acacia lasiocarpa* var. bracteolata long peduncle variant (G.J. Keighery 5026) (P1), *Jacksonia gracillima* (P3) and *Verticordia lindleyi* subsp. *lindleyi* (P4).
- The vegetation within the site was classified into the following eight plant communities that are present in 'very good', 'good', 'degraded', 'degraded – completely degraded' and 'completely degraded' condition.
    - Plant community **BaBm** was considered to represent floristic community type (FCT) 23a 'Central *Banksia attenuata – B. menziesii* woodlands'.
    - Plant community **BKg** was considered to represent FCT 21a 'Central *Banksia attenuata* - *Eucalyptus marginata* woodlands'.
    - Plant communities **BaMpKg, MpKg** and **AsRc** were considered to represent FCT 4 '*Melaleuca preissiana* damplands'.
    - Plant community **MpE** was considered to represent FCT 11 'Wet forests and woodlands'.
    - Plant community **Mr** was considered to represent FCT 15 'Forests and woodlands of deep seasonal wetlands'.
    - Cleared vegetation which contains buildings, bare ground and non-native vegetation and was too disturbed to assign to an FCT.
- The **BaBm**, **BKg** and **BaMpKg** vegetation comprises the 'Banksia woodlands of the Swan Coastal Plain' 'threatened ecological community' (TEC) which is listed as 'endangered' under the *Environment Protection and Biodiversity Conservation Act 1999* Act.

- The **BaBm**, **BKg** and **BaMpKg** vegetation also represents the state-listed 'priority ecological community' (PEC) 'Banksia woodlands of the Swan Coastal Plain'. This PEC is listed as Priority 3 in Western Australia.
- The site supports vegetation which has the potential to provide habitat for threatened fauna, including black cockatoos. The native vegetation in the site, particularly that in the southern portion, is contiguous with extensive areas of intact native vegetation outside of the site and would contribute to ecological linkages.

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Appendix B

Conservation Significant Flora Species and Likelihood of Occurrence Assessment

Appendix C

Conservation Significant Communities and Likelihood of Occurrence Assessment

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Flora Species List

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Flora Species x Plant Community Matrix

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Vegetation Sample Data

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Cluster Dendrograms

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DoW	Department of Water (now DWER)
DWER	Department of Water and Environmental Regulation
DPaW	Department of Parks and Wildlife (now DBCA)
DPIRD	Department of Primary Industries and Regional Development
WALGA	Western Australian Local Government Association

Table A2: Abbreviations – General terms

General terms	
CCW	Conservation category wetland
ESA	Environmentally sensitive area
FCT	Floristic community type
IBRA	Interim Biogeographic Regionalisation of Australia
MUW	Multiple use wetland
NVIS	National Vegetation Inventory System
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
PEC	Priority ecological community
REW	Resource enhancement wetland
T	Threatened
TEC	Threatened ecological community
UFI	Unique feature identifier
WoNS	Weeds of National Significance

Table A3: Abbreviations – Legislation

Legislation	
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BC Act	*Biodiversity Conservation Act 2016*
BC Regs	*Biodiversity Conservation Regulations 2018*
CALM Act	*Conservation and Land Management Act 1984*
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
LA Act	*Land Administration Act 1997*
SCRM Act	*Swan and Canning Rivers Management Act 2006*

Table A4: Abbreviations – Units of measurement

Units of measurement	
cm	Centimetre
ha	Hectare
km	Kilometre
m	Metre
m^2	Square metre
m AHD	m in relation to the Australian height datum
mm	Millimetre

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1 Introduction

1.1 Project background

Lots 600-606 Balannup Road and Lots 200-202 Skeet Road, Harrisdale are proposed to be developed for residential purposes. These lots (referred to herein as 'the site') are located approximately 25 kilometres (km) south of the Perth Central Business District within the City of Armadale.

The site is approximately 29.29 hectares (ha) in size and is bound by Ranford Road to the north-east, Skeet Road to the south-east, Balannup Road to the north-west and vacant land associated with the easement for the future continuation of Reilly Road to the south-west. The location and extent of the site is shown in **Figure 1**.

1.2 Purpose and scope of work

Emerge Associates (Emerge) were engaged to provide sufficient information on the flora and vegetation values within the site to support the future development of the site for residential purposes.

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

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

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

2 Environmental Context

2.1 Climate

Climate has a strong influence on the types of vegetation that grow in a region and the life cycles of the flora present. It is therefore critical for a flora and vegetation survey to respond appropriately to climatic conditions to ensure that surveys are conducted during times when flora species are easiest to detect and identify.

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

An average of 818.4 millimetres (mm) of rainfall is recorded annually from the Jandakot Aero weather station (no. 9172), which is the closest weather station that records both temperature and rainfall. The Jandakot Aero weather station is located approximately 5 km from the site. The majority of this rainfall is received between the months of April and September. Mean maximum temperatures at the Jandakot Aero weather station range from 18.0^{o}C in July to 31.6^{o}C in February, while mean minimum temperatures range from 7.1^{o}C in July to 17.2^{o}C in February (BoM 2022).

A total of 522.6 mm of rain was recorded from April to September 2020 prior to the primary survey. This is approximately 77% of the long-term average for this period (683.1 mm) (BoM 2022). Although lower than the long-term average, this amount of rainfall was considered to have been sufficient to promote the flowering and emergence of native flora.

A total of 572.6 mm of rain was recorded from April to July 2021 prior to the additional targeted surveys. This is higher than the long-term average for this period (472.5 mm) (BoM 2022).

2.2 Geomorphology and soils

Landform and soils influence vegetation types at regional and local scales. The site occurs on the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan area.

The Swan Coastal Plain is approximately 500 km long and 20 to 30 km wide and is roughly bound by the Indian Ocean to the west and the Darling Scarp to the east. Broadly the Swan Coastal Plain consists of two sedimentary belts of different origin. Its eastern side has formed from the deposition of alluvial material washed down from the Darling Scarp, while its western side is comprised of three dune systems that run roughly parallel to the Indian Ocean coastline (Seddon 2004). These dune systems, referred to as Quindalup, Spearwood and Bassendean associations, represent a succession of coastal deposition that has occurred since the late Quaternary period (approximately two million

years ago) (Kendrick *et al.* 1991) and, as a result, they contain soils at different stages of leaching and formation.

Examination of broad scale soil mapping places the site within the Southern River association of the Bassendean dunes (Churchward and McArthur 1980). The Southern River association comprises of sandplain with low dunes and many intervening swamps; iron and humus podzols, peats and clays.

Finer scale mapping by the Department of Primary Industries and Regional Development (DPIRD) places the site within the following soil associations:

- The south-western portion and northern portion of the site are mapped as Bassendean sands (B1), which are described as 'extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than 2 m depth' (DPIRD 2018).
- A small portion of the western edge of the site is mapped as comprising Bassendean sands (B3) which are described as 'closed depressions and poorly defined stream channels with moderately deep, poorly to very poorly drained bleached sands with an iron-organic pan, or clay subsoil (and) surfaces are dark grey sand or sandy loam' (DPIRD 2018).
- The south-eastern portion of the site is mapped as comprising Bassendean sands (B4) which are described as a 'broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depths generally greater than 1.5 m by clay or less frequently a strong iron-organic hardpan' (DPIRD 2018).

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

The soil types described above were later confirmed during the field survey.

2.3 Topography

The site is relatively flat. The elevation of the site ranges from 21 m in relation to the Australian height datum (m AHD) in the northern portion of the site, associated with a wetland feature, to 23 m AHD on the western side of the site (DoW 2008) (**Figure 2**).

2.4 Hydrology and wetlands

Wetlands include "areas of seasonally, intermittently or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh and saline, e.g. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries" (Wetlands Advisory Committee 1977). Wetlands can further be recognised by the presence of vegetation associated with waterlogging or the presence of hydric soils such as peat, peaty sand or carbonate mud (Hill *et al*. 1996).

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

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

No Ramsar or listed 'important wetlands' are located within or near the site. The Ramsar site 'Forrestdale and Thomsons Lakes' (ID 246) is located 3.2 km south of the site.

Examination of the Department of Water and Environmental Regulation (DWER) hydrography dataset (DWER 2018) shows a perennial lake present within Lot 201 and two earth dams present within Lots 601 and 602. These three features are located within a larger area that is mapped as an 'area subject to inundation' that extends over most of the eastern portion of the site (DWER 2018), as shown in **Figure 3**.

On the Swan Coastal Plain the Department of Biodiversity, Conservation and Attractions (DBCA) has used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence (hydro-period) (DBCA 2017a). DBCA maintains the *Geomorphic Wetlands, Swan Coastal Plain* dataset which further categorises geomorphic wetland features into specific management categories to guide land use and conservation (DBCA 2020a). Note that as this dataset was drafted at a regional scale the boundaries of mapped wetland features are often inconsistent with physical wetland boundaries.

A review of the *Geomorphic Wetlands, Swan Coastal Plain* dataset indicated that the entire site supports mapped geomorphic wetlands (DBCA 2020a). One 'conservation' category sumpland, UFI 14880, occurs in a small area in the south-eastern portion of the site and extends across Skeet Road to the south-east of the site. One 'resource enhancement' sumpland, UFI 15946, exists within Lot 600 and extends into Balannup Road. Two 'multiple use' category damplands, UFI 14879 and UFI 13347, are present within the western half of the site and one 'multiple use' sumpland, UFI 14404, is present over the eastern half of the site. The locations of the geomorphic wetlands in the vicinity of the site are shown in **Figure 3**.

2.5 Regional vegetation

Native vegetation is described and mapped at different scales in order to illustrate patterns in its distribution. At a continental scale the *Interim Biogeographic Regionalisation of Australia* (IBRA) divides the Swan Coastal Plain into two floristic subregions (Environment Australia 2000). The site is contained within the 'SWA02' or Perth subregion, which is characterised as mainly containing *Banksia* low woodland on leached sands with *Melaleuca* swamps where ill-drained; and woodland of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah) and *Corymbia calophylla* (marri) on less leached soils (Beard 1990). This subregion is recognised as a biodiversity hotspot and contains a wide variety of endemic flora and vegetation types.

Variations in native vegetation within the site can be further classified based on regional vegetation associations. Heddle *et al.* (1980) mapping shows the site as comprising the 'Southern River Complex', which is described as comprising open woodland of *Corymbia calophylla - Eucalyptus marginata - Banksia* spp. with fringing woodland of *Eucalyptus rudis - Melaleuca rhaphiophylla* along creek beds. This complex was determined to have 18.43% of its pre-European extent remaining on the Swan Coastal Plain in 2018. Of its Swan Coastal Plain pre-European extent, 1.37% is under formal protection (Government of Western Australia 2019).

More recent Beard *et al.* (2013) mapping shows the site comprises vegetation association 'Bassendean_1001'. This association is described as 'low forest, woodland or low woodland with

scattered trees' of '*Eucalyptus marginata*, *Banksia* spp., *Allocasuarina* spp.' (Beard *et al.* 2013). 'Bassendean_1001' association has 22.1% of its pre-European extent remaining on the Swan Coastal Plain with 2.8% protected for conservation purposes (Government of Western Australia 2018).

Studies have indicated that the loss of biodiversity caused by habitat fragmentation is significantly greater once a habitat type falls below 30% of its original extent (Miles 2001). The national objectives and targets for biodiversity conservation established an objective of retaining 30% of the original extent of each vegetation complex (Environment Australia 2001). However, a lower objective of 10% is applied in 'constrained urban areas' such as the Swan Coastal Plain (Ministry for Planning 1995). The percentage protected for conservation of the 'Southern River Complex' and the 'Bassendean_1001' association fall below the 30% and 10% retention objective.

2.6 Historic land use

Review of historical images available from 1953 (WALIA 2021) onwards shows that the site was uncleared in 1953 and the eastern half of the site was part of a large wetland. By 1961 a number of roads are present surrounding the site and by 1965 an easement across portions of Lots 604-606 can be seen. By 1974 Lots 201 and 202 were cleared and a large body of water is present across these lots. By 1977 Lot 200 was almost entirely cleared, with the exception of the south-east corner. Between 1965 and 1989 various small-scale clearing events are visible across Lots 604-606 and Lot 601 is entirely cleared. Between 1987 and 1989 a number of buildings including a poultry farm were constructed in Lot 202. By 1989 much of Lot 600 and half of Lot 602 was cleared. In 1991 a large fire scar is visible over the western portion of the site. Since 2008 most of the site has been subject to limited clearing, and areas of regrowth of native vegetation are visible, particularly in Lots 200, 600 and 604-606.

2.7 Significant flora and vegetation

2.7.1 Threatened and priority flora

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

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

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

2.7.2 Threatened and priority ecological communities

An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a unique habitat. An ecological community's structure, composition and distribution are influenced by environmental factors such as soil type, position in the landscape, altitude, climate and water availability (DAWE 2022a). 'Threatened ecological communities' (TECs) are ecological communities that are recognised as rare or under threat and therefore warrant special protection.

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

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

A plant community that is under consideration for listing as a TEC in Western Australia, but does not yet meet survey criteria or has not been adequately defined, may be listed as a 'priority ecological community' (PEC). Listing as a PEC is similarly considered during State approval processes. Further information on categories of TECs and PECs is provided in **Appendix A**.

2.7.3 Local and regional significance

Flora species and ecological communities may be significant for a number of reasons irrespective of whether they have special protection under policy or legislation.

Three key reasons that vegetation within the site may be significant are listed below:

- The vegetation within the site is closely associated with wetlands.
- The vegetation includes species listed in *Bush Forever* 'significant flora of the Bassendean dunes in the Perth metropolitan region' (Government of Western Australia 2000b).
- The vegetation within the site has potential value as habitat for threatened or priority fauna species including threatened species of black cockatoo.

2.8 Weeds

The term 'weed' can refer to any plant that requires some form of action to reduce its effect on the economy, the environment, human health and amenity. Many non-native flora species and some native species are considered to be weeds.

A particularly invasive or detrimental weed species may be listed as a 'declared pest' pursuant to Western Australia's *Biosecurity and Agriculture Management Act 2007* (BAM Act), indicating that it warrants special management to limit its spread. At a National level, the Australian government has compiled a list of 32 *Weeds of National Significance* (WoNS) (DAWE 2022b). Whilst the WoNS list is

non-statutory, many WoNS are also listed under the BAM Act. Further information on categories of declared pests is provided in **Appendix A**.

Due to historical disturbance, some weed species are expected to be present at the site.

2.9 Bush Forever

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

No *Bush Forever* sites are present within the site. *Bush Forever* Site 413 (Balannup Lake and Adjacent Bushland, Southern River/Forrestdale) is present to the north-east of the site. *Bush Forever* Site 342 (Anstey/Keane Dampland and Adjacent Bushland, Forrestdale) is present to the south-east of the site. The location of *Bush Forever* Site 413 is shown in **Figure 4**.

2.10 DBCA managed or legislated lands

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

No DBCA legislated lands or water occur within the site. Balannup Lake Nature Reserve is located to the immediate north of the site, whilst freehold land managed by DBCA is located to the north-east of the site. The location of the DBCA managed lands is shown in **Figure 4**.

2.11 Ecological linkages

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

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

No ecological linkages are present in close proximity to the site. However, a review of aerial imagery indicates that much of the vegetation within the site is connected to extensive areas of native vegetation within the local area.

2.12 Previous surveys

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

3 Methods

3.1 Desktop assessment

A search was conducted for threatened and priority flora that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020), *NatureMap* (DBCA 2020b) and DBCA's threatened and priority flora database (reference no. 22-1020FL).

A search was also conducted for TECs and PECs that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020), the *weed and native flora dataset* (Keighery *et al.* 2012) and DBCA's threatened and priority ecological communities' databases (reference no. 01-1120EC).

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

3.2 Field survey

Two botanists from Emerge visited the site on 15 October and 4 December 2020 to conduct the primary flora and vegetation field survey. Additional targeted surveys were undertaken within Lots 200 and 602 by a botanist and ecologist from Emerge on 6 August, 6 September, 5 October and 3 November 2021.

3.2.1 Flora and vegetation

During the primary field survey, the site was traversed on foot and the composition and condition of vegetation was recorded.

Detailed sampling of the vegetation was undertaken using a combination of non-permanent 10 x 10 m quadrats and relevés. The quadrats were established using fence droppers bound by measuring tape. The relevés were completed over an equivalent 10 x 10 m area without the use of physical markers and were included to provide a more rapid sample of patches of vegetation in poorer condition and/or of smaller size.

A total of eleven locations were sampled, comprised of four quadrats and seven relevés. The position of each sample location was recorded with a hand-held GPS unit, as shown in **Figure 5**.

The data recorded within each sample included:

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

Additional plant taxa not observed within samples were recorded opportunistically as the botanists traversed the site. Photographs were taken throughout the field visit to show particular site conditions.

The suitability of habitat within the site for conservation significant species identified in the desktop assessment was assessed (refer **Section 3.1**). Where identified, areas of suitable habitat were traversed to search for conservation significant species.

Vegetation condition was assigned at each sample and changes in vegetation condition were also noted and mapped across the site. The condition of the vegetation was assessed using methods from Keighery (1994). For vegetation in the site containing *Banksia* spp., the condition scale provided in the *Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community* (TSSC 2016) was applied in addition to the Keighery scale (as shown in **Table 1**).

Table 1: Vegetation condition scale applied during the field assessment

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

During additional targeted surveys, areas of suitable habitat were traversed to search for conservation significant species. When observed, the location of each conservation significant individual was recorded using a hand-held GPS unit.

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

3.3 Mapping and data analysis

3.3.1 Conservation significant flora and vegetation

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

Table 2: Likelihood of occurrence assessment categories and definitions

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

3.3.2 Plant community identification and description

The local plant communities within the site were identified from the sample data collected during the primary field survey. The vegetation was described according to the dominant species present using the structural formation descriptions of the *National Vegetation Inventory System* (NVIS) (ESCAVI 2003). The identified plant communities were mapped on aerial photography from the sample locations and boundaries were interpreted from aerial photography and notes taken in the field. Vegetation condition was mapped on aerial photography based on the locations and notes recorded during the field survey to define areas with differing condition.

3.3.3 Floristic community type assignment

The identified plant communities were then compared to the regional 'floristic community type' (FCT) dataset *A floristic survey of the southern Swan Coastal Plain* by Gibson *et al.* (1994). The sample data (presence/absence) was reconciled with Gibson *et al*. (1994) by standardising the names of taxa with those used in the earlier study. This was necessary due to changes in nomenclature in the intervening period. Taxa that were only identified to genus level were excluded, while some infra-species that have been identified since 1994 were reduced to species level. The combined dataset was then imported into the statistical analysis package PRIMER v6 (Clarke and Gorley 2006). As data

from a localised survey is often spatially correlated, data for each sample was compared to Gibson *et al.* (1994) separately. This removed the influence of spatial correlation when assigning a FCT. A resemblance matrix was generated using the Bray-Curtis distance measure which provided the percentage similarity between all pairs of samples. Subsequently, a cluster analysis was undertaken using the resemblance matrix and hierarchical agglomerative clustering to produce a dendrogram.

Where the sample tended to cluster with a grouping of different FCTs, samples were assessed separately to differentiate between FCTs. Ultimately the cluster analysis, as well as contextual information relating to the soils, landforms and known locations of FCTs within the region, were considered in the final determination of an FCT for vegetation within the site.

3.3.4 Threatened and priority ecological communities

Areas of native vegetation potentially representing a TEC were assessed against key diagnostic characteristics and, if available, size and/or vegetation condition thresholds provided in the following document:

- *Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community* (TSSC 2016).

3.3.5 Species accumulation curve

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

3.4 Survey limitations

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

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

Constraint	Degree of limitation	Details
Availability of contextual information	No limitation	The broad scale contextual information described in **Section 2** is adequate to place the site and vegetation in context.
	Minor limitation	Regarding assignment of FCTs, the authoritative Gibson *et al.* (1994) dataset was derived from a necessarily limited sample of vegetation from largely publicly owned land which is now more than 20 years out of date. Consequently, it is unknown to what degree official FCTs are an appropriate reference to biodiverse vegetation across the Swan Coastal Plain. Gibson *et al.* (1994) collected data in the spring main flowering period and in many cases sampled plots multiple times to provide a complete species list.
Experience level of personnel	No limitation	The primary flora and vegetation survey was undertaken by two qualified botanists with ten years of botanical experience in Western Australia. The additional targeted surveys were undertaken by a qualified botanist and ecologist with ten and eight years of botanical experience in Western Australia. Technical review was undertaken by a senior environmental consultant with over ten years' experience in environmental science in Western Australia.
Suitability of timing	No limitation	The primary survey was conducted in October and December 2020 and thus within the main flowering season. Moderate rainfall was recorded from April to September 2020 in the months preceding the site visit. Therefore, it is likely that many plant species would have been in flower and/or visible at the time of survey. The degraded nature of portions of the site limits the potential habitat for native geophytic plants such as orchids and the majority of threatened and priority flora species with potential to occur are perennial species. Additional targeted surveys were conducted between August and November 2021, multiple times within the main flowering season. High rainfall was recorded from April to July 2021 in the months preceding the site visits. Therefore, it is likely that many plant species would have been in flower and/or visible at the time of survey. The survey timing was considered adequate to allow the detection of species for which seasonal timing is critical.
Temporal coverage	Minor limitation	Detailed flora and vegetation assessments can require multiple visits, at different times of year, and over a period of a number of years, to enable observation of all species present. The site was visited twice in 2020 in October and December. The October survey coincided with the flowering period for many conservation significant flora species and the December site visit provided an insight into the vegetation condition and composition out of the main flowering period. The primary survey included visits to Lot 605 which was identified as potentially containing suitable habitat for a threated flora species, *Drakaea elastica*. This survey, however, was undertaken outside of the optimal survey period for this species (July to August). Lots 200 and 602 were visited four times in 2021 in August, September, October and November. These visits were conducted within the main flowering period for many conservation significant flora species and the lots were traversed systematically to record all conservation significant individuals. According to the EPA guidelines this survey is considered to meet the requirements of a 'detailed' survey.
Spatial coverage and access	Minor limitation	Site coverage was comprehensive (track logged). All lots were visited during the primary field survey. Only selected lots were included in the targeted survey the following year. This was based on assessment of habitat suitability for conservation significant species and access permissions.

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

Constraint	Degree of limitation	Details
Sampling intensity	Minor limitation	A total of 165 species were recorded, of which 121 were recorded from 11 sample locations and 44 were recorded opportunistically. Minimum species richness within site is estimated at between 181 (Jacknife1) and 201 (Chao2) species (refer species accumulation curve and estimates shown in **Plate 10**). This indicates that between 82 and 91% of the estimated 181-201 species in the site were recorded. Considering the degraded nature of a large portion of the site and the time spent sampling and searching the vegetation, the survey effort was considered to be adequate to prepare a representative species inventory.
Influence of disturbance	Minor limitation	Time since fire is approximately 30 years as interpreted form aerial imagery and therefore short lived species more common after fire may not have been visible.
	No limitation	Historical ground disturbance was evident in parts of the site and some native vegetation in the site is regrowth with minimal non-native species present. The disturbance history of the site was considered when undertaking field sampling.
Adequacy of resources	No limitation	All resources required to perform the survey were available.

4 Results

4.1 General site conditions

Most of the site has been subject to intensive historical disturbance and comprised cleared land and planted non-native vegetation, particularly in the eastern portion. The western and southern portions of the site support more intact native vegetation.

Soils are pale and sandy with underlying clay in some areas. The eastern portion of the site is slightly lower lying than the western portion and evidence of previous inundation was observed.

4.2 Flora

4.2.1 Desktop assessment

The database search results identified a total of 31 threatened and 59 priority flora species occurring or potentially occurring within a 10 km radius of the site. Information on these species including their habitat preferences and flowering period is provided in **Appendix B**.

Based on background information available for the site, suitable habitat was considered to potentially occur within the site for 17 threatened flora species and 29 priority flora species as shown in **Table 4.**

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

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Austrostipa jacobsiana	CR	CR	P	Grey sandy clay.	Nov-Jan
Caladenia huegelii	CR	EN	PG	Well-drained, deep sandy soils in lush undergrowth in a variety of moisture levels.	Sep-early Nov
Calytrix breviseta subsp. *breviseta*	CR	EN	P	Seasonally wet sandy-clay soil on swampy flats.	Oct-Nov
Drakaea elastica	CR	EN	PG	Bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps.	late Sep-Oct/Nov, survey Jul-Aug
Grevillea thelemanniana	CR	CR	P	Sand, sandy clay. Winter-wet low-lying flats.	May-Nov
Synaphea sp. Serpentine (G.R. Brand 103)	CR	CR	P	Seasonally damp areas, loam - sand.	Sep-Oct
Austrostipa bronwenae	EN	EN	P	Grey-brown sandy loam soil in low lying winter wet areas.	Sep-Nov
Diuris purdiei	EN	EN	PG	Sand to sandy clay soils in areas subject to winter inundation.	late September to mid-October

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

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Drakaea micrantha	EN	VU	PG	Open sandy patches often adjacent to winter-wet swamps.	Sept- early Oct
Eremophila glabra subsp. *chlorella*	EN	-	P	Sandy clay. Winter-wet depressions.	Jul-Nov
Grevillea curviloba subsp. *incurva*	EN	EN	P	Sand, sandy loam. Winter-wet heath.	Aug-Sep
Lepidosperma rostratum	EN	EN	P	Peaty sand and clay amongst low heath, in winter-wet swamps.	May-Jun (survey late Jun-Aug)
Macarthuria keigheryi	EN	EN	P	Low-lying winter-wet damp grey/white sands in open patches.	Sep-Dec or Feb-Mar
Synaphea sp. Pinjarra Plain (A.S. George 17182)	EN	CR	P	White grey clayey sand on edges of seasonally inundated low lying areas.	Sep-Oct
Banksia mimica	VU	EN	P	Flat to gentle slopes in grey and white sand in open woodlands.	Dec-Jan
Conospermum undulatum	VU	VU	P	Sand and sandy clay soils, on flat or gently sloping sites between the Swan and Canning Rivers.	May-Oct
Eleocharis keigheryi	VU	VU	P	Clay or sandy loam in freshwater creeks and transient waterbodies such as seasonally wet clay pans.	Aug-Dec
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)	P1	-	P	Grey or black sand over clay in winter wet areas.	May-Aug
Bolboschoenus fluviatilis	P1	-	P	Floodplain with grey/brown wet sand.	Nov
Ptilotus sericostachyus subsp. *roseus*	P1	-	P	Unknown. Seem to be associated with wetlands/rivers.	Sep-Dec
Comesperma rhadinocarpum	P2	-	P	Sandy soils.	Oct-Nov
Johnsonia pubescens subsp. *cygnorum*	P2	-	P	Grey white yellow sands on flats and seasonally wet areas.	Sep
Poranthera moorokatta	P2	-	A	Sandy or clay soils. Dampland or low sandy dunes.	Oct or Feb
Schoenus loliaceus	P2	-	A	Sandy soils in winter-wet depressions.	Aug-Nov
Stenanthemum sublineare	P2	-	P	White sand on coastal plains.	Oct-Dec
Babingtonia urbana	P3	-	P	Grey sand, lateritic gravel.	Jan-Mar
Byblis gigantea	P3	-	P	Sandy-peat swamps. Seasonally wet areas.	Sep-Jan

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

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Chamaescilla gibsonii	P3	-	P	Clay to sandy clay in winter-wet flats, shallow water-filled claypans.	Sep
Cyathochaeta teretifolia	P3	-	P	Grey sand, sandy clay in swamps and creek edges.	Oct-Jan
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)	P3	-	P	Grey brown sand or clay in winter wet flats.	Sep-Nov
Isotropis cuneifolia subsp. *glabra*	P3	-	P	Sand, clay loam in winter-wet flats.	Sep
Jacksonia gracillima	P3	-	P	Sand, often adjacent to winter wet areas.	Sep-Dec
Schoenus benthamii	P3	-	P	White, grey sands, sandy clay in winter wet flats and swamps.	Oct-Nov
Schoenus pennisetis	P3	-	A	Grey or peaty sand in swamps and winter-wet depressions.	Aug-Sep
Stylidium aceratum	P3	-	A	Sandy soils in swamp heathland.	Oct-Nov
Styphelia filifolia	P3	-	P	Brown over pale yellow sand.	Feb-Apr
Aponogeton hexatepalus	P4	-	P	Mud. Freshwater ponds, rivers, claypans.	Jul-Oct
Drosera occidentalis	P4	-	P	Flat, brown/white/yellow moist sand/clay/peat, often near swamps.	Oct-Dec/Jan
Hydrocotyle lemnoides	P4	-	A	Floating in swamps.	Aug-Oct
Ornduffia submersa	P4	-	A	Sandy clay in inundated wetland/creek.	Aug-Nov
Schoenus natans	P4	-	A	Aquatic, in winter-wet depressions.	Oct
Stylidium longitubum	P4	-	A	Seasonal wetlands.	Oct-Dec
Thysanotus glaucus	P4	-	P	White, grey or yellow sand, sandy gravel.	Oct-Mar
Tripterococcus sp. Brachylobus (A.S. George 14234)	P4	-	P	Winter-wet areas on grey sand.	Oct-Feb
Verticordia lindleyi subsp. *lindleyi*	P4	-	P	Sand and sandy clay in winter wet areas.	May or Nov-Jan
Ornduffia submersa	P4	-	A	Sandy clay in inundated wetland/creek.	Aug-Nov

CR=critically endangered, EN=endangered, VU=vulnerable, P1-P4=Priority 1-Priority 4, A=annual, P=perennial, PG=perennial geophyte.

4.2.2 Species inventory

A total of 123 native and 42 non-native (weed) species were recorded within the site during the field survey, representing 49 families and 122 genera. The dominant families containing native taxa were Myrtaceae (18 native taxa and five weed taxa) and Fabaceae (12 native taxa and five weed taxa). The

most common genera were *Melaleuca* with seven taxa and *Acacia* and *Lomandra* with five taxa each. Of the species recorded 121 were recorded in sample locations and 44 were recorded opportunistically.

A complete species list is provided in **Appendix D** and a species list by plant community matrix is provided in **Appendix E**.

4.2.3 Threatened and priority flora

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

Three priority flora species were recorded within the site. Fifty-eight individuals of *Acacia lasiocarpa* var. bracteolata long peduncle variant (G.J. Keighery 5026) (P1) were recorded, with 57 in Lot 200 and one in Lot 605. *Jacksonia gracillima* (P3) and *Verticordia lindleyi* subsp. *lindleyi* (P4) were recorded within Lot 604, with two individuals of *J. gracillima* in the central portion and 38 individuals of *V. lindleyi* subsp. *lindleyi* in the northern portion. The individuals of all three species appeared healthy and were flowering at the time of the surveys.

Images of priority flora recorded within the site are provided in **Plate 1** and their locations within the site are shown in **Figure 7**.

The survey was unable to confirm the presence or absence of one threatened flora species, *Drakaea elastica*. This species was not recorded during the primary field survey or the subsequent targeted surveys but suitable habitat exists within plant community **BKg** (refer to **Section 4.3.2**). As discussed in **Section 5.1**, the primary field survey, which incorporated Lot 605 within which plant community **BKg** occurs, was undertaken outside of the optimal survey period for *D. elastica*.

The remaining threatened and priority flora species identified in the desktop assessment are considered unlikely to occur in the site due to a lack of suitable habitat and/or because they were not recorded during the field survey. The likelihood of occurrence assessment is provided in **Appendix B**.



Plate 1: Priority flora species recorded within the site, clockwise from top; Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026) (P1), Verticordia lindleyi subsp. lindleyi (P4) and Jacksonia gracillima (P3)

4.2.4 Locally and regionally significant flora

Two flora species listed by the Government of Western Australia (2000b) as 'significant flora of the Bassendean dunes in the Perth metropolitan region' were recorded within the survey. These species were:

- *Hensmania turbinata* which was recorded in Lot 605 and is listed as it forms part of 'populations at the northern or southern limit of their known geographic range' and 'significant populations' (Government of Western Australia 2000b).
- *Gonocarpus cordiger* which was recorded in Lot 200 and is listed as it forms part of 'significant populations' (Government of Western Australia 2000b).

4.2.5 Declared pests

Three species were recorded within the site that are listed as declared pests (C3) pursuant to the BAM Act. These were **Asparagus asparagoides* (bridal creeper), *Echium plantagineum* (Paterson's curse) and **Zantedeschia aethiopica* (arum lily). Each species was recorded as scattered occurrences but none were widespread throughout the site.

Bridal creeper is also listed as a WoNS.

4.3 Vegetation

4.3.1 Desktop assessment

The database search results identified 11 TECs and seven PECs occurring or potentially occurring within a 10 km radius of the site. Information on these communities is provided in **Appendix C**.

Based on geomorphology, soils and regional vegetation patterns, one TEC and three PECs were considered to have potential to occur in the site:

- 'Banksia woodlands of the Swan Coastal Plain' TEC/PEC which is listed as 'endangered' under the EPBC Act and 'priority 3' (P3) in Western Australia.
- 'Low lying *Banksia attenuata* woodlands or shrublands' PEC (P3).
- '*Banksia ilicifolia* woodlands' PEC (P3).

4.3.2 Plant communities

Eight plant communities were identified within the site. Plant community **BaBm** exists across the south-western and western portion of the site and extends over 6.12 ha. Plant community **BKg** is present in the centre of Lot 605 and extends over 0.57 ha of the site. Plant community **BaMpKg** is located within portions of Lots 604 and 605 and extends over 0.96 ha. **MpKg** is present in the northern most portions of Lots 603 and 604 and extends over 0.61 ha. Plant community **AsRc** is present in a small area of Lot 200, covering 0.16 ha. Plant community **Mr** is present within Lots 201 and 600, extending over 1.21 ha. Plant community **MpE** is present in Lots 200, 601 and 602, extending over 2.25 ha.

The remainder of the site (16.96 ha) comprises cleared or non-native vegetation with buildings, bare soil, weeds or planted vegetation. An additional 0.45 ha comprises open water and was not mapped as a plant community.

A description and the area of each plant community is provided in **Table 5** and representative photographs of each are provided in **Plate 2** to **Plate 9**. The location of each plant community is shown in **Figure 5**. A matrix of species recorded within each plant community is provided in **Appendix E** and raw sample data is presented in **Appendix F**.

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

Plant community	Description	Area (ha)
BaBm	Low open woodland of *Banksia spp., Eucalyptus todtiana* and *Nuytsia floribunda* over shrubland of *Kunzea glabrescens, Xanthorrhoea spp, Macrozamia riedlei* and *Melaleuca thymoides* over low shrubland of *Scholtzia involucrata*, *Adenanthos obovatus, Bossiaea eriocarpa* and *Eremaea pauciflora* var. *pauciflora* over forbland of *Phlebocarya ciliata, Patersonia occidentalis, Lyginia* spp., *Dasypogon bromeliifolius, Lomandra* spp. and **Ursinia anthemoides* over open to closed tussock grassland **Ehrharta calycina* and **Briza maxima* (**Plate 2**).	6.12
BKg	Low open woodland of *Banksia* spp. and closed tall shrubland of *Kunzea glabrescens* over low sparse shrubland of *Xanthorrhoea brunonis, Hibbertia subvaginata* and *Bossiaea eriocarpa* over open forbland of *Dasypogon bromeliifolius, Patersonia occidentalis, Lyginia imberbis* and *Phlebocarya ciliata* (**Plate 3**).	0.57
BaMpKg	Open woodland *Banksia attenuata* and *Melaleuca preissiana* over tall shrubland of *Kunzea glabrescens* over shrubland of *Xanthorrhoea* spp., *Regelia ciliata, Melaleuca trichophylla, Hypocalymma angustifolium* and *Pericalymma ellipticum* over forbland of *Phlebocarya ciliata, Lyginia* spp., *Hypolaena exsulca, Evandra pauciflora* and *Dasypogon bromeliifolius* (**Plate 4**).	0.96
MpKg	Low open woodland of *Melaleuca preissiana* over tall shrubland *Kunzea glabrescens* over low shrubland *Hypocalymma angustifolium*, *Regelia ciliata*, *Verticordia lindleyi* subsp. *lindleyi* (P4), *Boronia dichotoma* and *Euchilopsis linearis* over open forbland *Stylidium brunonianum, Hypolaena pubescens* and *Schoenus efoliatus* (or understorey absent in degraded areas) (**Plate 5**).	0.61
AsRc	Sparse woodland of *Melaleuca preissiana* and **Eucalyptus camaldulensis* over closed shrubland of *Astartea scoparia*, *Regelia ciliata* and *Melaleuca teretifolia* with open vineland of *Cassytha racemosa* over sparse low shrubland of *Latrobea tenella* and *Euchilopsis linearis* over sparse forbland *Pterostylis vittata* and *Hypolaena exsulca* (**Plate 6**).	0.16
Mr	Open to closed tall shrubland of *Melaleuca rhaphiophylla* and *Melaleuca teretifolia* with open vineland of *Cassytha racemosa* over closed tussock grassland of *Typha domingensis* and pasture weeds (**Plate 7**).	1.21
MpE	Open forest of *Melaleuca preissiana, Eucalyptus rudis* and/or **Eucalyptus camaldulensis* over open to closed shrubland of *Melaleuca rhaphiophylla, M. lateritia* and *M. teretifolia* over grassland to closed grassland of pasture weeds (**Plate 8**).	2.25
Cleared/non-native	Heavily disturbed areas comprising bare ground, buildings and weeds with occasional native shrubs and forbs and planted vegetation (**Plate 9**).	16.96



*Plate 2: Plant community **BaBm** in 'excellent' condition*



*Plate 3: Plant community **BKg** in 'very good' condition*



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



*Plate 5: Plant community **MpKg** in 'very good' condition*



*Plate 6: Plant community **AsRc** in 'excellent' condition*



*Plate 7: Plant community **Mr** in 'degraded' condition*



*Plate 8: Plant community **MpE** in 'degraded' condition*



Plate 9: Cleared/non-native vegetation in 'completely degraded' condition

4.3.3 Vegetation condition

The most intact native vegetation was located in the southern and south-western portions of the site. Some of the **BaBm**, **BaMpKg** and **AsRc** vegetation was mapped as being in 'excellent' condition

as it retains the structure expected of banksia vegetation and has relatively high native species diversity. Past disturbance of these areas is evident from historical aerial photography and through the presence of low cover of weeds. Portions of the **BaBm**, **BKg** and **MpKg** vegetation were mapped as being in 'very good' condition due to lower native species diversity and higher weed cover. Portions of the **BaBm** and **BaMpKg** vegetation were also mapped as being in 'good' or 'degraded' condition due to higher weed densities with low to very low native species cover.

Similarly, much of the remaining vegetation in the eastern portion of the site (plant communities **Mr** and **MpE**) were mapped as being in 'degraded' condition due to a relatively intact overstorey but an understorey almost devoid of native species and with high densities of pasture weeds. Some native understorey plants were recorded in the **Mr** vegetation within Lot 600 but these were scattered and non-native plants were dominant.

One patch of **Mr** vegetation in Lot 201 was mapped as being in 'degraded – completely degraded' condition as it was similar to the patches of **Mr** vegetation mapped as being in 'degraded' condition but comprised even lower native species diversity and cover.

The remainder of the site was mapped as being in 'completely degraded' condition and consists of non-native species such as pasture grasses and planted trees. Sandy tracks within the site were also mapped as being in 'completely degraded' condition. The 0.45 ha of open water was not assigned to a vegetation condition category.

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

Table 6: Extent of vegetation condition categories within the site

Condition category (Keighery 1994)	Size (ha)
Pristine	0
Excellent	2.02
Very good	3.62
Good	0.76
Degraded	5.43
Degraded – completely degraded	0.05
Completely degraded	16.96
N/A (open water)	0.45

4.3.4 Floristic community types

Plant community **BaBm** was determined to represent FCT 23a 'Central *Banksia attenuata – Banksia menziesii* woodlands'. This FCT is listed as 'well reserved' and 'low risk' by Gibson *et al.* (1994). Q1 grouped with sites representing FCT 23a with 43% similarity (**Table 7**).

Plant community **BKg** was determined to represent FCT 21a 'Central *Banksia attenuata – Eucalyptus marginata* woodlands'. This FCT is listed as 'well reserved' and 'low risk' by Gibson *et al.* (1994). Q3 grouped with sites representing FCT 21a with 38% similarity (**Table 7**).

Plant communities **AsRc**, **BaMpKg** and **MpKg** were determined to represent FCT 4 '*Melaleuca preissiana* damplands'. This FCT is listed as 'well reserved' and 'low risk' by Gibson *et al.* (1994). Q2, Q4, R6 and R11 clustered with sites representing FCT 4 with 23%-44% similarity (**Table 7**).

Plant community **MpE** clustered with FCT 11 'wet forests and woodlands' with 37% similarity (**Table 7**). This FCT is listed as 'well reserved' and 'low risk' by Gibson *et al.* (1994).

R5 within plant community **Mr** clustered with FCT 15 'Forests and woodlands of deep seasonal wetlands' with 38% similarity (**Table 7**). This FCT is listed as 'well reserved' and 'vulnerable' by Gibson *et al.* (1994).

The relevant portions of the cluster dendrograms are provided in **Appendix G**.

The other samples and plant communities in the site were considered too degraded to assign to an FCT.

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

Plant community	Sample unit	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Most likely floristic community type (FCT)	Reservation and conservation status (Gibson *et al.* 1994)
BaBm	**Q1**	WAND-1 (FCT 23a)	43	FCT 23a: Central *Banksia attenuata – B. menziesii* woodlands	Well reserved Low risk
		HARRY-4 (FCT 23a)	43		
BKg	**Q3^**	NINE-2 (FCT 21a)	49	FCT 21a: Central *Banksia attenuata – Eucalyptus marginata* woodlands	Well reserved Low risk
		LOW07 (FCT 21c)	38		
AsRc	**Q2**	KOOLJ-1 (FCT 4)	44	FCT 4: *Melaleuca preissiana* damplands	Well reserved Low risk
BaMpKg	**Q4^**	CAPEL-3 (FCT 4)	45		
		MUCK-1 (FCT 23b)	40		
		MODO-2 (FCT 21c)	39		
	R6	PLINE-4 (FCT 4)	23		
		WHITE-2 (FCT 4)	23		
MpKg	**R11**	KOOLJ-1 (FCT 4)	28		
		MELA-1 (FCT 4)	28		
MpE	**R9**	MODO-3 (FCT 11)	37	FCT 11: Wet forests and woodlands	Well reserved Low risk
Mr	**R5**	TWIN-10 (FCT 15)	38	FCT 15: Forests and woodlands of deep seasonal wetlands	Well reserved Vulnerable

Note: ^ shows highest percent similarity to individual Gibson *et al.* (1994) samples rather than similarity to a cluster of samples.

4.3.5 Threatened and priority ecological communities

The assigned FCTs, structure and composition of plant communities **BaBm**, **BKg** and **BaMpKg** indicates that they have the potential to represent the 'Banksia woodlands of the Swan Coastal Plain'

TEC (herein referred to as the 'banksia woodland TEC'). This TEC is listed as 'endangered' under the EPBC Act. Whether a patch of vegetation is considered to represent the banksia woodland TEC depends on a number of diagnostic criteria including geographic location, soils, landform, structure, composition, condition and patch size (DoEE 2016).

As outlined in **Table 8**, the **BaBm**, **BKg** and **BaMpKg** vegetation satisfy the criteria to be considered to represent the banksia woodland TEC. The location of the banksia woodland TEC within the site is shown in **Figure 7**.

Table 8: Criteria for determining presence of Banksia woodlands of the Swan Coastal Plain TEC adapted from TSSC (2016)

Criteria	Requirements for meeting criteria	Site implications
1. Must meet key diagnostic characteristics	A variety of factors relating to: • Location • Soils • Structure • Composition	• Site meets location and soils criteria. • The **BaBm**, **BKg** and **BaMpKg** vegetation includes the key diagnostic feature of a tree layer of *Banksia attenuata, Banksia menziesii* and *Banksia ilicifolia*. • The **BaBm**, **BKg** and **BaMpKg** vegetation meets structure and composition criterion. • The **BaBm** and **BKg** vegetation represent FCT 23a and FCT 21a which are identified as two of the FCTs comprising the banksia woodland TEC. • The **BaMpKg** vegetation represents FCT 4 which is not identified as one of the FCTs comprising the banksia woodland TEC. However, the vegetation has a tree layer of Banksia spp. and the TEC conservation advice indicates that Melaleuca spp. may be present in the TEC.
2. Must meet condition thresholds	• A patch should at least meet the 'good' condition category (see **Table 1**)	• The **BaBm** vegetation is present in 'excellent', 'very good', 'good' and 'degraded' condition, which meets this criterion. • The **BKg** vegetation is present in 'very good' condition, which meets this criterion. • The **BaMpKg** vegetation is present in 'excellent', 'good' and 'degraded' condition, which meets this criterion. • They include areas of variable condition, meaning parts of the **BaBm** and **BaMpKg** vegetation in 'degraded' condition may still be considered the TEC.
3. Must meet minimum patch size	Minimum size of patch: • Pristine=no minimum size • Excellent=0.5 ha • Very Good=1 ha • Good=2 ha	• The **BaBm** and **BaMpKg** vegetation in 'excellent' condition comprises 1.86 ha and does independently meet this criterion. • The **BaBm** and **BKg** vegetation in 'very good' condition comprises 3.51 ha and does independently meet this criterion. • The **BaBm** and **BaMpKg** vegetation in 'good' condition comprises 0.61 ha and does not independently meet this criterion. • The adjoining **BaBm** and **BaMpKg** vegetation in 'degraded' condition would be viewed as contiguous and part of the same patch. • Therefore the mapped 7.65 ha of **BaBm**, **BKg** and **BaMpKg** vegetation does comprise a patch of the TEC.

Table 8: Criteria for determining presence of Banksia woodlands of the Swan Coastal Plain TEC adapted from TSSC (2016) (continued)

Criteria	Requirements for meeting criteria	Site implications
4. Must incorporate surrounding context	• Breaks (e.g. tracks) < 30 m do not separate vegetation into separate patches • Buffer zones may apply (20-50 m recommended from patch edge) • The site should be thoroughly sampled (2 surveys in same spring). • Survey timing should be appropriate. • Surrounding environment should be considered (e.g. connectivity, conservation values, fauna habitat)	• Small scale tracks (<30 m wide) exist within the patch. • Land surrounding the patch is a combination of industrial, residential, native vegetation and planted vegetation on the road verges. • This survey was conducted in October (within the main flowering season) and December (outside of the main flowering season). Survey timing was appropriate. • Intact native vegetation that is likely to meet criteria as banksia woodland exists in the south-west and east of the site but is separated by over 30 m.
Results	The site supports 7.65 ha of the banksia woodland TEC	

DBCA's list of priority ecological communities indicates that the description, area and condition thresholds that apply to the Commonwealth-listed TEC of the same name also apply to the 'Banksia woodlands of the Swan Coastal Plain' PEC ('banksia woodland PEC') (DBCA 2020c). Therefore, a total of 7.65 ha of this PEC occurs within the site. The location of the banksia woodland PEC within the site is shown in **Figure 7**.

Plant community **Mr** was identified as comprising FCT 15 'forests and woodlands of deep seasonal wetlands'. This FCT is synonymous with the state listed TEC SCP 15 'forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain', which is listed as 'vulnerable' in Western Australia. At the State level, there is no conservation advice for the SCP 15 TEC so it is unclear whether a condition threshold should be applied when identifying its presence. The DBCA has historically applied 'good' condition as a threshold for the identification of conservation significant vegetation. The **Mr** vegetation within the site occurs in 'degraded' and 'degraded – completely degraded' condition. Using 'good' condition as a basis for identification, the **Mr** vegetation is not considered to represent the SCP 15 TEC.

No other TECs or PECs occur within the site.

4.3.6 Locally and regionally significant vegetation

The site supports vegetation which has the potential to provide habitat for threatened fauna, including black cockatoos. In particular, potential breeding, foraging and roosting habitat for black cockatoos is present within the site.

The native vegetation in the site, particularly that in the southern portion, is contiguous with extensive areas of intact native vegetation outside of the site and would contribute to ecological linkages.

4.4 Species richness and sampling adequacy

A total of 121 species were recorded from 11 samples. A species accumulation curve derived from sample data is presented in **Plate 10**. After 11 samples the curve is still increasing and has not

reached its asymptote. This indicates that a proportion of species likely remain undetected by sampling.

Species richness was estimated in PRIMER v6 to be between 181 (Jacknife1) and 201 (Chao2). Based on the trend of the species accumulation curve approximately 30 to 40 samples would be required to capture that many species. Including the 44 additional species recorded opportunistically, a total of 165 species was recorded in the site. This indicates that between 82 and 91% of the estimated 181-201 species in the site were recorded. Considering the degraded nature of a large portion of the site and the time spent sampling and searching the more intact vegetation, the survey effort was considered to be adequate to prepare a representative species inventory.

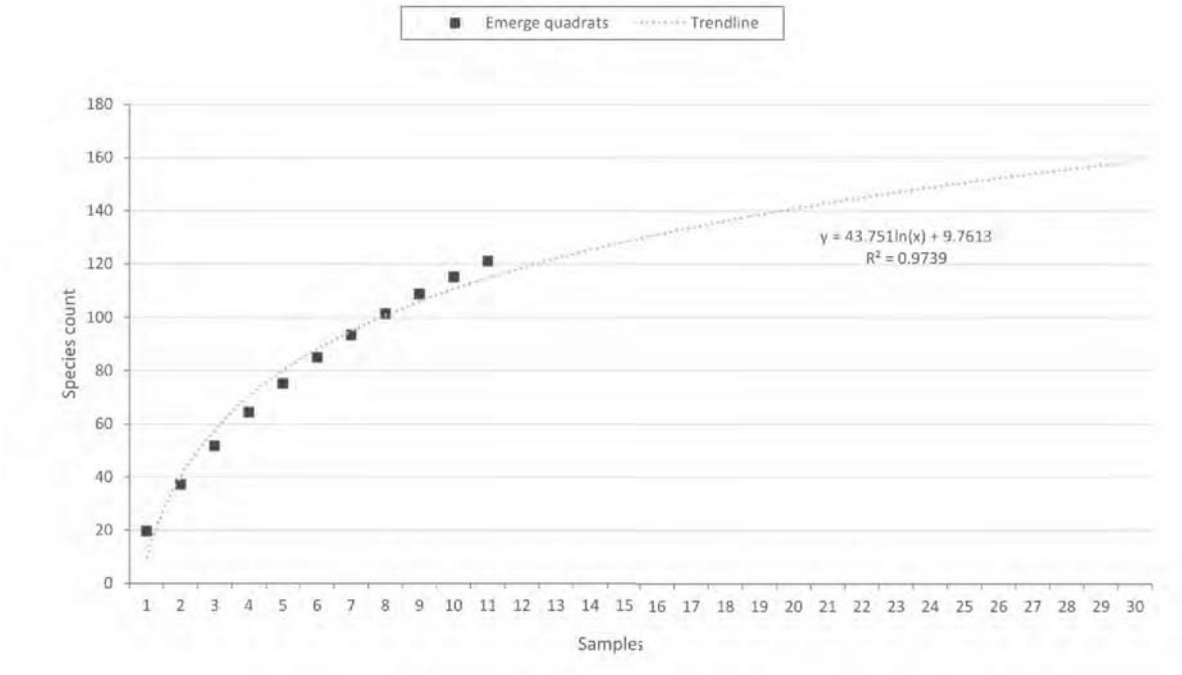


Plate 10: Species accumulation curve derived from sample data (y = 43.751ln(x) + 9.7613 R^2 = 0.9739)

5 Discussion

The site has been subject to significant past disturbance and approximately 77% supports vegetation in 'degraded', 'degraded – completely degraded' and 'completely degraded' condition. The most intact native vegetation occurs in the south-western portion of the site.

5.1 Threatened and priority flora

No threatened flora species were recorded within the site.

Prior to the survey, based on background information, 17 threatened and 29 priority flora species were considered to potentially occur within the site. The primary field survey in October and December 2020, and subsequent targeted surveys between August and November 2021, recorded three priority flora species and were considered sufficient to determine that the majority of other conservation significant species are unlikely to occur. This is because either suitable habitat does not occur or the species were not recorded during traverses within potentially suitable habitat.

The timing of the surveys coincided with the main flowering period of the majority of the conservation significant flora identified in the desktop assessment and therefore they should have been visible, if present. The species with flowering periods outside of August to December are perennials and would be visible throughout the year. Since no unidentified specimens which had potential to comprise conservation significant species were collected, the survey effort is also considered sufficient to determine that the majority of other conservation significant species are unlikely to occur at the site.

The survey was unable to confirm the presence or absence of one threatened flora species, *Drakaea elastica*. *Drakaea elastica* is listed as 'critically endangered' in Western Australia and 'endangered' under the EPBC Act. This species was not recorded during the primary field survey when all lots within the site were investigated. However, the survey timing for the primary field survey did not coincide with the optimal survey period for this species. Whilst *D. elastica* flowers in late September to October or November, the optimal survey period for this species coincides with the time during which the bright green leaf is visible in July and/or August (DEC 2009). Suitable habitat for *D. elastica* occurs within the site in plant community **BKg**. The targeted surveys undertaken between August and November 2021 did not include Lot 605 within which plant community **BKg** occurs. Multiple DBCA records for *D. elastica* occur in the wider region, with the closest being approximately 3 km north-east of the site. Additional surveys within plant community **BKg** during the species' optimal survey period would be required to determine if it occurs within Lot 605.

5.2 Vegetation condition

Assigning condition using a categorical scale is always most difficult when vegetation qualities are close to the boundary between two categories. Categorical schemes may also invariably yield different results when applied by different assessors, because of differences in skill levels or personal bias.

A vegetation condition score has the greatest implications when the condition of vegetation is close to the boundary between 'good' and 'degraded'. This is because 'good' condition is typically accepted as the threshold for conservation significance, while 'degraded' condition implies a low conservation requirement. Separating these two condition categories is further complicated by the fact that 'good' condition is more correctly understood to mean 'average' condition. Applying the Keighery (1994) condition scale 'good' condition vegetation can be expected to be significantly altered, with very obvious disturbance and the presence of aggressive weeds at high density. Therefore, good does not literally mean "good" as the label implies.

The method applied to assess vegetation condition was robust, as it combined the standard qualitative, categorical scheme of Keighery (1994), with the additional indicators for diversity and weed cover outlined in DoEE (2016).

One patch of plant community **Mr** was mapped as a compound condition category ('degraded – completely degraded') as this area almost met the 'completely degraded' condition category description but did contain some native scattered understorey species which are usually not present in 'completely degraded' vegetation.

5.3 Floristic community types

The FCT analysis was conclusive due to the high percentage of similarity between samples in the site and Gibson *et al.* (1994) sites. The assigned FCTs are also considered appropriate to the landform and geographic location of the site.

R5 within plant community **Mr** showed similarity to FCT 15. The high similarity between R5 and Gibson *et al.* (1994) sites was unexpected because only seven native species were recorded within R5. However, Gibson *et al.* (1994) notes that FCT 15 does have low species richness, with a mean of 17.5 species/plot. The native species recorded within R5 were very sparse and not consistent throughout the **Mr** vegetation in which the sample was taken or within the site. Historically, it is likely that the **Mr** vegetation would have represented FCT 15 but in its current state the majority is too degraded to assign to an FCT. Therefore, only a portion of the patch of vegetation in which R5 lies represents FCT 15.

5.4 Threatened and priority ecological communities

The **BaBm**, **BKg** and **BaMpKg** plant communities meet the criteria to represent the banksia woodland TEC. The conservation advice states that a patch of TEC may include areas of variable condition and that the condition that is most representative should be used to assign the overall condition of a patch. The **BaBm**, **BKg** and **BaMpKg** vegetation occurs in 'excellent' to 'degraded' condition and, as there are no breaks of 30 m or more between patches, these areas comprise a single patch. Given the vegetation is mainly in 'very good' condition, the whole patch was assessed against the 'very good' condition criteria. The DoEE (2016) conservation advice states that a patch of banksia woodland vegetation in 'very good' condition must be greater than 1 ha in size for it to be considered the TEC. Based on this, the **BaBm**, **BKg** and **BaMpKg** vegetation meets the minimum patch size threshold.

The banksia woodland TEC also represents a State listed PEC of the same name. Thus, the **BaBm**, **BKg** and **BaMpKg** plant communities are considered to represent the banksia woodland PEC.

The **Mr** vegetation within the site was not considered to represent a TEC due to vegetation condition. As discussed in **Section 5.2**, 'good' condition typically represents the threshold between conservation significant vegetation and lower quality vegetation. This is considered appropriate as a threshold for State-listed TECs and PECs which do not have specific conservation advice, such as the SCP 15 TEC. The **Mr** vegetation in the site is in 'degraded' and 'degraded – completely degraded' condition, due to high cover of weeds and very low cover of native understorey species. Therefore, this vegetation is not considered to represent the SCP 15 TEC.

5.5 Local and regional significance

The native vegetation within the site is contiguous with extensive areas of vegetation outside of the site and would contribute to ecological linkages. Habitat for conservation significant fauna species exists within the site, particularly for threatened black cockatoos.

6 Conclusions

No threatened flora species were recorded within the site. One threatened flora species, *Drakaea elastica*, is considered to have potential to occur within plant community **BKg** in Lot 605. Targeted surveys during the optimal survey period for this species would be required to confirm whether this species occurs in Lot 605.

Three priority flora species were recorded within the site: *Acacia lasiocarpa* var. bracteolata long peduncle variant (G.J. Keighery 5026) (P1), *Jacksonia gracillima* (P3) and *Verticordia lindleyi* subsp. *lindleyi* (P4). Fifty-eight individuals of *Acacia lasiocarpa* var. bracteolata long peduncle variant (G.J. Keighery 5026) (P1) were recorded, with 57 in Lot 200 and one in Lot 605. *Jacksonia gracillima* (P3) and *Verticordia lindleyi* subsp. *lindleyi* (P4) were recorded within Lot 604, with two individuals of *J. gracillima* in the central portion and 38 individuals of *V. lindleyi* subsp. *lindleyi* in the northern portion.

Eight plant communities were identified within the site, with the most intact native vegetation occurring in the south-western portion of the site.

The site has been subject to historical disturbance and over half was mapped as being in 'completely degraded' condition (16.96 ha/58% of the site). The remainder of the site comprises 11.88 ha of native vegetation that is present in 'degraded' to 'excellent' condition and 0.45 ha of open water.

Five FCTs were identified within the site:

- FCT 23a: Central *Banksia attenuata – B. menziesii* woodlands
- FCT 21a: Central *Banksia attenuata – Eucalyptus marginata* woodlands
- FCT 4: *Melaleuca preissiana* damplands
- FCT 11: Wet forests and woodlands
- FCT 15: Forests and woodlands of deep seasonal wetlands

The site contains a 7.65 ha patch of the Commonwealth TEC 'banksia woodlands of the Swan Coastal Plain' and the State listed PEC of the same name (P3).

The site supports vegetation which has the potential to provide habitat for threatened fauna, including black cockatoos. The native vegetation in the site, particularly that in the southern portion, is contiguous with extensive areas of intact native vegetation outside of the site and would contribute to ecological linkages.

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7.2 Online references

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

Table R 1 Access dates for online references

Reference	Date accessed	Website or dataset name
BoM (2022)	17 March 2022	Climate Data Online
DAWE (2020)	14 October 2020	Protected Matters Search Tool
DAWE (2022a)	17 March 2022	Threatened Ecological Communities
DAWE (2022b)	17 March 2022	Weeds of National Significance (WoNS)
DBCA (2020b)	14 October 2020	NatureMap
WALIA (2021)	12 January 2021	Landgate Map Viewer

Figures

Figure 1: Site Location

Figure 2: Soils and Topography

Figure 3: Wetland and Waterway Features

Figure 4: Environmental Features

Figure 5: Plant Communities

Figure 6: Vegetation Condition

Figure 7: Conservation Significant Values



Figure 1: Site Location

Project: Detailed Flora and Vegetation Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(02)--F03

Drawn:	GAR
Date:	06/01/2021
Checked:	SKP
Approved:	RAW
Date:	28/01/2021

N

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Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
©Landgate (2020). Nearmap Imagery date: 23/09/2020

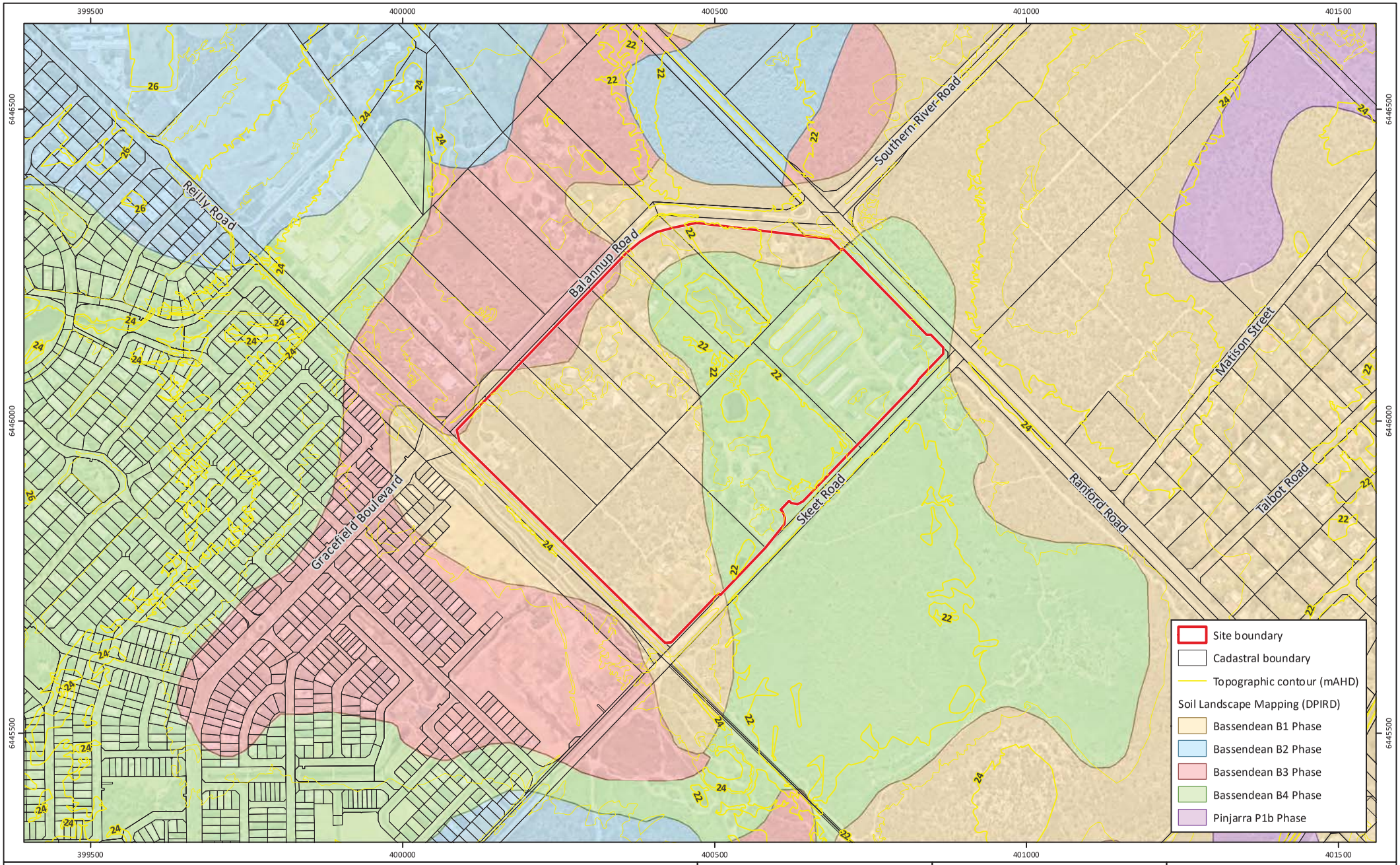


Figure 2: Soils and Topography

Project:	Detailed Flora and Vegetation Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(02)--F04

Drawn:	GAR
Date:	06/01/2021
Checked:	SKP
Approved:	RAW
Date:	28/01/2021

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Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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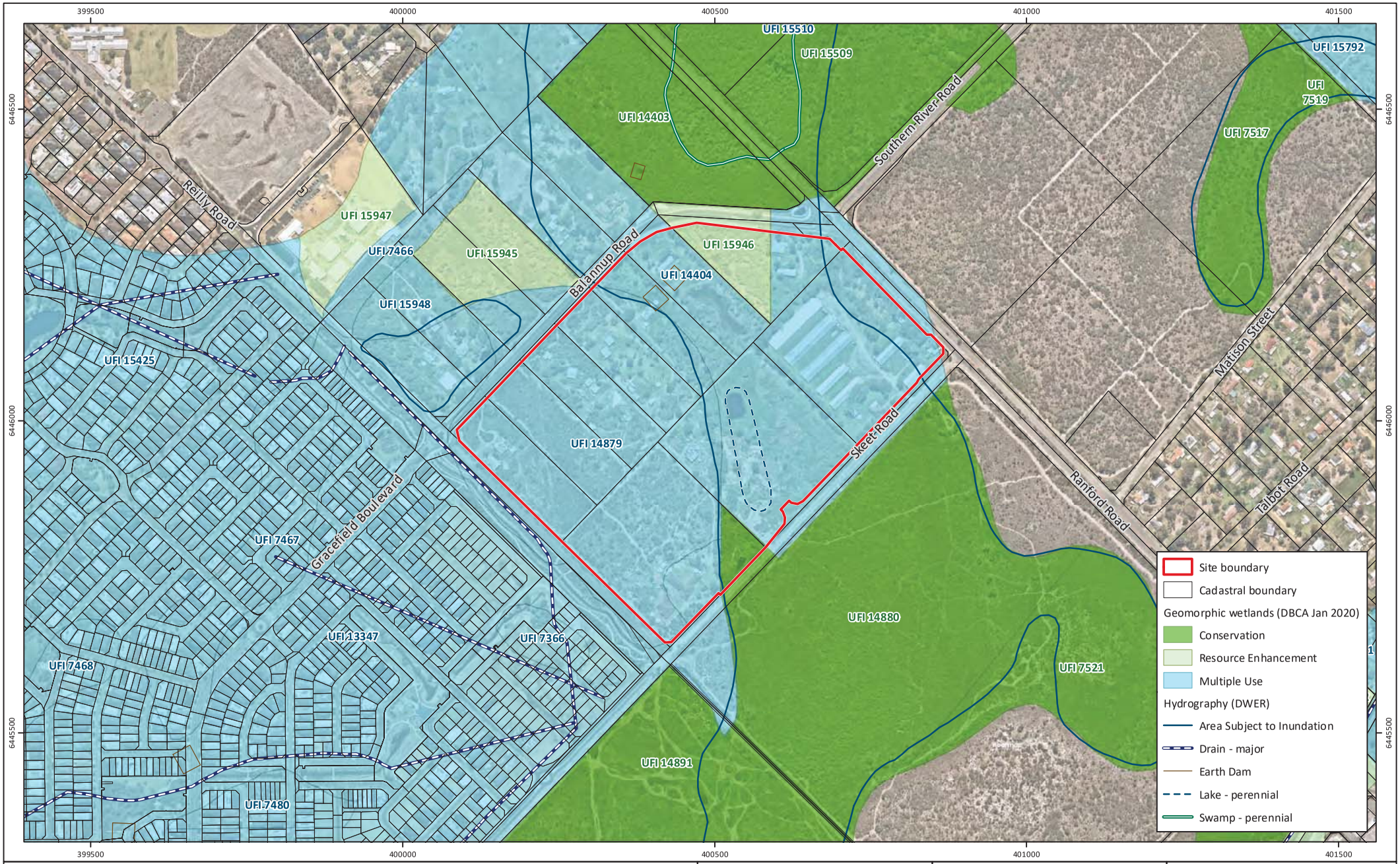


Figure 3: Wetland and Waterway Features

Project:	Detailed Flora and Vegetation Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(02)--F05a

Drawn:	SCM
Date:	29/03/2022
Checked:	ASF
Approved:	RAW
Date:	29/03/2022

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Scale: 1:8,000@A4

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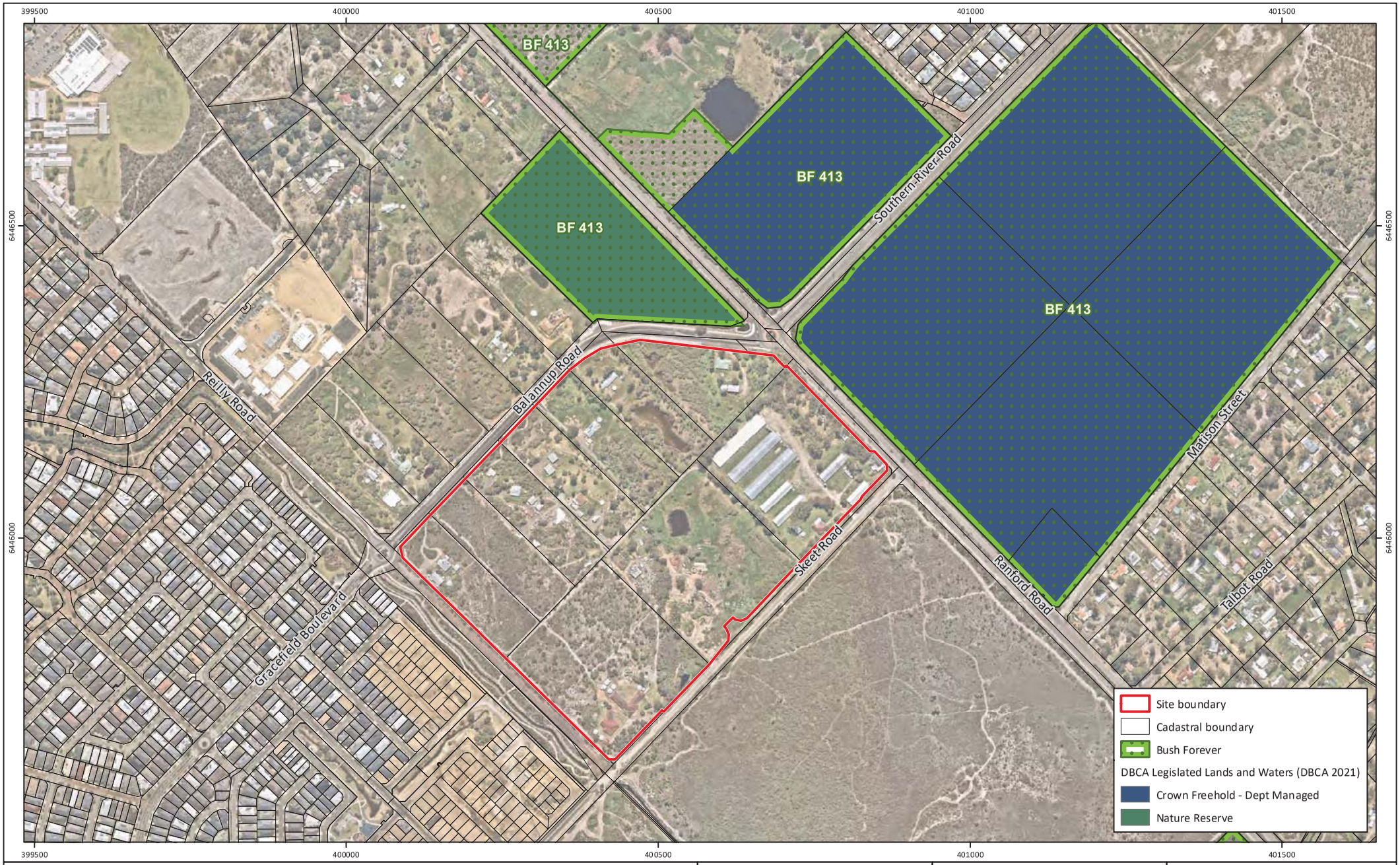


Figure 4: Environmental Features

Project: Detailed Flora and Vegetation Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(02)--F79
Drawn: SCM
Date: 29/03/2022
Checked: ASF
Approved: RAW
Date: 29/03/2022

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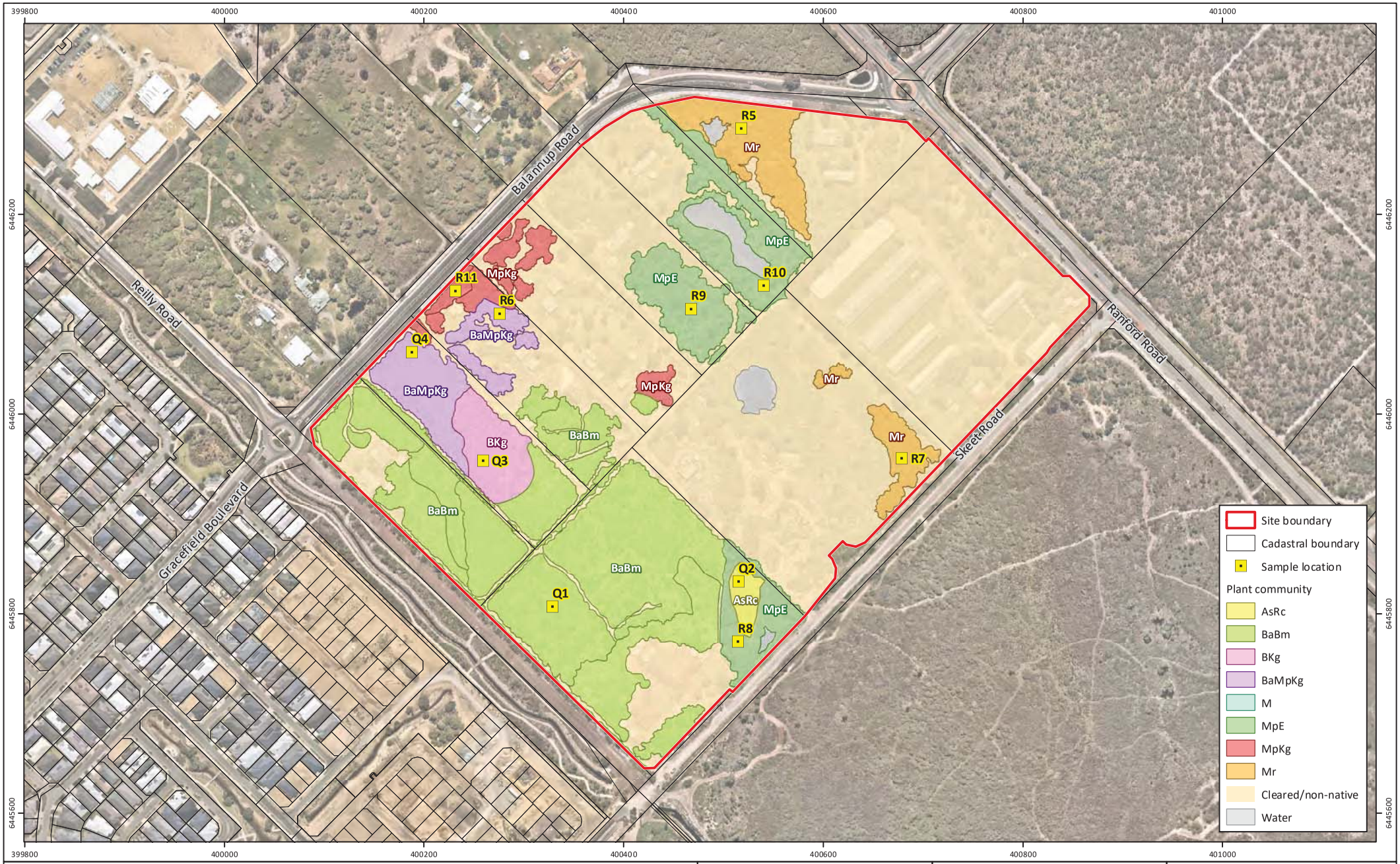


Figure 5: Plant Communities

Project: Detailed Flora and Vegetation Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(02)--F06a

Drawn:	SCM
Date:	29/03/2022
Checked:	ASF
Approved:	RAW
Date:	29/03/2022

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Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

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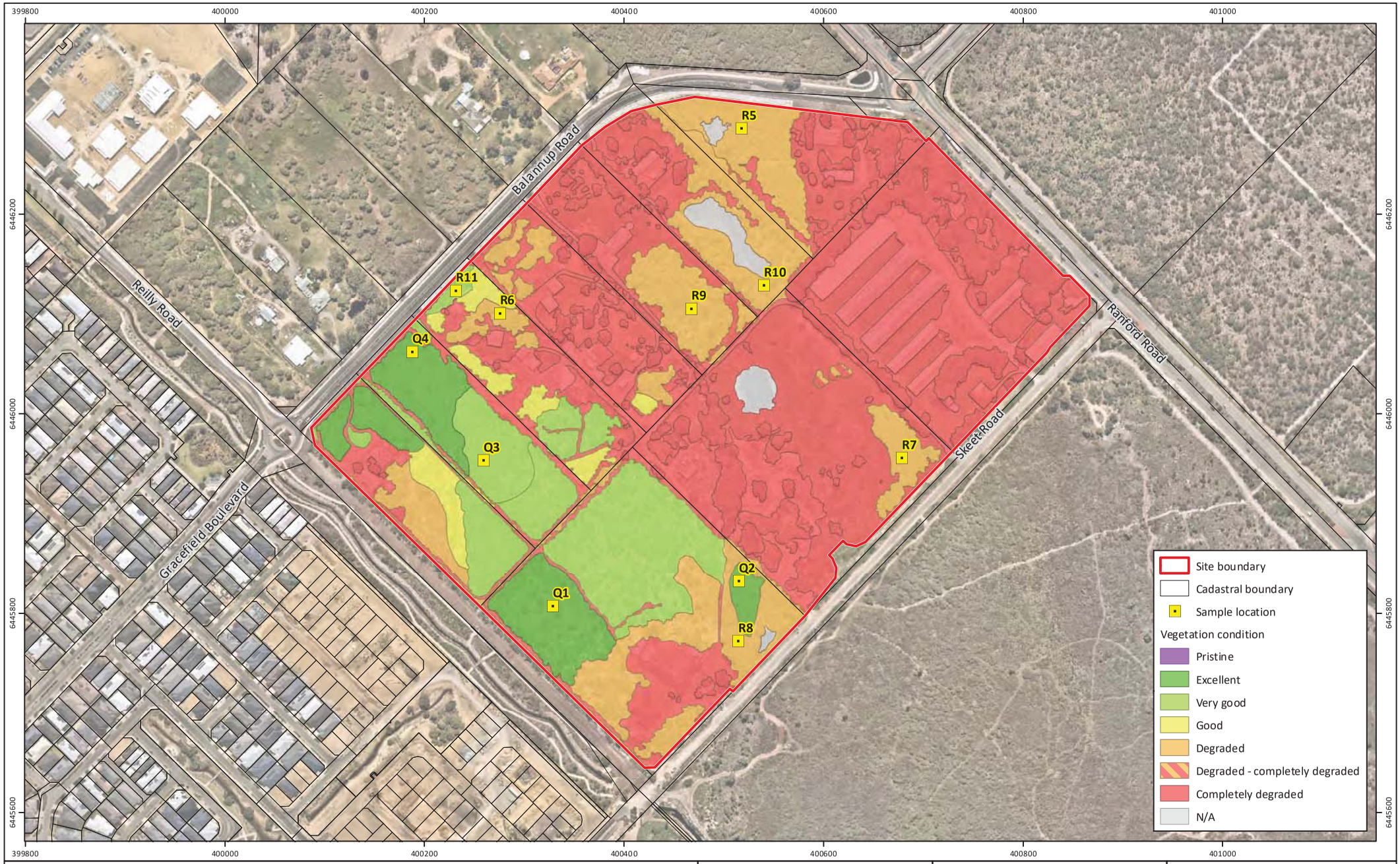


Figure 6: Vegetation Condition

Project: Detailed Flora and Vegetation Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(02)--F07a

Drawn:	SCM
Date:	29/03/2022
Checked:	ASF
Approved:	RAW
Date:	29/03/2022

N

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Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

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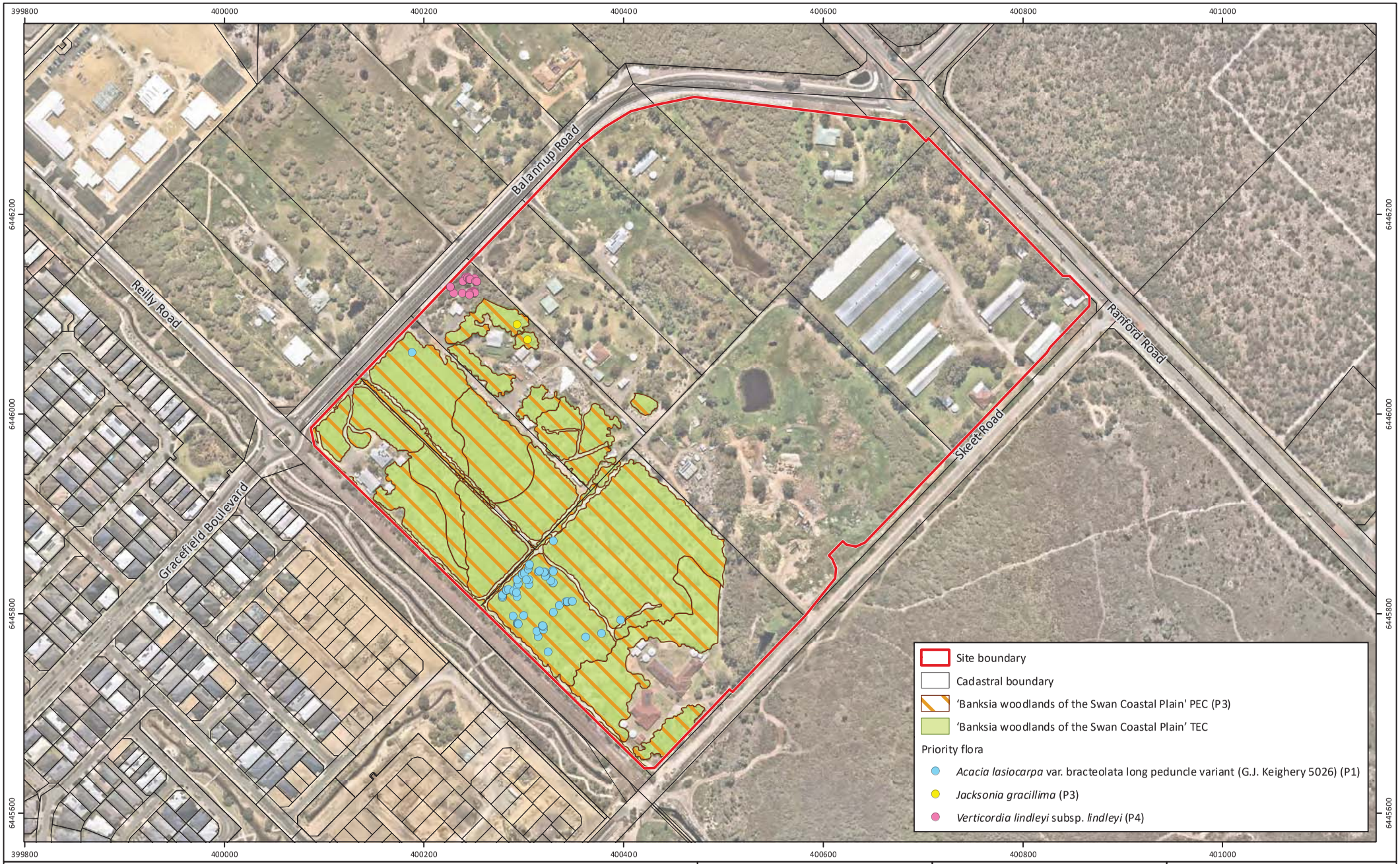


Figure 7: Conservation Significant Values

Project:	Detailed Flora and Vegetation Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(02)--F08a

Drawn:	SCM
Date:	29/03/2022
Checked:	ASF
Approved:	RAW
Date:	29/03/2022

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GDA 1994 MGA Zone 50

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Appendix A

Additional Information

Conservation Significant Flora and Vegetation

Threatened and priority flora

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

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

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

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

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

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

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

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

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

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

Threatened and priority ecological communities

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

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

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

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

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

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

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

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

Weeds

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

Declared Pests

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

Under the BAM Act, all declared pests are assigned a legal status, as described in **Table 4**. Species assigned to the 'declared pest, prohibited - s12' category are placed in one of three control categories, as described in **Table 5**.

The *Biosecurity and Agriculture Management Regulations 2013* specify keeping categories for species assigned to the 'declared pest - s22(2)' category, which relate to the purposes of which species can be kept, as well as the entities that can keep them. The categories are described in **Table 6**.

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

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

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

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

Category	Description
C1	Exclusion Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	Eradication Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	Management Established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

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

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

Wetland Habitat

Geomorphic wetland types

On the Swan Coastal Plain DBCA (2017a) have used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence (hydro-period) as outlined in **Table 7**.

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

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

Wetland management categories

DBCA maintains the *Geomorphic Wetland of the Swan Coastal Plain* dataset (DBCA 2018a), which also categorises individual wetlands into specific management categories as described in **Table 8**.

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

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

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

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

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

Wetland reclassification

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

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Appendix B

Conservation Significant Flora Species and Likelihood of Occurrence Assessment

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Austrostipa jacobsiana	CR	-	P	Grey sandy clay.	Nov-Jan	Unlikely
Caladenia huegelii	CR	EN	PG	Well-drained, deep sandy soils in lush undergrowth in a variety of moisture levels.	Sep-early Nov	Unlikely
Calectasia cyanea	CR	CR	P	Heathland on white sand or laterite gravel over laterite. Known only from one population near Albany.	Jun-Oct	Unlikely
Calytrix breviseta subsp. *breviseta*	CR	EN	P	Seasonally wet sandy-clay soil on swampy flats	Oct-Nov	Unlikely
Drakaea elastica	CR	EN	PG	Bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps.	late Sep-Oct/Nov, survey Jul-Aug	Possible
Eucalyptus x balanites	CR	EN	P	Light coloured sandy soils over laterite. Habitat consists of gently sloping heathlands; open mallee woodland over shrubland (Population 2) or heathland with emergent mallees (population 1)	Oct - Feb	Unlikely
Grevillea thelemanniana	CR	CR	P	Sand, sandy clay. Winter-wet low-lying flats.	May-Nov	Unlikely
Lasiopetalum pterocarpum	CR	EN	P	Dark brown or red brown loam or clayey-sand over granite, near creek lines and on sloping banks. Associated with riparian vegetation including flooded gum, marri and swamp peppermint.	Aug-Nov	Unlikely
Ptilotus pyramidatus	CR	CR	P	Seasonally inundated, flat floodplain on pale grey muddy sand.	Early Oct	Unlikely
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	CR	CR	P	Low woodland on grey, clayey sand with lateritic pebbles (Pinjarra Plain) near winter wet flats.	Sep-Nov	Unlikely
Synaphea sp. Serpentine (G.R. Brand 103)	CR	CR	P	Seasonally damp areas, loam - sand.	Sep-Oct	Unlikely
Thelymitra dedmaniarum	CR	EN	PG	Red brown sandy loam with dolerite and granite outcrops.	Oct-Nov	Unlikely
Austrostipa bronwenae	EN	-	P	Grey-brown sandy loam soil in low lying winter wet areas.	Sep-Nov	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Darwinia apiculata	EN	EN	P	Open jarrah-marri woodland on shallow gravely soil over laterite, or open heathland over sandy loams with granite boulders.	Oct-Nov	Unlikely
Diplolaena andrewsii	EN	EN	P	Granite outcrops & hillsides.	Jul-Oct	Unlikely
Diuris purdiei	EN	EN	PG	Sand to sandy clay soils in areas subject to winter inundation.	late Sep-Oct, only after a summer/early autumn fire	Unlikely
Drakaea micrantha	EN	VU	PG	Open sandy patches often adjacent to winter-wet swamps.	Sept- early Oct	Unlikely
Eremophila glabra subsp. *chlorella*	EN	-	P	Sandy clay. Winter-wet depressions.	Jul-Nov	Unlikely
Goodenia arthrotricha	EN	-	P	Granite rocks, slopes	Oct-Nov	Unlikely
Grevillea curviloba subsp. *Incurva*	EN	EN	P	Sand, sandy loam. Winter-wet heath.	Aug-Sep	Unlikely
Lepidosperma rostratum	EN	EN	P	Peaty sand and clay amongst low heath, in winter-wet swamps.	May-Jun (survey late Jun-Aug)	Unlikely
Macarthuria keigheryi	EN	EN	P	Low-lying winter-wet damp gey/white sands in open patches.	Sep-Dec or Feb-Mar	Unlikely
Synaphea sp. Pinjarra Plain (A.S. George 17182)	EN	CR	P	White grey clayey sand on edges of seasonally inundated low lying areas.	Sep-Oct	Unlikely
Thelymitra stellata	EN	EN	PG	Sandy loam, clay or gravel over laterite or gravel.	Sep-Nov	Unlikely
Andersonia gracilis	VU	EN	P	Seasonally damp, black sandy clay flats near or on the margins of swamps.	Sep-Nov	Unlikely
Anthocercis gracilis	VU	VU	P	Steep granite slopes along the Darling Scarp in shallow, humis-rich sandy or loamy soils.	Sep-Oct, Apr	Unlikely
Banksia mimica	VU	EN	P	Flat to gentle slopes in grey and white sand in open woodlands.	Dec-Jan	Unlikely
Conospermum undulatum	VU	VU	P	Sand and sandy clay soils, on flat or gently sloping sites between the Swan and Canning Rivers	May-Oct	Unlikely
Diuris drummondii	VU	VU	PG	In low-lying depressions in peaty and sandy clay swamps.	Nov-Jan	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Diuris micrantha	VU	VU	PG	Dark grey-black sandy clay-loam in winter wet depressions or swamps. Often in shallow standing water.	Aug/Sep- early Oct	Unlikely
Eleocharis keigheryi	VU	VU	P	Clay or sandy loam in freshwater creeks and transient waterbodies such as seasonally wet clay pans.	Aug-Dec	Unlikely
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026)	P1	-	P	Grey or black sand over clay in winter wet areas.	May-Aug	Recorded
Bolboschoenus fluviatilis	P1	-	P	Floodplain with grey/brown wet sand.	Nov	Unlikely
Calytrix simplex subsp. *simplex*	P1	-	P	Swamps to well drained lateritic gravel slopes and flats.	(Dec-) Jan	Unlikely
Eriochilus sp. Roleystone (G. Brockman 1140)	P1	-	PG	Lateritic or black sandy gravel.	Jul	Unlikely
Ptilotus sericostachyus subsp. *roseus*	P1	-	P	Unknown. Seem to be associated with wetlands/rivers.	Sep-Dec	Unlikely
Schoenus sp. Beaufort (G.J. Keighery 6291)	P1	-	A	Mud in winter-wet clay pans.	Sep-Oct	Unlikely
Thelymitra magnifica	P1	-	PG	Gravelly soil on stony ridges.	Sep-Oct	Unlikely
Acacia benthamii	P2	-	P	Sand, typically on limestone breakaways	Aug - Sept	Unlikely
Andersonia sp. Blepharifolia (F. & J. Hort 1919)	P2	-	P	Sandy clay with gravel.	Sep-Nov	Unlikely
Comesperma rhadinocarpum	P2	-	P	Sandy soils.	Oct-Nov	Unlikely
Johnsonia pubescens subsp. *cygnorum*	P2	-	P	Grey white yellow sands on flats and seasonally wet areas.	Sep	Unlikely
Poranthera moorokatta	P2	-	A	Sandy or clay soils. Dampland or low sandy dunes.	Oct or Feb	Unlikely
Schoenus loliaceus	P2	-	A	Sandy soils in winter-wet depressions.	Aug-Nov	Unlikely
Stenanthemum sublineare	P2	-	P	White sand on coastal plains.	Oct-Dec	Unlikely
Thysanotus sp. Badgingarra (E.A. Griffin 2511)	P2	-	P	Grey sand with lateritic gravel.	Dec	Unlikely
Acacia horridula	P3	-	P	Gravelly soils over granite, sand, rocky hillsides.	May-Aug	Unlikely
Allocasuarina grevilleoides	P3	-	P	Sand over laterite, gravel.	Sep-Nov	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Asteridea gracilis	P3	-	A	Sand, clay, gravelly soils.	Sep-Dec	Unlikely
Babingtonia urbana	P3	-	P	Grey sand, lateritic gravel.	Jan-Mar	Unlikely
Banksia kippistiana var. *paenepeccata*	P3	-	P	Lateritic gravelly soils.	Oct-Nov	Unlikely
Beaufortia purpurea	P3	-	P	Lateritic or granitic soils on rocky slopes.	Oct-Feb	Unlikely
Byblis gigantea	P3	-	P	Sandy-peat swamps. Seasonally wet areas.	Sep-Jan	Unlikely
Carex tereticaulis	P3	-	P	Black peaty sand.	Sep-Oct	Unlikely
Chamaescilla gibsonii	P3	-	P	Clay to sandy clay in winter-wet flats, shallow water-filled claypans.	Sep	Unlikely
Cyathochaeta teretifolia	P3	-	P	Grey sand, sandy clay in swamps and creek edges.	Oct-Jan	Unlikely
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)	P3	-	P	Grey brown sand or clay in winter wet flats.	Sep-Nov	Unlikely
Eryngium sp. Subdecumbens (G.J. Keighery 5390)	P3	-	A	Clay in seasonal wetlands.	Sep-Nov	Unlikely
Haemodorum loratum	P3	-	P	Grey or yellow sand, gravel.	Nov	Unlikely
Halgania corymbosa	P3	-	P	Gravelly soils, soils over granite.	Aug-Nov	Unlikely
Isotropis cuneifolia subsp. *glabra*	P3	-	P	Sand, clay loam in winter-wet flats.	Sep	Unlikely
Jacksonia gracillima	P3	-	P	Sand, often adjacent to winter wet areas	Sep-Dec	Recorded
Lasiopetalum glutinosum subsp. *glutinosum*	P3	-	P	Brown clay loam on slopes	Sep-Dec	Unlikely
Meionectes tenuifolia	P3	-	P	Clay loam in seasonally wet areas.	Oct-Dec	Unlikely
Myriophyllum echinatum	P3	-	A	Clay in winter-wet flats.	Nov	Unlikely
Phlebocarya pilosissima subsp. *pilosissima*	P3	-	P	White or grey sand, lateritic gravel.	Aug-Oct	Unlikely
Schoenus benthamii	P3	-	P	White, grey sands, sandy clay in winter wet flats and swamps	Oct-Nov	Unlikely
Schoenus capillifolius	P3	-	A	Brown mud in claypans	Oct-Nov	Unlikely
Schoenus pennisetis	P3	-	A	Grey or peaty sand in swamps and winter-wet depressions.	Aug-Sep	Unlikely
Stylidium aceratum	P3	-	A	Sandy soils in swamp heathland.	Oct-Nov	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Stylidium paludicola	P3	-	P	Peaty sand over clay. Winter wet habitats. Marri and Melaleuca woodland, Melaleuca shrubland	Oct-Dec	Unlikely
Stylidium periscelianthum	P3	-	P	Loamy clay, moist soils pockets on wet flats and low granitic hills.	Sep-Oct	Unlikely
Styphelia filifolia	P3	-	P	Brown over pale yellow sand.	Feb-Apr	Unlikely
Thysanotus anceps	P3	-	P	White or grey sand, lateritic gravel, laterite.	Oct-Dec	Unlikely
Acacia oncinophylla subsp. *patulifolia*	P4	-	P	Granitic soils, occasionally on laterite.	Aug-Nov/Nov-Dec	Unlikely
Aponogeton hexatepalus	P4	-	P	Mud. Freshwater: ponds, rivers, claypans.	Jul-Oct	Unlikely
Boronia tenuis	P4	-	P	Laterite, stony soils, granite.	Aug-Nov	Unlikely
Calothamnus accedens	P4	-	P	Sandy soils over laterite.	Sep-Jan	Unlikely
Calothamnus graniticus subsp. *leptophyllus*	P4	-	P	Clay over granite, lateritic soils. Hillsides.	Jun-Aug	Unlikely
Dodonaea hackettiana	P4	-	P	Sand, outcropping limestone.	Jul-Oct	Unlikely
Drosera occidentalis	P4	-	P	Flat, brown/white/yellow moist sand/clay/peat, often near swamps.	Oct-Dec/Jan	Unlikely
Hydrocotyle lemnoides	P4	-	A	Floating in swamps.	Aug-Oct	Unlikely
Jacksonia sericea	P4	-	P	Calcareous and sandy soils on Swan Coastal Plain	Dec-Feb	Unlikely
Kennedia beckxiana	P4	-	P	Sand or loam on granite hills and outcrops.	Sep-Dec	Unlikely
Ornduffia submersa	P4	-	A	Sandy clay in inundated wetland/creek.	Aug-Nov	Unlikely
Schoenus natans	P4	-	A	Aquatic, in winter-wet depressions.	Oct	Unlikely
Stylidium longitubum	P4	-	A	Seasonal wetlands.	Oct-Dec	Unlikely
Thysanotus glaucus	P4	-	P	White, grey or yellow sand, sandy gravel.	Oct-Mar	Unlikely
Tripterococcus sp. Brachylobus (A.S. George 14234)	P4	-	P	Winter-wet areas on grey sand.	Oct-Feb	Unlikely
Verticordia lindleyi subsp. *lindleyi*	P4	-	P	Sand and sandy clay in winter wet areas.	May or Nov-Jan	Recorded

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

Appendix C

Conservation Significant Communities and Likelihood of Occurrence Assessment

Code	Community name	TEC/ PEC	Level of significance		Likelihood of occurrence
			State	EPBC Act	
Banksia Woodlands	Banksia woodlands of the Swan Coastal Plain	TEC/ PEC	P3	EN	Recorded
Central Granite Shrublands (Com 5, Markey)	Central Northern Darling Scarp Granite Shrubland Community	PEC	P4	-	Does not occur
Claypans with shrubs over herbs	Claypans with mid dense shrublands of *Melaleuca lateritia* over herbs	PEC	P1	-	Does not occur
	Claypans of the Swan Coastal Plain	TEC		CR	Does not occur
Coastal Saltmarsh	Subtropical and temperate coastal saltmarsh	TEC/ PEC	P3	VU	Does not occur
Muchea Limestone	Shrublands and woodlands on Muchea Limestone of the Swan Coastal Plain	TEC	EN	EN	Does not occur
SCP3a	*Corymbia calophylla - Kingia australis* woodlands on heavy soils, Swan Coastal Plain	TEC	CR	EN	Does not occur
SCP3b	*Corymbia calophylla - Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain	TEC	VU	-	Does not occur
SCP07	Herb rich saline shrublands in clay pans	TEC	VU	CR	Does not occur
SCP08	Herb rich shrublands in clay pans	TEC	VU	CR	Does not occur
SCP10a	Shrublands on dry clay flats	TEC	EN	CR	Does not occur
SCP20b	*Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain	TEC	EN	EN	Does not occur
SCP21c	Low lying *Banksia attenuata* woodlands or shrublands	PEC	P3	-	Does not occur
SCP22	*Banksia ilicifolia* woodlands	PEC	P3	-	Does not occur
Tuart Woodlands	Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain	TEC/ PEC	P3	CR	Does not occur

Note: TEC=threatened ecological community, PEC=priority ecological community, CR=critically endangered, EN=endangered, VU=vulnerable, P1=priority 1, P3=priority 3, P4=priority 4. TECs or PECs recorded within the site are shaded in green.

Appendix D

Flora Species List

Family	Status	Species
Aizoaceae		
	*	*Carpobrotus edulis*
Anarthriaceae		
		Lyginia barbata
		Lyginia imberbis
Apiaceae		
		Homalosciadium homalocarpum
Apocynaceae		
	*, Pl	*Nerium oleander*
Araceae		
	*, DP	*Zantedeschia aethiopica*
Araliaceae		
		Trachymene pilosa
Asparagaceae		
	*	*Agave americana*
	*, DP, WoNS	*Asparagus asparagoides*
		Laxmannia ramosa subsp. *ramosa*
		Laxmannia squarrosa
		Lomandra caespitosa
		Lomandra hermaphrodita
		Lomandra nigricans
		Lomandra sericea
		Lomandra sonderi
		Thysanotus sp.
		Thysanotus triandrus
Asteraceae		
	*	*Helianthus* sp.
		Hyalosperma cotula
	*	*Lactuca serriola*
		Siloxerus filifolius
	*	*Sonchus asper*
	*	*Sonchus oleraceus*
	*	*Ursinia anthemoides*
Boraginaceae		
	*, DP	*Echium plantagineum*
Campanulaceae		
		Lobelia tenuior

Family	Status	Species
Celastraceae		
		Stackhousia monogyna
		Tripterococcus brunonis
Centrolepidaceae		
		Centrolepis drummondiana
Colchicaceae		
		Burchardia congesta
Convolvulaceae		
	*	*Ipomoea indica*
Cyperaceae		
		Baumea juncea
		Bolboschoenus caldwellii
		Chaetospora curvifolia
		Eleocharis acuta
		Evandra pauciflora
		Isolepis marginata
		Lepidosperma longitudinale
		Lepidosperma pubisquameum
		Schoenus efoliatus
Dasypogonaceae		
		Dasypogon bromeliifolius
Dilleniaceae		
		Hibbertia hypericoides
		Hibbertia stellaris
		Hibbertia subvaginata
Droseraceae		
		Drosera erythrorhiza
		Drosera menziesii
Ericaceae		
		Conostephium pendulum
		Leucopogon tenuis
		Lysinema ciliatum
		Styphelia conostephioides
Euphorbiaceae		
	*	*Euphorbia terracina*
	*	*Ricinus communis*
Fabaceae		
	*	*Acacia iteaphylla*

Family	Status	Species
Fabaceae (cont.)		
	P1	*Acacia lasiocarpa* var. bracteolata long peduncle variant (G.J. Keighery 5026)
	*	*Acacia longifolia*
		Acacia pulchella
		Acacia stenoptera
		Aotus gracillima
		Bossiaea eriocarpa
	*	*Chamaecytisus palmensis*
		Daviesia physodes
		Euchilopsis linearis
		Gompholobium tomentosum
		Hovea trisperma
		Jacksonia furcellata
	P3	*Jacksonia gracillima*
		Latrobea tenella
	*	*Lotus angustissimus*
	*	*Vicia sativa* subsp. *sativa*
Goodeniaceae		
		Dampiera linearis
Haemodoraceae		
		Anigozanthos humilis
		Anigozanthos manglesii
		Conostylis juncea
		Haemodorum spicatum
		Phlebocarya ciliata
Haloragaceae		
		Gonocarpus cordiger
Hemerocallidaceae		
		Dianella revoluta
		Hensmania turbinata
		Tricoryne elatior
Iridaceae		
		Gladiolus caryophyllaceus
		Patersonia occidentalis
	*	*Watsonia meriana*
Juncaceae		
		Juncus pallidus
Juncaginaceae		
		Cycnogeton lineare

Family	Status	Species
Lauraceae		
		Cassytha racemosa
Loganiaceae		
		Phyllangium paradoxum
Loranthaceae		
		Nuytsia floribunda
Meliaceae		
	*, Pl	*Melia azedarach*
Myrtaceae		
	*, Pl	*Agonis flexuosa*
		Astartea scoparia
		Calytrix flavescens
		Eremaea pauciflora var. *pauciflora*
	*, Pl	*Eucalyptus camaldulensis*
		Eucalyptus rudis
		Eucalyptus todtiana
	*, Pl	*Eucalyptus* sp.
		Hypocalymma angustifolium
		Kunzea glabrescens
	*, Pl	*Leptospermum laevigatum*
		Melaleuca lateritia
	*, Pl	*Melaleuca nesophila*
		Melaleuca preissiana
		Melaleuca rhaphiophylla
		Melaleuca teretifolia
		Melaleuca thymoides
		Melaleuca trichophylla
		Pericalymma ellipticum
		Regelia ciliata
		Scholtzia involucrata
		Verticordia densiflora var. *densiflora*
	P4	*Verticordia lindleyi* subsp. *lindleyi*
Orchidaceae		
		Caladenia falcata
		Caladenia flava subsp. *flava*
		Caladenia paludosa
		Microtis media
		Prasophyllum parvifolium
		Pterostylis sanguinea
		Pterostylis vittata
		Pyrorchis nigricans
		Thelymitra macrophylla

Family	Status	Species
Oxalidaceae		
	*	*Oxalis pes-caprae*
Papaveraceae		
	*	*Fumaria capreolata*
Phyllanthaceae		
		Poranthera microphylla
Poaceae		
	*	*Arundo donax*
		Austrostipa compressa
	*	*Avena barbata*
	*	*Briza maxima*
	*	*Briza minor*
	*	*Bromus* sp.
	*	*Cynodon dactylon*
	*	*Ehrharta calycina*
	*	*Ehrharta longiflora*
	*	*Lolium rigidum*
	*	*Polypogon monspeliensis*
Polygalaceae		
	*	*Rumex crispus*
Proteaceae		
		Adenanthos obovatus
		Banksia attenuata
		Banksia ilicifolia
		Banksia menziesii
	*, Pl	*Grevillea robusta*
		Hakea trifurcata
		Petrophile linearis
Ranunculaceae		
		Clematis pubescens
	*	*Ranunculus muricatus*
Restionaceae		
		?Cytogonidium leptocarpoides
		Hypolaena exsulca
		Hypolaena pubescens
		Leptocarpus canus
		Leptocarpus coangustatus
Rutaceae		
		Boronia dichotoma
		Philotheca spicata

Family	Status	Species
Solanaceae		
	*	*Solanum laciniatum*
Stylidiaceae		
		Levenhookia stipitata
		Stylidium brunonianum
		Stylidium repens
		Stylidium scariosum
		Stylidium schoenoides
Thymelaeaceae		
		Pimelea imbricata var. *piligera*
Typhaceae		
		Typha domingensis
Xanthorrhoeaceae		
		Chamaescilla corymbosa
		Xanthorrhoea brunonis
		Xanthorrhoea gracilis
		Xanthorrhoea preissii
Zamiaceae		
		Macrozamia riedlei

*=non-native, DP declared pest under the BAM Act, WoNS=weed of national significance, Pl=planted; P1=Priority 1 in WA, P3=Priority 3 in WA, P4=Priority 4 in WA.

Appendix E

Flora Species x Plant Community Matrix

Species	Plant community							
	AsRc	BaBm	BKg	BaMpKg	MpE	MpKg	Mr	Cleared/non-native
?Cytogonidium leptocarpoides						X		
Acacia iteaphylla					X			X
Acacia lasiocarpa var. bracteolata long peduncle variant (G.J. Keighery 5026) (P1)		X		X				
Acacia longifolia	X				X			X
Acacia pulchella			X	X				
Acacia stenoptera			X	X				
Adenanthos obovatus		X		X				
Agave americana								X
Agonis flexuosa					X			X
Anigozanthos humilis				X				
Anigozanthos manglesii		X						
Aotus gracillima	X							
Arundo donax					X			X
Asparagus asparagoides				X	X			
Astartea scoparia	X				X			
Austrostipa compressa		X		X				
Avena barbata		X						
Banksia attenuata		X	X	X				
Banksia ilicifolia			X					
Banksia menziesii		X	X					
Baumea juncea					X			
Bolboschoenus caldwellii							X	
Boronia dichotoma				X		X		
Bossiaea eriocarpa		X	X	X				
Briza maxima	X	X	X	X				X
Briza minor	X			X				
Bromus sp.	X							X
Burchardia congesta		X	X					
Caladenia falcata		X						
Caladenia flava subsp. *flava*			X					

Species	Plant community							
	AsRc	BaBm	BKg	BaMpKg	MpE	MpKg	Mr	Cleared/non-native
Caladenia paludosa					X			
Calytrix flavescens		X		X				
Carpobrotus edulis					X			X
Cassytha racemosa	X						X	
Centrolepis drummondiana		X						
Chaetospora curvifolia				X				
Chamaecytisus palmensis								X
Chamaescilla corymbosa		X						
Clematis pubescens		X						
Conostephium pendulum		X	X					
Conostylis juncea		X						
Cycnogeton lineare							X	
Cynodon dactylon					X		X	X
Dampiera linearis		X		X				
Dasypogon bromeliifolius		X	X	X				
Daviesia physodes		X						
Dianella revoluta	X							
Drosera erythrorhiza		X	X					
Drosera menziesii		X						
Echium plantagineum					X			X
Ehrharta calycina		X						X
Ehrharta longiflora		X	X	X				X
Eleocharis acuta							X	
Eremaea pauciflora subsp. *pauciflora*				X				
Eucalyptus camaldulensis	X				X			X
Eucalyptus rudis					X			
Eucalyptus todtiana		X	X					
Eucalyptus sp.					X			X
Euchilopsis linearis	X			X		X		
Euphorbia terracina				X				X

Species	Plant community							
	AsRc	BaBm	BKg	BaMpKg	MpE	MpKg	Mr	Cleared/non-native
Evandra pauciflora				X				
Fumaria capreolata	X			X				X
Gladiolus caryophyllaceus		X						
Gompholobium tomentosum			X	X				
Gonocarpus cordiger		X						
Grevillea robusta								X
Haemodorum spicatum		X						
Hakea trifurcata		X						
Helianthus sp.								X
Hensmania turbinata				X				
Hibbertia hypericoides		X						
Hibbertia stellaris				X				
Hibbertia subvaginata			X					
Homaloscidium homalocarpum	X			X				
Hovea trisperma		X	X	X				
Hyalosperma cotula		X						
Hypocalymma angustifolium				X		X		
Hypolaena exsulca	X	X	X	X				
Hypolaena pubescens				X		X		
Ipomoea indica								X
Isolepis marginata		X					X	
Jacksonia furcellata		X						
Jacksonia gracillima (P3)				X				
Juncus pallidus								X
Kunzea glabrescens		X	X	X	X	X		
Lactuca serriola							X	X
Latrobea tenella	X							
Laxmannia ramosa subsp. *ramosa*		X						
Laxmannia squarrosa		X						
Lepidosperma longitudinale					X			

Species	Plant community							
	AsRc	BaBm	BKg	BaMpKg	MpE	MpKg	Mr	Cleared/non-native
Lepidosperma pubisquameum		X		X				
Leptocarpus canus	X							
Leptocarpus coangustatus						X		
Leptospermum laevigatum			X					X
Leucopogon sp.				X				
Leucopogon tenuis		X						
Levenhookia stipitata		X						
Lobelia tenuior		X						
Lolium rigidum					X			X
Lomandra caespitosa		X						
Lomandra hermaphrodita			X					
Lomandra nigricans		X						
Lomandra sericea		X						
Lomandra sonderi				X				
Lotus angustissimus					X			
Lyginia barbata						X		
Lyginia imberbis		X	X	X				
Lysinema ciliatum		X						
Melaleuca lateritia					X			
Melaleuca nesophila					X			X
Melaleuca preissiana	X			X	X	X		X
Melaleuca rhaphiophylla					X		X	X
Melaleuca teretifolia					X		X	
Melaleuca thymoides		X	X	X				
Melaleuca trichophylla		X		X				
Melia azedarach								X
Microtis media		X	X					
Nerium oleander					X			X
Nuytsia floribunda			X					
Oxalis pes-caprae								X

Species	Plant community							
	AsRc	BaBm	BKg	BaMpKg	MpE	MpKg	Mr	Cleared/non-native
Patersonia occidentalis		X	X	X				
Pericalymma ellipticum	X			X				
Petrophile linearis		X						
Philotheca spicata		X						
Phlebocarya ciliata		X	X	X				
Phyllangium paradoxum		X						
Pimelea imbricata var. *piligera*				X		X		
Polypogon monspeliensis								X
Poranthera microphylla		X						
Prasophyllum parvifolium				X				
Pterostylis sanguinea			X					
Pterostylis vittata	X	X						
Pyrorchis nigricans			X					
Ranunculus muricatus							X	
Regelia ciliata	X			X	X	X		
Ricinus communis								X
Rumex crispus							X	X
Schoenus efoliatus	X			X				
Scholtzia involucrata		X						
Siloxerus filifolius		X						
Solanum laciniatum					X			X
Sonchus asper					X			X
Sonchus oleraceus					X		X	X
Stackhousia monogyna		X						
Stylidium brunonianum		X		X		X		
Stylidium repens		X						
Stylidium scariosum		X						
Stylidium schoenoides				X				
Styphelia conostephioides			X					
Thelymitra macrophylla		X						

Species	Plant community							
	AsRc	BaBm	BKg	BaMpKg	MpE	MpKg	Mr	Cleared/non-native
Thysanotus triandrus								
Thysanotus sp.		X						
Trachymene pilosa		X	X	X				
Tricoryne elatior		X						
Triptococcus brunonis		X						
Typha domingensis					X		X	X
Ursinia anthemoides		X	X	X				X
Verticordia densiflora				X				
Verticordia lindleyi subsp. *lindleyi* (P4)								
Vicia sativa subsp. *sativa*							X	X
Watsonia meriana								X
Xanthorrhoea brunonis		X	X	X	X			
Xanthorrhoea gracilis	X				X			
Xanthorrhoea preissii				X				
Zantedeschia aethiopica	X			X				X

Appendix F

Vegetation Sample Data

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: Q1

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: RAO,SKP Q1: Page 1 of 3

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	400329	NW corner northing:	6445807
Altitude (m):	23	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	low - weeds, rabbits
Soil type/texture	sand/	Bare ground (%):	10
Rocks (%) and type:	No rocks	Soil colour:	brown/grey
Litter:	20% (leaves,twigs,branches)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: Q1

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: RAO,SKP Q1: Page 2 of 3

Species Data

* denotes non-native species

Status		Confirmed name	Cover (%)
	P1	*Acacia lasiocarpa var. bracteolata long peduncle variant (G.J.*	opp
		Adenanthos obovatus	0.5
		Austrostipa compressa	0.5
	*	*Avena barbata*	3
		Banksia attenuata	20
		Banksia menziesii	25
		Bossiaea eriocarpa	1
	*	*Briza maxima*	5
		Burchardia congesta	0.5
		Caladenia falcata	0.5
		Calytrix flavescens	0.5
		Centrolepis drummondiana	0.5
		Chamaescilla corymbosa	opp
		Clematis pubescens	opp
		Conostephium pendulum	0.5
		Conostylis juncea	0.5
		Dampiera linearis	0.5
		Dasypogon bromeliifolius	1
		Daviesia physodes	0.5
		Drosera erythrorhiza	0.5
		Drosera menziesii	0.5
	*	*Ehrharta longiflora*	2
		Eucalyptus todtiana	opp
	*	*Gladiolus caryophyllaceus*	0.5
		Gonocarpus cordiger	opp
		Haemodorum spicatum	opp
		Hakea trifurcata	opp
		Hovea trisperma	0.5
		Hyalosperma cotula	0.5
		Hypolaena exsulca	0.5
		Isolepis marginata	0.5
		Jacksonia furcellata	0.5
		Kunzea glabrescens	0.5
		Laxmannia ramosa subsp. ramosa	opp

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: Q1

Project no.: EP20-127
Date: 0/01/1900 **Status** Non-permanent
Author: RAO,SKP Q1: Page 3 of 3

	Laxmannia squarrosa	opp
	Lepidosperma pubisquameum	0.5
	Leucopogon tenuis	opp
	Levenhookia stipitata	0.5
	Lomandra caespitosa	0.5
	Lomandra nigricans	0.5
	Lomandra sericea	*0.5*
	Lyginia imberbis	*40*
	Lysinema ciliatum	opp
	Melaleuca thymoides	10
	Melaleuca trichophylla	0.5
	Microtis media	0.5
	Patersonia occidentalis	40
	Petrophile linearis	0.5
	Philotheca spicata	0.5
	Phlebocarya ciliata	5
	Phlebocarya ciliata	opp
	Phyllangium paradoxum	0.5
	Poranthera microphylla	opp
	Poranthera microphylla	opp
	Pterostylis vittata	0.5
	Scholtzia involucrata	1
	Siloxerus filifolius	0.5
	Stylidium brunonianum	0.5
	Stylidium repens	0.5
	Stylidium scariosum	0.5
	Thysanotus sp.	0.5
	Trachymene pilosa	0.5
	Tricoryne elatior	0.5
	Tripterococcus brunonis	0.5
*	*Ursinia anthemoides*	3
	Xanthorrhoea brunonis	5

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: Q2

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: RAO,SKP Q2: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	400515	NW corner northing:	6445832
Altitude (m):	21	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	other
Time since fire:	no evidence	Disturbance:	low - weeds
Soil type/texture	sand/loam with organic layer	Bare ground (%):	50
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	10% (leaves,,)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: Q2

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: RAO,SKP Q2: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
*	*Acacia longifolia*	opp
	Astartea scoparia	50
*	*Briza maxima*	0.5
*	*Briza minor*	0.5
	Bromus sp.	opp
	Cassytha racemosa	3
	Dianella revoluta	opp
*, Pl	*Eucalyptus camaldulensis*	1
	Euchilopsis linearis	3
*	*Fumaria capreolata*	1
*	*Homaloscidium homalocarpum*	opp
	Hypolaena exsulca	0.5
	Latrobea tenella	0.5
	Leptocarpus canus	0.5
	Melaleuca preissiana	5
	Pericalymma ellipticum	0.5
	Pterostylis vittata	0.5
	Pterostylis vittata	0.5
	Regelia ciliata	40
	Schoenus efoliatus	0.5
*, DP	*Zantedeschia aethiopica*	0.5

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: Q3

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: RAO,SKP Q3: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	400259	NW corner northing:	6445953
Altitude (m):	24	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	low - weeds, rabbits
Soil type/texture	sand/ with organic layer	Bare ground (%):	30
Rocks (%) and type:	No rocks	Soil colour:	brown/grey
Litter:	60% (leaves,twigs,branches)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: Q3

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: RAO,SKP Q3: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella	0.5
	Acacia stenoptera	0.5
	Banksia attenuata	10
	Banksia ilicifolia	opp
	Banksia menziesii	5
	Bossiaea eriocarpa	2
*	*Briza maxima*	0.5
	Burchardia congesta	0.5
	Caladenia flava subsp. flava	0.5
	Conostephium pendulum	0.5
	Dasypogon bromeliifolius	10
	Drosera erythrorhiza	0.5
*	*Ehrharta longiflora*	0.5
	Eucalyptus todtiana	opp
	Gompholobium tomentosum	0.5
	Hibbertia subvaginata	0.5
	Hovea trisperma	0.5
	Hypolaena exsulca	0.5
	Kunzea glabrescens	80
*	*Leptospermum laevigatum*	0.5
	Lomandra hermaphrodita	0.5
	Lyginia imberbis	3
	Melaleuca thymoides	5
	Microtis media	0.5
	Nuytsia floribunda	opp
	Patersonia occidentalis	3
	Phlebocarya ciliata	5
	Pterostylis sanguinea	0.5
	Pyrorchis nigricans	0.5
	Styphelia conostephioides	0.5
	Trachymene pilosa	0.5
*	*Ursinia anthemoides*	0.5
	Xanthorrhoea brunonis	2

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: Q4

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: SKP,RAO Q4: Page 1 of 3

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	400188	NW corner northing:	6446062
Altitude (m):	24	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	low - weeds
Soil type/texture	sand/	Bare ground (%):	10
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	10% (branches,twigs,)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: Q4

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: SKP,RAO Q4: Page 2 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
P1	*Acacia lasiocarpa var. bracteolata long peduncle variant (G.J.*	1
	Acacia pulchella	0.1
	Acacia stenoptera	0.1
	Adenanthos obovatus	opp
	Anigozanthos humilis	opp
	Austrostipa compressa	0.1
	Banksia attenuata	15
	Boronia dichotoma	0.1
	Bossiaea eriocarpa	1
	Calytrix flavescens	1
	Dampiera linearis	0.1
	Dasypogon bromeliifolius	10
	Eremaea pauciflora subsp. pauciflora	1
	Euchilopsis linearis	0.1
	Evandra pauciflora	2
	Gompholobium tomentosum	1
	Hensmania turbinata	0.1
	Hibbertia stellaris	0.1
	Hovea trisperma	0.1
	Hypocalymma angustifolium	5
	Hypolaena exsulca	15
	Kunzea glabrescens	30
	Lepidosperma pubisquameum	0.5
	Leucopogon sp.	opp
	Lomandra sonderi	0.1
	Lyginia imberbis	10
	Melaleuca preissiana	1
	Melaleuca trichophylla	30
	Patersonia occidentalis	1
	Pericalymma ellipticum	2
	Phlebocarya ciliata	3
	Prasophyllum parvifolium	0.1
	Regelia ciliata	opp
	Schoenus efoliatus	1

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: Q4

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: SKP,RAO Q4: Page 3 of 3

	Stylidium schoenoides	opp
*	*Ursinia anthemoides*	0.1
	Xanthorrhoea preissii	10

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R5

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: RAO,SKP

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400517.9663	NW corner northing:	6446286.026
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	depression
Time since fire:	no evidence	Disturbance:	high - weeds, altered landform
Soil type/texture	sand/ with organic layer	Bare ground (%):	30
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	5% (leaves,twigs,branches)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R5

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: RAO,SKP

Species Data

* denotes non-native species

Status	Confirmed name
	Bolboschoenus caldwellii
	Cycnogeton lineare
*	*Cynodon dactylon*
	Eleocharis acuta
	Isolepis marginata
*	*Lactuca serriola*
	Melaleuca rhaphiophylla
	Melaleuca teretifolia
*	*Ranunculus muricatus*
*	*Rumex crispus*
*	*Sonchus oleraceus*
	Typha domingensis
*	*Vicia sativa subsp. sativa*

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R6

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: RAO,SKP

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400275.3958	NW corner northing:	6446100.421
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	moderate - weeds
Soil type/texture	sand/	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	10% (leaves,twigs,branches)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R6

Project no.: EP20-127
Date: 16/10/2020 **Status** Non-permanent
Author: RAO,SKP

Species Data

* denotes non-native species

Status	Confirmed name
	Acacia pulchella
*	*Asparagus asparagoides*
	Banksia attenuata
*	*Briza maxima*
*	*Briza minor*
	Chaetospora curvifolia
	Dasypogon bromeliifolius
*	*Ehrharta longiflora*
*	*Euphorbia terracina*
*	*Fumaria capreolata*
	Gompholobium tomentosum
	Homaloscidium homalocarpum
	Hypocalymma angustifolium
	Hypolaena exsulca
	Hypolaena pubescens
	Kunzea glabrescens
	Melaleuca preissiana
	Melaleuca thymoides
	Melaleuca trichophylla
	Phlebocarya ciliata
	Pimelea imbricata var. piligera
	Regelia ciliata
	Stylidium brunonianum
	Trachymene pilosa
	Verticordia densiflora
	Xanthorrhoea brunonis
*	*Zantedeschia aethiopica*

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R7

Project no.: EP20-127
Date: 4/12/2020 **Status** Non-permanent
Author: SKP, R7: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400678.6216	NW corner northing:	6445955.429
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	depression
Time since fire:	no evidence	Disturbance:	high - weeds, partial clearing
Soil type/texture	sand/ with organic layer	Bare ground (%):	30
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	10% (leaves,twigs,branches)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R7

Project no.: EP20-127
Date: 4/12/2020 **Status** Non-permanent
Author: SKP, R7: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name
	Melaleuca rhaphiophylla
	Cassytha racemosa
	Melaleuca teretifolia
*	*Cynodon dactylon*
*	*Rumex crispus*
*	*Sonchus oleraceus*

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R8

Project no.: EP20-127
Date: 4/12/2020 **Status** Non-permanent
Author: SKP, R8: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400514.5796	NW corner northing:	6445771.807
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - weeds, partial clearing
Soil type/texture	sand/ with organic layer	Bare ground (%):	30
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	10% (leaves,twigs,branches)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R8

Project no.: EP20-127
Date: 4/12/2020 **Status** Non-permanent
Author: SKP, R8: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name
	Baumea juncea
	Caladenia paludosa
*	*Cynodon dactylon*
*	*Eucalyptus camaldulensis*
	Lepidosperma longitudinale
	Melaleuca lateritia
	Melaleuca preissiana
	Melaleuca teretifolia

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R9

Project no.: EP20-127
Date: 4/12/2020 **Status** Non-permanent
Author: SKP, R9: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400467.4837	NW corner northing:	6446105.183
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - weeds, partial clearing
Soil type/texture	sand/ with organic layer	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	5% (leaves,twigs,branches)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R9

Project no.: EP20-127
Date: 4/12/2020 **Status** Non-permanent
Author: SKP, R9: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name
*	*Acacia longifolia*
*, DP	*Asparagus asparagoides*
	Astartea scoparia
*	*Carpobrotus edulis*
	Eucalyptus rudis
*	*Eucalyptus sp.*
	Kunzea glabrescens
	Lepidosperma longitudinale
	Melaleuca preissiana
	Melaleuca rhaphiophylla
	Melaleuca teretifolia
	Regelia ciliata
	Xanthorrhoea brunonis

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R10

Project no.: EP20-127
Date: 4/12/2020 **Status** Non-permanent
Author: SKP, R10: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400540.5088	NW corner northing:	6446128.466
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - weeds, partial clearing
Soil type/texture	sand/ with organic layer	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	20% (leaves,twigs,branches)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R10

Project no.: EP20-127
Date: 4/12/2020 **Status** Non-permanent
Author: SKP, R10: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name
*	*Acacia iteaphylla*
*	*Arundo donax*
*	*Cynodon dactylon*
*, DP	*Echium plantagineum*
*	*Eucalyptus camaldulensis*
*	*Lolium rigidum*
	Melaleuca lateritia
*	*Melaleuca nesophila*
	Melaleuca rhaphiophylla
	Melaleuca teretifolia
*	*Nerium oleander*
*	*Solanum laciniatum*
*	*Sonchus asper*
*	*Sonchus oleraceus*
	Typha domingensis

Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R11

Project no.: EP20-127
Date: 4/12/2020 **Status** Non-permanent
Author: SKP, R11: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400231.4748	NW corner northing:	6446123.175
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	moderate - track, weeds
Soil type/texture	sand/	Bare ground (%):	20
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	5% (leaves,twigs,branches)	Vegetation condition:	very good



Vegetation Sample Data

Lots 600 - 606 Balannup Road and
200 - 202 Skeet Road, Harrisdale

Sample Name: R11

Project no.: EP20-127
Date: 4/12/2020 **Status** Non-permanent
Author: SKP, R11: Page 2 of 2

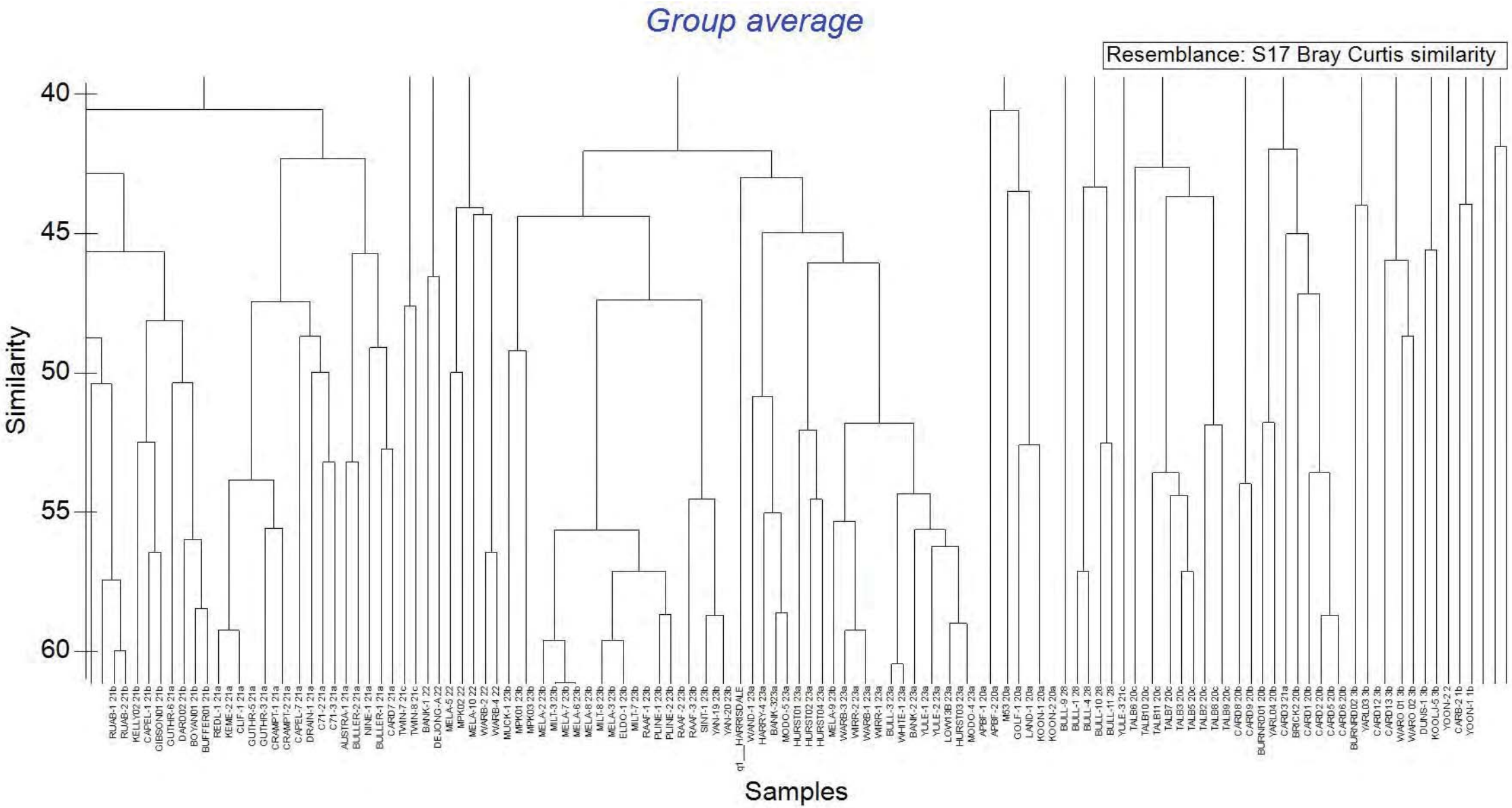
Species Data

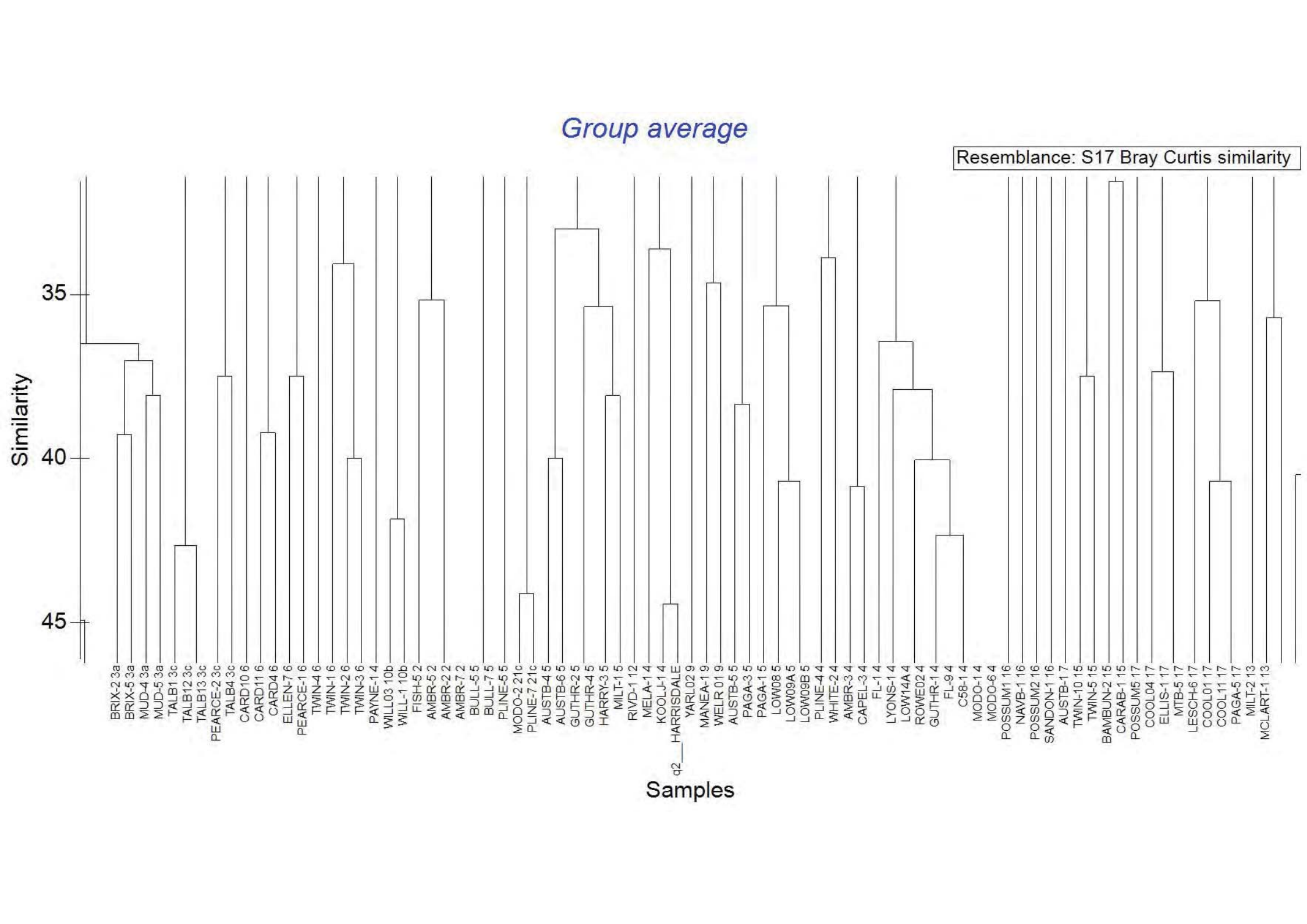
* denotes non-native species

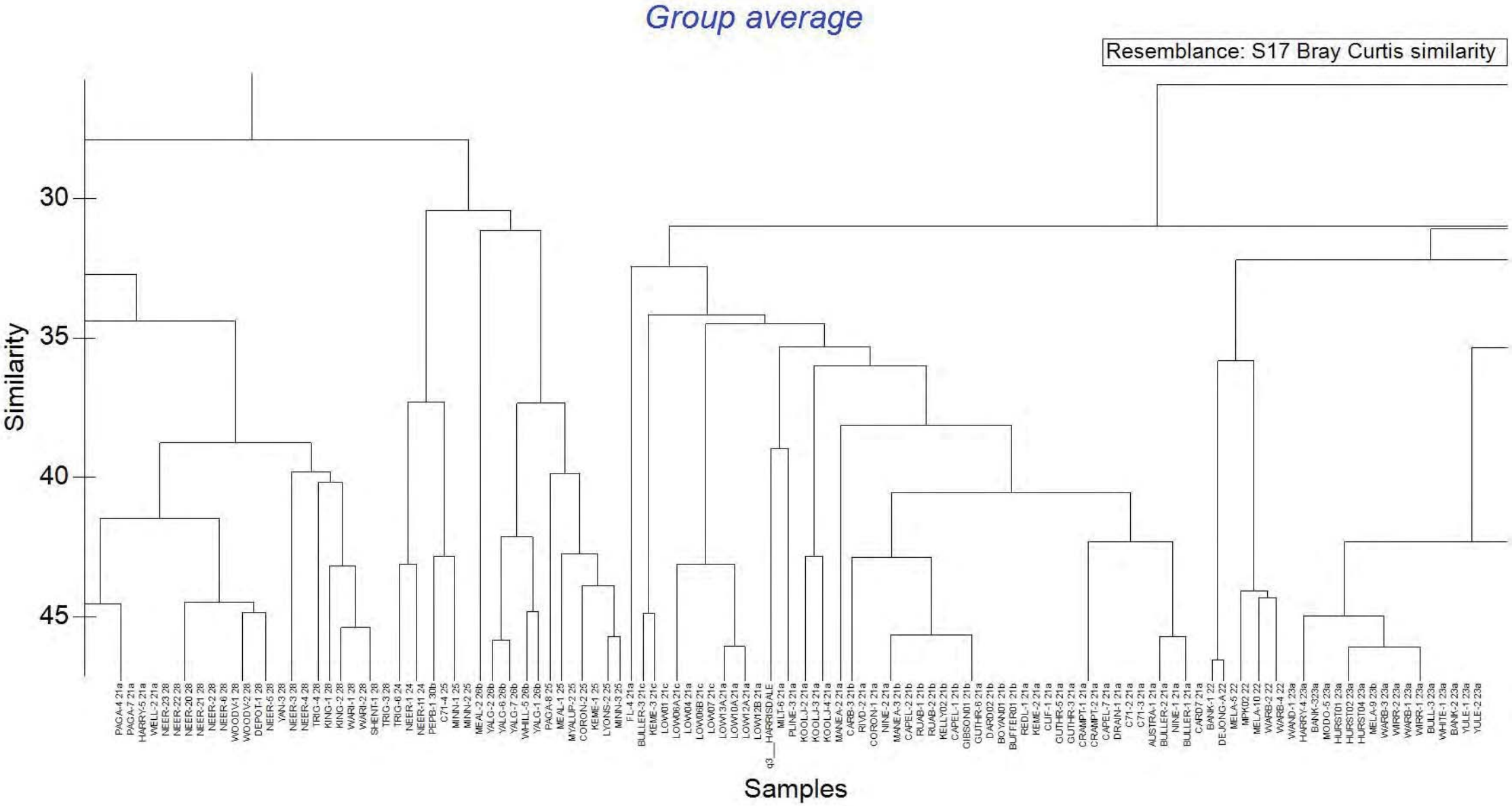
Status	Confirmed name
	?Cytogonidium leptocarpoides
	Boronia dichotoma
	Euchilopsis linearis
	Hypocalymma angustifolium
	Hypolaena pubescens
	Kunzea glabrescens
	Lyginia barbata
	Melaleuca preissiana
	Pimelea imbricata var. piligera
	Regelia ciliata
	Stylidium brunonianum
P4	*Verticordia lindleyi subsp. lindleyi*

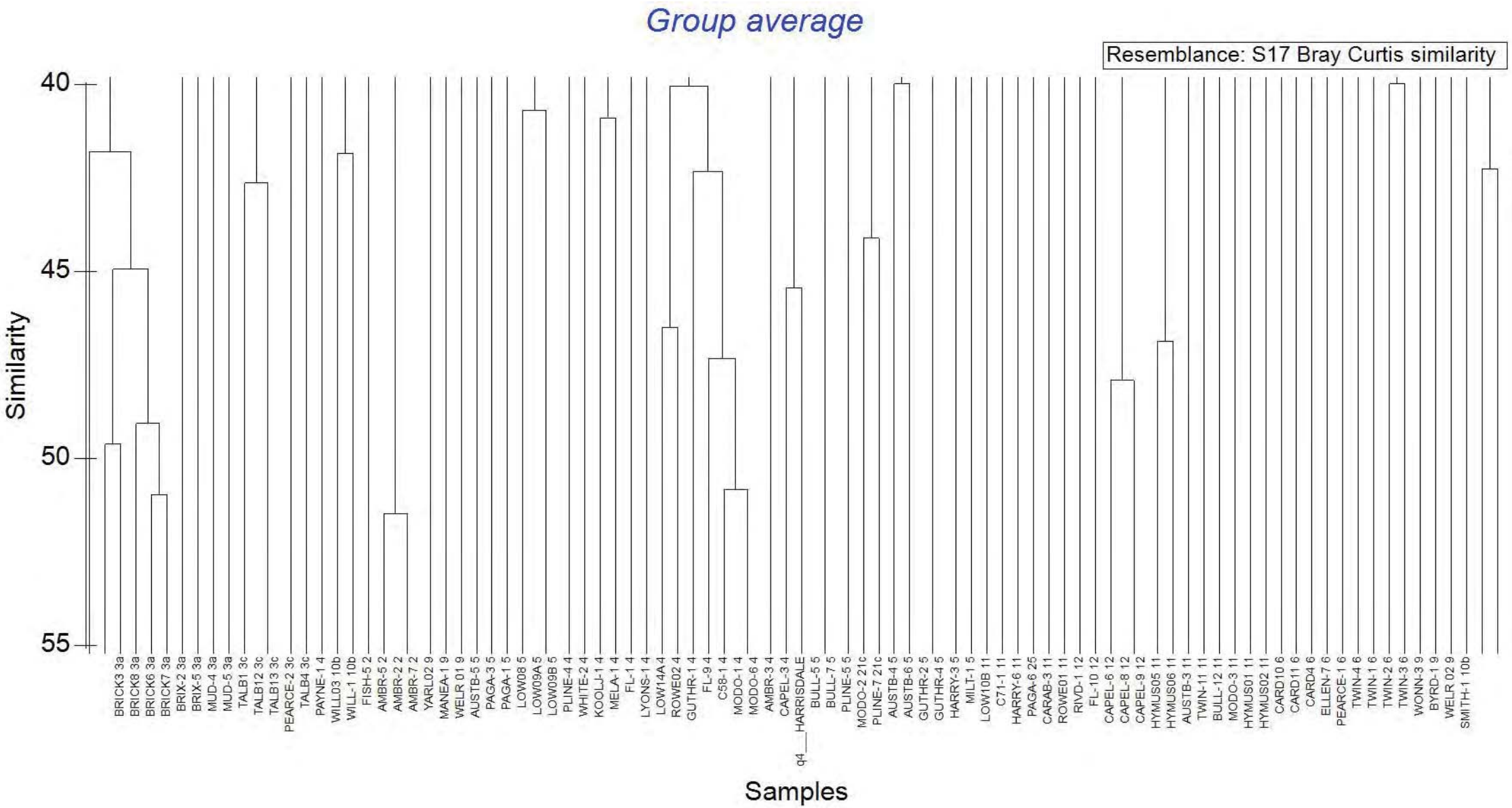
Appendix G

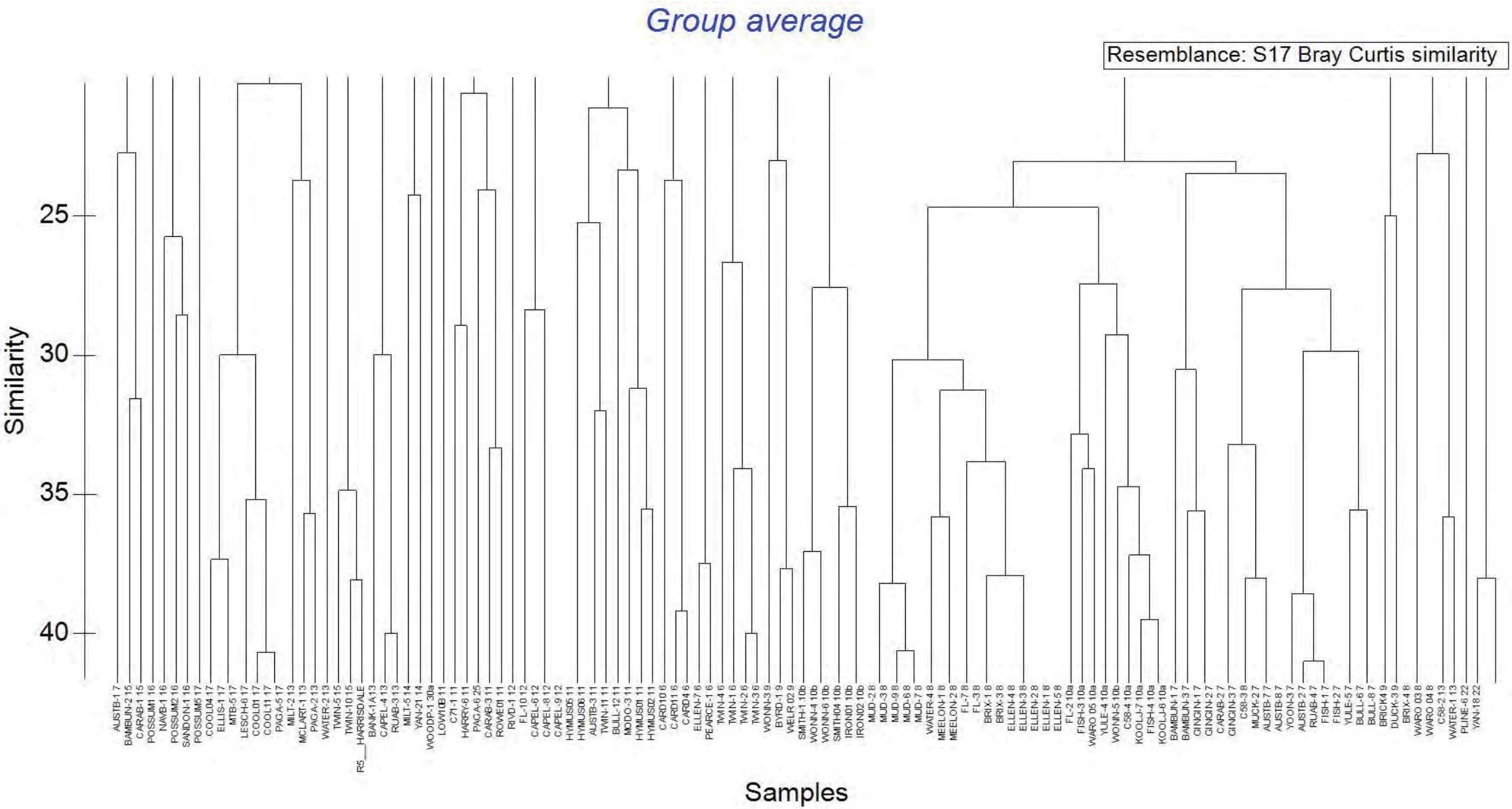
Cluster Dendrograms

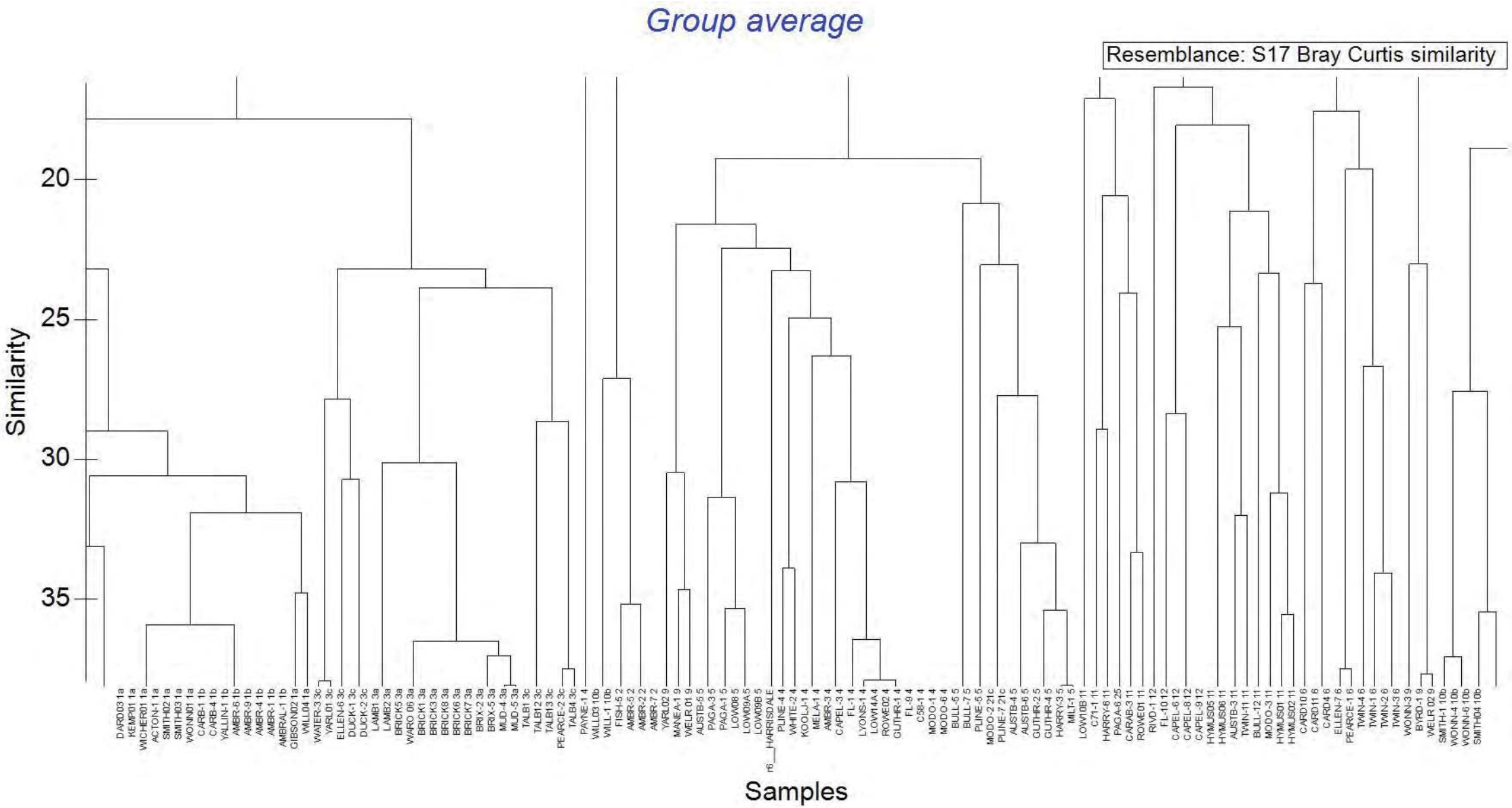

Group average
Resemblance: S17 Bray Curtis similarity
Similarity
40
45
50
55
60
Samples
RUAB-1 21b
RUAB-2 21b
KELLY02 21b
CAPEL-1 21b
GIBSON01 21b
GUTHR-6 21a
DARD02 21b
BOYAN01 21b
BUFFER01 21b
REDL-1 21a
KEME-2 21a
CLIF-1 21a
GUTHR-5 21a
GUTHR-3 21a
CRAMPT-1 21a
CRAMPT-2 21a
CAPEL-7 21a
DRAIN-1 21a
C71-2 21a
C71-3 21a
AUSTRA-1 21a
BULLER-2 21a
NINE-1 21a
BULLER-1 21a
CARD7 21a
TWIN-7 21c
TWIN-8 21c
BANK-1 22
DE JONG-A 22
MELA-5 22
MPK02 22
MELA-10 22
WARB-2 22
WARB-4 22
MUCK-1 23b
MPK01 23b
MPK03 23b
MELA-2 23b
MILT-3 23b
MELA-7 23b
MELA-6 23b
MELA-8 23b
MILT-8 23b
MELA-3 23b
ELDO-1 23b
MILT-7 23b
RAAF-1 23b
PLINE-1 23b
PLINE-2 23b
RAAF-2 23b
RAAF-3 23b
SINT-1 23b
YAN-19 23b
YAN-20 23b
HARRISDALE
WAND-1 23a
HARRY-4 23a
BANK-323a
MODO-5 23a
HURST01 23a
HURST02 23a
HURST04 23a
MELA-9 23b
WARB-3 23a
WIRR-2 23a
WARB-1 23a
WIRR-1 23a
BULL-3 23a
WHITE-1 23a
BANK-2 23a
YULE-1 23a
YULE-2 23a
LOWI3B 23a
HURST03 23a
MODO-4 23a
APBF-1 20a
APBF-2 20a
M53 20a
GOLF-1 20a
LAND-1 20a
KOON-1 20a
KOON-2 20a
BULL-9 28
BULL-1 28
BULL-4 28
BULL-10 28
BULL-11 28
YULE-3 21c
TALB6 20c
TALB10 20c
TALB11 20c
TALB7 20c
TALB3 20c
TALB5 20c
TALB2 20c
TALB8 20c
TALB9 20c
CARD8 20b
CARD9 20b
BURNRD01 20b
YARL04 20b
CARD3 21a
BRICK2 20b
CARD1 20b
CARD2 20b
CARD5 20b
CARD6 20b
BURNRD02 3b
YARL03 3b
CARD12 3b
CARD13 3b
WARO 01 3b
WARO 02 3b
DUNS-1 3b
KOOLI-5 3b
YOON-2 2
CARB-2 1b
YOON-1 1b

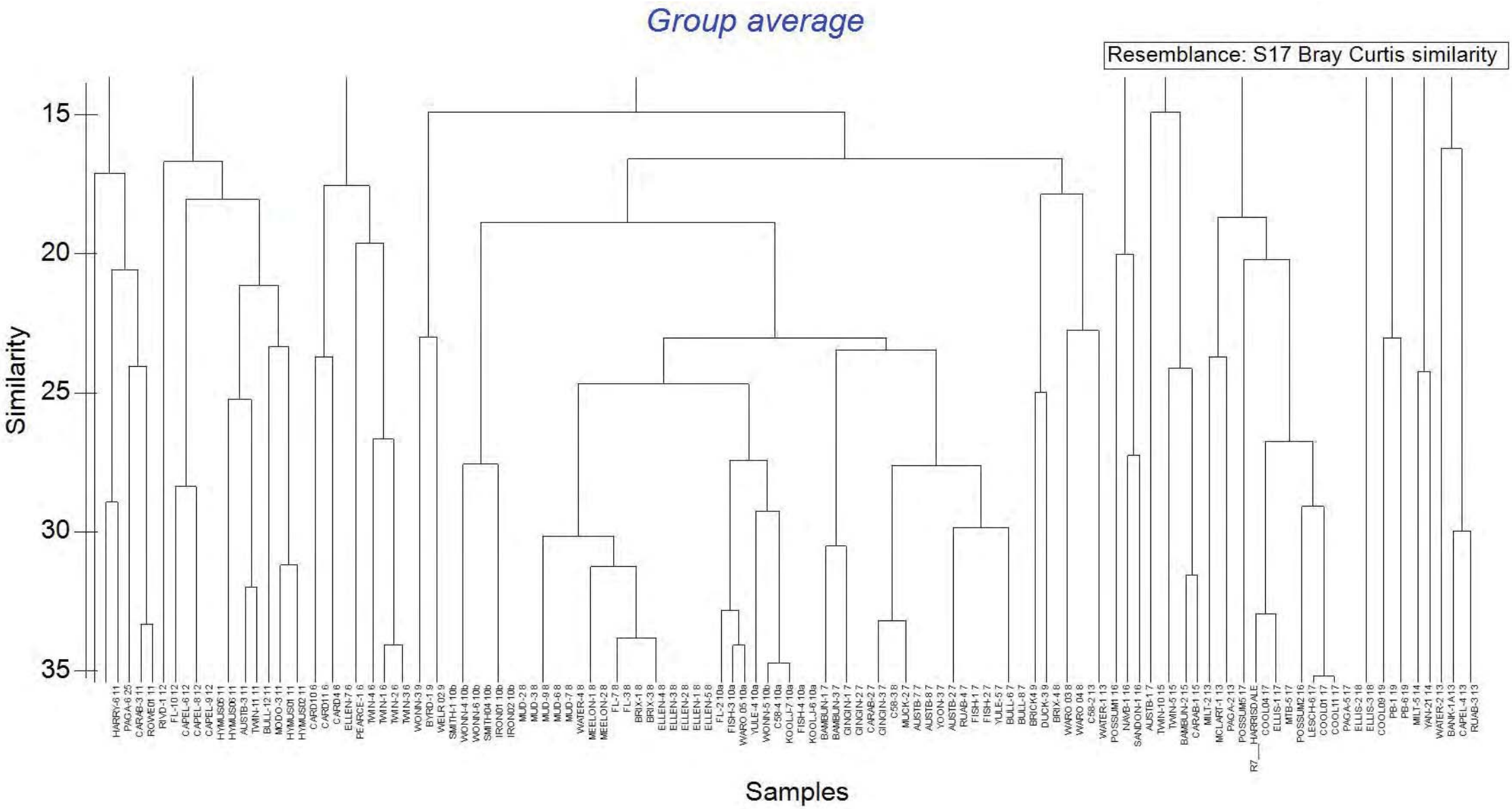

Group average
Resemblance: S17 Bray Curtis similarity
Similarity
35
40
45
Samples
BRIX-2 3a
BRIX-5 3a
MUD-4 3a
MUD-5 3a
TALB1 3c
TALB12 3c
TALB13 3c
PEARCE-2 3c
TALB4 3c
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
PAYNE-1 4
WILL03 10b
WILL-1 10b
FISH-5 2
AMBR-5 2
AMBR-2 2
AMBR-7 2
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
RIVD-1 12
MELA-1 4
KOOLJ-1 4
q2__HARRISDALE
YARL02 9
MANEA-1 9
WELR 01 9
AUSTB-5 5
PAGA-3 5
PAGA-1 5
LOW08 5
LOW09A 5
LOW09B 5
PLINE-4 4
WHITE-2 4
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWE02 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
POSSUM1 16
NAVB-1 16
POSSUM2 16
SANDON-1 16
AUSTB-1 7
TWIN-10 15
TWIN-5 15
BAMBUN-2 15
CARAB-1 15
POSSUM5 17
COOL04 17
ELLIS-1 17
MTB-5 17
LESCH-6 17
COOL01 17
COOL11 17
PAGA-5 17
MILT-2 13
MCLART-1 13

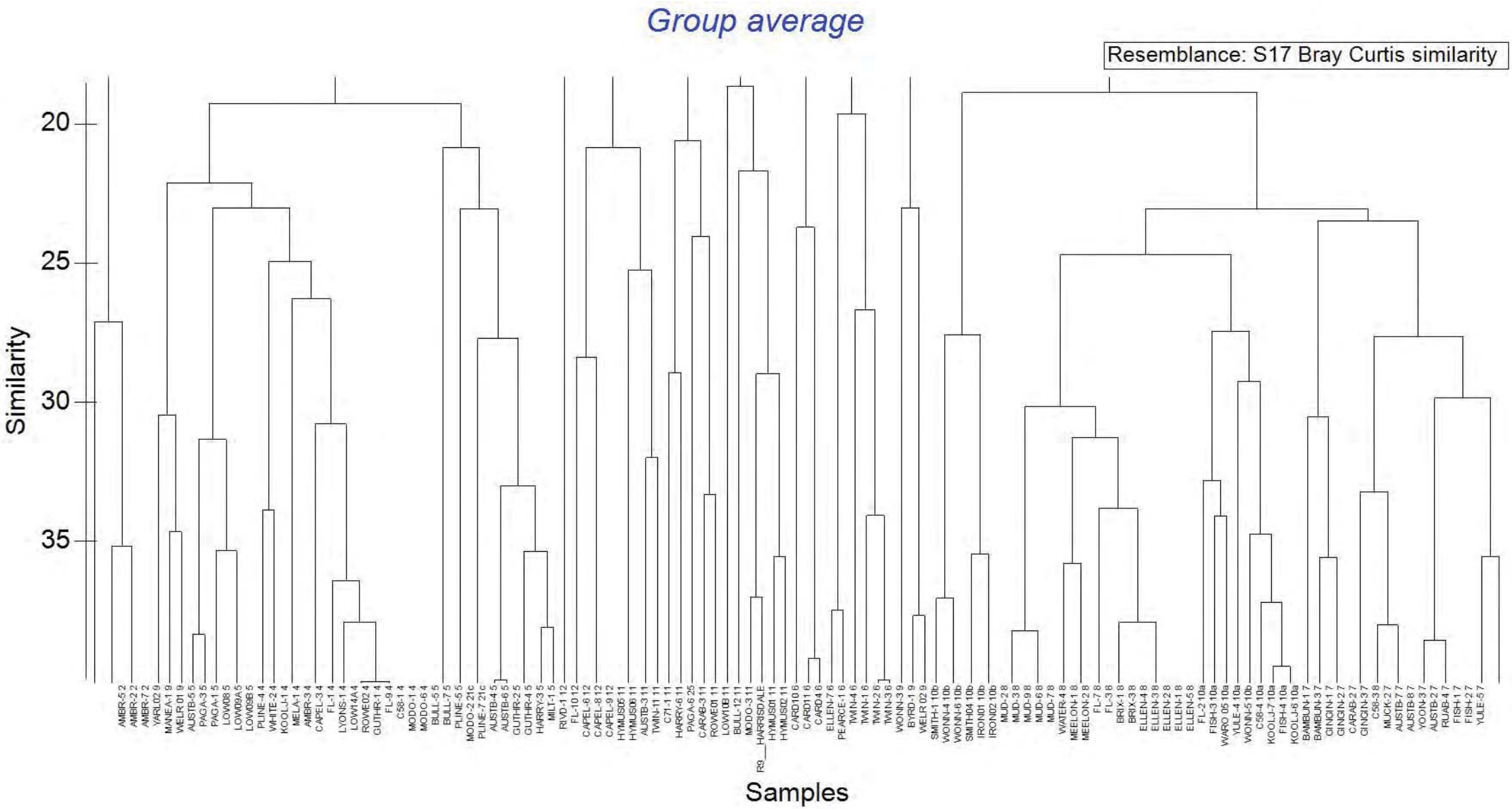

Group average
Resemblance: S17 Bray Curtis similarity
Similarity
30
35
40
45
Samples
PAGA-4 21a
PAGA-7 21a
HARRY-5 21a
WELL-2 21a
NEER-23 28
NEER-22 28
NEER-20 28
NEER-21 28
NEER-2 28
NEER-6 28
WOODV-1 28
WOODV-2 28
DEPOT-1 28
NEER-5 28
YAN-3 28
NEER-3 28
NEER-4 28
TRIG-4 28
KING-1 28
KING-2 28
WARI-1 28
WARI-2 28
SHENT-1 28
TRIG-3 28
TRIG-6 24
NEER-1 24
NEER-11 24
PEPB-1 30b
C71-4 25
MINN-1 25
MINN-2 25
MEAL-2 26b
YALG-2 26b
YALG-6 26b
YALG-7 26b
WHILL-5 26b
YALG-1 26b
PAGA-8 25
MEAL-1 25
MYALUP-2 25
CORON-2 25
KEME-1 25
LYONS-2 25
MINN-3 25
FL-4 21a
BULLER-3 21c
KEME-3 21c
LOW01 21c
LOW06A 21c
LOW04 21a
LOW06B 21c
LOW07 21c
LOW13A 21a
LOW10A 21a
LOW12A 21a
LOW12B 21a
HARRISDALE
MILF-6 21a
PLINE-3 21a
KOOLJ-2 21a
KOOLJ-3 21a
KOOLJ-4 21a
MANEA-2 21a
CARB-3 21b
RIVD-2 21a
CORON-1 21a
NINE-2 21a
MANEA-3 21b
CAPEL-2 21b
RUAB-1 21b
RUAB-2 21b
KELLY02 21b
CAPEL-1 21b
GIBSON01 21b
GUTHR-6 21a
DARD02 21b
BOYAN01 21b
BUFFER01 21b
REDL-1 21a
KEME-2 21a
CLIF-1 21a
GUTHR-5 21a
GUTHR-3 21a
CRAMPT-1 21a
CRAMPT-2 21a
CAPEL-7 21a
DRAIN-1 21a
C71-2 21a
C71-3 21a
AUSTRA-1 21a
BULLER-2 21a
NINE-1 21a
BULLER-1 21a
CARD7 21a
BANK-1 22
DEJONG-A22
MELA-5 22
MPK02 22
MELA-10 22
WARB-2 22
WARB-4 22
WAND-1 23a
HARRY-4 23a
BANK-323a
MODO-5 23a
HURST01 23a
HURST02 23a
HURST04 23a
MELA-9 23b
WARB-3 23a
WIRR-2 23a
WARB-1 23a
WIRR-1 23a
BULL-3 23a
WHITE-1 23a
BANK-2 23a
YULE-1 23a
YULE-2 23a

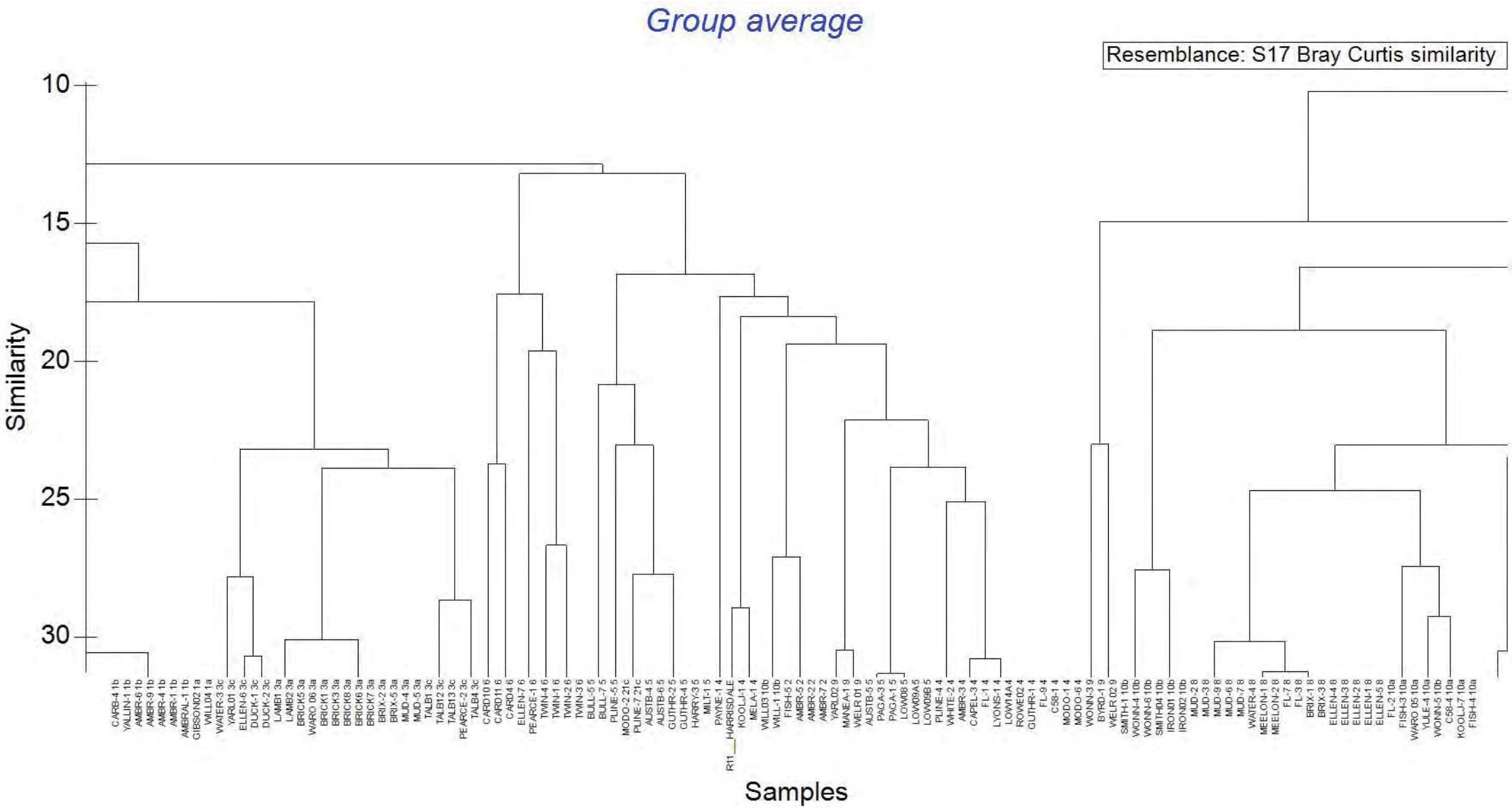

Group average
Resemblance: S17 Bray Curtis similarity
Similarity
40
45
50
55
Samples
BRICK3 3a
BRICK8 3a
BRICK6 3a
BRICK7 3a
BRIX-2 3a
BRIX-5 3a
MUD-4 3a
MUD-5 3a
TALB1 3c
TALB12 3c
TALB13 3c
PEARCE-2 3c
TALB4 3c
PAYNE-1 4
WILL03 10b
WILL-1 10b
FISH-5 2
AMBR-5 2
AMBR-2 2
AMBR-7 2
YARL02 9
MANEA-1 9
WELR 01 9
AUSTB-5 5
PAGA-3 5
PAGA-1 5
LOW08 5
LOW09A 5
LOW09B 5
PLINE-4 4
WHITE-2 4
KOOLI-1 4
MELA-1 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWE02 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
AMBR-3 4
CAPEL-3 4
q4___HARRISDALE
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
LOW10B 11
C71-1 11
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWE01 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
25
30
35
40
Samples
AUSTB-1 7
BAMBUN-2 15
CARAB-1 15
POSSUM1 16
NAVB-1 16
POSSUM2 16
SANDON-1 16
POSSUM5 17
COOL04 17
ELLIS-1 17
MTB-5 17
LESCH-6 17
COOLD1 17
COOL11 17
PAGA-5 17
MILT-2 13
MCLART-1 13
PAGA-2 13
WATER-2 13
TWIN-5 15
TWIN-10 15
R5___HARRISDALE
BANK-1 A13
CAPEL-4 13
RUAB-3 13
MILT-5 14
YAN-21 14
WOODP-1 30a
LOWT0B 11
C71-1 11
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWED1 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK4 9
DUCK-3 9
BRIX-4 8
WARO 03 8
WARO 04 8
C58-2 13
WATER-1 13
PLINE-6 22
YAN-18 22


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
20
25
30
35
Samples
D/ARD03 1a
KEMP01 1a
WCHER01 1a
ACTON-1 1a
SMITH02 1a
SMITH03 1a
WONN01 1a
CARB-1 1b
CARB-4 1b
YALLIN-1 1b
AMBR-6 1b
AMBR-9 1b
AMBR-4 1b
AMBR-1 1b
AMBRAL-1 1b
GIBSON02 1a
WILL04 1a
WATER-3 3c
YARL01 3c
ELLEN-6 3c
DUCK-1 3c
DUCK-2 3c
LAMB1 3a
LAMB2 3a
BRICK5 3a
WARO 06 3a
BRICK1 3a
BRICK3 3a
BRICK8 3a
BRICK6 3a
BRICK7 3a
BRIX-2 3a
BRIX-5 3a
MUD-4 3a
MUD-5 3a
TALB1 3c
TALB12 3c
TALB13 3c
PEARCE-2 3c
TALB4 3c
PAYNE-1 4
WILL03 10b
WILL-1 10b
FISH-5 2
AMBR-5 2
AMBR-2 2
AMBR-7 2
YARL02 9
MANEA-1 9
WELR 01 9
AUSTB-5 5
PAGA-3 5
PAGA-1 5
LOW08 5
LOW09A 5
LOW09B 5
HARRISDALE
PLINE-4 4
WHITE-2 4
KOOLJ-1 4
MELA-1 4
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWE02 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
LOW10B 11
C71-1 11
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWE01 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
WONN-5 10b
SMITH04 10b


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
15
20
25
30
35
Samples
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWE01 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK4 9
DUCK-3 9
BRIX-4 8
WARO 03 8
WARO 04 8
C58-2 13
WATER-1 13
POSSUM1 16
NAVB-1 16
SANDON-1 16
AUSTB-1 7
TWIN-10 15
TWIN-5 15
BAMBUN-2 15
CARAB-1 15
MILT-2 13
MCLART-1 13
PAGA-2 13
POSSUM5 17
R7___HARRISDALE
COOL04 17
ELLIS-1 17
MTB-5 17
POSSUM2 16
LESCH-6 17
COOL01 17
COOL11 17
PAGA-5 17
ELLIS-2 18
ELLIS-3 18
COOL09 19
PB-1 19
PB-6 19
MILT-5 14
YAN-21 14
WATER-2 13
BANK-1 A13
CAPEL-4 13
RUAB-3 13


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
20
25
30
35
Samples
AMBR-5 2
AMBR-2 2
AMBR-7 2
YARL02 9
MANEA-1 9
WELR 01 9
AUSTB-5 5
PAGA-3 5
PAGA-1 5
LOW08 5
LOW09A 5
LOW09B 5
PLINE-4 4
WHITE-2 4
KOOLJ-1 4
MELA-1 4
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWE02 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
C71-1 11
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWE01 11
LOW10B 11
BULL-12 11
MODO-3 11
R9
HARRISDALE
HYMUS01 11
HYMUS02 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-8 10b
SMITH04 10b
IRONI01 10b
IRONI02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WAPO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
10
15
20
25
30
Samples
CARB-4 1b
YALLIN-1 1b
AMBR-6 1b
AMBR-9 1b
AMBR-4 1b
AMBR-1 1b
AMBRAL-1 1b
GIBSON02 1a
WILL04 1a
WATER-3 3c
YARL01 3c
ELLEN-6 3c
DUCK-1 3c
DUCK-2 3c
LAMB1 3a
LAMB2 3a
BRICK5 3a
WARO 06 3a
BRICK1 3a
BRICK3 3a
BRICK8 3a
BRICK6 3a
BRICK7 3a
BRIX-2 3a
BRIX-5 3a
MUD-4 3a
MUD-5 3a
TALB1 3c
TALB12 3c
TALB13 3c
PEARCE-2 3c
TALB4 3c
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILI-1 5
PAYNE-1 4
R11
HARRISDALE
KOOLI-1 4
MELA-1 4
WILL03 10b
WILL-1 10b
FISH-5 2
AMBR-5 2
AMBR-2 2
AMBR-7 2
YARL02 9
MANEA-1 9
WELR 01 9
AUSTB-5 5
PAGA-3 5
PAGA-1 5
LOW08 5
LOW09A 5
LOW09B 5
PLINE-4 4
WHITE-2 4
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOWY14A 4
ROWE02 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLI-7 10a
FISH-4 10a

Appendix C

Fauna and Detailed Black Cockatoo Assessment – Lots 600 - 606 Balannup Road and 200-202 Skeet Road, Harrisdale (Emerge Associates 2021)

Basic Fauna and Targeted Black Cockatoo Assessment

Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Project No: EP20-127(03)

Prepared for Yolk Property Group Pty Ltd
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Executive Summary

Emerge Associates (Emerge) were engaged to conduct a 'basic' fauna and a 'targeted' black cockatoo assessment for Lots 600 - 606 Balannup Road and Lots 200 - 202 Skeet Road, Harrisdale (referred to herein as 'the site'). The purpose of this assessment was to provide technical documentation to support the future development of the site for residential purposes.

As part of the assessment a desktop assessment of relevant background information was completed and a field survey was undertaken on 4 December 2020. During the field survey an assessment was made on the fauna habitat within the site and its suitability to provide habitat for conservation significant fauna. A targeted black cockatoo survey was also undertaken to determine the presence of habitat for threatened black cockatoo species.

Outcomes of the basic fauna survey include the following:

- The majority of the site has been impacted by historical clearing, with approximately half of the site (14.94 ha) supporting predominantly cleared areas with native vegetation.
- Seven fauna habitats were identified within the site, with the highest value habitat being in the south western portion due to the presence of relatively intact native vegetation.
- A total of 18 native fauna species were positively identified to occur within the site, including one conservation significant species, quenda (P4).
- A further 15 species of conservation significance not recorded during the field survey are considered to have potential to occur within the site. These species would primarily be associated with the **banksia woodland** habitat, and to a lesser extent, waterbody habitats, if they occur at all. Targeted surveys would need to be undertaken to confirm whether these species occur within the site.

Outcomes of the targeted black cockatoo survey include the following:

- The site is located within the modeled distribution of all three species of threatened black cockatoo and within the breeding range of forest red-tailed black cockatoo.
- No evidence of black cockatoos was recorded during the survey.
- All three species of black cockatoo may utilise the site due to the presence of suitable habitat and the records within the broader area.
- Six habitat trees were recorded in the site but none contained suitable hollows for breeding by black cockatoos. Therefore, the site is not considered to currently provide suitable breeding habitat for black cockatoos.
- No evidence of black cockatoo roosting activity was observed within the site. Potential roosting habitat that is suitable for all three species of black cockatoo occurs within the site in the form of tall native and non-native trees.
- Foraging habitat for all three species of black cockatoo was mapped within the site, primarily within the southern portion.
- A total of 1.95 ha of primary foraging habitat for Carnaby's cockatoo, less than 0.01 ha for Baudin's cockatoo and 0.09 ha for forest red-tailed black cockatoo was mapped within the site. The site also contains secondary foraging habitat for all three species of black cockatoo.

Extensive areas of additional remnant native vegetation that may provide foraging habitat for all three species of black cockatoo occur adjacent to and in the wider area of the site.

- The overall habitat score was determined to be three (low) for Carnaby's cockatoo, two (low) for Baudin's and four (moderate) for forest red-tailed black cockatoo. The site scored highest for the breeding habitat component for forest red-tailed black cockatoos due to the presence of potential habitat trees, albeit without hollows, and the presence of foraging habitat within the broader area.

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
BoM	Bureau of Meteorology
CoA	City of Armadale
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DPaW	Department of Parks and Wildlife (now DBCA)
DAWE	Department of Agriculture, Water and the Environment
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environmental Regulation
WA Museum	Western Australian Museum

Table A2: Abbreviations – General terms

General terms	
AHD	Australian height datum
EN	Endangered
EX	Extinct
IA	International Agreement
MI	Migratory
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
VU	Vulnerable

Table A3: Abbreviations –Legislation

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

Table A4: Abbreviations – planning

Planning terms	
MRS	Metropolitan Region Scheme

Table A5: Abbreviations – units of measurement

Units of measurement	
DBH	Diameter at breast height
cm	Centimetre
ha	Hectare
km	Kilometre
m	Metre

1 Introduction

1.1 Project background

Lots 600 - 606 Balannup Road and Lots 200 - 202 Skeet Road, Harrisdale are proposed to be developed for residential purposes. These lots (referred to herein as 'the site') are located approximately 20 kilometres (km) south of the Perth Central Business District within the City of Armadale.

The site is approximately 29.29 hectares (ha) in size and is bound by Ranford Road to the north east, Skeet Road to the south east, Balannup Road to the north west and vacant land associated with the easement for the future continuation of Reilly Road to the south west. The location and extent of the site is shown in **Figure 1**.

1.2 Purpose and scope of work

Emerge Associates (Emerge) were engaged to provide sufficient information on the fauna values within the site to support the future development of the site for residential purposes, with particular focus on identifying habitat for threatened species of black cockatoo.

The scope of work was specifically to conduct a terrestrial vertebrate fauna assessment to the standard required of a 'basic' fauna survey and a 'targeted' black cockatoo survey in accordance with the Environmental Protection Authority's (EPA's) technical guidance (EPA 2020) and the *Environment Protection and Biodiversity Conservation Act* black cockatoo referral guidelines (DSEWPaC 2012).

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

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

2 Environmental Context

2.1 Climate

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

A total of 5 mm of rainfall was recorded in December 2020 prior to the field survey from the Forrestdale weather station (Bureau of Meteorology (BoM)) weather station number 9257), which is the closest weather station, located approximately 3.6 km south of the site. This is lower than the average rainfall of 13.8 mm for December recorded from the same weather station (BoM 2021).

Temperatures at the Jandakot Aero weather station BoM weather station number 9172, which is the closest temperature recording weather station, ranged from a mean maximum of 31.6^{o}C to a mean minimum of 16.2^{o}C in December 2020 (BoM 2021). These temperatures are slightly higher than the average maximum temperature of 29.3^{o}C and average minimum temperature of 14.8^{o}C recorded at the Jandakot Aero weather station from 1989-2020 (BoM 2021).

2.2 Geomorphology and soils

Landform and soils influence fauna habitat and species at regional and local scales. The site occurs on the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan area.

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

The Department of Primary Industries and Regional Development (DPIRD) has compiled data from various surveys to produce a soil landscape mapping dataset for Western Australia (DPIRD 2018), which places the site within the following three soil landscapes:

- ‘Bassendean B1 phase’ which occurs over the western portion of the site and is described as ‘extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than 2 m; banksia dominant.’
- ‘Bassendean B3 phase’ which occurs in a localised portion in the east of the site and is described as ‘closed depressions and poorly defined stream channels with moderately deep, poorly to very poorly drained bleached sands with an iron-organic pan, or clay subsoil. Surfaces are dark grey sand or sandy loam.’

- 'Bassendean B4 phase' which occurs over the eastern portion of the site and is described as 'broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depths generally greater than 1.5 m by clay or less frequently a strong iron-organic hardpan.'

The soil types mapped within the site are shown in **Figure 3**.

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

2.3 Topography

The elevation of the site ranges from 21 m in relation to the Australian height datum (m AHD) in the northern portion of the site, associated with a wetland feature, to 23 m AHD on the western side of the site (DoW 2008) (**Figure 3**). The site is predominantly flat, located at the 22 m AHD elevation.

2.4 Hydrology and wetlands

Wetlands include "areas of seasonally, intermittently or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh and saline, e.g. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries" (Wetlands Advisory Committee 1977). Many wetlands provide important fauna habitat and support high levels of fauna biodiversity and endemism.

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

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

No Ramsar or listed 'important wetlands' are located within or near the site. The Ramsar site 'Forrestdale and Thomsons Lakes' (ID 246) is located 3.2 km south of the site.

A review of aerial imagery indicates that there are three surface water features within the site, two wetlands located within the northern portion of the site (Lot 600 and 601 Balannup Road), with one wetland located in the central portion of the site (Lot 201). The wetland located within Lot 601 retains water year-round, whilst the other two wetlands dry out over the summer months.

On the Swan Coastal Plain the Department of Biodiversity, Conservation and Attractions (DBCA) have used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence (hydro-period) (DBCA 2017c). DBCA maintains the *Geomorphic Wetlands of the Swan Coastal Plain* dataset which further categorises geomorphic wetland features into specific wetland types and management categories to guide land use and conservation (DBCA 2020). Note that as this dataset was drafted at a regional scale the boundaries of mapped wetland features are often inconsistent with physical wetland boundaries.

A review of the *Geomorphic Wetlands of the Swan Coastal Plain* dataset indicates that the entire site is mapped as comprising geomorphic wetlands (DBCA 2020). One 'conservation' category sumpland, UFI 14880, occurs in a small area in the south-eastern portion of the site and extends across Skeet Road to the south east of the site. One 'resource enhancement' sumpland, UFI 15946, exists within Lot 600 and extends into Balannup Road. Two 'multiple use' category damplands, UFI 14879 and UFI 13347, wetlands are present within the western half of the site and one 'multiple use' sumpland, UFI 14404, is present over the eastern half of the site. The locations of the geomorphic wetlands in the vicinity of site are shown in **Figure 3**.

2.5 Regional vegetation

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

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

Variations in native vegetation within the site can be further classified based on regional vegetation associations. Heddle *et al.* (1980) mapping shows the site as comprising the 'Southern River Complex', which is described as comprising open woodland of *Corymbia calophylla - Eucalyptus marginata - Banksia* spp. with fringing woodland of *Eucalyptus rudis - Melaleuca rhaphiophylla* along creek beds.

2.6 Historic land use

Review of historical images available from 1953 (WALIA 2021) onwards shows that the site was uncleared in 1953 and the eastern half of the site was part of a large wetland. By 1961 multiple roads are present surrounding the site and by 1965 an easement across portions of Lots 604 - 606 can be seen. By 1974 Lots 201 and 202 were cleared and a large body of water is present across these lots. By 1977 Lot 200 was almost entirely cleared, with the exception of the south east corner.

Between 1965 and 1989 various small-scale clearing events are visible across Lots 604-606 and Lot 601 is entirely cleared. Between 1987 and 1989 buildings including a poultry farm were constructed in Lot 202. By 1989 much of Lot 600 and half of 602 was cleared. In 1991 a large fire scar is visible over the western portion of the site. Since 2008 most of the site has been subject to limited clearing, and areas of regrowth of native vegetation are visible, particularly in Lots 200, 600 and 604 - 606.

2.7 Significant fauna

2.7.1 Threatened fauna species

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

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

Threatened fauna species listed under the EPBC Act and/or BC Act are assigned a conservation status according to attributes such as population size and geographic distribution. Further information on threatened species and their categories is provided in **Appendix A**. An assessment of the likelihood of occurrence of conservation significant fauna within the site was undertaken (refer to **Sections 3.3.3** and **4.3.3** and **Appendix E**).

2.7.1.1 Black cockatoos

Three threatened species of black cockatoo occur on the Swan Coastal Plain (referred to herein collectively as 'black cockatoos'):

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

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

- Black cockatoos nest in hollows that form in trees which are usually more than ~200 years old. 'Breeding habitat' is therefore described as 'habitat trees' which are trees of a species known to support black cockatoo breeding and which either have a suitably large enough nest hollow or have a large enough diameter at breast height (DBH) to indicate that a suitable nest hollow could develop in time (DSEWPaC 2012). A minimum DBH for a habitat trees is defined as ≥50 centimetres (cm) for most tree species used by black cockatoos and ≥30 cm for *Eucalyptus wandoo* (wandoo) and *Eucalyptus salmonophloia* (salmon gum) (DSEWPaC 2012). Breeding habitat is also generally expected to be located within 7 km of food and water resources (Saunders 1990).
- 'Roosting habitat' consists of groups or individual tall trees that are used by black cockatoos for roosting during the day or overnight. Roosts generally comprise the tallest trees in an area and can include native and non-native trees (DSEWPaC 2012). Roosts are often located within 6 km of water and food resources, with additional foraging ranges within 12 km (Shah 2006; DSEWPaC

2012; Le Roux 2017). The use of a particular roost site may vary depending on availability of food and water resources.

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

Each black cockatoo species has a defined breeding season, with Baudin's cockatoo breeding from August/September to February/March and Carnaby's cockatoo breeding from July/August to January/February (DSEWPaC 2012). Forest red-tailed black cockatoo breeds in October/November but may breed in March/April if there is good autumn rainfall (DSEWPaC 2012). There is also evidence that forest red-tail black cockatoos breed throughout the year, with peaks in April – June and August – October (Johnstone *et al.* 2013).

Publicly available regional datasets relating to black cockatoo distribution, records and extent of habitat types were reviewed in relation to the site and surrounding area, as summarised in **Table 1**, **Table 2** and **Table 3**, and shown in **Figure 5.** Detailed information on each dataset considered as part of the desktop review is provided in **Appendix A**.

Table 1: Summary of black cockatoo background review

Category		Site context	Source
Species distribution		• Site is located within the modelled distribution of Baudin's cockatoo, but not within its known or predicted breeding range. • Site is within the modelled distribution of Carnaby's cockatoo, but not within its predicted breeding range. • Site is within the modelled distribution for forest red-tailed black cockatoo and within its known breeding range.	(DoEE 2016a, c, b)
Breeding sites		• No nesting records occur within the site. • Two confirmed forest red-tailed black cockatoo nesting locations occur within 12 km of the site. One is a natural hollow within Cockburn where a nest was recorded in 2020, with the other is an artificial hollow in Murdoch, where nesting was last confirmed in 2013.	BirdLife Australia database search (2020)
Carnaby's cockatoo breeding areas (12 km radius surrounding breeding sites)		• One confirmed breeding area intersects the site. • One possible breeding area intersects the site.	(Glossop *et al.* 2011)
Important bird areas for Carnaby's cockatoo		• None within the site. • None within 12 km of the site.	DPaW (2013)
Roost site		• None within the site. • 41 roost sites within 12 km of the site (see **Table 2** and **Table 3**): o 15 associated with white-tailed^ black cockatoos o 12 associated with forest red-tailed black cockatoos o 14 associated with white^ and red-tailed black cockatoos	BirdLife Australia database search (2020)
Foraging habitat	White-tailed black cockatoo^	• Potential native foraging habitat mapped within the south-western and north-western portions of the site. • Extensive areas of potential native foraging habitat mapped within the wider local area of the site, including within Bush Forever sites to the west and immediate south-east of the site.	(Emerge Associates 2020a)

Table 1: Summary of black cockatoo background review (continued)

Category		Site context	Source
	White-tailed black cockatoo^	• No pine plantations mapped within the site or within 12 km.	(Forest Products Commission 2020)
	Forest red-tailed black cockatoo	• Potential native foraging habitat mapped within the south-western and north-western portions of the site. • Extensive areas of potential native foraging habitat mapped within the wider local area of the site, including within Bush Forever sites to the west and immediate south-east of the site.	(Emerge Associates 2020b)

^Carnaby's and/or Baudin's cockatoo

Table 2: Number of white-tailed black cockatoos recorded in roosts within 12 km of the site (Birdlife Australia 2021)

Roost ID	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
ARMFORR001	NS	NS	NS	0	0	18	0	0	NS	0
ARMHARR001	NS	0	0	NS	0	1	3	0	0	0
ARMKELR001	14	0	0	0	0	NS	NS	NS	0	0
ARMKELR002	0	10	NS	0	0	0	0	0	0	NS
ARMROLR003	NS	0	0	50	0	0	0	0	0	0
ARMROLR004	NS	NS	NS	NS	0	NS	28	0	0	0
CANFERR001	NS	NS	NS	5	0	0	0	0	0	NS
CANWILR001	0	0	0	0	68	0	0	0	0	0
COCBANR001	NS	NS	NS	NS	NS	45	NS	0	20	0
COCBANR002	NS	NS	NS	NS	53	NS	0	0	0	0
COCBANR003	NS	NS	NS	NS	NS	NS	NS	6	16	0
COCSCCR001	252	0	NS	NS	NS	NS	NS	NS	NS	NS
COCSCCR002	15	3	NS	NS	NS	NS	NS	NS	NS	NS
GOSCNVR001	0	19	NS	NS	0	0	0	0	NS	80
GOSCNVR002	NS	NS	26	52	0	0	151	0	0	0
GOSMARR001	NS	NS	NS	NS	NS	NS	NS	0	120	36
GOSSOUR002	NS	NS	NS	NS	NS	NS	50	0	0	0
KWIWANR001	63	0	0	1	0	0	0	0	0	NS

Table 2: Number of white-tailed black cockatoos recorded in roosts within 12 km of the site (Birdlife Australia 2021) (continued)

Roost ID	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
KWIWANR002	NS	NS	NS	0	0	0	0	5	0	0
KWIWANR004	NS	NS	NS	NS	NS	NS	NS	73	0	0
MELBATR001	8	0	0	0	0	0	0	0	0	0
MELLEER001	0	0	12	0	70	0	0	0	15	2
MELMURR001	700	60	142	127	234	24	78	0	227	249
SERDARR001	NS	NS	NS	NS	NS	NS	8	0	0	0
SEROAKR004	45	3	0	0	50	0	26	2	33	NS
SEROAKR005	31	0	.	0	0	0	0	0	0	NS
SEROAKR007	NS	NS	NS	NS	NS	NS	NS	2	0	NS

NS = not surveyed

Table 3: Number of forest red-tailed black cockatoos recorded in roosts within 12 km of the site (Birdlife Australia 2021)

Roost ID	Year					
	2014	2015	2016	2017	2018	2019
ARMARMR002	NS	NS	17	NS	15	0
ARMARMR004	NS	NS	NS	0	6	4
ARMASHR001	NS	NS	NS	3	NS	NS
ARMBEDR001	21	0	0	0	0	13
ARMBEDR006	NS	NS	NS	14	14	15
ARMCHAR001	NS	NS	NS	11	16	0
ARMKELR004	NS	NS	NS	NS	NS	6
ARMROLR003	0	0	0	4	0	0
ARMROLR004	0	NS	35	0	0	50
CANRIVR001	NS	NS	6	11	7	16
CANROSR001	NS	NS	0	0	14	2
CANWILR001	4	7	7	5	16	82

Table 3: Number of forest red-tailed black cockatoos recorded in roosts within 12 km of the site (Birdlife Australia 2021) (continued)

Roost ID	Year					
	2014	2015	2016	2017	2018	2019
COCBANR001	NS	0	NS	6	17	0
COCBANR002	3	NS	32	24	109	15
COCCOCR001	NS	NS	NS	NS	15	102
GOSCNVR001	2	0	0	0	NS	0
GOSCNVR002	0	4	0	0	0	0
GOSGOSR004	19	NS	31	32	79	0
GOSKENR001	NS	NS	NS	51	334	35
GOSKENR002	NS	NS	NS	NS	72	0
GOSMARR001	NS	NS	NS	75	37	18
GOSSOUR002	NS	NS	0	36	208	15
MELLEER001	0	0	11	25	5	0
MELMURR001	199	33	125	209	441	214
SERBYFR003	NS	NS	6	NS	0	NS
SERDARR001	NS	NS	26	0	24	0

NS = not surveyed

2.7.2 Priority fauna species

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

2.7.3 Migratory fauna species

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

2.7.4 Specially protected fauna species

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

2.7.5 Pest fauna species

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

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

2.8 Bush Forever

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

No *Bush Forever* sites are present within the site. *Bush Forever* Site 413 (Balannup Lake and Adjacent Bushland, Southern River/Forestdale) is present to the north east of the site. *Bush Forever* Site 342 (Anstey/Keane Dampland and Adjacent Bushland, Forestdale) is present to the south-east of the site. The location of *Bush Forever* Sites 413 and 342 are shown in **Figure 4**.

2.9 Environmentally sensitive areas

'Environmentally sensitive areas' (ESAs) are prescribed under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* and have been identified to protect native vegetation values of areas surrounding values such as significant wetlands, threatened flora, threatened communities and *Bush Forever* sites. Within an ESA none of the exemptions under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* apply. However, exemptions under Schedule 6 of the EP Act still apply, which includes any clearing in accordance with a subdivision approval under the *Planning and Development Act 2005* (a recognised exemption under the Schedule 6 of the EP Act).

An ESA is present over the entirety of the site. The location of this ESA is shown in **Figure 4**.

2.10 DBCA managed or legislated lands

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

No DBCA legislated lands or water occur within the site. Balannup Lake Nature Reserve is located to the immediate north of the site, whilst freehold land managed by DBCA is located to the immediate north-east of the site. The location of the DBCA managed lands is shown in **Figure 4**.

2.11 Ecological linkages

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

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

No ecological linkages are present in close proximity to the site.

2.12 Previous surveys

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

3 Methods

3.1 Desktop assessment

A search was conducted for fauna species that have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020), *NatureMap* (DBCA 2021), DBCA's conservation significant fauna database (reference no. FAUNA6492) and literature references.

3.2 Field survey

Four ecologists from Emerge visited the site on the 4 December 2020 during the day to conduct the basic fauna survey and targeted black cockatoo field survey. The survey was conducted from approximately 10:30 AM until 3:30 PM.

3.2.1 Basic fauna

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

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

3.2.2 Targeted black cockatoo

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

3.2.2.1 Breeding habitat

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

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

- have an entrance opening of at least 10 cm but preferably 20-30 cm (Saunders *et al.* 1982; Groom 2010; Johnstone *et al.* 2013) (Groom 2010; Saunders et al. 1982; Johnstone et al 2013)
- be located at least 3 m from the ground (Saunders 1979b; Johnstone and Storr 1998; Groom 2010; Saunders 2014)

- be located in a trunk or branch that is generally large enough to contain a hollow that has a floor diameter of at least 40 cm and depth of 50-200 cm such that it could house an adult black cockatoo and nestlings (Saunders 1979a; Johnstone and Storr 1998; Saunders 2014; DPaW 2015)
- have vertical or near vertical orientation (Johnstone and Kirkby 2008; Johnstone *et al.* 2013).

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

Habitat trees were individually identified, tagged and the attributes outlined in **Table 4** were recorded for each tree.

Table 4: Attributes recorded for each habitat tree in the site

Attribute	Description
Tag	Unique identifier on a metal tag was nailed to each habitat tree
Image	Each habitat tree was individually photographed
GPS location	The location of each habitat tree was recorded using a handheld GPS unit
Tree species	Species and common name were identified
Diameter at breast height (DBH) (cm)	DBH was measured at breast height (1.3 metres) using a diameter tape
Hollows potentially suitable for breeding by a black cockatoo	Number of hollows potentially suitable for breeding by a black cockatoo (assessed from ground level only)

Hollows that appeared potentially suitable for use by a black cockatoo from the ground were further inspected using a drone and/or a pole-mounted camera. During the hollow inspection the internal dimensions of the hollow were confirmed, if possible, and an assessment was made for signs of use such as chew marks around the hollow entrance, nesting material, feathers or the presence of birds within the hollow.

All recorded habitat trees were assigned to a category listed in **Table 5**.

Table 5: Habitat tree categories

Category	Specifications
Nest	The tree contains a hollow used by black cockatoos for breeding as confirmed by records of black cockatoos, their eggs or fledglings or other evidence of recent nesting activity by black cockatoos
Potential nest	The tree contains one or more hollows that are suitable for use by black cockatoos as breeding habitat as confirmed by internal hollow inspection^ and evidence of use by an unidentified bird such as feathers, chew marks or nest material has been recorded within a hollow
Suitable hollow(s)	The tree contains one or more hollows that are suitable for use by black cockatoos as breeding habitat as confirmed by internal hollow inspection^

Table 5: Habitat tree categories (continued)

Category	Specifications
Potentially suitable hollow(s)	The tree contains or is suspected to contain one or more hollows that have the potential to be suitable for use by black cockatoos when either viewed from the ground or following an internal hollow inspection that was inconclusive^
No suitable hollow(s)	The tree does not contain hollow(s) that have the potential to be suitable for use by black cockatoos when viewed from the ground or contains hollows that were determined to be unsuitable for use by black cockatoos by internal inspection^

^Hollow determined to be suitable for use as breeding habitat by black cockatoos as listed above in **Section 3.1.1**.

3.2.2.2 Roosting habitat

The site was assessed for the presence of active or historical roosts and its potential to provide roosting habitat for black cockatoos. Groups of large native and non-native trees were generally assumed to provide potential roosting habitat.

No evening roost survey was undertaken within the site. The site was searched during the daytime survey for secondary evidence of roosting activity, such as branch clippings, droppings or moulted feathers.

3.2.2.3 Foraging habitat

Foraging habitat was identified by comparing the literature on plant species known to be foraged upon by black cockatoos (Davies 1966; Saunders 1980; Johnstone and Storr 1998; Johnstone and Kirkby 1999; Groom 2011; Johnstone *et al.* 2011; DSEWPaC 2012) against the vegetation within the site.

Foraging habitat was then further classified as primary or secondary foraging habitat. Primary foraging plants were defined as those with historical and contemporary records of regular consumption by black cockatoos. Secondary foraging plants were defined as plants that black cockatoos have been recorded consuming occasionally or that, based on their limited extent or agricultural origin, should not be considered a sustaining resource. Each patch of foraging habitat was assigned a percentage cover of primary and secondary foraging plants. Where plants that had no foraging value occurred amongst foraging plants, they were also assigned a cover value if practicable. A list of plant species classified as primary or secondary foraging plants is provided as **Appendix B.**

Secondary evidence of black cockatoo foraging, such as chewed marri, jarrah, tuart or banksia fruits, was searched for within the site and allocated to a species where possible. The locations of black cockatoo foraging evidence within the site were mapped using a hand-held GPS unit.

3.3 Data analysis, presentation and mapping

3.3.1 Desktop assessment

A total number of species within the desktop assessment search area was calculated by adding the total count of non-conservation significant species provided by *NatureMap* to the combined number of conservation significant species provided by *NatureMap* and *Protected Matters Search Tool*.

Habitat requirements of conservation significant vertebrate fauna was specifically reviewed in relation to habitat within the site to determine a total number of conservation significant fauna species with potential to occur. Fauna species with no potential to occur within the site were excluded from this count (e.g. marine mammals and marine fish).

3.3.2 Fauna habitat

Fauna habitats were described according to the dominant flora species and vegetation type present, as determined from observations made during the field survey and information provided in the '*Spring Flora and Vegetation Assessment*' (Emerge Associates 2021). The identified fauna habitats were mapped on aerial photography with the boundaries interpreted from aerial photography, previously identified plant communities (Emerge Associates 2021) and notes taken in the field.

3.3.3 Likelihood of occurrence

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

Based on the results of the desktop assessment and information recorded during the field survey, an assessment of the likelihood of occurrence of conservation significant fauna within the site was undertaken using the categories outlined in **Table 6**.

Table 6: Likelihood of occurrence assessment categories and definitions

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

3.3.4 Black cockatoo habitat

Habitat trees were classified according to the scheme outlined in **Table 5** and mapped on aerial imagery. A complete summary of the recorded attributes of habitat trees was compiled in a tabular format.

Foraging habitat was mapped on aerial photography with the boundaries interpreted from aerial photography and notes taken in the field.

Foraging habitat was described according to the dominant flora species and vegetation type present, as determined from observations made during the field survey. Primary and secondary foraging habitat was mapped on aerial photography with the boundaries interpreted from aerial photography and notes taken in the field. Patches of vegetation comprising a combination of primary and secondary foraging plants were mapped as 'mixed' foraging habitat. As it was not always possible to

separate non-foraging plants from foraging plants, some of the mapped foraging habitat also include a proportion of non-foraging plant species.

3.3.4.1 Overall black cockatoo habitat quality

As part of environmental impact assessment and offset calculation, the Department of Agriculture, Water and the Environment (DAWE) requires that a score out of ten is provided for the overall quality of back cockatoo habitat (DAWE 2020). DAWE does not provide a methodology for scoring habitat quality but instead specifies that an assessment of quality should be undertaken by an experienced technical expert (DSEWPaC 2012).

Emerge have developed a method to provide a systematic assessment of overall back cockatoo habitat quality. The method assesses and scores the quality of breeding, roosting and foraging habitat separately and then provides an overall quality score out of ten based on the highest score determined for the respective habitat categories. The assessment methodology is detailed in **Appendix C.**

3.4 Nomenclature and sources of information

Taxonomy and nomenclature of scientific and common names for fauna species follow the *Western Australian Museum* (WAM) *Checklist of the Terrestrial Vertebrate Fauna of Western Australia* (WAM 2020). This is contrary to the recent EPA (2020) advice to follow the *Australian Faunal Directory* (DAWE 2021) nomenclature for birds. Nomenclature may be adapted once the EPA (2020) technical guidance is further established and generally accepted within the professional community. Where common names were not provided by Western Australian Museum (2019); (WAM 2020), these have been derived from other sources.

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

3.5 Survey limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard constraints outlined in the EPA's document *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020) is provided in **Table 7**.

Table 7: Evaluation of survey methodology against standard constraints outlined in the EPA's Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020)

Constraint	Degree of limitation	Details
Level of survey	No limitation	A basic survey (desktop study and field survey) in combination with a targeted black cockatoo survey was undertaken. The level of survey and survey effort are considered adequate to assess the fauna and black cockatoo habitat values within the site.
Scope	No limitation	The survey focused on vertebrate fauna and habitat values, with particular focus on black cockatoos and other conservation significant taxa with potential to occur within the site.

Table 7: Evaluation of survey methodology against standard constraints outlined in the EPA's Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020) (continued)

Constraint	Degree of limitation	Details
Proportion of fauna identified, recorded and/or collected.	No limitation	All observed vertebrate fauna were identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	No limitation	Adequate information was available from database searches and previous surveys. The guidance currently available from Commonwealth and State agencies on the assessment of black cockatoo habitat is of limited value and relies heavily on technical experts preparing their own assessment methodology.
The proportion of the task achieved and further work which might be needed.	No limitation	The task was achieved in its entirety.
Experience level of personnel	No limitation	This fauna assessment was led by qualified ecologists with 12- and three-years' experience. Technical review was undertaken by a senior environmental consultant with over 10 years' experience in environmental science in Western Australia.
Suitability of timing, weather and season	Minor limitation	Survey timing is not considered to be of great importance for basic fauna assessments. Nonetheless, the day time survey limits the ability to detect nocturnal species.
Completeness	No limitation	The desktop assessment, field survey and targeted black cockatoo components of the survey were completed comprehensively.
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged).
	Minor limitation	Lot 202 was not accessible at the time of the survey. Observations were made from the road and surrounding lots, and from photographs taken within the lot during an earlier flora survey.
Survey intensity	No limitation	The intensity of the survey was adequate given the size of the site.
Influence of disturbance	No limitation	Portions of the site are modified due to historical disturbance. However, no recent disturbance was noted that may have affected outcomes of the survey.
Adequacy of resources	No limitation	All resources required to perform the survey were available. The guidance currently available from Commonwealth and State agencies on the assessment of black cockatoo habitat is limited and relies heavily on technical experts preparing their own methodology. This assessment applies an internally developed methodology that is considered to provide a systematic and balanced characterisation of black cockatoo habitat.
Compliance with EPA (2020) guidance	Minor limitation	The EPA guidance requires that a full list of all fauna species with potential to occur within the site is compiled. As part of this assessment a comprehensive list of fauna species of conservation significance was compiled. Non-conservation taxa with potential to occur within the site were not compiled into a list but are provided as raw data in **Appendix D**. Given that all species with potential to occur within the site are still identified within the relevant appendices this is not considered to affect the outcomes of this assessment. The EPA guidance recommends that *the Australian Faunal Directory* (DAWE 2021) nomenclature is used for bird species. This assessment uses the WAM *Checklist of the Terrestrial Vertebrate Fauna of Western Australia* (WAM 2020) nomenclature for birds and therefore does not strictly comply.

4 Results

4.1 General site conditions

Most of the site has been subject to intensive historical disturbance and comprised cleared land and planted non-native vegetation, particularly in the eastern portion. The western half of the site supported more intact native vegetation. The eastern portion of the site is slightly lower lying then the western portion and evidence of previous inundation was observed.

4.2 Fauna habitat

Seven fauna habitats were identified within the site: '**woodland**', '**woodland – limited understorey**', '**open melaleuca woodland**', '**closed melaleuca forest**', '**native and non-native eucalypts**' '**waterbody**' and '**predominantly cleared area**'.

A description and the area of each habitat is provided in **Table 8** and representative photographs of each are provided in **Plate 1** to **Plate 7**. The location of each habitat is shown on **Figure 6**.

Table 8: Fauna habitats identified within the site.

Fauna habitat classification	Description	Area (ha)
Woodland	Low open woodland generally consisting of overstorey trees of *Banksia* spp., *Eucalyptus todtiana*, *Nuytsia floribunda*, *Melaleuca preissiana*, **Eucalyptus camaldulensis*, over shrubland of *Kunzea glabrescens, Xanthorrhoea spp, Macrozamia riedlei* and *Melaleuca thymoides* and forbland species including *Dasypogon bromeliifolius* and *Hypolaena exsulca* (or understorey absent in degraded areas) (**Plate 1**).	7.84
Woodland – limited understorey	Low open woodland of *Banksia* spp. and closed tall shrubland of *Kunzea glabrescens* over low sparse shrubland of *Xanthorrhoea brunonis, Hibbertia subvaginata* and *Bossiaea eriocarpa* over open forbland of *Dasypogon bromeliifolius, Patersonia occidentalis, Lyginia imberbis* and *Phlebocarya ciliata* (**Plate 2**).	0.57
Open melaleuca woodland	Open to closed tall shrubland of *Melaleuca rhaphiophylla* and *Melaleuca teretifolia* with open vineland of *Cassytha racemosa* over closed tussock grassland of *Typha domingensis* and pasture weeds (**Plate 3**).	1.21
Closed melaleuca forest	Open forest of *Melaleuca preissiana, Eucalyptus rudis* and/or **Eucalyptus camaldulensis* over open to closed shrubland of *Melaleuca rhaphiophylla, M. lateritia* and *M. teretifolia* over grassland to closed grassland of pasture weeds (**Plate 4**).	2.25
Native and non-native eucalypts	Scattered native eucalypts including *Eucalyptus rudis* and planted non-native eucalypts including *E. camaldulensis* and *E. botryoides* (**Plate 5**).	2.02
Waterbody	Temporary or permanent areas of water within wetlands (**Plate 6**).	0.45
Predominantly cleared area	Heavily disturbed areas comprising weeds with occasional native shrubs and forbs and planted vegetation (**Plate 7**)**.**	14.94



Plate 1: ***Woodland***



Plate 2: ***Woodland – limited understorey***



Plate 3: ***Open melaleuca woodland***



Plate 4: ***Closed melaleuca forest***



Plate 5: ***Scattered native and non-native eucalypts***



Plate 6: ***Waterbody***



Plate 7: ***Predominantly cleared areas***

4.3 Fauna

4.3.1 Desktop assessment

A total number of 523 fauna species were identified from database searches as occurring or potentially occurring within 10 km of the site[1] as listed in **Appendix D**.

Of these species, 78 are conservation significant, including 33 threatened, 17 priority, 26 migratory fauna and 2 other specially protected species as listed in **Appendix E**.

4.3.2 Species inventory

A total of 18 native and three introduced fauna species were recorded during the field survey, including one species of conservation significance, *Isoodon fusciventer* (quenda) (P4). A complete species list is provided in **Appendix F**.

4.3.3 Conservation significant fauna

One conservation significant fauna species was recorded within the site during the field survey, a single quenda (P4).

In addition, four threatened, six priority, three migratory and one specially protected fauna species were considered to possibly occur within the site as listed in **Table 9**.

The remainder of the conservation significant fauna species identified in the desktop assessment (63 species) are considered unlikely to occur in the site due to lack of suitable habitat or because the

[1] Includes native and non-native species

site lies outside of the species known distribution. Fauna species classed as unlikely to occur are listed in **Appendix F**.

Table 9: Summary of conservation significant fauna species recorded or deemed possible or likely to occur within the site

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
Birds					
Apus pacificus	Pacific swift	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Johnstone and Storr 1998).	**Possible:** May opportunistically occur in or fly over the site on commute or while searching for prey.
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU	Eucalypt and Corymbia forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding *Corymbia calophylla*, *Eucalyptus marginata*, introduced **Melia azedarach* and *Eucalyptus* spp. trees (Johnstone and Storr 1998).	**Likely:** Several records of the species in close proximity (<2 km) to the site and there is foraging habitat within the site.
Calyptorhynchus baudinii	Baudin's cockatoo	EN	EN	Mainly eucalypt forests. Attracted to seeding *Corymbia calophylla*, *Banksia* spp., *Hakea* spp., and to fruiting apples and pears (Johnstone and Storr 1998).	**Possible:** Species known to occur within the broader area and there is limited foraging habitat within the site.
Calyptorhynchus latirostris	Carnaby's cockatoo	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of *Pinus* spp. Attracted to seeding *Banksia* spp., *Dryandra* spp., *Hakea* spp., *Eucalyptus* spp., *Corymbia calophylla, Grevillea* spp., and *Allocasuarina* spp. (Johnstone and Storr 1998).	**Likely:** Historical records within and adjacent to the site and there are areas of foraging habitat within the site.
Falco peregrinus	*Peregrine falcon*	OS	-	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	**Possible:** May opportunistically occur in or fly over the site on commute or while searching for prey.

Table 9: Summary of conservation significant fauna species recorded or deemed possible or likely to occur within the site (continued)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
Oxyura australis	*Blue-billed duck*	P4	-	Mainly deeper freshwater swamps and lakes; occasionally saltlakes and estuaries freshened by flood waters (Johnstone and Storr 1998).	**Possible:** May utilise the wetlands within the site whilst water is present.
Plegadis falcinellus	*Glossy Ibis*	MI	MI	Well-vegetated wetlands, wet pasture, ricefields, floodwaters, floodplains, brackish or occasionally saline wetlands, mangroves, mudflats and occasionally dry grassland (Pizzey & Knight 2012).	**Possible:** May utilise the wetlands within the site whilst water is present.
Tringa hypoleucos	*Common sandpiper*	MI	MI	Edge of sheltered waters salt or fresh, e.g. estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations where low perches are available (Johnstone & Storr 1998).	**Possible:** Small numbers of occasional transient individuals may utilise the site when wetlands have water.
Invertebrates					
Idiosoma sigillatum	*Swan Coastal Plain shield-backed trapdoor spider*	P3	-	Widely distributed in sandy areas on the Swan Coastal Plain and on Rottnest Island (Prince 2003).	**Possible:** Suitable habitat present
Leioproctus contrarius	*a short-tongued bee*	P3	-	Life history and habits are poorly documented/ unknown. It has been recorded only on flowers of Goodeniaceae and possibly Lechenaultia stenosepala (Bamford 2003).	**Possible:** Historic records within the broader area and one Goodeniaceae species present within the site
Neopasiphae simplicior	*a short-tongued bee*	EN	CR	This species of native bee has been collected on flowers of *Goodenia filiformis, Lobelia tenuior, Angianthus preissianus* and *Velleia* sp. (Houston 2000).	**Possible** Historic records within the broader area, and *Lobelia tenuior* present within the site
Mammals					
Isoodon fusciventer	*Quenda*	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012).	**Recorded**

Table 9: Summary of conservation significant fauna species recorded or deemed possible or likely to occur within the site (continued)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
Notamacropus irma	*Western brush wallaby*	P4	-	Dry sclerophyll forest, *Banksia* spp. woodlands and shrublands, typically favouring dense low vegetation that provides dense cover (Christensen and Strahan 1983).	**Possible** Recent records of a population within the broader area
Reptiles					
Lerista lineata	Perth slider	P3	-	Sandy coastal heath and low scrubland. *Banksia* spp. woodland, *Eucalyptus gomphocephala* open woodland over deep sands, and coastal dunes immediately adjacent to the beach.	**Possible:** Historic records adjacent to the site and there is potentially suitable habitat within the site.
Neelaps calonotos	Black-striped snake	P3	-	Coastal and near-coastal dunes, sandplains supporting heathlands and *Banksia* spp. woodlands.	**Possible:** Historic records adjacent to the site and there is habitat within the site.

4.3.1 Declared pests

One species listed as a declared pest (C3) pursuant to the BAM Act, **Oryctolagus cuniculus* (rabbit) was identified from scats within the site.

4.4 Black cockatoos

4.4.1 Habitat

4.4.1.1 Breeding

A total of six black cockatoo habitat trees were recorded within the site as shown in **Figure 7**. The habitat trees were all *Eucalyptus rudis* (flooded gum). None of the habitat trees present within the site contain hollows that are suitable for use for breeding by black cockatoos and no internal hollow inspection was undertaken.

A summary of the habitat trees recorded within the site is provided in **Table 10** and an inventory in **Appendix G.**

Table 10: Habitat trees recorded within the site

Category	No. trees	No. suitable hollows
Confirmed nest	0	0
Potential nest	0	0
Suitable hollow(s)	0	0
Potentially suitable hollow(s)	0	0
No suitable hollow(s)	6	0
Total	**6**	**0**

4.4.1.2 Roosting

Tall native and non-native trees within the site have the potential to provide roosting habitat for black cockatoos.

No roosts or secondary evidence of roosting, such as droppings, moulted feathers or branch clippings were observed within the site during the survey.

4.4.1.3 Foraging

No foraging evidence attributed to black cockatoos was recorded within the site.

The site contains potential foraging habitat for Carnaby's cockatoo, Baudin's cockatoo and forest red-tailed black cockatoo. The main primary foraging plants recorded within the site were *Banksia attenuata* (slender banksia) and *B. menziesii* (firewood banksia). Secondary foraging plants included **Eucalyptus camaldulensis* (river red gum), *Eucalyptus todtiana* (coastal blackbutt) and *Xanthorrhoea preissii* (grasstree). A summary of the dominant foraging plants within the site is provided in **Table 11**.

Table 11: Dominant primary and secondary black cockatoo foraging plants recorded within the site

Common name	Foraging habitat category and black cockatoo species		
	Carnaby's	Baudin's	Forest red-tailed
Slender banksia	Primary	-	-
Firewood banksia	Primary	-	-
River red gum	-	-	Secondary
Coastal blackbutt	Secondary	-	-
Grasstree	Secondary	Secondary	-

A total of 7.1 ha of foraging habitat was mapped for Carnaby's cockatoo, 6.91 ha for Baudin's and 5.52 ha for forest red-tailed black cockatoos within the site. A total of 1.95 ha of primary foraging habitat was mapped for Carnaby's cockatoo. The amount of primary foraging species mapped within the site was very low (less than 0.1 ha) for both Baudin's cockatoo and forest red-tailed black cockatoo. Secondary foraging habitat was greater for both forest red-tailed black cockatoo and Baudin's cockatoo.

The proportion of primary, secondary and non-foraging plants within the mapped foraging habitat for each black cockatoo species is provided in **Table 12**. A large percentage of the foraging plants within the site occur as scattered trees and small patches of vegetation. Therefore, it was not always possible to separate the foraging habitat from non-foraging plants which resulted in a relatively high cover of non-foraging plants within patches mapped as foraging habitat as outlined in **Table 12.**

The location of foraging habitat mapped within the site is shown in **Figure 8** to **Figure 10**.

Table 12: Proportion of primary, secondary and non-foraging plants within patches of foraging habitat

	Area of foraging habitat (ha) and black cockatoo species		
	Carnaby's	Baudin's	Forest red-tailed
Primary foraging plants	1.95	0.002	0.09
Secondary foraging plants	0.47	2.22	3.31
Non-foraging plants	4.68	4.69	2.12
Total	**7.1**	**6.91**	**5.52**

4.4.1.4 Overall quality

The outcome of the overall black cockatoo habitat quality assessment is provided in **Table 13** and summarised in **Table 14**.

The site was determined to have an overall habitat score of four out of a maximum possible score of 10 for forest red-tailed black cockatoo, which is 'moderate' using the scale provided in **Appendix C**. The site was determined to have an overall habitat score of two for Baudin's cockatoo and three for Carnaby's cockatoo which is both low'.

The full results of the quality assessment are provided in **Appendix H**.

Table 13: Habitat quality assessment scores

Habitat category	Score		
	Carnaby's	Baudin's	Forest red-tailed
Breeding	N/A^	N/A^	4
Roosting	2	2	2
Foraging	3	2	2
Overall Score	**3 Low**	**2 Low**	**4 Moderate**

^ No breeding score was assigned as the site is located outside of the species breeding range.

Table 14: Summary of attributes contributing to black cockatoo habitat quality scores

Habitat category	Quality component category	Attributes and black cockatoo species		
		Carnaby's	Baudin's	Forest red-tailed
Breeding	Site condition	N/A – site is located outside of its predicted breeding range.	N/A – site is located outside of its known and predicted breeding range.	The site supports habitat trees without suitable hollows.
	Site context			No confirmed forest-red-tailed nest tree occurs within 6 km of the site and 2,435 ha of potential forest red-tailed black cockatoo foraging habitat is mapped within 6 km of the site as shown in **Figure 5**.
	Species stocking rate			N/A – no evidence of breeding was recorded within the site.
Roosting	Site condition	The site supports potential roosting habitat.	The site supports potential roosting habitat.	The site supports potential roosting habitat.
	Site context	The site is located more than 1 km from a large roost and more than 500 m from a small roost.	The site is located more than 1 km from a large roost and more than 500 m from a small roost.	The site is located more than 1 km from a large roost and more than 500 m from a small roost.
	Species stocking rate	N/A - no evidence of roosting was recorded within the site.	N/A - no evidence of roosting was recorded within the site.	N/A - no evidence of roosting was recorded within the site.
Foraging	Site condition	The site supports foraging habitat that is proportionally of 27.51% primary foraging plants.	The site supports foraging habitat that is proportionally of 0.96% primary foraging plants.	The site supports foraging habitat that is proportionally of 1.55% primary foraging plants.
	Site context	Confirmed white-tailed black cockatoo roosts occur within 6 km of the site, indicating the foraging habitat within the site could potentially be used by the birds utilising the roosts.	Confirmed white-tailed black cockatoo roosts occur within 6 km of the site, indicating the foraging habitat within the site could potentially be used by the birds utilising the roosts.	Confirmed forest red-tailed black cockatoo roosts occur within 6 km of the site, indicating the foraging habitat within the site could potentially be used by the birds utilising the roosts.
	Species stocking rate	No evidence of Carnaby's cockatoo foraging was observed in the site.	No evidence of Baudin's cockatoo foraging was observed in the site.	No evidence of forest red-tailed black cockatoo foraging was observed in the site.

5 Discussion

5.1 Fauna and fauna habitat values

The 18 native and three non-native fauna opportunistically recorded within the site are all generally common and widespread across the Swan Coastal Plain.

Habitat values within the site are highest within the south-western portion of the site within the **woodland** and **woodland – limited understorey** habitats**.** In particular, where vegetation occurs in 'good' or better condition as mapped by Emerge Associates (2021), it provides a cover of native trees, shrubs and ground cover and contains microhabitats such as logs, rocks and leaf litter.

The **scattered native and non-native eucalypts** provide varying value to native fauna depending on the plant species and density present, noting that the northern portion of the site contains continuous canopy coverage, which may support avian species.

The remainder of the site supports degraded vegetation mapped as **open melaleuca woodland** and **closed melaleuca forest** habitats, in addition to highly modified habitats associated with historical clearing such as the **waterbody** and **predominantly cleared area**. These habitats provide varying value to native fauna depending on the plant species and density present but are likely to be primarily be used by common and widespread native and non-native fauna with non-specific habitat requirements.

5.2 Conservation significant fauna

One species of conservation significance, quenda, was recorded within the site. This species is likely to persist in the **woodland** habitat where the understorey shrubland layer is present, as it provides suitable cover for the species. This species is likely to utilise the site as part of a larger home range, extending to the south-east where areas of contiguous native vegetation are present.

An additional 15 species of conservation significance are considered to have potential to occur in the site.

Apus pacificus (pacific swift) and *Falco peregrinus* (peregrine falcon) may opportunistically fly over or utilise habitat within the site as part of a much larger home range but the site is considered unlikely to provide important habitat for these species.

Carnaby's cockatoo and forest red-tailed black cockatoo are considered likely to use the site. Historic records of Carnaby's cockatoo utilising the site have been recorded, whilst there are several records of forest red-tailed black cockatoo within close proximity to the site. Baudin's cockatoo may possibly utilise the site for foraging and there are three records of the species within 10 km of the site. The site supports primary and secondary foraging habitat for all three species.

The **waterbody** and adjacent **closed melaleuca forest** provide potential habitat for *Oxyura australis* (blue-billed duck), *Plegadis falcinellus* (glossy ibis) and *Tringa hypoleucos* (common sandpiper), which may utilise the site when there is water present within the wetlands, albeit in small, transient numbers.

The **banksia woodland** provides potential habitat for *Idiosoma sigillatum* (Swan Coastal Plain shield-backed trapdoor spider), *Leioproctus contrarius* (a short-tongued bee) and *Neopasiphae simplicior* (a short-tongued bee), with known host plants for the bee species recorded within the site. The **banksia woodland** also represents potential habitat for *Lerista lineata* (Perth slider) and *Neelaps calonotos* (black-striped snake), with historic records adjacent to the site.

Banksia woodland, **kunzea, melaleuca and banksia woodland** and **kunzea and banksia woodland – limited understorey** may represent potential habitat for *Notamacropus irma* (western brush wallaby), as there are numerous records surrounding the site. However, this species is likely to utilise the site as part of a larger home range and it is unlikely that a population would reside within the site permanently, given the human activity present within the site.

Targeted surveys would need to be undertaken to confirm whether other conservation significant fauna species occur within the site.

5.3 Black cockatoos

No black cockatoos were observed during the survey and no evidence of foraging, roosting or nesting was recorded. The site is located within the expected range of all three species and suitable habitat occurs within the site and local area, so it is possible that all three species may utilise the site at varying times. A historic record from 2013 for Carnaby's cockatoo is present within the central portion of the site.

5.3.1 Habitat

5.3.1.1 Breeding

The site lies within the known breeding range of forest red-tailed black cockatoo only. No hollows suitable for breeding by black cockatoos were observed in the habitat trees within the site. Therefore, the site does not currently support breeding habitat for black cockatoos. While all of the habitat trees within the site have the potential to form hollows in the future, based on their age and size, it would likely take many years for hollows to form that are suitable for use by black cockatoos.

5.3.1.2 Roosting

No evidence suggesting that roosting occurs within the site was observed during the field survey and the BirdLife Australia dataset does not include any roost records within the site. Therefore, there is no reason to suspect that roosting occurs within the site. Nevertheless, the site contains tall trees and groups of tall trees that have the potential to provide roosting habitat for black cockatoos.

5.3.1.3 Foraging

Given the historic use of the local area by Carnaby's cockatoo and the forest red-tailed black cockatoos, and the presence of foraging habitat within the site, the lack of foraging evidence was notable, although not necessarily evidence that foraging has not occurred recently.

Whilst the site supports black cockatoo foraging habitat, the majority of the habitat comprises non-foraging plants (75% for Carnaby's cockatoo, 76% for Baudin's cockatoo and 81% for forest red-tailed

black cockatoo). Given the high percentage of non-foraging plants, and the amount of foraging habitat within the broader area (as shown in **Figure 5**), it is possible the foraging habitat within the site is less favoured compared to that in the surrounding area.

5.3.1.4 Overall quality

The overall habitat score was determined to be three (low) for Carnaby's cockatoo, two (low) for Baudin's and four (moderate) for forest red-tailed black cockatoo.

The vegetation within the site scored highest in the foraging habitat value for Carnaby's cockatoo (three out of 10), due to the presence of a higher proportion of primary foraging habitat plants compared to the low amount of foraging available for Baudin's cockatoo and forest red-tailed black cockatoo (both two out of 10). No evidence of foraging by any species was recorded within the site.

As the site is located outside of the known breeding range of Carnaby's cockatoo and Baudin's cockatoo, no score was attributed to these species. Due to the presence of potential breeding habitat trees, albeit without suitable hollows, and the presence of large areas of foraging habitat surrounding the site, the site was determined to have a moderate (four) value for breeding habitat for forest red-tailed black cockatoo.

The roosting score was consistent between all three species and, as no evidence of roosting was recorded within the site, roosting quality was determined from basic habitat condition attributes (tall trees).

6 Conclusions

6.1 Fauna and fauna habitat

Approximately one third of the site (36.5%) contains native vegetation with high fauna habitat values. The remainder of the site has been subject to historical disturbance and is dominated by cleared areas, open waterbodies or planted non-native vegetation.

A total of 18 native and three introduced fauna species were positively identified to occur within the site, including one conservation significant species, quenda (P4). The site contains habitat for all three species of black cockatoo but no individuals were recorded within the site.

A further 12 species of conservation significance not recorded during the field survey are also considered to have potential to occur within the site. These species would primarily be associated with the **banksia woodland** and to a lesser extent **waterbody** habitats, if they occur at all. Targeted surveys would need to be undertaken to confirm whether these species occur within the site.

6.2 Black cockatoos

The site occurs within the modelled distribution of all three species of black cockatoo and within the breeding range of forest red-tailed black cockatoo.

No evidence of any of the three black cockatoo species was recorded within the site. All three species may utilise the site due to the presence of suitable habitat and the records within the broader area.

Six habitat trees were recorded in the site of which none contain hollows that are suitable for breeding by black cockatoos. Therefore, the site does not currently provide breeding habitat for black cockatoos. Some of the habitat trees are large enough that they may form hollows in the future that provide breeding habitat for forest red-tailed black cockatoo. The site lies outside of the known and predicted breeding range of Carnaby's cockatoo and so is not considered to have the potential to provide breeding habitat for these species in the future.

No evidence of black cockatoo roosting activity was observed within the site. Potential roosting habitat that is suitable for all three species of black cockatoo occurs within the site in the form of tall native and non-native trees.

Foraging habitat for all three species of black cockatoo was mapped within the site, primarily within the southern portion. A total of 1.95 ha of primary foraging habitat for Carnaby's cockatoo, less than 0.01 ha for Baudin's cockatoo and 0.09 ha for forest red-tailed black cockatoo was mapped within the site. The site also contains secondary foraging habitat for all three species of black cockatoo. Extensive areas of additional remnant native vegetation that may provide foraging habitat for all three species of black cockatoo occur adjacent to and in the wider area of the site.

The overall habitat score was determined to be three (low) for Carnaby's cockatoo, two (low) for Baudin's and four (moderate) for forest red-tailed black cockatoo. The site scored highest for the breeding habitat component for forest red-tailed black cockatoos due to the presence of potential habitat trees, albeit without hollows, and the presence of foraging habitat within the broader area.

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Figure 1: Site Location

Project: Basic Fauna and Targeted Black Cockatoo Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F29

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

N

0 100 200 300
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

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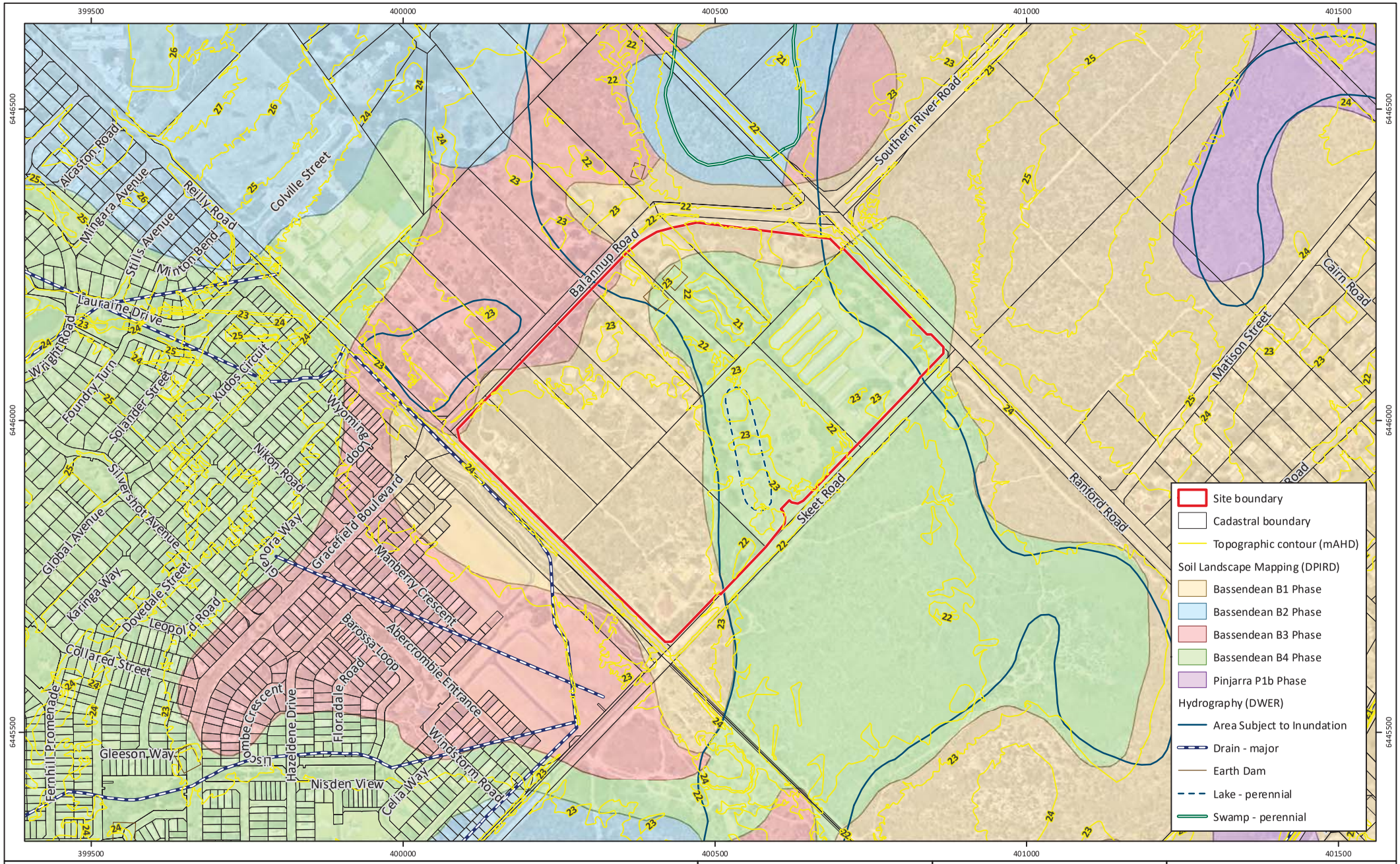


Figure 2: Hydrography, Soils and Topography

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F30

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

N

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Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

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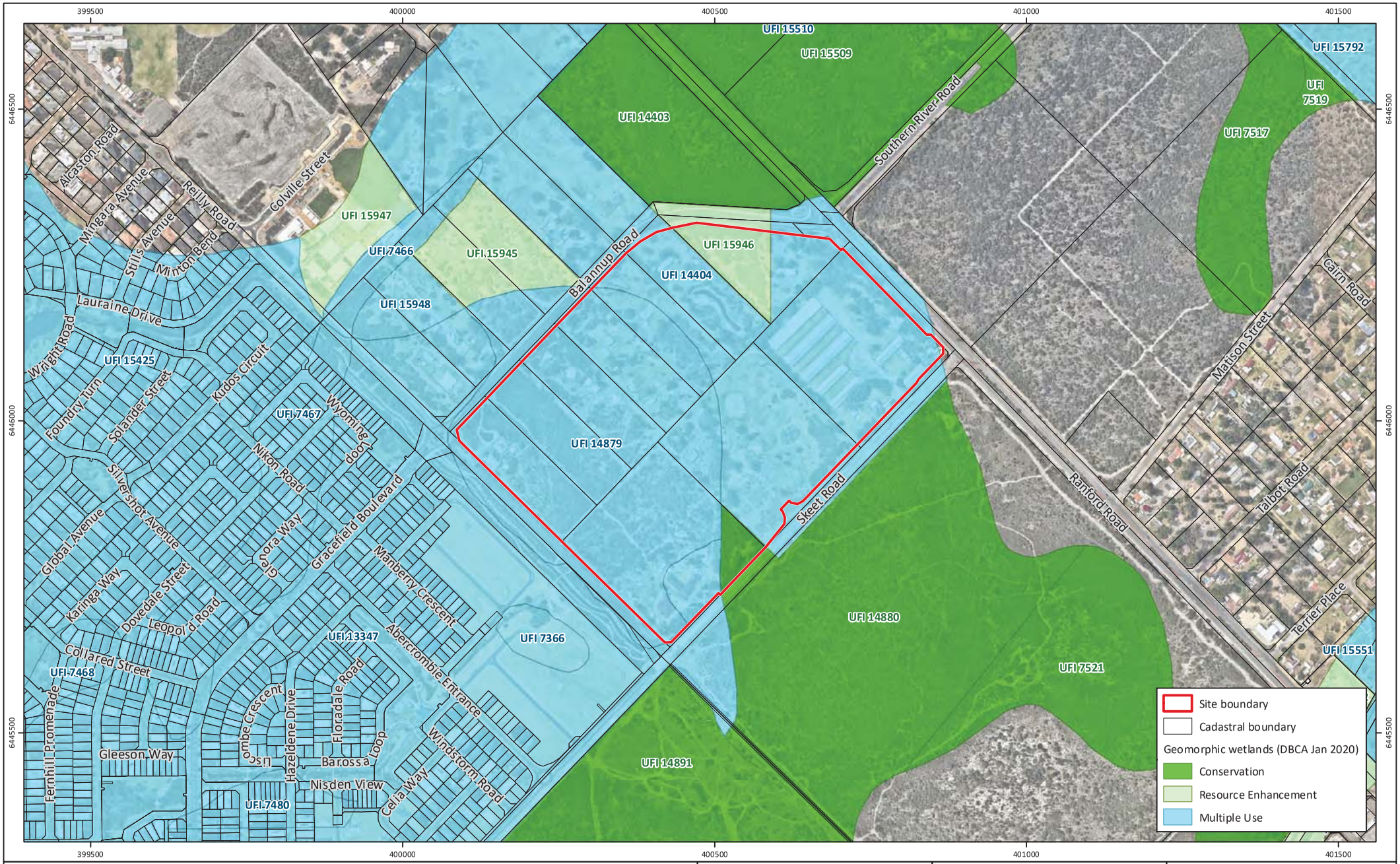


Figure 3: Wetland Features

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F31

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

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Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

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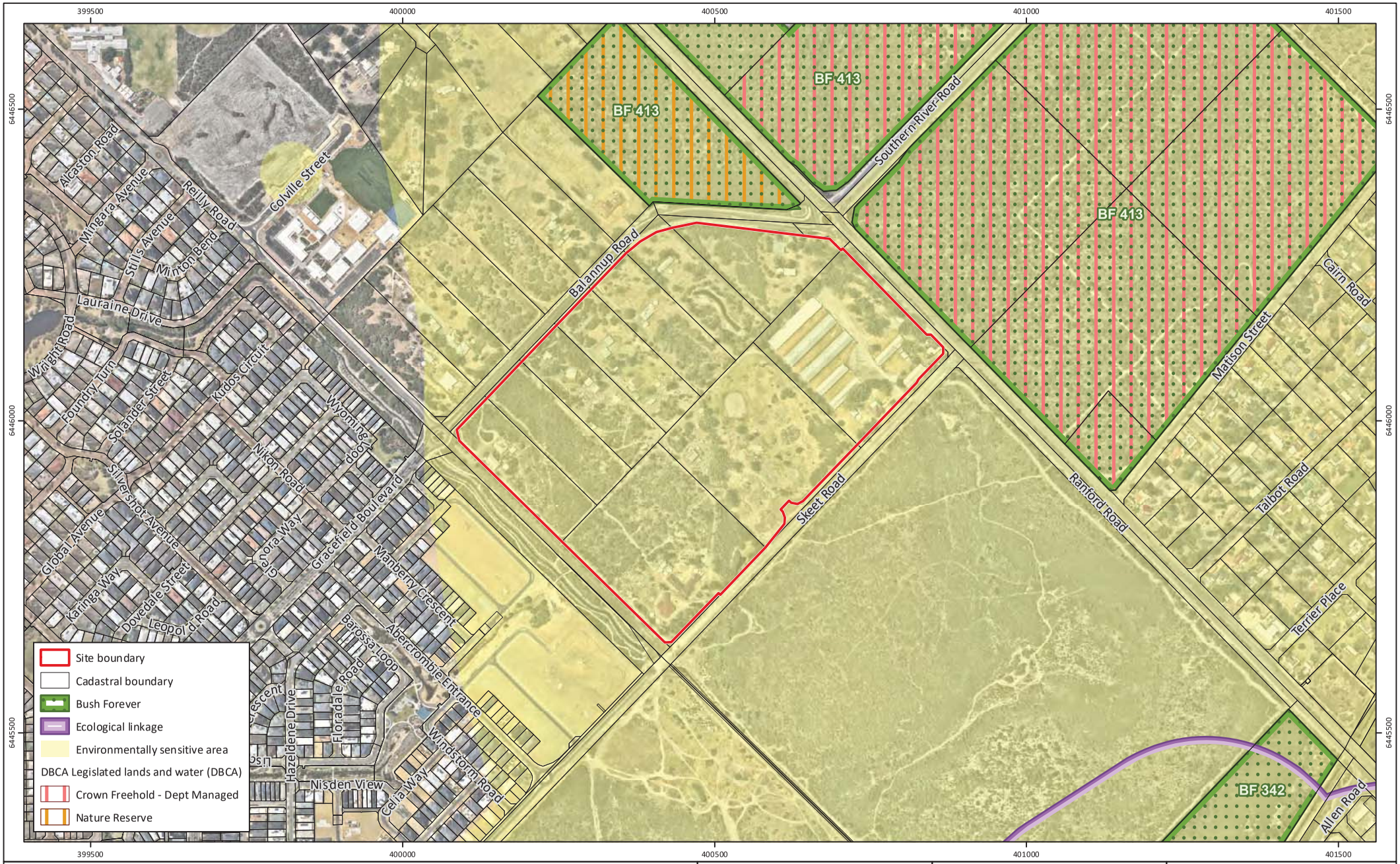


Figure 4: Environmental Features

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F32

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

N

0 100 200 300
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

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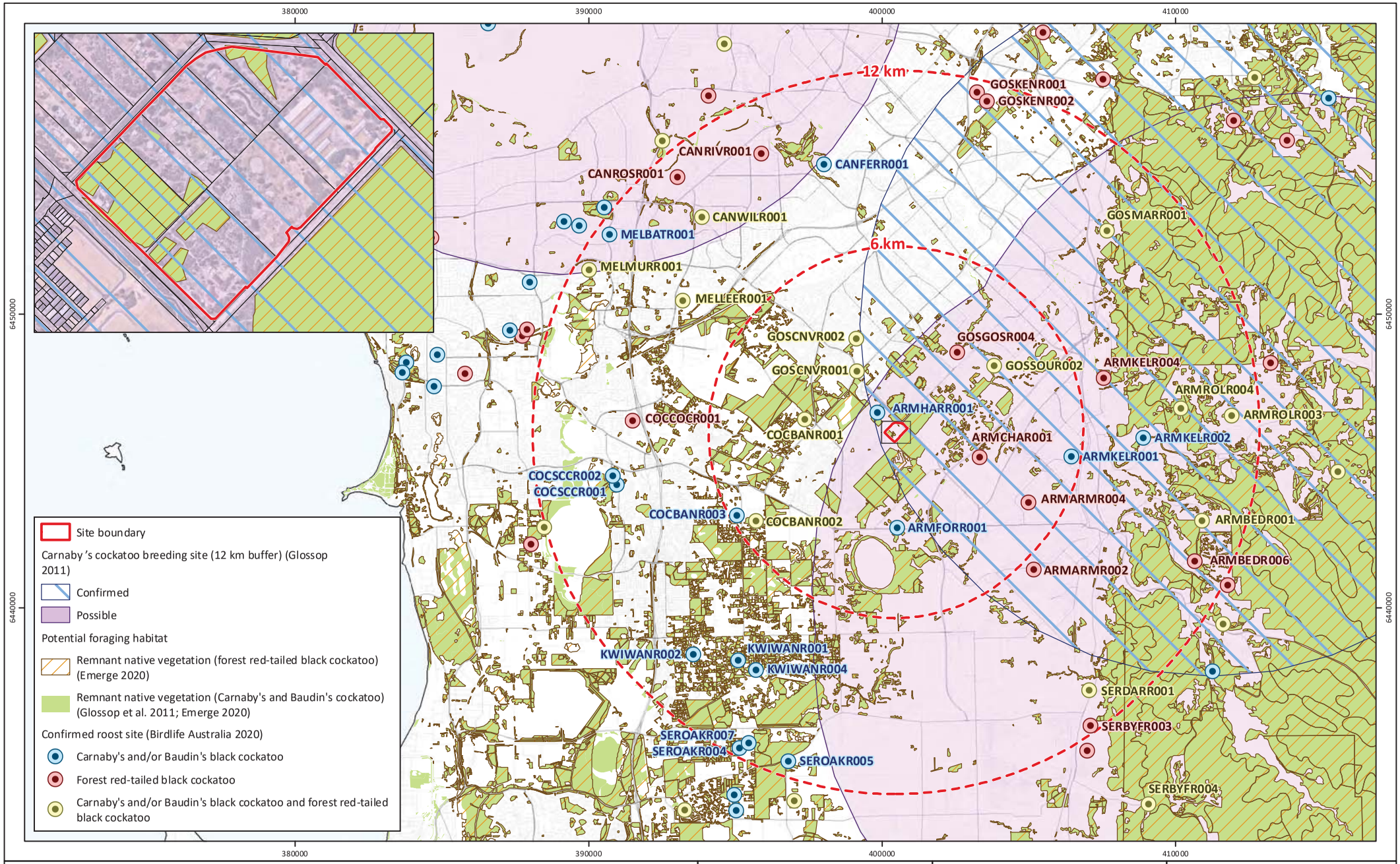


Figure 5: Black Cockatoo Habitat Context

Project: Basic Fauna and Targeted Black Cockatoo Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F33

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

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Kilometres

Scale: 1:170,000@A4

GDA 1994 MGA Zone 50

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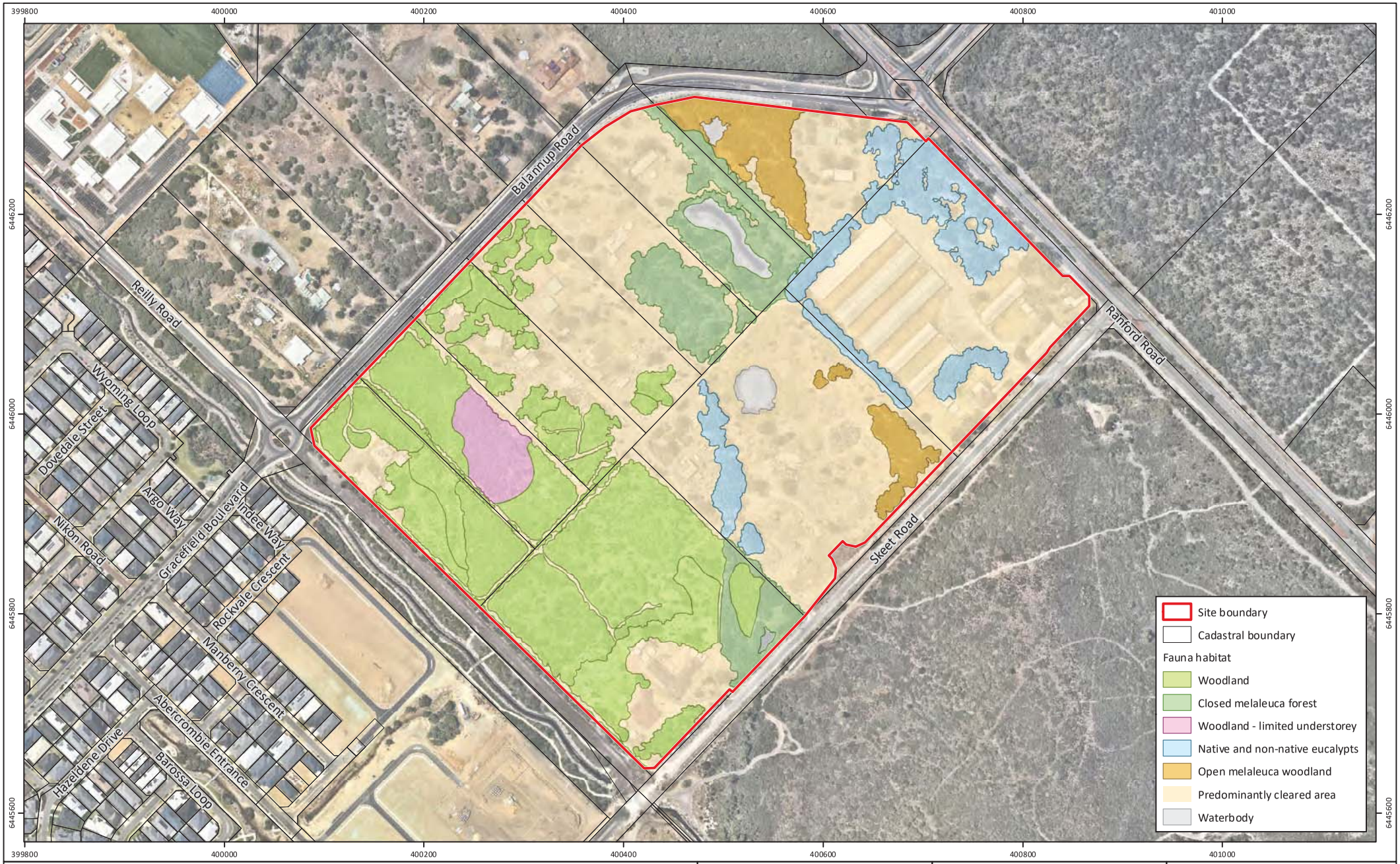


Figure 6: Fauna Habitat

Project: Basic Fauna and Targeted Black Cockatoo Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F34

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

N

0 100 200
Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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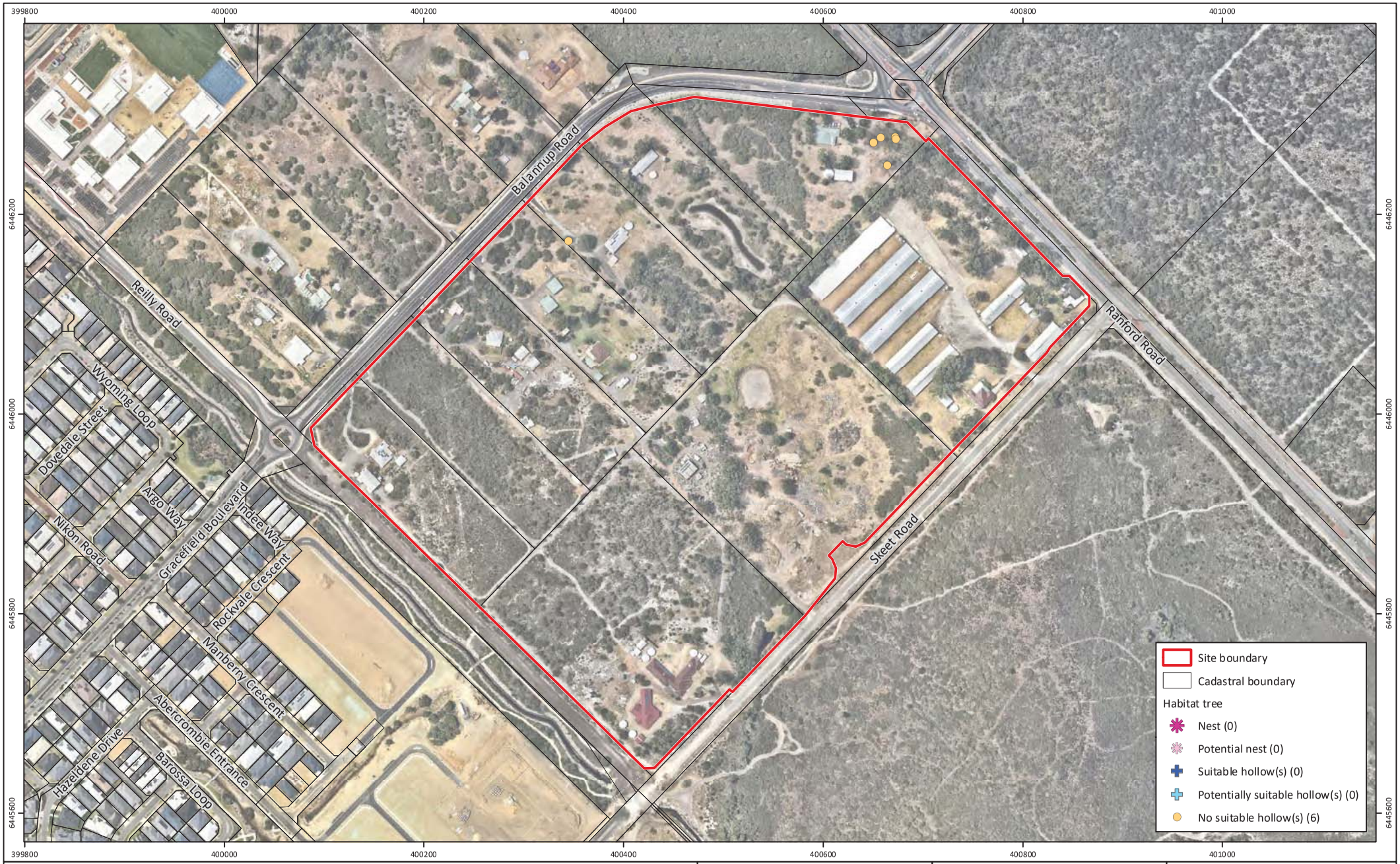


Figure 7: Black Cockatoo Habitat Trees

Project: Basic Fauna and Targeted Black Cockatoo Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F39

Drawn:	GAR
Date:	28/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

N

0 100 200
Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

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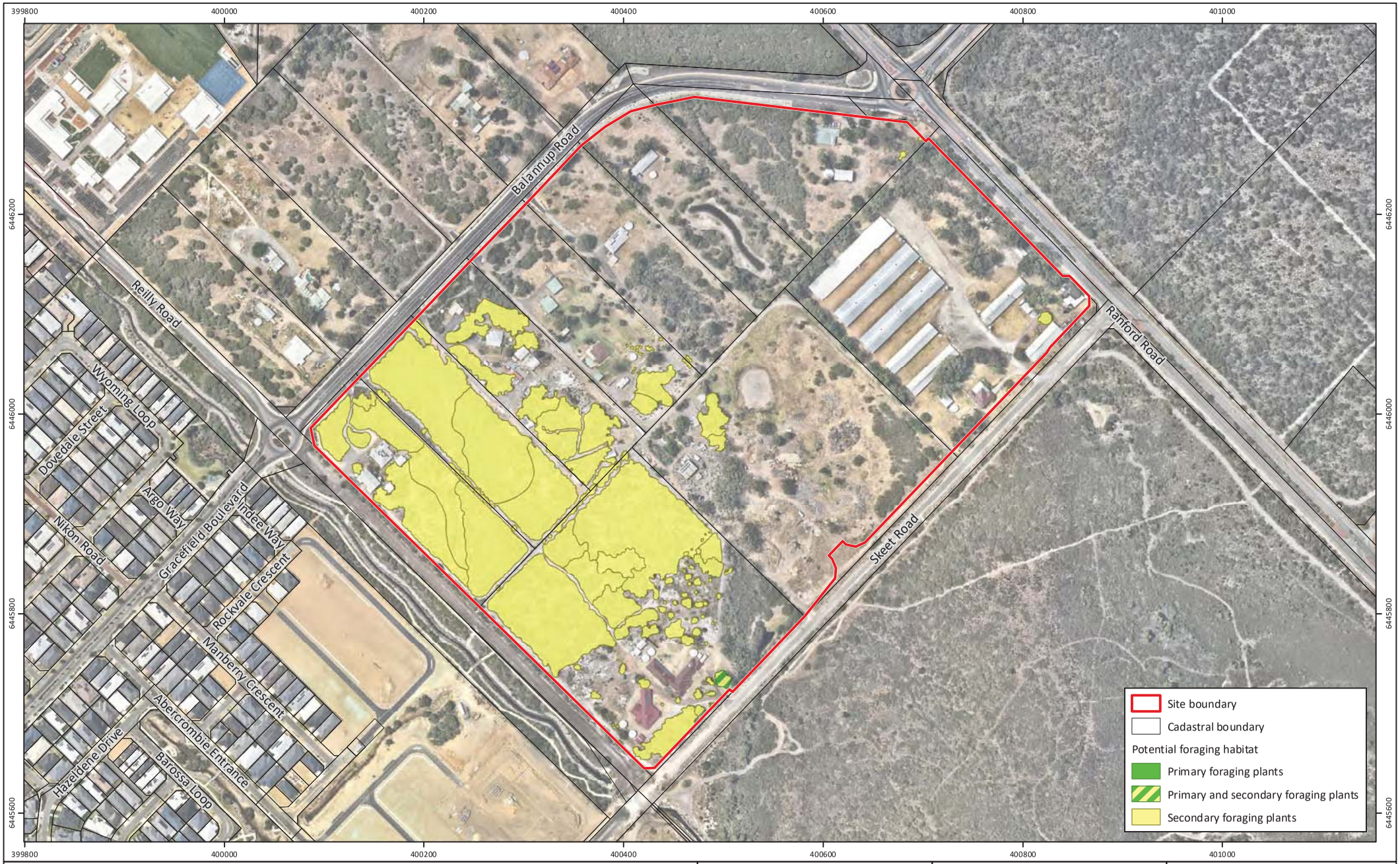


Figure 8: Potential Baudin's Cockatoo Foraging Habitat

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F35

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

N

0 100 200
Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

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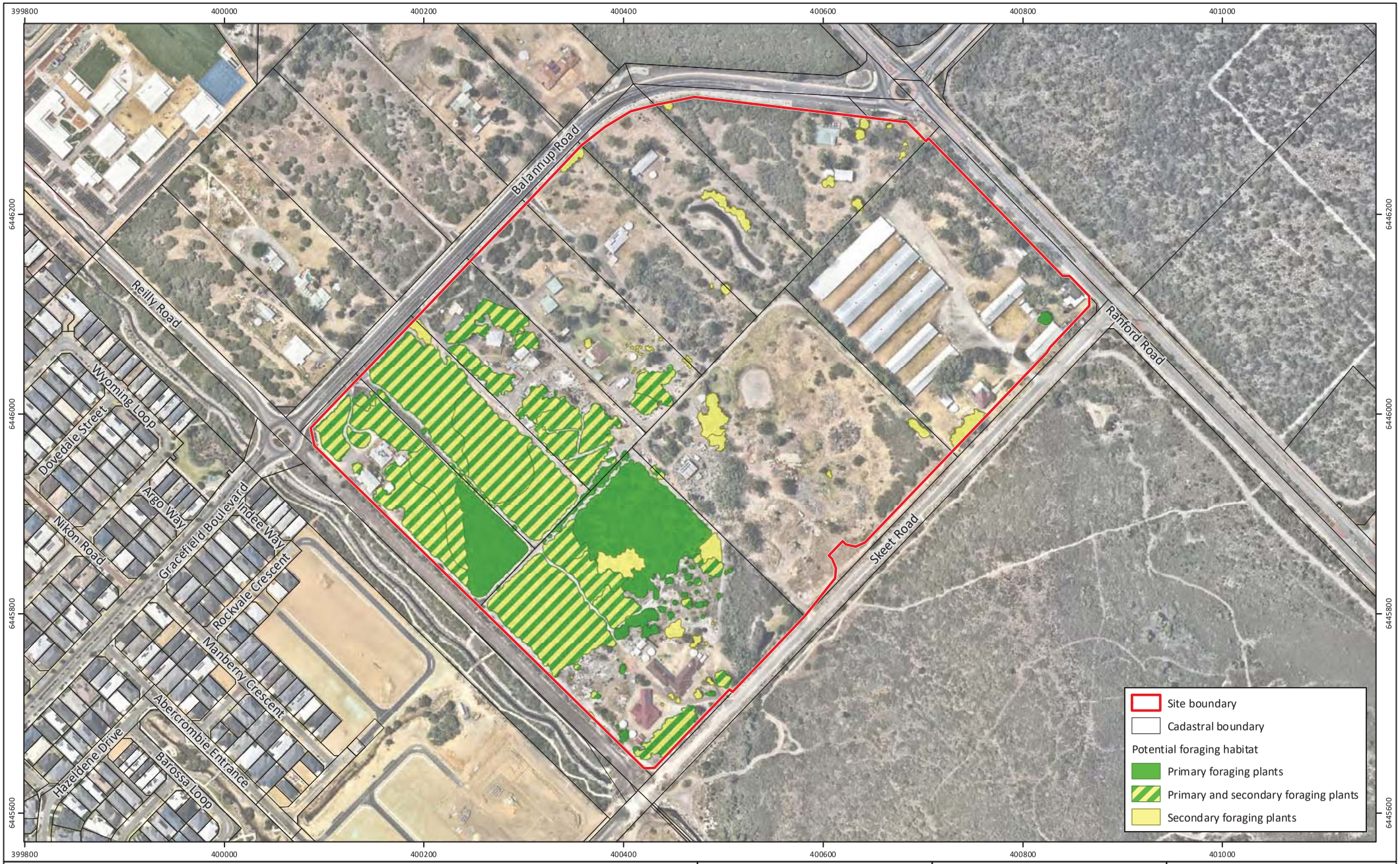


Figure 9: Potential Carnaby's Cockatoo Foraging Habitat

Project: Basic Fauna and Targeted Black Cockatoo Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F36
Drawn: GAR
Date: 27/01/2021
Checked: SCM
Approved: RAW
Date: 29/01/2021

N

0 100 200
Metres
Scale: 1:5,000@A4
GDA 1994 MGA Zone 50

emerge ASSOCIATES

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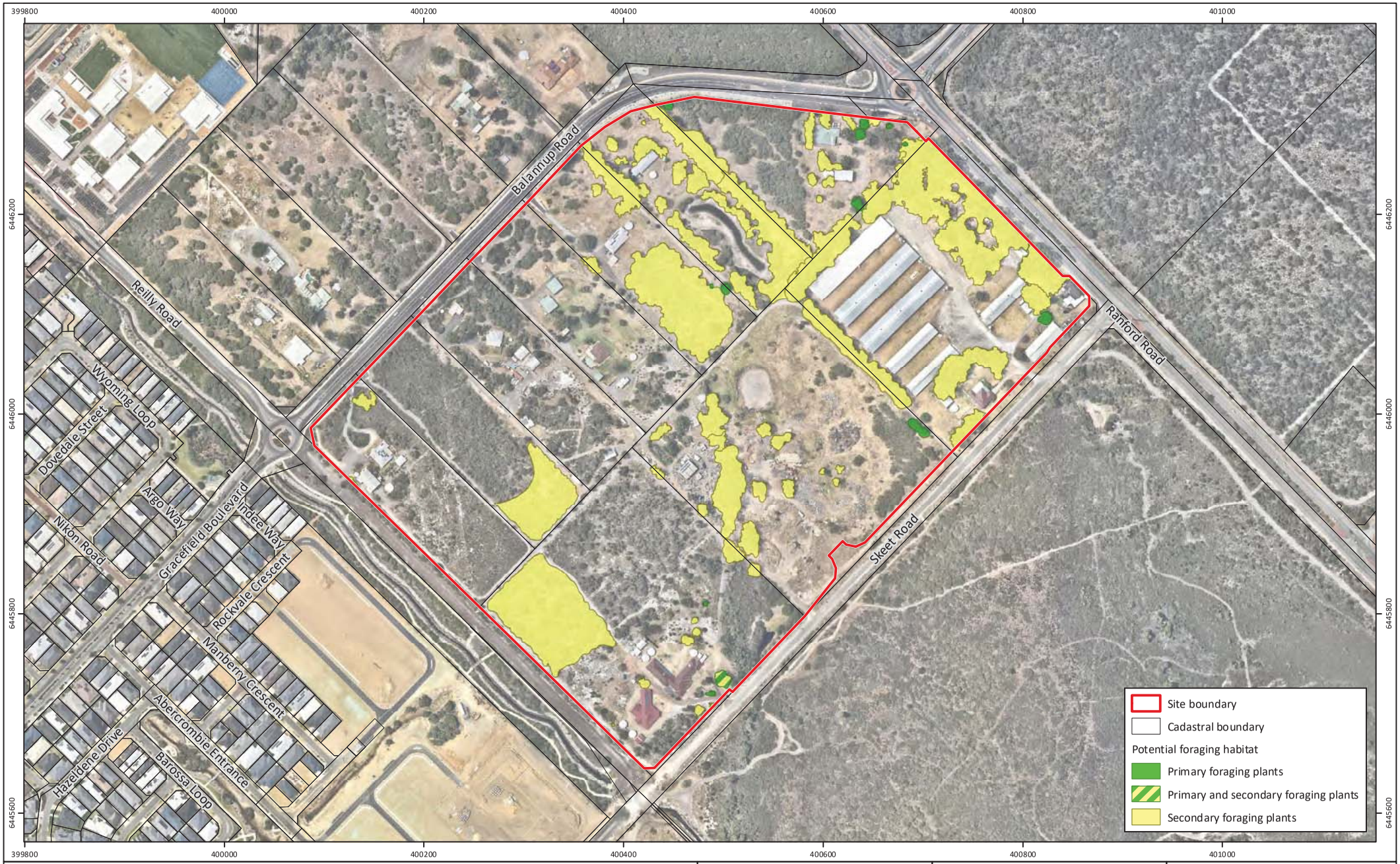


Figure 10: Potential Forest Red-tailed Black Cockatoo Foraging Habitat

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F37

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

N

0 100 200
Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

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Appendix A

Additional Information

Conservation Significant Fauna

Threatened and priority fauna

Fauna species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, fauna species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Migratory birds may be recognised under international treaties including:

- *Japan Australia Migratory Bird Agreement 1981* (JAMBA)
- *China Australia Migratory Bird Agreement 1998* (CAMBA)
- *Republic of Korea-Australia Migratory Bird Agreement 2007* (ROKAMBA)
- *Bonn Convention 1979* (The Convention on the Conservation of Migratory Species of Wild Animals).

All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as 'matters of national environmental significance' (MNES) under the EPBC Act. Fauna species considered 'threatened' pursuant to Schedule 1 of the EPBC Act are assigned categories as outlined in **Table 1**.

Table 1: Definitions of conservation significant fauna species pursuant to the EPBC Act

Conservation Code	Category
X	Threatened Fauna –Extinct There is no reasonable doubt that the last member of the species has died.
EW[#]	Threatened Fauna –Extinct in the Wild Taxa which are known only to survive in cultivation, captivity or as a naturalised population outside its past range, or taxa which have not been recorded in its known and/or expected habitat despite appropriate exhaustive surveys.
CR[#]	Threatened Fauna – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN[#]	Threatened Fauna – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU[#]	Threatened Fauna – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
Migratory[#]	Migratory Fauna All migratory species that are: (i) native species; and (ii) from time to time included in the appendices to the Bonn Convention; and (b) all migratory species from time to time included in annexes established under JAMBA, CAMBA and ROKAMBA; and All native species from time to time identified in a list established under, or an instrument made under, an international agreement approved by the Minister.
Ma	Marine Fauna Species in the list established under s248 of the EPBC Act

[#]matters of national environmental significance (MNES) under the EPBC Act

In Western Australia, fauna taxa may be classed as 'threatened', 'extinct', or 'specially protected' under the *Biodiversity Conservation Act 2016* (BC Act), which is enforced by Department of Biodiversity Conservation and Attractions (DBCA) (DBCA 2019a). The definitions of these categories are provided in **Table 2**.

Table 2: Definitions of fauna categories listed under the BC Act (DBCA 2019a)

Category	Conservation Code	Definition
Threatened	CR	Critically endangered Threatened species considered to be facing an extremely high risk of extinction in the wild in the immediate future.
	EN	Endangered Threatened species considered to be facing a very high risk of extinction in the wild in the near future.
	VU	Vulnerable Threatened species considered to be facing a high risk of extinction in the wild in the medium-term future.
Extinct	EX	Extinct Species where there is no reasonable doubt that the last member of the species has died.
	EW	Extinct in the wild Species that is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form. Note that no species are currently listed as EW.
Specially protected	MI	Migratory species Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth Includes birds that subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds.
	CD	Species of special conservation interest (conservation dependent fauna) Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
	OS	Other specially protected species Fauna otherwise in need of special protection to ensure their conservation.

Fauna species that may be threatened or near threatened but lack sufficient information to be legislatively listed may be added to the DBCA's *Priority Fauna List* (DBCA 2018). Species listed under priorities 1-3 comprise possible threatened species that do not meet survey criteria or are otherwise data deficient. Species listed under priority 4 are those that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons (DBCA 2019a).

Priority fauna species are considered during State approval processes. Priority fauna categories and definitions are listed in **Table 3** (DBCA 2019a).

Table 3: Definitions of priority fauna categories on DBCA's Priority Fauna List (DBCA 2019a)

Conservation Code	Category
P1	Priority 1 – Poorly known Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	Priority 2 – Poorly known Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	Priority 3 – Poorly known Species that are known from several locations and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4	(a) Priority 4 – Rare species Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Priority 4 – Near Threatened Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Priority 4 – Other Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Black cockatoos

Three threatened species of black cockatoo occur on the Swan Coastal Plain (referred to herein collectively as 'black cockatoos'):

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

There are a range of regional studies and spatial datasets available which provide information on black cockatoo records and potential habitat mapping. These are detailed below.

Species distribution and breeding range

Broad-scale maps are available for the modelled distribution of Baudin's cockatoo, Carnaby's cockatoo and forest red-tailed black cockatoo (DSEWPaC 2011; DoEE 2016a, b).

The modelled distribution maps also include 'known breeding areas' and 'predicted breeding range' for Baudin's cockatoo and 'breeding range' and 'non-breeding range' for Carnaby's cockatoo.

No breeding range modelling is available for forest red-tailed black cockatoo but the species is known to breed mainly in the jarrah forest region (DBCA 2017) and in small populations on the Swan Coastal Plain within the Baldivis, Stake Hill, Lake McLarty and Capel area and increasingly in the Perth metropolitan area (DAWE 2020).

Breeding habitat

Department of Environment and Conservation (DEC, now Department of Biodiversity, Conservation and Attractions (DBCA)) and fauna experts, have identified and mapped Carnaby's cockatoo habitat on the Swan Coastal Plain and Jarrah Forest regions (Glossop *et al.* 2011). This dataset includes mapping of Carnaby's cockatoo breeding sites based on point records of breeding from a range of sources. Breeding sites were classified as 'confirmed' where eggs or chicks were recorded and 'possible' where observations relating to Carnaby's cockatoo breeding that did not include actual records of eggs or chicks (e.g. chewed hollows or records of breeding or nesting behaviour by an expert observer).

A 12 km buffer applies to each site to 'reflect the flexible use of these areas by cockatoos and to indicate the important zone for access to potential feeding habitat' (Glossop *et al.* 2011). Glossop *et al.* (2011) state that the areas mapped in the dataset are not a comprehensive record of Carnaby's cockatoo breeding and that many nesting sites are not known.

While this dataset only applies to Carnaby's cockatoo, the information it contains is also applicable for Baudin's cockatoo and forest red-tailed black cockatoo as they have similar breeding habitat requirements. That is, breeding sites that are suitable for Carnaby's cockatoo may also be suitable for

Baudin's cockatoo and forest red-tailed black cockatoo, if located within their distribution/breeding ranges.

BirdLife Australia also maintain a database of confirmed black cockatoo breeding sites which is accessible via a paid search system. BirdLife Australia have advised that their database is comprised of data collected during surveys by staff and volunteers of which most (>99%) surveys are of Carnaby's cockatoo. They have also advised that the dataset is not comprehensive and that an absence of known nests does not necessarily indicate a lack of breeding activity.

The Carnaby's cockatoo recovery plan also identifies 13 'important bird areas' for Carnaby's cockatoo, which are identified as 'sites of global bird conservation importance' (DPaW 2013). These 'important bird areas' comprise sites supporting at least 20 breeding pairs or 1% of the population regularly utilising an area in the non-breeding part of the range.

Confirmed roost sites

BirdLife Australia undertakes annual monitoring of black cockatoo overnight roost sites as part of the annual 'Great Cocky Count' community-based survey. Information gathered from these monitoring events provides roost locations and recorded black cockatoo numbers (Peck *et al.* 2019).

Native foraging habitat

Glossop et al. (2011) also mapped 'areas requiring investigation as Carnaby's cockatoo feeding habitat' for the Swan Coastal Plain and Jarrah Forest regions, based on regional vegetation mapping that may contain plant species known to be foraged upon by Carnaby's cockatoo. Note that this dataset does not include observations or point records of Carnaby's cockatoo feeding. This dataset represents areas of vegetation that may potentially provide foraging habitat for Carnaby's cockatoo.

Given this dataset was created in 2011 and in order to account for clearing of native vegetation that has occurred since this time, Emerge have updated this dataset using the current native vegetation extent as provided by DPIRD (2019a) to only show potential foraging habitat that currently exists (Emerge Associates 2020a).

Pine plantations also provide an important food source for Carnaby's cockatoo, but were not included in the Glossop et al. (2011) dataset. Mapping of pine plantations is available from the Forest Products Commission (Forest Products Commission 2020).

The Glossop et al. (2011) dataset is broadly applicable to other black cockatoos as many plant species that are foraged upon by Carnaby's cockatoo are also consumed by Baudins' cockatoo (e.g. fruit of *Banksia* spp., *Corymbia calophylla* (marri) and *Eucalyptus marginata* (jarrah)) and forest red-tailed black cockatoo (e.g. jarrah and marri fruit). However, using the Glossop et al. (2011) potential foraging habitat dataset for forest red-tailed cockatoos likely overestimates available foraging habitat as it includes multiple plant species that are not consumed by this species (e.g. *Banksia* spp.), and to a lesser extent the foraging value is also over-estimated for Baudin's cockatoo.

Emerge Associates (2020b) have used a similar methodology to Glossop et al. (2011) to define potential foraging habitat for forest-red tailed cockatoos. Specifically, DBCA (2019b) regional vegetation complex mapping has been used to determine which areas of remnant vegetation

support plant species known to be foraged upon by forest red-tailed cockatoos, including *Allocasuarina fraseriana* (sheoak), *Corymbia calophylla* (marri), *Eucalyptus gomphocephala* (tuart) and *Eucalyptus marginata* (jarrah). Where these vegetation complexes intersect remnant vegetation mapped by DPIRD (2019b) they were considered to represent potential foraging habitat for forest red-tailed cockatoos.

Pest fauna

A number of legislative and policy documents exist in relation to pest fauna management at state and national levels. The *Biosecurity and Agriculture Management Act 2007* (BAM Act) is the principle legislation guiding pest fauna management in Western Australia and lists declared pest species.

Declared Pests

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

Under the BAM Act, all declared pests are assigned a legal status, as described in **Table 4**. Species assigned to the 'declared pest, prohibited - s12' category are placed in one of three control categories, as described in **Table 5**.

The *Biosecurity and Agriculture Management Regulations 2013* specify keeping categories for species assigned to the 'declared pest - s22(2)' category, which relate to the purposes of which species can be kept, as well as the entities that can keep them. The categories are described in **Table 6**.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DAFWA 2016).

Table 4: Legal status of declared pest species listed under the BAM Act (DAFWA 2016)

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

Table 5: Control categories of declared pest species listed under the BAM Act (DAFWA 2016)

Category	Description
C1	Exclusion Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	Eradication Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	Management Established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Table 6: Keeping categories of declared pest species listed under the BAM Act (DAFWA 2016)

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

Literature

The main literature used for identifying fauna and fauna habitats is listed in **Table 7** below.

Table 7: Standard literature used for identifying fauna species and habitats.

Conservation Code	Category
Birds	Johnstone and Storr (1998b), Johnstone and Storr (1998a), Pizzey and Knight (2012), Slater *et al.* (2003)
Mammals	Menkhorst and Knight (2011), Triggs (2003)
Amphibia	Tyler and Doughty (2009), Bush *et al.* (2002)
Reptiles	Bush *et al.* (2002)

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Appendix B

Black Cockatoo Foraging Plants

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Acacia baileyana	Cootamundra wattle	Secondary			Groom 2011
Acacia pentadenia	Karri wattle	Secondary			Groom 2011
Acacia saligna	Orange wattle	Secondary			Groom 2011
Agonis flexuosa	Peppermint tree	Secondary			Groom 2011
Allocasuarina fraseriana	Sheoak		Secondary	Secondary	Johnstone & Storr 1998; Johnstone et al. 2010; Johnstone 2017; DoEE 2017
Allocasuarina spp.		Secondary		Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Anigozanthos flavidus	Tall kangaroo paw		Secondary		Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Araucaria heterophylla	Norfolk island pine	Secondary			Groom 2011; DoEE 2017
Banksia ashbyi	Ashby's banksia	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Banksia attenuata	Slender banksia	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia baxteri	Baxter's banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia carlinoides	Pink dryandra	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia coccinea	Scarlet banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia dallanneyi	Couch honeypot dryandra	Primary	Secondary		Groom 2011; DoEE 2017
Banksia ericifolia	Heath-leaved banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia fraseri		Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia gardneri	Prostrate banksia	Primary	Secondary		Groom 2011; DoEE 2017
Banksia grandis	Bull banksia	Primary	Secondary		Saunders 1980; Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia hookeriana	Hooker's banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia ilicifolia	Holly banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; Johnstone & Storr 1998; DoEE 2017
Banksia kippistiana		Primary	Secondary		Groom 2011; DoEE 2017
Banksia leptophylla		Primary	Secondary		Groom 2011; DoEE 2017
Banksia lindleyana	Porcupine banksia	Primary	Secondary		Johnstone et al. 2010; DoEE 2017

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Banksia littoralis	Swamp banksia	Primary	Secondary		Saunders 1980; Groom 2011Johnstone & Storr 1998; Johnstone et al. 2010; DoEE 2017
Banksia menziesii	Firewood banksia	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia mucronulata	Swordfish dryandra	Primary	Secondary		Groom 2011; DoEE 2017
Banksia nivea	Honeypot dryandra	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Banksia nobilis	Golden dryandra	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Banksia praemorsa	Cut-leaf banksia	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia prionotes	Acorn banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia prolata		Primary	Secondary		Johnstone et al. 2010; DoEE 2017
Banksia quercifolia	Oak-leaved banksia	Primary	Secondary		Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia sessilis	Parrot bush	Primary	Secondary		Saunders 1980; Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia speciosa	Showy banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia spp.		Primary	Secondary		Saunders 1979; DSEWPaC 2012; DoEE 2017
Banksia squarrosa	Pingle	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia tricuspis	Pine banksia	Primary	Secondary		Groom 2011; DoEE 2017
Banksia undata	Urchin dryandra	Primary	Secondary		Groom 2011; DoEE 2017
Banksia verticillata	Granite banksia	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Brassica campestris	Canola	Secondary			Groom 2011; DoEE 2017
Callistemon spp.		Secondary	Secondary		Johnstone et al. 2010; DoEE 2017
Callistemon viminalis	Captain cook bottlebrush	Secondary			Groom 2011
Callitris sp.		Secondary			Johnstone et al. 2010; Groom 2011
Carya illnoinensis	Pecan	Primary	Secondary		Johnstone et al. 2010; Groom 2011; Groom 2014; DoEE 2017
Casuarina cunninghamiana	River sheoak	Secondary			Groom 2011
Citrullus lanatus	Pie or afghan melon	Secondary			Johnstone et al. 2010; Groom 2011

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Corymbia calophylla	Marri	Primary	Primary	Primary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone 2017; Saunders 1979; Johnstone & Kirkby 2008
Corymbia citriodora	Lemon scented gum	Secondary	Secondary	Secondary	Johnstone et al. 2010; DSEWPaC 2012; Groom 2011; Johnstone 2017
Corymbia ficifolia	Red flowering gum	Secondary			Groom 2011
Corymbia haematoxylon	Mountain marri	Secondary		Secondary	Groom 2011; DoEE 2012; DoEE 2017
Corymbia maculata	Spotted gum	-	-	-	-
Darwinia citriodora	Lemon-scented darwinia	Secondary	Secondary		Groom 2011; Johnstone et al. 2010
Diospryros sp.	Sweet persimmon	Secondary	Secondary		Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eremophila glabra	Tarbush	Secondary			Groom 2011
Erodium aureum		Secondary			Groom 2011
Erodium botrys	Long storksbill	Secondary	Secondary		Groom 2011; Johnstone & Storr 1998; Johnstone et al. 2010
Erodium spp.		Secondary	Secondary		Johnstone et al. 2010; DoEE 2017
Eucalyptus accedens	Powderbark	-	-	-	-
Eucalyptus caesia	Silver princess	Secondary		Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017; Johnstone 2017
Eucalyptus camaldulensis	River red gum			Secondary	DoEE 2012; DoEE 2017
Eucalyptus decipiens	Red heart/moit			Secondary	Johnstone 2017
Eucalyptus diversicolor	Karri			Primary	Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone & Storr 1998
Eucalyptus erythrocorys	Illyarrie	Secondary		Secondary	DSEWPaC 2012; DoEE 2017; Johnstone 2017, Johnstone et al. 2010
Eucalyptus globulus	Tasmanian blue gum	-	-	-	-
Eucalyptus gomphocephala	Tuart	Secondary		Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eucalyptus grandis	Flooded gum, rose gum			Secondary	DoEE 2012; DoEE 2017

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Eucalyptus lehmannii	Bushy yate			Secondary	Johnstone 2017
Eucalyptus leucoxylon	Yellow gum	Secondary			Groom 2014
Eucalyptus longicornis	Red morrell	-	-	-	-
Eucalyptus loxophleba	York gum	Secondary			Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eucalyptus marginata	Jarrah	Primary	Secondary	Primary	Saunders 1980; Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017; Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone 2017
Eucalyptus megacarpa	Bullich	-	-	-	-
Eucalyptus occidentalis	Swamp yate	-	-	-	-
Eucalyptus patens	Blackbutt	Primary		Primary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone 2017; Groom 2011
Eucalyptus pleurocarpa	Tallerack	Secondary			Groom 2011
Eucalyptus preissiana	Bell-fruited mallee	Secondary			Groom 2011
Eucalyptus robusta	Swamp mahogany	Secondary			Johnstone et al. 2010; Groom 2011
Eucalyptus rudis	Flooded gum	-	-	-	-
Eucalyptus salmonophloia	Salmon gum	Primary			Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DSEWPaC 2012; DoEE 2017
Eucalyptus salubris	Gimlet	-	-	-	-
Eucalyptus staeri	Albany blackbutt			Secondary	Johnstone & Storr 1998
Eucalyptus todtiana	Coastal blackbutt	Secondary			Saunders 1980; Johnstone et al. 2010; Groom 2011; Johnstone & Kirkby 2008
Eucalyptus wandoo	Wandoo	Primary	Secondary	Primary	Saunders 1980; Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Ficus sp.	Fig	Secondary			Groom 2011
Grevillea armigera	Prickly toothbrushes	Primary			Groom 2011
Grevillea bipinnatifida	Fuschia grevillea	Primary			Groom 2011

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Grevillea hookeriana	Red toothbrushes	Primary			Groom 2011
Grevillea hookeriana subsp. api	Black toothbrushes	Primary			Groom 2011
Grevillea paniculata	Kerosene bush	Primary			Groom 2011
Grevillea paradoxa	Bottlebrush grevillea	Primary			Groom 2011
Grevillea petrophiloides	Pink poker	Primary			Groom 2011
Grevillea robusta	Silky oak	Primary			Johnstone et al. 2010; Groom 2011
Grevillea spp.		Primary			Saunders 1979; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Grevillea wilsonii	Native fuchsia		Secondary		Johnstone et al. 2010
Hakea auriculata		Primary			Saunders 1980; Groom 2011
Hakea candolleana		Primary			Groom 2011
Hakea circumalata	Coastal hakea	Primary			Groom 2011
Hakea commutata		Primary			Groom 2011
Hakea conchifolia	Shell-leaved hakea	Primary			Groom 2011
Hakea costata	Ribbed hakea	Primary			Groom 2011
Hakea cristata	Snail hakea	Primary	Secondary		Groom 2011; Johnstone et al. 2010
Hakea cucullata	Snail hakea	Primary			Groom 2011
Hakea cyclocarpa	Ramshorn	Primary			Saunders 1980; Groom 2011
Hakea eneabba		Primary			Groom 2011
Hakea erinacea	Hedgehog hakea	Primary	Secondary		Johnstone et al. 2010; Groom 2011
Hakea falcata	Sickle hakea	Primary			Groom 2011
Hakea flabellifolia	Fan-leaved hakea	Primary			Groom 2011
Hakea gilbertii		Primary			Saunders 1980; Groom 2011
Hakea incrassata	Golfball or marble hakea	Primary			Johnstone et al. 2010; Groom 2011
Hakea lasiantha	Woolly flowered hakea	Primary			Johnstone et al. 2010; Groom 2011
Hakea lasianthoides		Primary	Secondary		Johnstone et al. 2010; Groom 2011
Hakea laurina	Pin-cushion hakea	Primary			Johnstone et al. 2010; Groom 2011
Hakea lissocarpha	Honeybush	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea marginata			Secondary		Johnstone et al. 2010

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Hakea megalosperma	Lesueur hakea	Primary			Groom 2011
Hakea multilineata	Grass leaf hakea	Primary			Groom 2011
Hakea neospathulata		Primary			Groom 2011
Hakea obliqua	Needles and corks	Primary			Saunders 1980; Groom 2011
Hakea oleifolia	Dungyn	Primary			Groom 2011
Hakea pandanicarpa subsp. crassifolia	Thick-leaved hakea	Primary			Groom 2011
Hakea petiolaris	Sea urchin hakea	Primary			Groom 2011
Hakea polyanthema		Primary			Groom 2011
Hakea preissii	Needle tree	Primary			Groom 2011
Hakea prostrata	Harsh hakea	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea psilorrhyncha		Primary			Groom 2011
Hakea ruscifolia	Candle hakea	Primary	Secondary		Saunders 1980; Groom 2011; Johnstone et al. 2010
Hakea scoparia	Kangaroo bush	Primary			Groom 2011
Hakea smilacifolia		Primary			Groom 2011
Hakea spp.		Primary	Secondary		Saunders 1979; DSEWPaC 2012; DoEE 2017
Hakea stenocarpa	Narrow-fruited hakea	Primary	Secondary		Johnstone et al. 2010; Groom 2011
Hakea sulcata	Furrowed hakea	Primary			Groom 2011
Hakea trifurcata	Two-leaved hakea	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea undulata	Wavy-leaved hakea	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea varia	Variable-leaved hakea	Primary	Secondary		Saunders 1980; Groom 2011
Harpephyllum caffrum	Kaffir plum			Secondary	Johnstone 2017
Helianthus annuus	Sunflower	Secondary			Johnstone et al. 2010; Groom 2011
Hibiscus sp.	Hibiscus	Secondary			Groom 2011
Isopogon scabriusculus		Secondary			Groom 2011
Jacaranda mimosifolia	Jacaranda	Secondary	Secondary		Johnstone et al. 2010; Groom 2011

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Jacksonia furcellata	Grey stinkwood	Secondary			Groom 2011
Kingia australis	Kingia		Secondary		Johnstone et al. 2010
Lambertia inermis	Chittick	Secondary			Johnstone & Storr 1998; Groom 2011
Lambertia multiflora	Many-flowered honeysuckle	Secondary			Saunders 1980; Groom 2011
Liquidamber styraciflua	Liquid amber	Primary		Secondary	Johnstone et al. 2010; Groom 2011; Groom 2014; Personal observation
Lupinus sp.	Lupin	Secondary			Saunders 1980; Groom 2011
Macadamia integrifolia	Macadamia	Primary	Secondary		Johnstone et al. 2010; Grooms 2011; Groom 2014
Malus domestica	Apple	Secondary	Secondary		Johnstone et al. 2010; Johnstone & Storr 1998; DSEWPaC 2012; DoEE 2017; Groom 2011
Melaleuca leuropoma		Secondary			Saunders 1980; Groom 2011
Melia azedarach	Cape lilac or white cedar	Secondary		Primary	Johnstone et al. 2010; Groom 2011
Mesomeleana spp.		Secondary			Johnstone et al. 2010; Groom 2011
Olea europea	Olive			Secondary	Johnstone 2017
Persoonia longifolia	Snottygobble			Secondary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Pinus canariensis	Canary island pine	Primary			Johnstone et al. 2010; Groom 2011
Pinus caribea	Caribbean pine	Primary			Johnstone et al. 2010; Groom 2011
Pinus pinaster	Pinaster or maritime pine	Primary			Groom 2011
Pinus radiata	Radiata pine	Primary	Secondary		Johnstone et al. 2010; Groom 2011
Pinus spp.		Primary	Secondary		Johnstone & Storr 1998; Saunders 1979; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Protea 'Pink Ice'		Secondary			Groom 2011
Protea repens		Secondary			Groom 2011
Protea spp.		Secondary			Johnstone et al. 2010

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Prunus amygdalus	Almond tree	Secondary			Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Pyrus communis	European pear		Secondary		Johnstone & Storr 1998; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Quercus spp.	Oak		Secondary		Johnstone et al. 2010
Raphanus raphanistrum	Wild radish	Secondary			Groom 2011; DoEE 2017
Reedia spathacea			Secondary		Johnstone et al. 2010
Rumex hypogaeus	Doublegee	Secondary			Saunders 1980
Stenocarpus sinuatus		Secondary			Johnstone et al. 2010
Syzygium smithii	Lilly pilly	Secondary			Groom 2014
Tipuana tipu	Tipu or rosewood tree	Primary			Groom 2011, Groom 2014
Xanthorrhoea preissii	Grass tree	Secondary	Secondary		Groom 2011; Johnstone et al. 2010
Xylomelum occidentale	Woody pear	Secondary			Groom 2014

CBC=Carnaby's cockatoo, BBC=Baudin's cockatoo and FRTBC=Forest red-tailed black cockatoo

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Appendix C

Black Cockatoo Habitat Quality Assessment (Emerge 2020)

Introduction

As part of environmental impact assessment and offset calculation, the Department of Agriculture, Water and the Environment (DAWE) requires that a score out of ten is provided for the overall quality of back cockatoo habitat within a site (DAWE 2020). DAWE does not provide a methodology for scoring habitat quality, specifying instead that an assessment of quality should be undertaken by an experienced technical expert (DSEWPaC 2012).

Emerge Associates (Emerge) have developed this method to provide a systematic assessment of overall black cockatoo habitat quality. Black cockatoo habitat is conventionally separated into breeding, roosting and foraging categories. Our method assesses and scores the quality of breeding, roosting and foraging habitat separately and then provides an overall quality score (out of ten) based on the highest score determined for the respective habitat categories.

Methodology

The International Organization for Standardization defines 'quality' as the "*degree to which a set of inherent characteristics fulfils requirements*" (ISO 9000 2020). Developing an objective scoring system for quality is therefore challenging, as quality is both relative and, to some extent, subjective. An ecological value like habitat may also have a wide range of characteristics, with varying relevance to the requirements of a species and that may be independent, interdependent or contrasting with other characteristics, such that habitat quality must be assessed holistically to be properly understood.

The three categories of black cockatoo habitat are intrinsically linked in that breeding and roosting activity is directly related to the availability of foraging and watering resources surrounding nests or roosts (Saunders 1990; Shah 2006; Le Roux 2017). Black cockatoos can also move over large distances within their range to access breeding and foraging habitat and will not necessarily return to the same locations within a year or across years (Saunders 1980; Johnstone and Kirkby 2008; Johnstone *et al.* 2017; Peck *et al.* 2019). Therefore, evaluating the overall quality of black cockatoo habitat requires acknowledgement of the relationships between the different habitat categories and the potential for use of all habitats within a site, given the condition of each habitat, the sites' location and the history of use of habitat within a site by black cockatoos.

While breeding, roosting and foraging habitat are interrelated, we suggest that the different habitat categories should not be scored cumulatively as this can overestimate quality. That is, if a site contains multiple categories of habitat it does not necessarily contain greater quality habitat. For example, a site that contains a roost is not necessarily of higher overall quality if it also contains breeding habitat.

Alternatively, averaging the scores from all three habitat categories can act to underestimate habitat, since certain types of habitat are recorded less frequently than others and therefore their absence would act to devalue quality. For example, the likelihood of recording a roost is generally low compared to recording foraging or breeding habitat but a site that lacks a roost is not necessarily of lower overall quality.

Hence, our scoring system selects the highest habitat category score to represent overall habitat quality. Adopting the highest score from any habitat category within a site avoids over or under estimating habitat quality because the most important value always drives, or is reflected in, the overall score.

To provide a score for each habitat category, the following three 'quality components' are considered as recommended by DAWE (DAWE 2020):

- Site condition which is the "*condition of a site in relation to the ecological requirements of a threatened species or ecological community. This includes considerations such as vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features".*
- Site context which is the "*relative importance of a site in terms of its position in the landscape, taking into account the connectivity needs of a threatened species or ecological community. This includes considerations such as movement patterns of the species, the proximity of the site in relation to other areas of suitable habitat, and the role of the site in relation to the overall population or extent of a species or community*".
- Species stocking rate which is the "*usage and/or density of a species at a particular site...It includes considerations such as survey data for a site in regards to a particular species population or, in the case of a threatened ecological community this may be a number of different populations. It also includes consideration of the role of the site population in regards to the overall species population viability or community extent*".

A habitat quality assessment should aim to combine current information on the status of black cockatoos and habitat characteristics within a site with the best available information regarding the status of black cockatoo populations and black cockatoo habitat within areas surrounding a site. Black cockatoo habitat assessments for a given site don't typically allow scope for physical survey of areas surrounding a site and so the ability to obtain new information is usually limited to that which can be obtained within a site. Therefore, we considered that, when assessing the above components, site condition is best defined from a current survey, site context is best defined from literature and relevant databases (Glossop *et al.* 2011; DPaW 2013; DoEE 2016a, c, b; Peck *et al.* 2019) and information on species stocking rate is best obtained from a combination of current survey, previous survey or databases (Glossop *et al.* 2011; DPaW 2013; DoEE 2016a, c, b; Peck *et al.* 2019).

Method

The *Habitat Quality Scale* provided as **Plate 1** outlines the attributes measured within each habitat category and quality component. It also shows the associated quality classification (low, moderate or high) and score (1-10).

As shown in the *Habitat Quality Scale*, the highest scores are reserved for habitat that has active or historical roosts or nests as it is considered that the presence of black cockatoos provides the best indication of the quality of habitat. Foraging habitat is weighted lower than breeding and roosting habitat as the occurrence of roost or nests provides the best confirmation that foraging habitat surrounding a site is adequate and therefore worthy of a higher quality score. Therefore, a maximum

total of ten is achievable for breeding habitat and a total of eight is achievable for both roosting and foraging habitat (refer **Plate 1**).

The *Habitat Scoring Tool* provided as **Plate 2** is an *Excel* spreadsheet document that is used to determine a quality score for each habitat category component by answering queries about habitat within and surrounding the site. A quality score is calculated for each habitat category by summing maximum scores for each query. Because maximum scores are selected, multiple answers may be provided for any query where appropriate without exaggerating the quality score. For key confirmed habitat such as roosts or nests, the scoring tool ensures that relevant, higher scores are achieved irrespective of whether all preceding queries have been answered positively (for example a roost always scores 7 or 8 irrespective of whether other quality criteria have been met).

The highest score from any of the three habitat categories is then adopted as the overall score for black cockatoo habitat quality within the site.

Emerge Black Cockatoo Habitat Quality Assessment - Scale

		Habitat Quality Score									
		Low			Moderate			Moderate - High	High		
	Quality Component	1	2	3	4	5	6	7	8	9	10
Breeding habitat	Site condition	Habitat trees with suitable hollows occur within the site AND / OR habitat trees without suitable hollows occur within the site					Habitat trees with suitable hollows occur within the site			N/A	
	Site context	No nest has been recorded within 12 km of the site AND <100 ha of potential foraging habitat occurs within 6 km of the site	A nest(s) (active, historical or potential) has been recorded within 12 km of the site AND / OR >100 ha of potential native foraging habitat occurs within 6 km of the site				A nest(s) (active, historical or potential) has been recorded within 6 km of the site AND / OR >1000 ha of potential native foraging habitat occurs within 6 km of the site				
	Species stocking rate	No evidence of black cockatoos nesting has been recorded within the site						A potential nest(s) occurs within the site OR a historical nest(s) has been recorded within the site	A Potential nest(s) occurs within the site AND a historical nest(s) has been recorded within the site	An active nest(s) occurs within the site	An active nest(s) occurs within the site AND a historical nest(s) has been recorded within the site
Roosting habitat	Site condition	Trees potentially suitable for roosting occur within the site						N/A			
	Site context	No water source occurs within or nearby the site	A water source occurs within or nearby the site OR no water source occurs within or nearby the site								
		No roost has been recorded within 1 km of the site	A small roost (active or historical) has been recorded within 500 m of the site OR a large roost (active or historical) has been recorded within 1 km of the site OR no roost has been recorded within 1 km of the site								
	Species stocking rate	No roost has been recorded within the site				A small roost (active or historical) has been recorded within the site	A large roost (active or historical) has been recorded within the site	An active small roost occurs within the site	An active large roost occurs within the site		
	Site condition	Foraging habitat with 1-10% primary foraging plants occurs within the site	Foraging habitat with 1-50% primary foraging plants occurs within the site		Foraging habitat with 1-100% primary foraging plants occurs within the site		Foraging habitat with 10-100% primary foraging plants occurs within the site	Foraging habitat with 50-100% primary foraging plants occurs within the site		N/A	
	Site context	No nest or roost has been recorded within 12 km of the site	A nest(s) (active, potential or historical) AND / OR a roost(s) (active or historical) has been recorded within 12 km of the site					A nest(s) (active, potential or historical) has been recorded within 6 km of the site			
	Species stocking rate	No evidence of foraging by black cockatoos has been recorded within the site	Evidence of foraging by black cockatoos may have been recorded within the site (limted or abundant)						Abundant evidence of foraging by black cockatoos has been recorded in the site		

Note that breeding, roosting and foraging habitat are assessed separately and the highest score is the overall quality score.

Black Cockatoo Habitat Scale definitions

'**Habitat tree**' is a native eucalypt that is typically known to support black cockatoo breeding such as marri, jarrah, blackbutt, tuart, wandoo, salmon gum or to a lesser extent flooded gum, with a DBH ≥50 cm or DBH ≥30 cm for wandoo or salmon gum (DSEWPaC 2012).

'**Nest**' is a hollow in which black cockatoo breeding has been recorded. A nest is '**active**' if breeding was recorded within the last 2 years and '**historical**' if breeding was recorded more than 2 years ago. A hollow with potential secondary signs of breeding (e.g. chew marks) or a hollow with potential signs of breeding that could not be attributed to a bird species is a '**potential**' nest.

'**Roost**' is a black cockatoo roost site confirmed by a roost survey (e.g. BirdLife Australia Great Cocky Count). A roost is considered '**large**' if more than 150 individuals were recorded and '**small**' if less than 150 individuals were recorded (BirdLife Australia 2019). A roost is '**active**' if roosting was

'**Primary foraging plants**' are plants with historical and/or contemporary records of regular consumption by black cockatoos, including native and non-native plant species.

Plate 1: Black Cockatoo Habitat Quality Scale

Black Cockatoo Habitat Quality Assessment - Scoring Tool (Carnaby's cockatoo)
<insert site name>

		Query		Answer	Potential score	Site score	Sum
Breeding habitat	**Site condition**	1.1	The site contains:				
			habitat tree(s) with suitable hollow(s)		2.0	0.0	0.0
			habitat tree(s) without suitable hollow(s)		1.0	0.0	
	Site context	1.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)		1.0	0.0	0.0
			6-12 km from a nest(s) (active, historical or potential)		0.5	0.0	
		1.3	The site is located within 6 km of:				
			>1000 ha of potential foraging habitat		3.0	0.0	0.0
			100 to 1000 ha of potential foraging habitat		1.0	0.0	
	Species stocking rate	1.4	The site contains:				
			historical nest(s)		1.0	0	0.0
			The site contains:				
			active nest(s)		3.0	0	
			potential nest(s)		1.0	0	0.0
			Score	0	10.0		
Roosting habitat	**Site condition**	2.1	The site contains trees potentially suitable for roosting		1.0	0.0	0.0
		2.2	The site contains a water source or one exists nearby		1.0	0.0	
	Site context	2.3	The site is located:				
			within 1 km of a large roost (≥150 individuals) (active or historical)		1.0	0.0	0.0
			within 500 m of a small roost (< 150 individuals) (active or historical)		1.0	0.0	
	Species stocking rate	2.4	The site contains:				
			a historical record of a large roost (≥150 individuals)		2.0	0	
			a historical record of a small roost (<150 individuals)		1.0	0	0.0
			The site contains:				
			an active record of a large roost (≥150 individuals)		2.0	0.0	0.0
			an active record of a small roost (<150 individuals)		1.0	0.0	
			Score	0	7.0		
Foraging habitat	**Site condition**	3.1	The site contains foraging habitat comprising:				
			≥50% primary foraging plants		4.0	0.0	0.0
			≥10% to <50% primary foraging plants		2.0	0.0	
			<10% primary foraging plants		1.0	0.0	
	Site context	3.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)		2.0	0.0	0.0
			6-12 km from a nest(s) (active, historical or potential)		1.00	0.0	
		3.3	The site is located:				
			within 6 km of a roost(s) (active or historical)		1.0	0.0	
			6-12 km from a roost(s) (active or historical)		0.5	0.0	
	Species stocking rate	3.4	The site contains:				
			abundant evidence of foraging		2.0	0.0	0.0
			limited evidence of foraging		1.0	0.0	
			Score	0	8.0		

SUMMARY		
Habitat category	**Score**	**Habitat quality**
Breeding	0	No habitat
Roosting	0	No habitat
Foraging	0	No habitat
Overall habitat quality score	**0**	No habitat

Note:
1. Within the breeding category, a score of 9 applies if an active nest(s) occurs within the site and a score of 10 applies if an active nest(s) and a historical nest(s) occurs within the site, regardless of the answer to other queries in this category
2. Within the roosting category, a score of 7 applies if a small roost occurs within the site and a score of 8 applies if a large roost occurs within the site, regardless of the answer to other queries in this category.
3. The final score consists of the highest score from each habitat category

Plate 2: Black Cockatoo Habitat Scoring Tool

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Appendix D

Database Search Results

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 22/01/2021

Kingdom Animalia
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 56' 42" E,32° 07' 04" S
Buffer 10km
Group By Conservation Status

Conservation Status	Species	Records
Non-conservation taxon	440	50037
Other specially protected fauna	3	37
Priority 1	1	4
Priority 2	1	1
Priority 3	7	107
Priority 4	7	471
Protected under international agreement	17	293
Rare or likely to become extinct	12	2599
TOTAL	**488**	**53549**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Rare or likely to become extinct					
1.	24345	*Botaurus poiciloptilus (Australasian Bittern)*		T	
2.	24784	*Calidris ferruginea (Curlew Sandpiper)*		T	
3.	24731	*Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black Cockatoo)*		T	
4.	24733	*Calyptorhynchus baudinii (Baudin's Cockatoo, White-tailed Long-billed Black Cockatoo)*		T	
5.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)*		T	
6.	48400	*Calyptorhynchus sp. (white-tailed black cockatoo)*		T	
7.	25575	*Charadrius leschenaultii (Greater Sand Plover)*		T	
8.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
9.	33983	*Leioproctus douglasiellus (a short-tongued bee)*		T	
10.	24146	*Myrmecobius fasciatus (Numbat, Walpurti)*		T	
11.	33984	*Neopasiphae simplicior (a short-tongued bee)*		T	
12.	34113	*Westralunio carteri (Carter's Freshwater Mussel)*		T	
Protected under international agreement					
13.	41323	*Actitis hypoleucos (Common Sandpiper)*		IA	
14.	25554	*Apus pacificus (Fork-tailed Swift, Pacific Swift)*		IA	
15.	25736	*Arenaria interpres (Ruddy Turnstone)*		IA	
16.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
17.	24786	*Calidris melanotos (Pectoral Sandpiper)*		IA	
18.	24788	*Calidris ruficollis (Red-necked Stint)*		IA	
19.	24789	*Calidris subminuta (Long-toed Stint)*		IA	
20.	47954	*Gelochelidon nilotica (Gull-billed Tern)*		IA	
21.	25741	*Limosa limosa (Black-tailed Godwit)*		IA	
22.	48591	*Pandion cristatus (Osprey, Eastern Osprey)*		IA	
23.	24843	*Plegadis falcinellus (Glossy Ibis)*		IA	
24.	24382	*Pluvialis fulva (Pacific Golden Plover)*		IA	
25.	24383	*Pluvialis squatarola (Grey Plover)*		IA	
26.	24516	*Stercorarius longicaudus (long-tailed jaeger, long-tailed skua)*		IA	
27.	24806	*Tringa glareola (Wood Sandpiper)*		IA	
28.	24808	*Tringa nebularia (Common Greenshank, greenshank)*		IA	
29.	24809	*Tringa stagnatilis (Marsh Sandpiper, little greenshank)*		IA	
Other specially protected fauna					
30.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
31.	24475	*Falco peregrinus subsp. macropus (Australian Peregrine Falcon)*		S	
32.	48070	*Phascogale tapoatafa subsp. wambenger (South-western Brush-tailed Phascogale, Wambenger)*		S	

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Priority 1					
33.	33994	*Throscodectes xiphos (Stylet Bush Cricket, Stylet Throsco (Jandakot))*		P1	Y
Priority 2					
34.	33971	*Austroconops mcmillani (McMillan's biting midge (Swan Coastal Plain), biting midge (southwest))*		P2	
Priority 3					
35.	25242	*Acanthophis antarcticus (Southern Death Adder)*		P3	
36.	41641	*Ctenotus ora (Coastal Plains Skink)*		P3	
37.	48579	*Euoplos inornatus (inornate trapdoor spider (northern Jarrah Forest))*		P3	
38.	48935	*Idiosoma sigillatum (Swan Coastal Plain shield-backed trapdoor spider)*		P3	
39.	33982	*Leioproctus contrarius (a short-tongued bee)*		P3	
40.	25147	*Lerista lineata (Perth Slider, Lined Skink)*		P3	
41.	25249	*Neelaps calonotos (Black-striped Snake, black-striped burrowing snake)*		P3	
Priority 4					
42.	25035	*Ctenotus delli (Dell's skink, Darling Range southwest Ctenotus)*		P4	
43.	24215	*Hydromys chrysogaster (Water-rat, Rakali)*		P4	
44.	48588	*Isoodon fusciventer (Quenda, southwestern brown bandicoot)*		P4	
45.	47975	*Ixobrychus dubius (Australian Little Bittern)*		P4	
46.	48022	*Notamacropus irma (Western Brush Wallaby)*		P4	
47.	24328	*Oxyura australis (Blue-billed Duck)*		P4	
48.	33992	*Synemon gratiosa (Graceful Sunmoth)*		P4	
Non-conservation taxon					
49.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
50.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
51.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
52.	24262	*Acanthiza inornata (Western Thornbill)*			
53.	24560	*Acanthorhynchus superciliosus (Western Spinebill)*			
54.		*Acariformes sp.*			
55.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
56.	24281	*Accipiter cirrocephalus subsp. cirrocephalus (Collared Sparrowhawk)*			
57.	25536	*Accipiter fasciatus (Brown Goshawk)*			
58.	24283	*Accipiter fasciatus subsp. didimus (Brown Goshawk)*			
59.	24282	*Accipiter fasciatus subsp. fasciatus (Brown Goshawk)*			
60.	42368	*Acritoscincus trilineatus (Western Three-lined Skink)*			
61.	25755	*Acrocephalus australis (Australian Reed Warbler)*			
62.	24831	*Acrocephalus australis subsp. gouldi (Australian Reed Warbler)*			
63.	24301	*Aegotheles cristatus subsp. cristatus (Australian Owlet-nightjar)*			
64.		*Akamptogonus novarae*			
65.		*Aname mainae*			
66.		*Aname tepperi*			
67.	24310	*Anas castanea (Chestnut Teal)*			
68.	24312	*Anas gracilis (Grey Teal)*			
69.	24313	*Anas platyrhynchos (Mallard)*			
70.		*Anas platyrhynchos subsp. domesticus*			
71.	24315	*Anas rhynchotis (Australasian Shoveler)*			
72.	24316	*Anas superciliosa (Pacific Black Duck)*			
73.		*Ancylidae sp.*			
74.	47414	*Anhinga novaehollandiae (Australasian Darter)*			
75.	44629	*Anilios australis*			
76.		*Anser anser*			
77.	25241	*Antaresia stimsoni subsp. stimsoni (Stimson's Python)*			
78.	25449	*Antechinus flavipes (Yellow-footed Antechinus)*			
79.	24088	*Antechinus flavipes subsp. leucogaster (Yellow-footed Antechinus, Mardo)*			
80.	24561	*Anthochaera carunculata (Red Wattlebird)*			
81.	24562	*Anthochaera lunulata (Western Little Wattlebird)*			
82.	24990	*Aprasia pulchella (Granite Worm-lizard)*			
83.	24991	*Aprasia repens (Sand-plain Worm-lizard)*			
84.	24285	*Aquila audax (Wedge-tailed Eagle)*			
85.		*Arachnura higginsi*			
86.		*Araneus senicaudatus*			
87.	24337	*Ardea garzetta subsp. nigripes (Little Egret)*			
88.	25558	*Ardea ibis (Cattle Egret)*			
89.	41324	*Ardea modesta (great egret, white egret)*			
90.	24340	*Ardea novaehollandiae (White-faced Heron)*			
91.	24341	*Ardea pacifica (White-necked Heron)*			
92.		*Argiope protensa*			
93.		*Argiope trifasciata*			
94.	25566	*Artamus cinereus (Black-faced Woodswallow)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
95.	24352	*Artamus cinereus subsp. melanops (Black-faced Woodswallow)*			
96.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
97.	24356	*Artamus personatus (Masked Woodswallow)*			
98.		*Artamus sordidus*			
99.		*Artoria flavimana*			
100.		*Artoria linnaei*			
101.		*Artoria taeniifera*			
102.		*Asadipus kunderang*			
103.		*Atherinosoma wallacei*			
104.		*Austracantha minax*			
105.	47713	*Austronomus australis (White-striped Free-tailed Bat)*			
106.	24318	*Aythya australis (Hardhead)*			
107.		*Backobourkia heroine*			
108.		*Baetidae sp.*			
109.		*Ballarra longipalpus*			
110.		*Barnardius zonarius*			
111.	24319	*Biziura lobata (Musk Duck)*			
112.		*Bostockia porosa*			
113.	42381	*Brachyurophis semifasciatus (Southern Shovel-nosed Snake)*			
114.	24359	*Burhinus grallarius (Bush Stone-curlew)*			
115.	25713	*Cacatua galerita (Sulphur-crested Cockatoo)*			
116.	25714	*Cacatua pastinator (Western Long-billed Corella)*			
117.	25715	*Cacatua roseicapilla (Galah)*			
118.	25716	*Cacatua sanguinea (Little Corella)*			
119.	24729	*Cacatua tenuirostris (Eastern Long-billed Corella)*	Y		
120.	25598	*Cacomantis flabelliformis (Fan-tailed Cuckoo)*			
121.	24427	*Cacomantis flabelliformis subsp. flabelliformis (Fan-tailed Cuckoo)*			
122.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
123.		*Caenidae sp.*			
124.	25717	*Calyptorhynchus banksii (Red-tailed Black-Cockatoo)*			
125.		*Celaenia excavata*			
126.		*Ceratopogonidae sp.*			
127.	24086	*Cercartetus concinnus (Western Pygmy-possum, Mundarda)*			
128.		*Cercophonius sulcatus*			
129.		*Ceryerda cursitans*			
130.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
131.	24187	*Chalinolobus morio (Chocolate Wattled Bat)*			
132.	24377	*Charadrius ruficapillus (Red-capped Plover)*			
133.	43380	*Chelodina colliei (South-western Snake-necked Turtle)*			
134.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
135.	47909	*Cheramoeca leucosterna (White-backed Swallow)*			
136.	33939	*Cherax cainii (Marron)*			
137.		*Cherax destructor*			
138.		*Cherax preissii*			
139.		*Cherax quinquecarinatus*			
140.		*Cherax sp.*			
141.		*Chironominae sp.*			
142.	24980	*Christinus marmoratus (Marbled Gecko)*			
143.		*Chroicocephalus novaehollandiae*			
144.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
145.	25601	*Chrysococcyx lucidus (Shining Bronze Cuckoo)*			
146.	24432	*Chrysococcyx lucidus subsp. plagosus (Shining Bronze Cuckoo)*			
147.	24288	*Circus approximans (Swamp Harrier)*			
148.	24289	*Circus assimilis (Spotted Harrier)*			
149.	24774	*Cladorhynchus leucocephalus (Banded Stilt)*			
150.		*Clynotis severus*			
151.		*Coenagrionidae sp.*			
152.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
153.	24399	*Columba livia (Domestic Pigeon)*	Y		
154.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
155.	24362	*Coracina novaehollandiae subsp. novaehollandiae (Black-faced Cuckoo-shrike)*			
156.		*Corixidae sp.*			
157.		*Cormocephalus aurantiipes*			
158.		*Cormocephalus rubriceps*			
159.	24416	*Corvus bennetti (Little Crow)*			
160.	25592	*Corvus coronoides (Australian Raven)*			
161.	24417	*Corvus coronoides subsp. perplexus (Australian Raven)*			
162.	24671	*Coturnix pectoralis (Stubble Quail)*			
163.	25701	*Coturnix ypsilophora (Brown Quail)*			
164.	24673	*Coturnix ypsilophora subsp. australis (Brown Quail)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
165.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
166.	25595	*Cracticus tibicen (Australian Magpie)*			
167.	24422	*Cracticus tibicen subsp. dorsalis (White-backed Magpie)*			
168.	24423	*Cracticus tibicen subsp. tibicen (Black-backed Magpie)*			
169.	25596	*Cracticus torquatus (Grey Butcherbird)*			
170.	24424	*Cracticus torquatus subsp. torquatus (Grey Butcherbird)*			
171.	24918	*Crenadactylus ocellatus subsp. ocellatus (Clawless Gecko)*			
172.	25398	*Crinia georgiana (Quacking Frog)*			
173.	25399	*Crinia glauerti (Clicking Frog)*			
174.	25400	*Crinia insignifera (Squelching Froglet)*			
175.	25401	*Crinia pseudinsignifera (Bleating Froglet)*			
176.	30893	*Cryptoblepharus buchananii*			
177.	25020	*Cryptoblepharus plagiocephalus*			
178.		*Cryptoerithus quobba*			
179.	30899	*Ctenophorus adelaidensis (Southern Heath Dragon, Western Heath Dragon)*			
180.	24883	*Ctenophorus ornatus (Ornate Crevice-Dragon)*			
181.	25027	*Ctenotus australis*			
182.	25039	*Ctenotus fallens*			
183.	25040	*Ctenotus gemmula (Jewelled South-west Ctenotus (Swan Coastal Plain subpop P3), skink)*			
184.	25047	*Ctenotus impar*			
185.	25049	*Ctenotus labillardieri*			
186.		*Cyclosa trilobata*			
187.	24322	*Cygnus atratus (Black Swan)*			
188.	24323	*Cygnus olor (Mute Swan)*	Y		
189.	30901	*Dacelo novaeguineae (Laughing Kookaburra)*	Y		
190.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
191.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
192.	24999	*Delma grayii*			
193.	25468	*Demansia psammophis (Yellow-faced Whipsnake)*			
194.	25296	*Demansia psammophis subsp. reticulata (Yellow-faced Whipsnake)*			
195.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
196.		*Dingosa serrata*			
197.		*Dinocambala ingens*			
198.	24929	*Diplodactylus granariensis subsp. granariensis*			
199.	44654	*Diplodactylus lateroides (Speckled Stone Gecko)*			
200.	24939	*Diplodactylus polyophthalmus*			
201.	24940	*Diplodactylus pulcher*			
202.		*Dytiscidae sp.*			
203.	25251	*Echiopsis curta (Bardick)*			
204.	25096	*Egernia kingii (King's Skink)*			
205.	25100	*Egernia napoleonis*			
206.		*Egretta garzetta*			
207.		*Egretta novaehollandiae*			
208.		*Elanus axillaris*			
209.	25540	*Elanus caeruleus (Black-shouldered Kite)*			
210.	24290	*Elanus caeruleus subsp. axillaris (Australian Black-shouldered Kite)*			
211.	25250	*Elapognathus coronatus (Crowned Snake)*			
212.	47937	*Elseyornis melanops (Black-fronted Dotterel)*			
213.		*Eodelena convexa*			
214.		*Eodelena lapidicola*			
215.		*Eolophus roseicapillus*			
216.	24652	*Eopsaltria georgiana (White-breasted Robin)*			
217.	24567	*Epthianura albifrons (White-fronted Chat)*			
218.		*Eriophora biapicata*			
219.		*Erythracarus decoris*			
220.	24379	*Erythrogonys cinctus (Red-kneed Dotterel)*			
221.		*Eucyrtops latior*			
222.	24368	*Eurostopodus argus (Spotted Nightjar)*			
223.	25621	*Falco berigora (Brown Falcon)*			
224.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
225.	24472	*Falco cenchroides subsp. cenchroides (Australian Kestrel, Nankeen Kestrel)*			
226.	25623	*Falco longipennis (Australian Hobby)*			
227.	24474	*Falco longipennis subsp. longipennis (Australian Hobby)*			
228.	24041	*Felis catus (Cat)*	Y		
229.	25727	*Fulica atra (Eurasian Coot)*			
230.	24761	*Fulica atra subsp. australis (Eurasian Coot)*			
231.	30916	*Funambulus pennanti (Indian Palm Squirrel)*	Y		
232.	34028	*Galaxias occidentalis (Western Minnow)*			
233.	25729	*Gallinula tenebrosa (Dusky Moorhen)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
234.	24763	*Gallinula tenebrosa subsp. tenebrosa (Dusky Moorhen)*			
235.	25730	*Gallirallus philippensis (Buff-banded Rail)*			
236.	24765	*Gallirallus philippensis subsp. mellori (Buff-banded Rail)*			
237.		*Gallus gallus*			
238.	42314	*Gavicalis virescens (Singing Honeyeater)*			
239.		*Gea theridioides*			
240.	24959	*Gehyra variegata*			
241.	25404	*Geocrinia leai (Ticking Frog)*			
242.	25530	*Gerygone fusca (Western Gerygone)*			
243.	24271	*Gerygone fusca subsp. fusca (Western Gerygone)*			
244.		*Glossiphoniidae sp.*			
245.	47962	*Glyciphila melanops (Tawny-crowned Honeyeater)*			
246.		*Gomphidae sp.*			
247.	24443	*Grallina cyanoleuca (Magpie-lark)*			
248.		*Gripopterygidae sp.*			
249.		*Gyrinidae sp.*			
250.	24487	*Haematopus longirostris (Pied Oystercatcher)*			
251.	24293	*Haliaeetus leucogaster (White-bellied Sea-Eagle)*			
252.	24295	*Haliastur sphenurus (Whistling Kite)*			
253.	25410	*Heleioporus eyrei (Moaning Frog)*			
254.	25412	*Heleioporus psammophilus (Sand Frog)*			
255.	25115	*Hemiergis initialis subsp. initialis*			
256.	25119	*Hemiergis quadrilineata*			
257.		*Henicops dentatus*			
258.	47965	*Hieraaetus morphnoides (Little Eagle)*			
259.	25734	*Himantopus himantopus (Black-winged Stilt)*			
260.	24491	*Hirundo neoxena (Welcome Swallow)*			
261.		*Hydrometridae sp.*			
262.		*Hydrophilidae sp.*			
263.		*Hydropsychidae sp.*			
264.		*Hydroptilidae sp.*			
265.		*Hyriidae sp.*			
266.		*Idiommata blackwalli*			
267.		*Isometroides vescus*			
268.		*Isopeda leishmanni*			
269.		*Ixodes australiensis*			
270.		*Karaops ellenae*			
271.	24367	*Lalage tricolor (White-winged Triller)*			
272.		*Lampona cylindrata*			
273.	24511	*Larus novaehollandiae subsp. novaehollandiae (Silver Gull)*			
274.		*Latrodectus hasseltii*			
275.		*Leiopotherapon unicolor*			
276.		*Leptoceridae sp.*			
277.		*Leptophlebiidae sp.*			
278.	25131	*Lerista distinguenda*			
279.	25133	*Lerista elegans*			
280.	25005	*Lialis burtonis*			
281.		*Libellulidae sp.*			
282.	25661	*Lichmera indistincta (Brown Honeyeater)*			
283.	25415	*Limnodynastes dorsalis (Western Banjo Frog)*			
284.	25378	*Litoria adelaidensis (Slender Tree Frog)*			
285.	25388	*Litoria moorei (Motorbike Frog)*			
286.	25683	*Lonchura castaneothorax (Chestnut-breasted Mannikin)*			
287.		*Longepi woodman*			
288.		*Longrita insidiosa*			
289.		*Lophoictinia isura*			
290.		*Lycosa ariadnae*			
291.		*Lycosa gilberta*			
292.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
293.	24326	*Malacorhynchus membranaceus (Pink-eared Duck)*			
294.	25650	*Malurus elegans (Red-winged Fairy-wren)*			
295.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
296.	25654	*Malurus splendens (Splendid Fairy-wren)*			
297.	24583	*Manorina flavigula (Yellow-throated Miner)*			
298.		*Maratus pavonis*			
299.		*Marsupiopus antechinus*			
300.	25758	*Megalurus gramineus (Little Grassbird)*			
301.	47997	*Melanodryas cucullata (Hooded Robin)*			
302.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
303.	24586	*Melithreptus brevirostris subsp. leucogenys (Brown-headed Honeyeater)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
304.	24587	*Melithreptus chloropsis (Western White-naped Honeyeater)*			
305.	24736	*Melopsittacus undulatus (Budgerigar)*			
306.	25184	*Menetia greyii*			
307.	24598	*Merops ornatus (Rainbow Bee-eater)*			
308.		*Microcarbo melanoleucos*			
309.	25693	*Microeca fascinans (Jacky Winter)*			
310.	25542	*Milvus migrans (Black Kite)*			
311.		*Missulena granulosa*			
312.		*Missulena hoggi*			
313.		*Missulena occatoria*			
314.		*Mituliodon tarantulinus*			
315.		*Mitzoruga insularis*			
316.	25240	*Morelia spilota subsp. imbricata (Carpet Python)*			
317.	25191	*Morethia lineoocellata*			
318.	25192	*Morethia obscura*			
319.	24223	*Mus musculus (House Mouse)*	Y		
320.	25610	*Myiagra inquieta (Restless Flycatcher)*			
321.	25420	*Myobatrachus gouldii (Turtle Frog)*			
322.		*Nannoperca vittata*			
323.	25248	*Neelaps bimaculatus (Black-naped Snake)*			
324.	25686	*Neochmia temporalis (Red-browed Finch)*	Y		
325.	24738	*Neophema elegans (Elegant Parrot)*			
326.		*Nephila edulis*			
327.		*Nicodamus mainae*			
328.	25747	*Ninox connivens (Barking Owl)*			
329.	25252	*Notechis scutatus (Tiger Snake)*			
330.		*Notiasemus glauerti*			
331.		*Notonectidae sp.*			
332.		*Nunciella aspera*			
333.	25564	*Nycticorax caledonicus (Rufous Night Heron)*			
334.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
335.	41424	*Nyctophilus major (Greater Long-eared Bat)*			
336.	24742	*Nymphicus hollandicus (Cockatiel)*			
337.		*Ocrisiona leucocomis*			
338.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
339.		*Oligochaeta sp.*			
340.		*Ommatoiulus moreleti*			
341.		*Ommatoiulus moreletii*			
342.		*Orthocladiinae sp.*			
343.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
344.		*Oxidus gracilis*			
345.		*Oxyopes gracilipes*			
346.		*Oxyopes punctatus*			
347.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
348.	24624	*Pachycephala rufiventris subsp. rufiventris (Rufous Whistler)*			
349.		*Palaemonidae sp.*			
350.		*Paralampona marangaroo*			
351.		*Parastacidae sp.*			
352.	25253	*Parasuta gouldii*			
353.	25255	*Parasuta nigriceps*			
354.	25681	*Pardalotus punctatus (Spotted Pardalote)*			
355.	24625	*Pardalotus punctatus subsp. punctatus (Spotted Pardalote)*			
356.	25682	*Pardalotus striatus (Striated Pardalote)*			
357.	24630	*Pardalotus striatus subsp. westraliensis (Striated Pardalote)*			
358.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
359.	48060	*Petrochelidon ariel (Fairy Martin)*			
360.	48061	*Petrochelidon nigricans (Tree Martin)*			
361.	48066	*Petroica boodang (Scarlet Robin)*			
362.	24659	*Petroica goodenovii (Red-capped Robin)*			
363.	25697	*Phalacrocorax carbo (Great Cormorant)*			
364.	25698	*Phalacrocorax melanoleucos (Little Pied Cormorant)*			
365.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
366.	25699	*Phalacrocorax varius (Pied Cormorant)*			
367.	24409	*Phaps chalcoptera (Common Bronzewing)*			
368.	25587	*Phaps elegans (Brush Bronzewing)*			
369.		*Phenasteron longiconductor*			
370.		*Phryganoporus candidus*			
371.	48071	*Phylidonyris niger (White-cheeked Honeyeater)*			
372.	24596	*Phylidonyris novaehollandiae (New Holland Honeyeater)*			
373.		*Physidae sp.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
374.		*Pinkfloydia harveii*			
375.		*Planorbidae sp.*			
376.	24841	*Platalea flavipes (Yellow-billed Spoonbill)*			
377.	24842	*Platalea regia (Royal Spoonbill)*			
378.	25720	*Platycercus icterotis (Western Rosella)*			
379.	24745	*Platycercus icterotis subsp. icterotis (Western Rosella)*			
380.	24747	*Platycercus spurius (Red-capped Parrot)*			
381.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
382.	24750	*Platycercus zonarius subsp. semitorquatus (Twenty-eight Parrot)*			
383.	24751	*Platycercus zonarius subsp. zonarius (Port Lincoln Parrot)*			
384.	25509	*Pletholax gracilis (Keeled Legless Lizard)*			
385.	25007	*Pletholax gracilis subsp. gracilis (Keeled Legless Lizard)*			
386.	25703	*Podargus strigoides (Tawny Frogmouth)*			
387.	24679	*Podargus strigoides subsp. brachypterus (Tawny Frogmouth)*			
388.	25704	*Podiceps cristatus (Great Crested Grebe)*			
389.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
390.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
391.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
392.		*Poltys laciniosus*			
393.		*Polygonarea repanda*			Y
394.	25722	*Polytelis anthopeplus (Regent Parrot)*			
395.	25731	*Porphyrio porphyrio (Purple Swamphen)*			
396.	24767	*Porphyrio porphyrio subsp. bellus (Purple Swamphen)*			
397.	24769	*Porzana fluminea (Australian Spotted Crake)*			
398.	25732	*Porzana pusilla (Baillon's Crake)*			
399.	24770	*Porzana pusilla subsp. palustris (Baillon's Crake)*			
400.	24771	*Porzana tabuensis (Spotless Crake)*			
401.		*Prionosternum scutatum*			
402.	25261	*Pseudechis australis (Mulga Snake)*			
403.	25511	*Pseudonaja affinis (Dugite)*			
404.	25259	*Pseudonaja affinis subsp. affinis (Dugite)*			
405.	42416	*Pseudonaja mengdeni (Western Brown Snake)*			
406.	25433	*Pseudophryne guentheri (Crawling Toadlet)*			
407.	48085	*Psittacula krameri (Indian Ringnecked Parrot, Rose-ringed Parakeet)*	Y		
408.	24702	*Pterodroma brevirostris (Kerguelen Petrel)*			
409.	24703	*Pterodroma lessonii (White-headed Petrel)*			
410.	25710	*Pterodroma macroptera (Great-winged Petrel)*			
411.	24173	*Pteropus scapulatus (Little Red Flying-fox)*			
412.	24711	*Puffinus assimilis subsp. assimilis (Little Shearwater)*			
413.		*Purpureicephalus spurius*			
414.	25008	*Pygopus lepidopodus (Common Scaly Foot)*			
415.	24245	*Rattus rattus (Black Rat)*	Y		
416.		*Raveniella cirrata*			
417.		*Raveniella peckorum*			
418.	24776	*Recurvirostra novaehollandiae (Red-necked Avocet)*			
419.	48096	*Rhipidura albiscapa (Grey Fantail)*			
420.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
421.	24454	*Rhipidura leucophrys subsp. leucophrys (Willie Wagtail)*			
422.		*Richardsonianidae sp.*			
423.		*Scolopendra laeta*			
424.		*Scolopendra morsitans*			
425.	25534	*Sericornis frontalis (White-browed Scrubwren)*			
426.	24279	*Sericornis frontalis subsp. maculatus (White-browed Scrubwren)*			
427.	25266	*Simoselaps bertholdi (Jan's Banded Snake)*			
428.		*Simuliidae sp.*			
429.	30948	*Smicrornis brevirostris (Weebill)*			
430.	24111	*Sminthopsis gilberti (Gilbert's Dunnart)*			
431.		*Sminthopsis murina*			
432.		*Sphaerotrichopus ramosus*			
433.	24645	*Stagonopleura oculata (Red-eared Firetail)*			
434.		*Steatoda grossa*			
435.	24329	*Stictonetta naevosa (Freckled Duck)*			
436.		*Storena formosa*			
437.	25597	*Strepera versicolor (Grey Currawong)*			
438.	25589	*Streptopelia chinensis (Spotted Turtle-Dove)*	Y		
439.	30951	*Streptopelia chinensis subsp. tigrina (Spotted Turtle-Dove)*	Y		
440.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
441.	30950	*Streptopelia senegalensis subsp. senegalensis (Laughing Turtle-Dove)*	Y		
442.	24943	*Strophurus spinigerus subsp. inornatus*			
443.		*Supunna funerea*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
444.		*Supunna picta*			
445.		*Synothele durokoppin*			
446.		*Synothele rastelloides*			
447.		*Tabanidae sp.*			
448.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
449.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
450.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
451.	24331	*Tadorna tadornoides (Australian Shelduck, Mountain Duck)*			
452.		*Tamopsis perthensis*			
453.		*Tandanus bostocki*			
454.		*Tanypodinae sp.*			
455.	24167	*Tarsipes rostratus (Honey Possum, Noolbenger)*			
456.		*Tasmanicosa leuckartii*			
457.		*Tetragnatha demissa*			
458.	48136	*Threskiornis moluccus (Australian White Ibis)*			
459.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
460.	25203	*Tiliqua occipitalis (Western Bluetongue)*			
461.	25519	*Tiliqua rugosa*			
462.	25204	*Tiliqua rugosa subsp. aspera*			
463.	25207	*Tiliqua rugosa subsp. rugosa*			
464.		*Tipulidae sp.*			
465.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
466.	24309	*Todiramphus sanctus subsp. sanctus (Sacred Kingfisher)*			
467.	48141	*Tribonyx ventralis (Black-tailed Native-hen)*			
468.	25723	*Trichoglossus haematodus (Rainbow Lorikeet)*			
469.	24755	*Trichoglossus haematodus subsp. moluccanus (Rainbow Lorikeet)*	Y		
470.	25521	*Trichosurus vulpecula (Common Brushtail Possum)*			
471.	24158	*Trichosurus vulpecula subsp. vulpecula (Common Brushtail Possum)*			
472.	48147	*Turnix varius (Painted Button-quail)*			
473.	24852	*Tyto alba subsp. delicatula (Barn Owl)*			
474.	24983	*Underwoodisaurus milii (Barking Gecko)*			
475.		*Urocampus carinirostris*			
476.		*Urodacus novaehollandiae*			
477.		*Urodacus planimanus*			
478.		*Urodacus woodwardii*			
479.	25577	*Vanellus miles (Masked Lapwing)*			
480.	24386	*Vanellus tricolor (Banded Lapwing)*			
481.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
482.	25225	*Varanus rosenbergi (Heath Monitor)*			
483.	25526	*Varanus tristis (Racehorse Monitor)*			
484.		*Venator immansueta*			
485.	24206	*Vespadelus regulus (Southern Forest Bat)*			
486.	24040	*Vulpes vulpes (Red Fox)*	Y		
487.		*Withius piger*			
488.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

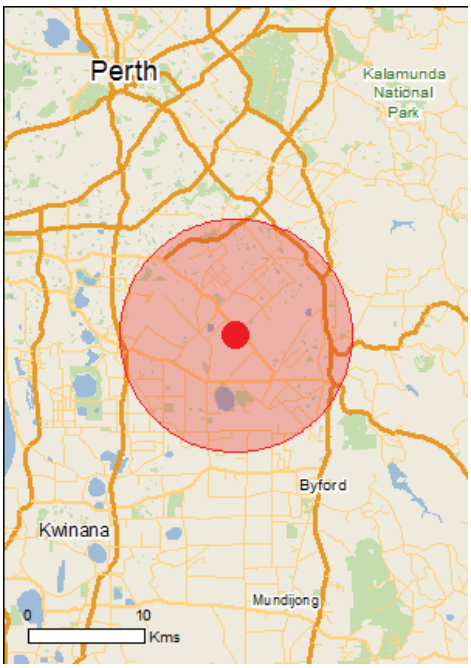
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 14/10/20 15:04:16

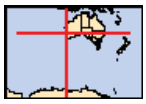
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



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Coordinates
Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	64
Listed Migratory Species:	36

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	46
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	9
Regional Forest Agreements:	1
Invasive Species:	44
Nationally Important Wetlands:	3
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Forrestdale and thomsons lakes	Within Ramsar site
Peel-yalgorup system	40 - 50km upstream

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area
Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain	Endangered	Community known to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Roosting known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Insects		
Leioproctus douglasiellus a short-tongued bee [66756]	Critically Endangered	Species or species habitat known to occur within area
Neopasiphae simplicior A native bee [66821]	Critically Endangered	Species or species habitat likely to occur within area
Mammals		
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat may occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat likely to occur within area
Other		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat known to occur within area
Anthocercis gracilis Slender Tailflower [11103]	Vulnerable	Species or species habitat may occur within area
Austrostipa bronwenae [87808]	Endangered	Species or species habitat may occur within area
Austrostipa jacobsiana [87809]	Critically Endangered	Species or species habitat known to occur within area
Banksia mimica Summer Honeypot [82765]	Endangered	Species or species habitat likely to occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area
Calytrix breviseta subsp. breviseta Swamp Starflower [23879]	Endangered	Species or species habitat likely to occur within area
Conospermum undulatum Wavy-leaved Smokebush [24435]	Vulnerable	Species or species habitat likely to occur within area
Darwinia apiculata Scarp Darwinia [8763]	Endangered	Species or species habitat known to occur within area
Diplolaena andrewsii [6601]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat known to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat known to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat known to occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved	Endangered	Species or species

Name	Status	Type of Presence
Hammer Orchid, Warty Hammer Orchid [16753]		habitat known to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat known to occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat known to occur within area
Eremophila glabra subsp. chlorella [84927]	Endangered	Species or species habitat likely to occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat known to occur within area
Goodenia arthrotricha [12448]	Endangered	Species or species habitat likely to occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat may occur within area
Grevillea thelemanniana Spider Net Grevillea [32835]	Critically Endangered	Species or species habitat known to occur within area
Lasiopetalum pterocarpum Wing-fruited Lasiopetalum [64922]	Endangered	Species or species habitat may occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat known to occur within area
Macarthuria keigheryi Keighery's Macarthuria [64930]	Endangered	Species or species habitat likely to occur within area
Ptilotus pyramidatus Pyramid Mulla-mulla [18216]	Critically Endangered	Species or species habitat known to occur within area
Synaphea sp. Fairbridge Farm (D. Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat likely to occur within area
Synaphea sp. Pinjarra Plain (A.S. George 17182) [86878]	Endangered	Species or species habitat likely to occur within area
Synaphea sp. Serpentine (G.R. Brand 103) [86879]	Critically Endangered	Species or species habitat known to occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat may occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Migratory Marine Species		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area

Name	Threatened	Type of Presence
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Pandion haliaetus		
Osprey [952]		Breeding known to occur within area
Philomachus pugnax		
Ruff (Reeve) [850]		Roosting known to occur within area
Recurvirostra novaehollandiae		
Red-necked Avocet [871]		Roosting known to occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Thinornis rubricollis		
Hooded Plover [59510]		Species or species habitat likely to occur within area
Tringa glareola		
Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Mammals		
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Balannup Lake	WA
Canning River	WA
Forrestdale Lake	WA
Gibbs Road	WA
Kenwick Wetlands	WA
Piara	WA
Unnamed WA42044	WA
Unnamed WA49299	WA
Unnamed WA49363	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Brixton Street Swamps	WA
Forrestdale Lake	WA
Gibbs Road Swamp System	WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-32.11764 115.94507

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-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
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Appendix E

Conservation Significant Species and Likelihood of Occurrence Assessment

Species	Common name	Level of		Habitat	Likelihood of occurrence
		BC Act	EPBC Act		
Birds					
Anous tenuirostris melanops	*Australian lesser noddy*	EN	VU	Very common in blue-water seas around the Abrolhos (endemic to this area, accidental occurrences on lower west coast of Australia) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Apus pacificus	*Pacific swift*	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Pizzey & Knight 2012).	**Possible** May opportunistically occur in or fly over the site on commute or while searching for prey.
Arenaria interpres	*Ruddy turnstone*	MI	MI	Tidal mud and reef flats, sheltered rocky coasts, stony and seaweedy beaches and sandpits, dry coral ridges (Abrolhos) and pebbly shores of near-coastal saltlakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Botaurus poiciloptilus	*Australasian bittern*	EN	EN	In or over water, in tall reedbeds, sedges, rushes, cumbungi, lignum. Also occurs in ricefields, drains in tussocky paddocks and occasionally in saltmarshes and brackish wetlands.	**Unlikely** No suitable habitat
Calidris acuminata	*Sharp-tailed sandpiper*	MI	MI	Occurs in tidal mudflats, saltmarshes and mangroves, as well as, shallow fresh,brackish or saline inland wetlands. It is also known from floodwaters, irrigated pastures and crops, sewage ponds, saltfields.	**Unlikely** No suitable habitat
Calidris canutus	*Red knot*	EN	EN (MI)	Mud and sand flats in estuaries and on sheltered coasts. Also near-coastal saltlakes, including saltwork ponds.	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Calidris ferruginea	*Curlew sandpiper*	CR	CR (MI)	Mainly shallows of estuaries and near-coastal saltlakes (including saltwork ponds) and drying near-coastal freshwater lakes and swamps. Also beaches and near-coastal sewage ponds.	**Unlikely** No suitable habitat
Calidris melanotos	*Pectoral sandpiper*	MI	MI	Mainly fresh waters (swamps, lagoons, river pools, irrigation channels and sewage ponds); also samphire flats around estuaries and saltlakes (Johnstone & Storr 1998).	**Unlikely** No suitable habitat
Calidris ruficollis	*Red-necked stint*	MI	MI	Tidal mudflats, saltmarshes, sandy or shelly beaches, saline and freshwater wetlands (coastal and inland), saltfields, sewage ponds (Pizzey and Knight 2012).	**Unlikely** No suitable habitat
Calidris subminuta	*Long-toed stint*	MI	MI	Mainly freshwater swamps (especially when drying and where vegetation is short), river pools, lagoons and claypans; also brackish pools, sewage ponds and samphire flats around estuaries and saltlakes.	**Unlikely** No suitable habitat
Calidris tenuirostris	*Great knot*	CR	CR (MI)	Mud or sand flats in estuaries and on sheltered coasts. Also near-coastal saltlakes, including saltwork ponds.	**Unlikely** No suitable habitat
Calyptorhynchus banksii naso	*Forest red-tailed black cockatoo*	VU	VU	Eucalypt and Corymbia forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding Corymbia calophylla, Eucalyptus marginata, introduced Melia azdarach and Eucalyptus spp. trees.	**Likely** Several records of the species in close proximity (<2 km) to the site and there is foraging habitat present within the site.

		BC Act	EPBC Act		
Calyptorhynchus baudinii	*Baudin's cockatoo*	EN	EN	Mainly eucalypt forests. Attracted to seeding Corymbia calophylla, Banksia spp., Hakea spp., and to fruiting apples and pears (Johnstone and Storr 1998).	**Possible** Species known to occur within the broader area and there is limited foraging habitat within the site.
Calyptorhynchus latirostris	*Carnaby's cockatoo*	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of Pinus spp. Attracted to seeding Banksia spp., Dryandra spp., Hakea spp., Eucalyptus spp., Corymbia calophylla, Grevillea spp., and Allocasuarina spp. (Johnstone and Storr 1998).	**Likely** Historical records within and adjacent to the site and there are areas of foraging habitat present within the site.
Charadrius dubius	*Little ringed plover*	MI	MI	Open, muddy or sandy shores of lakes, swamps, tidal areas, sewage ponds or farm dams. Rare but regular summer migrant to Australia (Pizzey & Knight 2012).	**Unlikely** Limited habitat present
Charadrius leschenaultii	*Great sand plover*	VU	VU (MI)	Wide sandy or shelly beaches, sandpits, tidal mudflats, reefs, sand cays, mangroves, saltmarsh, dune wilderness, bare paddocks, seldom far inland (Pizzey & Knight 2012).	**Unlikely** No suitable habitat
Diomedea amsterdamensis	*Amsterdam albatross*	CR	EN (MI)	The Amsterdam albatross is a marine, pelagic seabird. It nests in open patchy vegetation (among tussocks, ferns or shrubs) near exposed ridges or hillocks (Weimerskirch et al. 1985). It sleeps and rests on ocean waters when not breeding (Marchant and Higgins 1990)	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Diomedea epomophora	*Southern royal albatross*	VU	VU (MI)	Rare visitor to Western Australian seas; it breeds on subantarctic islands south of New Zealand (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Diomedea exulans	*Wandering albatross*	VU	VU (MI)	Marine, pelagic and aerial species. It breeds on Macquarie Island and feeds in Australian portions of the Southern Ocean (DoE 2018).	**Unlikely** No suitable habitat
Diomedea sanfordi	*Northern royal albatross*	EN	EN	Species is marine, pelagic and aerial. Habitat includes subantarctic, subtropical, and occasionally Antarctic waters (Marchant & Higgins 1990). Rare visitors to south Western Australian waters.	**Unlikely** No suitable habitat
Elanus scriptus	*Letter-winged kite*	P4	-	Open to sparsely wooded country and grassland near tree-lined streams or watercourses (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Falco peregrinus	*Peregrine falcon*	OS	-	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	**Possible** May opportunistically occur in or fly over the site on commute or while searching for prey.
Gallinago megala	*Swinhoe's snipe*	MI	MI	Wet, grassy ground; edges of reedy swamps (Pizzey & Knight 2012).	**Unlikely** Limited habitat present
Gallinago stenura	*Pin-tailed snipe*	MI	MI	Boggy edges of vegetated wetlands; sewage and other ponds; stubbles, grasslands with shrubs, pastures (Pizzey & Knight 2012).	**Unlikely** Limited habitat present
Glareola maldivarum	*Oriental pratincole*	MI	MI	Plains, shallow wet and dry edges of open bare wetlands, tidal mudflats and beaches (Pizzey & Knight 2012).	**Unlikely** Limited habitat present

		BC Act	EPBC Act		
Ixobrychus dubius	*Australian little bittern*	P4	-	Dense vegetation surrounding/within freshwater pools, swamps and lagoons, well screened with trees. Shelters in dense beds of Typha spp., Baumea spp. and tall rushes in freshwater swamps around lakes and along rivers (Johnstone and Storr 1998).	**Unlikely** Limited habitat present
Leipoa ocellata	*Mallefowl*	VU	VU	Scrubs and thickets of Eucalyptus spp., Melaleuca lanceolata and Acacia linophylla; also other dense litter-forming shrublands. Attracted to fallen wheat in stubbles and along roads (Johnstone and Storr 1998).	**Unlikely** Locally extinct
Limosa lapponica	*Bar-tailed godwit*	MI	MI	Estuarine sand and mudflats and sandy beaches with loads of seaweed; also reef flats and near-coastal saltlakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely** Limited habitat present
Limosa limosa	*Black-tailed godwit*	MI	MI	Tidal mudflats, estuaries, sewage ponds, shallow river margins, brackish or saline inland lakes, flooded pastures, airfields (Pizzey & Knight 2012).	**Unlikely** Limited habitat present
Macronectes giganteus	*Southern giant-petrel*	MI	EN (MI)	Breeds on southern subantarctic and antarctic islands. May visit Western Australian waters from February to December (mostly June to September) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Macronectes halli	*Northern giant petrel*	MI	VU (MI)	Breeds on subantarctic islands. May visit Western Australian water from February to September (Johnstone and Storr 1998).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Motacilla cinerea	*Grey wagtail*	MI	MI	In Australia mostly near running water in disused quarries, sandy and rocky streams in escarpments and rainforests, sewage ponds, ploughed fields and airfields (Pizzey & Knight 2012).	**Unlikely** Rarely occurs in general area.
Numenius madagascariensis	*Eastern curlew*	CR	CR (MI)	Mainly tidal mudflats; also reef flats, sandy beaches and rarely near-coastal lakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Numenius minutus	*Little curlew*	MI	MI	Dry grasslands, floodplains, margins of drying swamps; tidal mudflats, airfields, playing fields, crops, commercial saltfields, sewage ponds (Pizzey & Knight 2012).	**Unlikely** No suitable habitat
Oxyura australis	*Blue-billed duck*	P4	-	Mainly deeper freshwater swamps and lakes; occasionally saltlakes and estuaries freshened by flood waters (Johnstone and Storr 1998).	**Possible** May utilise the wetlands within the site whilst water is present
Pachyptila turtur subantarctica	*Fairy prion*	-	VU	Breeds on subantarctic islands and is presumed to frequent subtropical waters during non-breeding period (TSSC 2015).	**Unlikely** No suitable habitat
Pandion haliaetus	*Osprey*	MI	MI	Coasts, estuaries, bays, inlets, islands, and surrounding waters; coral atolls, reefs, lagoons, rock cliffs, stacks (Pizzey & Knight 2012).	**Unlikely** No suitable habitat
Philomachus pugnax	*Ruff*	MI	MI	Fresh, brackish and saline wetlands; tidal mudflats, saltfields, sewage ponds (Pizzey & Knight 2012).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Plegadis falcinellus	*Glossy Ibis*	MI	MI	Well-vegetated wetlands, wet pasture, ricefields, floodwaters, floodplains, brackish or occasionally saline wetlands, mangroves, mudflats and occasionally dry grassland (Pizzey & Knight 2012).	**Possible** May utilise the wetlands within the site whilst water is present
Pluvialis fulva	*Pacific golden plover*	MI	MI	Estuaries, mudflats, saltmarshes, mangroves; rocky reefs and stranded seaweed on ocean shores; margins of shallow open inland swamps; sewage ponds, short-grass paddocks, sportsgrounds, airfields, ploughed land (Pizzey & Knight 2012).	**Unlikely** Limited habitat present
Pluvialis squatarola	*Grey Plover*	MI	MI	Mudflats, saltmarsh, tidal reefs and estuaries, rarely inland (Pizzey and Knight 2012).	**Unlikely** No suitable habitat
Rostratula australis	*Australian painted snipe*	EN	EN	Mainly shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans (Marchant and Higgins 1993).	**Unlikely** Limited habitat present
Stercorarius longicaudus	*Long-tailed skua*	MI	MI	Marine, migratory species that rarely occurs in south-western Australia (Pizzey & Knight 2012)	**Unlikely** No suitable habitat
Sterna bergii	*Crested tern*	MI	MI	Mainly blue-water seas (especially within 3 km of land), including southern estuaries in summer and autumn (when free of silt); also tidal creeks in north, but not penetrating far into larger estuaries.	**Unlikely** No suitable habitat
Sterna nilotica	*Gull-billed tern*	MI	MI	Beaches, mudflats; fresh, brackish wetlands, including far inland; grasslands, crops, ploughed fields, airfields (Pizzey & Knight 2012).	**Unlikely** No suitable habitat
Sternula nereis nereis	*Australian fairy tern*	VU	VU	Sheltered blue-water seas close to land, estuaries (when free of silt) and near-coastal lakes (Johnstone and Storr 1998).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Thalassarche cauta cauta	*Shy albatross*	VU	VU (MI)	Scarce visitor (late May to mid-October) to southwestern and western seas. Breeds on islands off Tasmania and south New Zealand (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Thalassarche chrysostoma	*Grey-headed albatross*	VU	E (MI)	Very common in blue-water seas around the Abrolhos (endemic to this area, accidental occurrences on lower west coast of Australia) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Thalassarche melanophris	*Black-browed albatross*	EN	VU (MI)	Seas of south and west coasts. Visitor to Western Australian mainland from January to early November (mostly May to September). Breeds on southern subantarctic and antarctic islands (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Thalassarche melanophris impavida	*Campbell albatross*	VU	VU (MI)	Scarce visitor to south western and western seas. Breeds on Campbell island.	**Unlikely** No suitable habitat
Thalassarche steadi	*White-capped albatross*	VU	VU (MI)	Marine species that occurs in subantarctic and subtropical waters. It reaches tropical areas associated with the cool Humboldt Current off South America (Marchant & Higgins 1990). The species has been noted in shelf-waters around breeding islands and over adjacent rises. During the non-breeding season, birds have been observed over continental shelves around continents. The species occurs both inshore and offshore (Marchant 1977) and enters harbours and bays (Jehl 1973). Birds gather to scavenge at commercial fishing grounds.	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Tringa glareola	*Wood sandpiper*	MI	MI	Mainly shallow fresh waters (lagoons, swamps, claypans, river pools, dams, bore overflows and sewage ponds); occasionally brackish swamps, rarely saltlakes and estuaries (Pizzey & Knight).	**Unlikely** No suitable habitat
Tringa hypoleucos	*Common sandpiper*	MI	MI	Edge of sheltered waters salt or fresh, e.g. estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations wherelow perches are available (Johnstone & Storr 1998).	**Possible** Small numbers of occasional transient individuals may utilise the site when wetlands have water
Tringa nebularia	*Common greenshank*	MI	MI	Mudflats, estuaries, saltmarshes, margins of lakes, wetlands, claypans (fresh amd saline), commercial saltfields, sewage ponds (Pizzey & Knight 2012).	**Unlikely** No suitable habitat
Tringa stagnatilis	*Marsh sandpiper*	MI	MI	Mainly shallow fresh or brackish waters: swamps, lakes, river pools, soaks, sewage ponds and bore overflows. Occasionally estuaries and salt ponds, and rarely coasts.	**Unlikely** No suitable habitat
Invertebrates					
Austroconops mcmillani	*McMillan's biting midge*	P2	-	Unknown.	**Unlikely** No suitable habitat
Euoplos inornatus	*Inornate trapdoor spider*	P3	-	Has previously been recorded in jarrah forest, including near clay banks and granite outcrop. Most records are from the Darling scarp/Jarrah Forest Region, with limited records from the Swan Coastal Plain (DBCA 2020).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Idiosoma sigillatum	*Swan Coastal Plain shield-backed trapdoor spider*	P3	-	Widely distributed in sandy areas on the Swan Coastal Plain and on Rottnest Island (Prince 2003).	**Possible** Suitable habitat present
Leioproctus contrarius	*a short-tongued bee*	P3	-	Life history and habits are poorly documented/ unknown. It has been recorded only on flowers of Goodeniaceae and possibly Lechenaultia stenosepala (Bamford 2003).	**Possible** Historic records within the broader area, and one Goodeniaceae species present within the site
Leioproctus douglasiellus	*a short-tongued bee*	EN	CR	Life history and habits are poorly documented/ unknown. It has been recorded only on the flowers of Goodenia filiformis and Anthotium junctiforme (Houston 2000).	**Unlikely** Host species not recorded within site
Neopasiphae simplicior	*a short-tongued bee*	EN	CR	This species of native bee has been collected on flowers of Goodenia filiformis, Lobelia tenuior, Angianthus preissianus and Velleia sp. (Houston 2000).	**Possible** Historic records within the broader area, and Lobelia tenuior present within the site
Synemon gratiosa	*Graceful sunmoth*	P4	-	Coastal heathland on Quindalup dunes where it is restricted to secondary sand dunes due to the abundance of the preferred host plant Lomandra maritima. Banksia woodland on Spearwood and Bassendean dunes, where the second known host plant L. hermaphrodita is widespread (DEC 2011).	**Unlikely** No suitable habitat
Throscodectes xiphos	*Stylet bush cricket*	P1	-	Species poorly understood and documented. Known from Jandacot area, where it was originally collected in the axial leaf bases of grass trees (Xanthorrhoea preissei) (Invertebrate Solutions 2019).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Westralunio carteri	*Carter's freshwater mussel*	VU	VU	Occurs in greatest abundance in slower flowing streams with stable sediments that are soft enough for burrowing amongst woody debris and exposed tree roots. Also occupies lentic systems including large water supply dams and even on-stream farm dams. Salinity tolerance quite low (Morgan et al. 2011).	**Unlikely** No suitable habitat
Mammals					
Bettongia penicillata ogilbyi	*Woylie*	CR	EN	Woodlands and adjacent heaths with a dense understorey of shrubs, particularly Gastrolobium spp. (TSSC 2018).	**Unlikely** Locally extinct
Dasyurus geoffroii	*Chuditch*	VU	VU	Wide range of habitats from woodlands, dry sclerophyll forests, riparian vegetation, beaches and deserts. Appears to utilise native vegetation along road sides in the wheatbelt (DEC 2012b).	**Unlikely** No suitable habitat
Hydromys chrysogaster	*Rakali*	P4	-	Areas with permanent water, fresh, brackish or marine. Likely to occur in all major rivers and most of the larger streams as well as bodies of permanent water in the lower south west (Christensen et al. 1985).	**Unlikely** No suitable habitat
Isoodon fusciventer	*Quenda*	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012)	**Recorded**
Myrmecobius fasciatus	*Numbat*	EN	EN	Generally dominated by Eucalyptus spp. that provide hollow logs and branches for shelter and termites for food (van Dyck & Strahan 2008).	**Unlikely** Locally extinct

		BC Act	EPBC Act		
Notamacropus irma	*Western brush wallaby*	P4	-	Dry sclerophyll forest, Banksia spp. woodlands and shrublands, typically favouring dense low vegetation that provides dense cover (Christensen and Strahan 1983).	**Possible** Recent records of a population within the broader area
Phascogale tapoatafa wambenger	*South-western brush-tailed phascogale*	CD	-	Dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover (Triggs 2003).	**Unlikely** No suitable habitat
Pseudocheirus occidentalis	*Western ringtail possum*	CR	CR	Dense stands of Agonis flexuosa, as well as Eucalyptus gomphocephala, Corymbia calophylla and Eucalyptus marginata forests (DBCA 2017b).	**Unlikely** Outside species known range
Setonix brachyurus	*Quokka*	VU	VU	On the mainland mostly dense streamside vegetation or shrubland and heath areas, particularly around swamps (Cronin 2007).	**Unlikely** Locally extinct
Reptiles					
Acanthophis antarcticus	*Southern death adder*	P3	-	Mostly in woodlands, grasslands and heaths. In the Darling Range this species is typically found within Eucalyptus marginata woodlands adjacent to granite outcrops and along densely vegetated creeks (Bush et al. 2007).	**Unlikely** No suitable habitat
Ctenotus delli	*Dell's skink*	P4	-	Jarrah and marri woodland with a shrub dominated understorey, sheltering in dense vegetation, inside grass trees and beneath rocks, sometimes in burrows (Nevill 2005).	**Unlikely** No suitable habitat
Ctenotus ora	*Coastal plains skink*	P3	-	Sandy substrates with low vegetation (including heath) in open Eucalyptus spp. and Corymbia calophylla woodland over Banksia spp. (Kay and Keogh 2012).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Lerista lineata	*Perth slider*	P3	-	Sandy coastal heath and low scrubland. Banksia spp. woodland, Eucalyptus gomphocephala open woodland over deep sands, and coastal dunes immediately adjacent to the beach (Wilson and Swan 2017).	**Possible** Historic records adjacent to the site and there is potentially suitable habitat present within the site
Neelaps calonotos	*Black-striped snake*	P3	-	Coastal and near-coastal dunes, sandplains supporting heathlands and Banksia spp. woodlands (Bush et al. 2002).	**Possible** Historic records adjacent to the site and there is habitat present within the site

Note: CE=critically endangered, EN=endangered, VU=vulnerable, CD=conservation dependent, MI=migratory, OS=other specially protected, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4. Species recorded or considered to potentially occur within the site are shaded green.

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Appendix F

Species List

Fauna List

Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Category	Status	Species name	Common name	Record type
Birds		*Anas superciliosa*	Pacific black duck	Sight
		Anthochaera carunculata	Red wattlebird	Sight, call
		Coracina novaehollandiae	Black-faced cuckoo-shrike	Sight
		Corvus coronoides	Australian raven	Sight
		Cracticus tibicen	Australian magpie	Sight, call
		Grallina cyanoleuca	Magpie-lark	Sight, call
		Lichmera indistincta	Brown honeyeater	Call
		Merops ornatus	Rainbow bee-eater	Sight
		Ocyphaps lophotes	Crested pigeon	Sight
		Pachycephala occidentalis	Western whistler	Call
		Platycercus zonarius semitorquatos	Twenty-eight parrot	Sight
		Porphyrio porphyrio	Purple swamphen	Sight
		Rhipidura leucophrys	Willie wagtail	Sight, call
		Smicronis brevirostris	Weebill	Call
	*	*Spilopelia chinensis*	Spotted turtle dove	Sight
		Threskiornis moluccus	Australian white ibis	Sight
	*	*Trichoglossus moluccanus*	Rainbow lorikeet	Sight
Mammals	P4	*Isoodon fusciventer*	Quenda	Sight (dead individual)
		Macropus fuliginosus	Western grey kangaroo	Scats
	* DP	*Oryctolagus cuniculus*	Rabbit	Scats
Reptiles		*Varanus gouldii*	Sand goanna	Sight

Note: * denotes introduced fauna species, DP=declared pest under the BAM Act, EN=Endangered under the EPBC Act,VU=Vulnerable under the EPBC Act

Appendix G

Black Cockatoo Habitat Tree Data

Black Cockatoo Habitat Tree Inventory
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
371	400657.47	6446277.20	50	*Eucalyptus rudis*	No suitable hollows	
-	400650.44	6446272.03	51	*Eucalyptus rudis*	No suitable hollows	
-	400344.90	6446173.46	63	*Eucalyptus rudis*	No suitable hollows	
-	400671.99	6446277.56	91	*Eucalyptus rudis*	No suitable hollows	Small hollow present
-	400664.23	6446249.44	67	*Eucalyptus rudis*	No suitable hollows	
-	400672.86	6446275.68	51	*Eucalyptus rudis*	No suitable hollows	

Appendix H

Overall Habitat Quality Assessment

Black Cockatoo Habitat Quality Assessment - Scoring Tool (Baudin's cockatoo)
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

		Query		Answer	Potential score	Site score	Sum
Breeding habitat	**Site condition**	1.1	The site contains:				
			habitat tree(s) with suitable hollow(s)	N/A	2.0	0.0	0.0
			habitat tree(s) without suitable hollow(s)	N/A	1.0	0.0	
	Site context	1.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N/A	1.0	0.0	0.0
			6-12 km from a nest(s) (active, historical or potential)	N/A	0.5	0.0	
		1.3	The site is located within 6 km of:				
			>1000 ha of potential foraging habitat	N/A	3.0	0.0	0.0
			100 to 1000 ha of potential foraging habitat	N/A	1.0	0.0	
	Species stocking rate	1.4	The site contains:				
			historical nest(s)	N/A	1.0	0	0.0
			The site contains:				
			active nest(s)	N/A	3.0	0	
			potential nest(s)	N/A	1.0	0	0.0
			Score	0	10.0		

Roosting habitat	**Site condition**	2.1	The site contains trees potentially suitable for roosting	Y	1.0	1.0	2.0
		2.2	The site contains a water source or one exists nearby	Y	1.0	1.0	
	Site context	2.3	The site is located:				
			within 1 km of a large roost (≥150 individuals) (active or historical)	N	1.0	0.0	0.0
			within 500 m of a small roost (< 150 individuals) (active or historical)	N	1.0	0.0	
	Species stocking rate	2.4	The site contains:				
			a historical record of a large roost (≥150 individuals)	N	2.0	0	
			a historical record of a small roost (<150 individuals)	N	1.0	0	0.0
			The site contains:				
			an active record of a large roost (≥150 individuals)	N	2.0	0.0	0.0
			an active record of a small roost (<150 individuals)	N	1.0	0.0	
			Score	2	7.0		

Foraging habitat	**Site condition**	3.1	The site contains foraging habitat comprising:				
			≥50% primary foraging plants	N	4.0	0.0	
			≥10% to <50% primary foraging plants	N	2.0	0.0	1.0
			<10% primary foraging plants	Y	1.0	1.0	
	Site context	3.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N	2.0	0.0	
			6-12 km from a nest(s) (active, historical or potential)	N	1.00	0.0	1.0
		3.3	The site is located:				
			within 6 km of a roost(s) (active or historical)	Y	1.0	1.0	
			6-12 km from a roost(s) (active or historical)	Y	0.5	0.5	
	Species stocking rate	3.4	The site contains:				
			abundant evidence of foraging	N	2.0	0.0	0.0
			limited evidence of foraging	N	1.0	0.0	
			Score	2	8.0		

SUMMARY		
Habitat category	**Score**	**Habitat quality**
Breeding	0	No habitat
Roosting	2	Low
Foraging	2	Low

Overall habitat quality score	**2**	Low

Note:

1. Within the breeding category, a score of 9 applies if an active nest(s) occurs within the site and a score of 10 applies if an active nest(s) and a historical nest(s) occurs within the site, regardless of the answer to other queries in this category
2. Within the roosting category, a score of 7 applies if a small roost occurs within the site and a score of 8 applies if a large roost occurs within the site, regardless of the answer to other queries in this category.
3. The final score consists of the highest score from each habitat category

Black Cockatoo Habitat Quality Assessment - Scoring Tool (Carnaby's cockatoo)
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

		Query		Answer	Potential score	Site score	Sum
Breeding habitat	**Site condition**	1.1	The site contains:				
			habitat tree(s) with suitable hollow(s)	N/A	2.0	0.0	0.0
			habitat tree(s) without suitable hollow(s)	N/A	1.0	0.0	
	Site context	1.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N/A	1.0	0.0	0.0
			6-12 km from a nest(s) (active, historical or potential)	N/A	0.5	0.0	
		1.3	The site is located within 6 km of:				
			>1000 ha of potential foraging habitat	N/A	3.0	0.0	0.0
			100 to 1000 ha of potential foraging habitat	N/A	1.0	0.0	
	Species stocking rate	1.4	The site contains:				
			historical nest(s)	N/A	1.0	0	0.0
			The site contains:				
			active nest(s)	N/A	3.0	0	
			potential nest(s)	N/A	1.0	0	0.0
			Score	0	10.0		

Roosting habitat	**Site condition**	2.1	The site contains trees potentially suitable for roosting	Y	1.0	1.0	2.0
		2.2	The site contains a water source or one exists nearby	Y	1.0	1.0	
	Site context	2.3	The site is located:				
			within 1 km of a large roost (≥150 individuals) (active or historical)	N	1.0	0.0	0.0
			within 500 m of a small roost (< 150 individuals) (active or historical)	N	1.0	0.0	
	Species stocking rate	2.4	The site contains:				
			a historical record of a large roost (≥150 individuals)	N	2.0	0	
			a historical record of a small roost (<150 individuals)	N	1.0	0	0.0
			The site contains:				
			an active record of a large roost (≥150 individuals)	N	2.0	0.0	0.0
			an active record of a small roost (<150 individuals)	N	1.0	0.0	
			Score	2	7.0		

Foraging habitat	**Site condition**	3.1	The site contains foraging habitat comprising:				
			≥50% primary foraging plants	N	4.0	0.0	
			≥10% to <50% primary foraging plants	Y	2.0	2.0	2.0
			<10% primary foraging plants	N	1.0	0.0	
	Site context	3.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N	2.0	0.0	
			6-12 km from a nest(s) (active, historical or potential)	N	1.00	0.0	
		3.3	The site is located:				1.0
			within 6 km of a roost(s) (active or historical)	Y	1.0	1.0	
			6-12 km from a roost(s) (active or historical)	Y	0.5	0.5	
	Species stocking rate	3.4	The site contains:				
			abundant evidence of foraging	N	2.0	0.0	0.0
			limited evidence of foraging	N	1.0	0.0	
			Score	3	8.0		

SUMMARY		
Habitat category	**Score**	**Habitat quality**
Breeding	0	No habitat
Roosting	2	Low
Foraging	3	Low

Overall habitat quality score	**3**	Low

Note:

1. Within the breeding category, a score of 9 applies if an active nest(s) occurs within the site and a score of 10 applies if an active nest(s) and a historical nest(s) occurs within the site, regardless of the answer to other queries in this category
2. Within the roosting category, a score of 7 applies if a small roost occurs within the site and a score of 8 applies if a large roost occurs within the site, regardless of the answer to other queries in this category.
3. The final score consists of the highest score from each habitat category

Black Cockatoo Habitat Quality Assessment - Scoring Tool (Forest red-tailed black cockatoo)
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

		Query		Answer	Potential score	Site score	Sum
Breeding habitat	**Site condition**	1.1	The site contains:				
			habitat tree(s) with suitable hollow(s)	N	2.0	0.0	1.0
			habitat tree(s) without suitable hollow(s)	Y	1.0	1.0	
	Site context	1.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N	1.0	0.0	0.5
			6-12 km from a nest(s) (active, historical or potential)	Y	0.5	0.5	
		1.3	The site is located within 6 km of:				
			>1000 ha of potential foraging habitat	Y	3.0	3.0	3.0
			100 to 1000 ha of potential foraging habitat	N	1.0	0.0	
	Species stocking rate	1.4	The site contains:				
			historical nest(s)	N	1.0	0	0.0
			The site contains:				
			active nest(s)	N	3.0	0	
			potential nest(s)	N	1.0	0	0.0
			Score	4	10.0		
Roosting habitat	**Site condition**	2.1	The site contains trees potentially suitable for roosting	Y	1.0	1.0	2.0
		2.2	The site contains a water source or one exists nearby	Y	1.0	1.0	
	Site context	2.3	The site is located:				
			within 1 km of a large roost (≥150 individuals) (active or historical)	N	1.0	0.0	0.0
			within 500 m of a small roost (< 150 individuals) (active or historical)	N	1.0	0.0	
	Species stocking rate	2.4	The site contains:				
			a historical record of a large roost (≥150 individuals)	N	2.0	0	
			a historical record of a small roost (<150 individuals)	N	1.0	0	0.0
			The site contains:				
			an active record of a large roost (≥150 individuals)	N	2.0	0.0	0.0
			an active record of a small roost (<150 individuals)	N	1.0	0.0	
			Score	2	7.0		
Foraging habitat	**Site condition**	3.1	The site contains foraging habitat comprising:				
			≥50% primary foraging plants	N	4.0	0.0	
			≥10% to <50% primary foraging plants	N	2.0	0.0	1.0
			<10% primary foraging plants	Y	1.0	1.0	
	Site context	3.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N	2.0	0.0	
			6-12 km from a nest(s) (active, historical or potential)	N	1.00	0.0	1.0
		3.3	The site is located:				
			within 6 km of a roost(s) (active or historical)	Y	1.0	1.0	
			6-12 km from a roost(s) (active or historical)	Y	0.5	0.5	
	Species stocking rate	3.4	The site contains:				
			abundant evidence of foraging	N	2.0	0.0	0.0
			limited evidence of foraging	N	1.0	0.0	
			Score	2	8.0		

SUMMARY		
Habitat category	**Score**	**Habitat quality**
Breeding	4	Moderate
Roosting	2	Low
Foraging	2	Low

Overall habitat quality score	**4**	Moderate

Note:

1. Within the breeding category, a score of 9 applies if an active nest(s) occurs within the site and a score of 10 applies if an active nest(s) and a historical nest(s) occurs within the site, regardless of the answer to other queries in this category
2. Within the roosting category, a score of 7 applies if a small roost occurs within the site and a score of 8 applies if a large roost occurs within the site, regardless of the answer to other queries in this category.
3. The final score consists of the highest score from each habitat category

Appendix D

DPAW advice pertaining to wetland mapping review (DPaW 2015)

Government of **Western Australia**
Department of **Parks and Wildlife**
Science and Conservation Division

Your ref:
Our ref: 2015/000227-1
Enquiries: Adam Turnbull
Phone: 08 9219 8788
Email: adam.turnbull@dpaw.wa.gov.au

Rachel Halton
360 Environmental
PO Box 14
WEST PERTH WA 6872

Dear Ms Halton

APPLICATION TO REVIEW THE WETLAND MAPPING DISPLAYED WITHIN THE *GEOMORPHIC WETLANDS SWAN COASTAL PLAIN* DATASET

I refer to your correspondence dated 27 January 2015 requesting the Department of Parks and Wildlife to review the wetland mapping within the Geomorphic Wetlands Swan Coastal Plain dataset (the dataset) for Lots 116, 117, 118, 119, 172, 179, 180, 500, 501, 502, 503, 504, 505, 509, 510, 515 and 516 bound by Skeet Road, Balannup Road and Hatch Court, Harrisdale (the site).

The wetland area at the site is currently identified in the dataset as UFI 14404 a Resource Enhancement management category sumpland (Figure 1). Parks and Wildlife has reviewed all the available information and has partially accepted the proposed changes to the dataset based upon the following assessment of the request.

Clearing of the site began between 1965 and 1974. By 1985 all of the current lots had been visibly subdivided with fire breaks fragmenting the vegetation and by 1995 the lots had been mostly cleared of vegetation. The site has been used for rural residential and rural industrial. Surrounding the site is mostly native vegetation with residential development to the west.

The wetland is recognised in the Directory of Important Wetlands and a small portion is also recognised by the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992. The site is located within the Bennet Brook consanguineous suite of which approximately 7.7 per cent of the dampland area is identified as Conservation category. The site is located within the Southern River Heddle vegetation complex of which 19.69 per cent of the pre-European extent is remaining. The areas of wetland within the site which have been used for residential purposes have become degraded to the extent that they no longer retain representative aspects of sumpland within the Bennet Brook suite or vegetation of Southern River complex.

360 Environmental considers the area of wetland on the site to range from Very Good to Completely Degraded condition in accordance with the *Bush Forever* vegetation condition scale (Government of Western Australia 2000). 360 Environmental describes the remnant vegetation of within the dampland area as supporting woodland of *Eucalyptus rudis*, *Melaleuca rhaphiophylla* and/or *Melaleuca preissiana* over shrubland or sedgeland. The flora and vegetation survey conducted by 360 Environmental

identified three Priority flora species within the vegetated portions at the site *Jacksonia gracillima* (P3), *Verticordia lindleyi* subsp. *lindleyi* (P3) and *Meeboldina decipiens* (P4).

There are two regional ecological linkages nearby, one 500m to the northwest and another 600m to the southeast. The wetland area that is completely degraded is unlikely to provide any significant linkage role as it does not retain viable habitat.

Recommendations

360 Environmental has provided sufficient information to warrant a reclassification for the majority of UFI 14404 on the site from Resource Enhancement to Multiple Use management category. Given the presence of conservation significant flora and areas of greater vegetation condition the vegetated portions within the site were assessed separately. The vegetated portion in the western portion of UFI 14404, dominated by *M. rhaphiophylla* and *M. preissiana* low open woodland over *Melaleuca teretifolia, Melaleuca viminea, Kunzea micrantha* subsp. *micrantha* and *Regelia ciliata* shrubland over *Lepidosperma longitudinale* and *Chaetanthus aristatus* open sedgeland, was commensurate with Resource Enhancement management category. The vegetated portion in the southern portion of UFI 14404, dominated by *M. preissiana* low woodland over *R. ciliata* and *A. scoparia* heath over *L. longitudinale* open sedgeland, was commensurate with Conservation management category and will be incorporated into UFI 14880 (Figure 2).

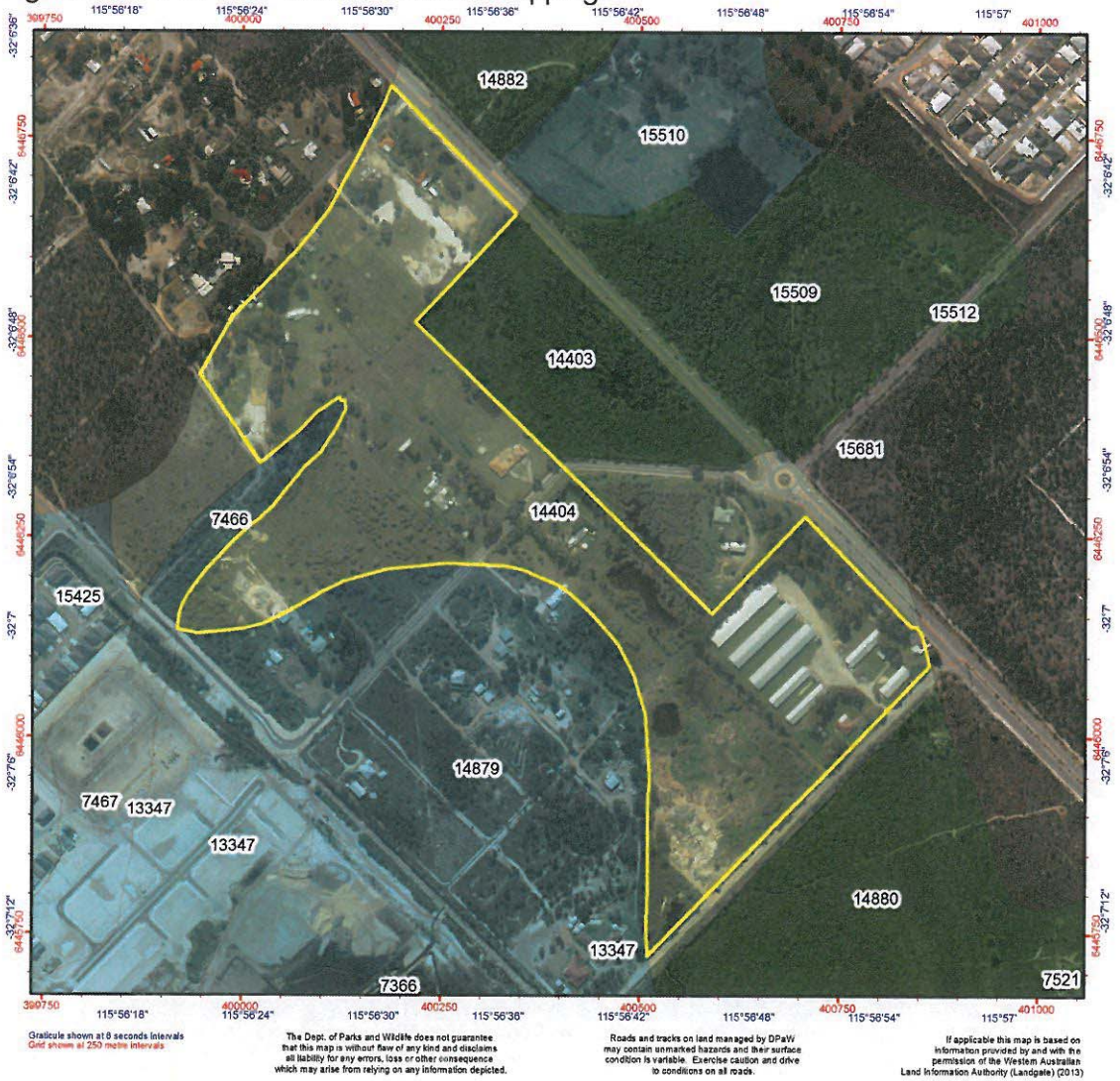
The dataset will be updated and revised wetland mapping will be available from the WA Atlas (Landgate) when the next version of the dataset is publicly released. Please contact Adam Turnbull on 9219 8788 if you require further information on this matter.

Yours sincerely

Michael Coote
Principal Coordinator
Wetland Section

30 January 2015

Figure 1. UFI 14404 – current wetland mapping.



Various lots bound by Skeet Road, Balannup Road and Hatch Court, Harrisdale

Legend

- Site boundary

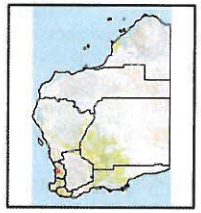
Geomorphic Wetlands Swan Coastal Plain (Management)

- Conservation
- Multiple Use
- Not Applicable
- Not Assessed
- Resource Enhancement

N

(A4)
1:6,500

0 45 90 180 270 360
Metres
Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94



Produced by the Department of Parks and Wildlife

Produced at 3:30pm, on January 30, 2015

Graticule shown at 0 seconds intervals
Grid shown at 250 metre intervals

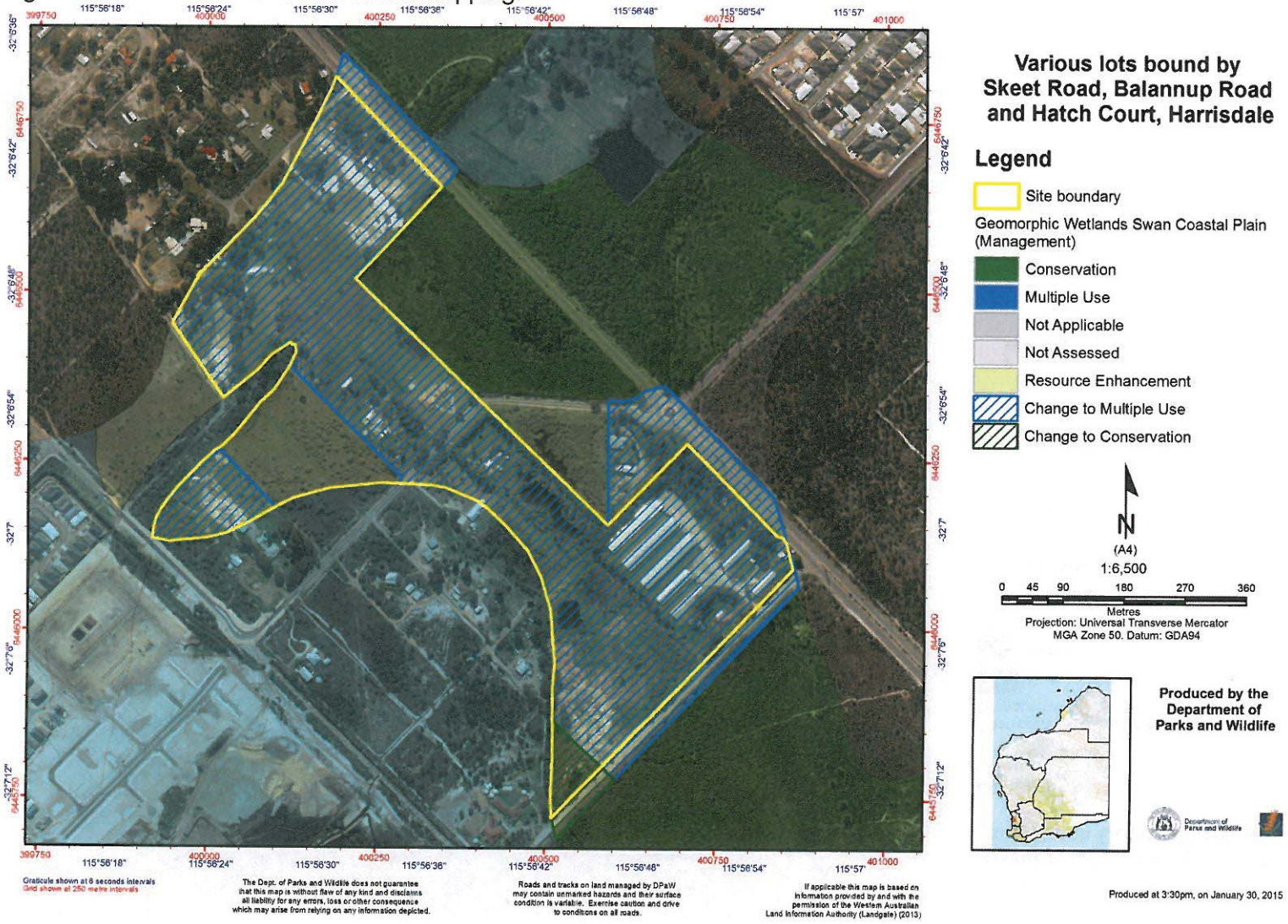
The Dept. of Parks and Wildlife does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Roads and tracks on land managed by DPaW may contain unmarked hazards and their surface condition is variable. Exercise caution and drive to conditions on all roads.

If applicable this map is based on information provided by and with the permission of the Western Australian Land Information Authority (Landgate) (2013)

Environmental Management Branch
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
www.dpaw.wa.gov.au

Figure 2. UFI 14404 – revised wetland mapping.



Appendix E

Wetland Assessment (Emerge Associates 2021)

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Emerge Environmental Services Pty Ltd ABN 57144772510 trading as Emerge Associates

Document Reference: EP20-127(14)—013 SKP

Emerge contact: Rachel Weber

10 June 2021

Attention: Tao Burton
Yolk Property Group Pty Ltd
4/1 High Street Fremantle 6061

Delivered by email to: tao@yolkpropertygroup.com.au

Dear Tao,

WETLAND ASSESSMENT – LOTS 600-606 BALANNUP ROAD AND 200-202 SKEET ROAD, HARRISDALE

1 INTRODUCTION

1.1 Project background

Yolk Property Group Pty Ltd (Yolk) are seeking to lift the urban deferred zoning of Lots 600-606 Balannup Road and Lots 200-202 Skeet Road in Harrisdale (referred to herein as the 'site'). As part of the application process the Department of Biodiversity Conservation and Attractions (DBCA) reviewed the *Detailed Flora and Vegetation Assessment* previously prepared for the site (Emerge Associates 2021). The wetlands branch of DBCA indicated the current DBCA (2020) *Geomorphic Wetlands of the Swan Coastal Plain* dataset may not align with on-ground values.

At the request of DBCA, representatives from the wetlands branch and a botanist from Emerge conducted a site visit on 23 March 2021. The purpose of the site visit was for DBCA to confirm the vegetation condition mapping previously provided by Emerge Associates (2021) and consider whether a wetland evaluation was required to be conducted. Following the site visit DBCA identified four 'areas of interest' within the site which are referred to as areas A-D, as shown on **Figure 1**. DBCA requested that a 'wetland survey and evaluation' is undertaken for the areas of interest.

Yolk engaged Emerge to undertake a wetland assessment of the areas of interest to provide additional information to DBCA.

1.2 Purpose and scope of work

This letter has been prepared to document the wetland values present within the areas of interest (collectively referred to as the 'survey area').

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

- A review of relevant background information.
- A field survey to record flora species and assess and map vegetation type.
- Floristic community type (FCT) analysis of the survey data using the Gibson *et al.* (1994) dataset.
- Evaluation of wetlands using the DBCA (2017) evaluation methodology.
- Documentation of the survey methodology and results into a letter report.

2 ENVIRONMENTAL CONTEXT

2.1 Geomorphic wetlands

The *Geomorphic Wetlands, Swan Coastal Plain* dataset shows that wetlands are mapped across the whole site and survey area (DBCA 2020). The details of the wetland features within each area of interest are provided in **Table 1**.

The locations of the mapped wetlands in the vicinity of site are shown in **Figure 2.**

Table 1: Geomorphic wetlands mapped within areas of interest (DBCA 2020)

Area of interest	Unique feature identifier (UFI)	Management category
A	14879	Multiple use wetland (MUW)
	13347	MUW
B	14879	MUW
C	14880	Conservation category wetland (CCW)
	13347	MUW
	14879	MUW
D	15946	Resource enhancement wetland (REW)
	14404	MUW
	14879	MUW

2.2 Historical land use

Review of historical images available from 1953 onwards shows that the site was undisturbed in 1953, with the western portion supporting a sandy rise and the eastern portion supporting part of a large wetland referred to as Balannup Lake, as shown in **Plate 1** (WALIA 2021). By 1974 Lots 201 and 202 were cleared and a large body of water is visible across these lots (**Plate 2**). In 1989 additional clearing is visible, particularly in the eastern portion of the site. Lots 201, 600 and 601 support considerable areas of standing water in imagery from 1989 and there is an oval dam within Lot 201 (**Plate 3**). Since 2008 most of the site has been subject to some form of clearing and areas of regrowth of native vegetation are visible, particularly in Lots 200, 600 and 604-606 (**Plate 4**).

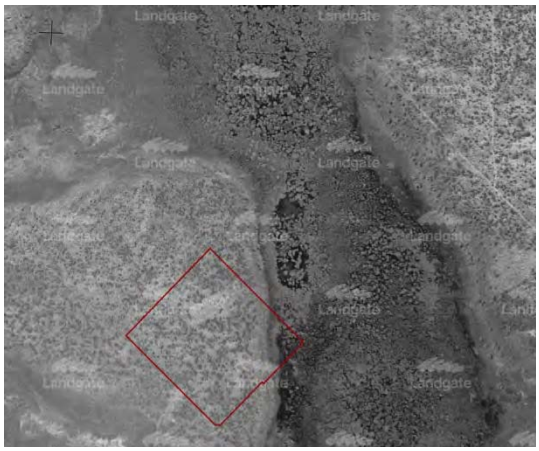


Plate 1: Historical aerial photography from 1953 showing the large wetland present over the eastern portion of the site and the sandy rise over the western portion of the site (red outline represents Lot 200 in the south-western corner of the site) (WALIA 2021).



Plate 2: Historical aerial photography from 1974 showing clearing within the eastern portion of the site (red outline represents Lot 200 in the south-western corner of the site) (WAILIA 2021).



Plate 3: Historical aerial photography from 1989 showing disturbance within the site (red outline represents Lot 200 in the south-western corner of the site) (WALIA 2021).



Plate 4: Historical aerial photography from 2020 showing scattered patches of native vegetation and disturbed areas (red outline represents Lot 200 in the south-western corner of the site) (WALIA 2021).

3 METHODS

3.1 Field surveys

A botanist and an ecologist from Emerge visited the survey area on 5 May 2021 to conduct the field survey. The survey consisted of flora and vegetation sampling and wetland data collection.

3.1.1 Flora and vegetation

Sampling of the vegetation was undertaken using a combination of non-permanent 10 m x 10 m quadrats and relevés. The quadrats were established using fence droppers bound by measuring tape. The relevés were completed over an equivalent 10 m x 10 m area without the use of physical markers and were included to provide a more rapid sample of patches of vegetation in poorer condition and/or of smaller size. The position of each sample was recorded with a hand-held GPS unit.

The data recorded within each sample included:

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

'Foliage projective cover' of each species was also recorded within quadrats. Photographs were taken throughout the field survey to show particular conditions.

3.1.2 Wetlands

As the survey area was traversed data required for undertaking the DBCA (2017) evaluation methodology was collected. Other wetland characteristics, such as size, shape and boundary were also recorded.

3.2 Data analysis

3.2.1 Floristic community type assignment

The samples were compared to the regional 'floristic community type' (FCT) dataset *A floristic survey of the southern Swan Coastal Plain* by Gibson *et al.* (1994). The sample data (presence/absence) was reconciled with Gibson *et al.* (1994) by standardising the names of taxa with those used in the earlier study. This was

necessary due to changes in nomenclature in the intervening period. Taxa that were only identified to genus level were excluded, while some infra-species that have been identified since 1994 were reduced to species level. The combined dataset was then imported into the statistical analysis package PRIMER v6 (Clarke and Gorley 2006).

As data from a localised survey is often spatially correlated, each sample was compared to Gibson *et al.* (1994) separately which removes the influence of spatial correlation when assigning an FCT. The analysis included the compilation of a resemblance matrix using the Bray-Curtis distance measure which provided the percentage similarity between all pairs of samples. Subsequently, a cluster analysis was undertaken using the resemblance matrix and hierarchical agglomerative clustering, to produce a dendrogram.

Where the sample tended to cluster with a grouping of different FCTs, samples were assessed separately to differentiate between FCTs. Ultimately the cluster analysis, as well as contextual information relating to the soils, landforms and known locations of FCTs within the region, was considered in the final determination of an FCT for vegetation within the survey area.

3.2.2 Wetland evaluation

Wetlands on the Swan Coastal Plain are assigned management categories using the DBCA (2017) methodology. Each area of interest was evaluated using the DBCA (2017) methodology to determine its appropriate management category.

4 RESULTS

4.1 Flora and vegetation

A total of 13 locations were sampled, comprised of three quadrats and ten relevés, as shown in **Figure 3**.

Samples were located within areas A, B and D. No samples were located within area C as it was not considered to require additional FCT analysis.

The raw sample data is provided in **Attachment 2**.

4.2 Floristic community type assignment

The results of the floristic community type assessment are summarised in **Table 1**.

Table 2: Sampling units and likely FCT represented within the survey area

DBCA area of interest	Sample	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Most likely floristic community type (FCT)
Area A	Q1	NINE-2 (FCT 21a)	47	FCT 21a: central *Banksia attenuata* – *Eucalyptus marginata* woodlands / FCT 23a: central *Banksia attenuata* – *B. menziesii* woodlands
		HARRY-4 (FCT 23a)	46	
	R2	MODO-5 (FCT 23a)	36	
		NINE-2 (FCT 21a)	36	
	Q3	HARRY-4 (FCT 23a)	34	
		MODO-5 (FCT 23a)	34	
	R4	RUAB-2 (FCT 21b)	39	
		CARD7 (FCT 21a)	34	
	R8	NINE-2 (FCT 21a)	25	
		RIVD-2 (FCT 21a)	24	
	R9	NINE-2 (FCT 21a)	32	
		LOW01 (FCT 21c)	31	
	Q10	HARRY-4 (FCT 23a)	44	
		NINE-2 (FCT 21a)	43	

Table 1: Sampling units and likely FCT represented within the survey area (continued)

DBCA area of interest	Sample	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Most likely floristic community type (FCT)
Area B	R5	CARD4 (FCT 6)	14	FCT 4: *Melaleuca preissiana* damplands
		ROWE01 (FCT 11)	12	
		KOOLJ-1 (FCT 4)	9	
	R6	KOOLJ-1 (FCT 4)	36	
		MELA-1 (FCT 4)	33	
		BANKS-1A (FCT 13)	32	
	R7	MILT-5 (FCT 14)	32	
		MELA-1 (FCT 4)	30	
Area D	R12	WATER-1 (FCT 13)	29	FCT 13: deeper wetlands on heavy soils
		WATER2 (FCT 12)	29	
	R13	MILT-5 (FCT 14)	22	FCT 11: wet forests and woodlands / FCT 14: deeper wetlands on sandy soils
		MODO-3 (FCT 11)	21	

4.3 Wetland evaluation

The results of the wetland evaluation using the DBCA (2017) methodology are summarised in **Table 2**. Some areas of interest were divided due to differences in vegetation condition and/or level of intactness.

The completed wetland evaluation documents are provided in **Attachment 1** and the proposed boundaries and management categories are shown on **Figure 3**.

Table 3: Summary of wetland evaluation for areas of interest

DBCA area of interest	Management category		
	Current (DBCA 2020)	Preliminary evaluation	Secondary evaluation
Area A	MUW	N/A – does not support wetland vegetation	
Area B1	MUW	CCW	Not required
Area B2	MUW	CCW^	REW (case-by-case basis)
Area C	CCW/MUW	CCW	Not required
Area D1	REW/MUW	-	REW
Area D2	MUW	-	REW (case-by-case basis)
Area D3	MUW	-	REW (case-by-case basis)

^due solely to the area meeting the criterion '≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)'.

5 DISCUSSION

5.1 Area A

Area A supports banksia woodland vegetation that represents either FCT 21a or FCT 23a. This aligns with the previous FCT analysis which indicated the vegetation represented FCT 23a (Emerge Associates 2021). These FCTs are not associated with wetland landforms and so this area is not considered to represent a wetland.

5.2 Area B

Area B supports woodland vegetation with *Banksia* spp. and *Melaleuca preissiana* that represents FCT 4. This aligns with the previous FCT analysis (Emerge Associates 2021). FCT 4 is a shrub-rich dampland wetland community (Gibson *et al.* 1994). Therefore, area B is considered to be a wetland.

5.2.1 Area B1

Area B1 supports vegetation in excellent condition and meets the DBCA criteria to comprise a CCW. This management category is considered appropriate due to the condition of the vegetation.

5.2.2 Area B2

Area B2 is more fragmented and disturbed than area B1. It supports patches of remnant vegetation within a developed landscape with driveways, houses and sheds. The vegetation ranges from 'completely degraded' to 'very good' condition. The preliminary evaluation indicated that the area comprises a CCW because 8.4% of all wetlands within the Bennett Brook consanguineous suite are classified as CCWs. In accordance with the DBCA (2017) methodology this wetland was not considered to be commensurate with the values of a CCW and so the secondary evaluation was undertaken. The secondary evaluation, which looks at a larger variety of attributes, indicated that a management category of REW (case-by-case basis) was applicable.

5.3 Area C

Area C supports vegetation in 'very good' and degraded' condition and was previously determined to represent FCT 11 and FCT 4. These FCTs are wetland communities and so area C is considered to be a wetland.

In the current DBCA (2020) dataset, area C supports part of a large CCW (UFI 14880) which extends beyond the site. In accordance with the DBCA methodology, UFI 14880 was assessed as a whole (rather than dividing the feature into two parts). The wetland evaluation confirmed that the conservation management category is still applicable. However, the boundary of UFI 14880 within the site is recommended to be extended to the west to align with the edge of the wetland vegetation.

5.4 Area D

Area D supports *Melaleuca* spp. woodland vegetation in varying levels of intactness. Where it is most intact, it represents FCT 11 or FCT 14, which are both wetland communities.

5.4.1 Area D1

Area D1 supports the most intact vegetation within area D but is still highly disturbed, being in 'degraded' condition with a dense layer of non-native grasses. Since the vegetation represents a wetland community and is low-lying, this area is considered to be a wetland. The wetland evaluation indicates that it comprises an REW which is considered appropriate based on the values and condition of vegetation.

5.4.2 Area D2

Area D2 comprises a small artificial lake surrounded by a mixture of native wetland species (particularly *Baumea articulata* and scattered *Melaleuca viminea*, *Melaleuca rhaphiophylla* and *M. teretifolia* plants) with planted **Eucalyptus* spp. and other non-native garden plantings over dense non-native grasses. This area likely previously supported vegetation similar to area D1 but has been subject to long-term historical disturbance.

The wetland evaluation indicated that area D2 represents an REW (case-by-case basis).

5.4.3 Area D3

Area D3 supports an open forest of *Eucalyptus rudis*, **Eucalyptus* spp. and *Melaleuca preissiana* with scattered *Banksia littoralis* over a closed tall shrubland of *Kunzea glabrescens* and **Acacia longifolia* over a non-native grasses and bare ground. This area also likely previously supported vegetation similar to area D1 but has been subject to long-term historical disturbance.

The wetland evaluation indicated that area D3 represents an REW (case-by-case basis).

6 RECOMMENDATIONS AND CLOSING

The wetland assessment was conclusive in determining whether the areas of interest currently comprise wetlands. This was based primarily on vegetation classification using FCT analysis.

Area A is not considered to represent a wetland and is recommended to be excluded from the geomorphic wetland database.

Area B1 represents a CCW rather than its currently mapped MUW. Area C aligns with its current listing as a CCW, albeit with an extension recommended to the mapped boundary.

Area D1 aligns with its current listing as a REW and remapping of the wetland boundary is recommended.

Under the preliminary evaluation criteria area B2 represents a CCW, due to one attribute. Using the secondary evaluation criteria this area represents a REW (case-by-case basis). The applicable management category and retention value of this wetland requires discussion with DBCA.

For areas D2 and D3, the REW (case-by-case) management category indicates that these areas could comprise REW or MUW wetlands. Due to the level of disturbance rehabilitation would be challenging and discussions with the DBCA regarding the appropriate management category are required.

We trust that this letter provides a comprehensive summary of the wetland values within the areas of interest. Should you have any questions regarding the content of this letter, please do not hesitate to contact the undersigned.

Yours sincerely
Emerge Associates



Rachel Weber
SENIOR ENVIRONMENTAL CONSULTANT, ECOLOGY TEAM LEADER

cc: Carolyn Harding, DBCA
Catherine Prideaux, DBCA
Michael Coote, DBCA

Encl: Figure 1 – Site Location and DBCA Areas of Interest
Figure 2 – Current Geomorphic Wetlands
Figure 2 – Proposed Geomorphic Wetlands
Attachment 1 – Wetland evaluation forms
Attachment 2 – Raw survey data

General References

Clarke, K. R. and Gorley, R. N. 2006, *PRIMER v6: User Manual/Tutorial*, PRIMER-E, Plymouth.

Department of Biodiversity, Conservation and Attractions (DBCA) 2017, *A methodology for the evaluation of wetlands on the Swan Coastal Plain*, draft prepared by the Wetlands Section of the Department of Biodiversity, Conservation and Attractions and the Urban Water Branch of the Department of Water and Environmental Regulation, Perth.

Department of Biodiversity, Conservation and Attractions (DBCA) 2020, *Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)*.

Emerge Associates 2021, *Detailed Flora and Vegetation Assessment - Lots 600-606 Balannup Road and 200-202 Skeet Road Harrisdale*, EP20-127(02)--003 SKP, Version 1.

Gibson, N., Keighery, B., Keighery, G., Burbidge, A. and Lyons, M. 1994, *A Floristic survey of the southern Swan Coastal Plain*, Department of Conservation and Land Management and the Conservation Council of Western Australia, Perth.

Online References

West Australian Land Information Authority (WALIA) 2021, *Landgate Map Viewe*r, viewed 27 May 2021, <http://landgate.wa.gov.au>.

Figures

Figure 1: Site Location and DBCA Areas of Interest

Figure 2: Current Geomorphic Wetlands

Figure 3: Proposed Geomorphic Wetlands

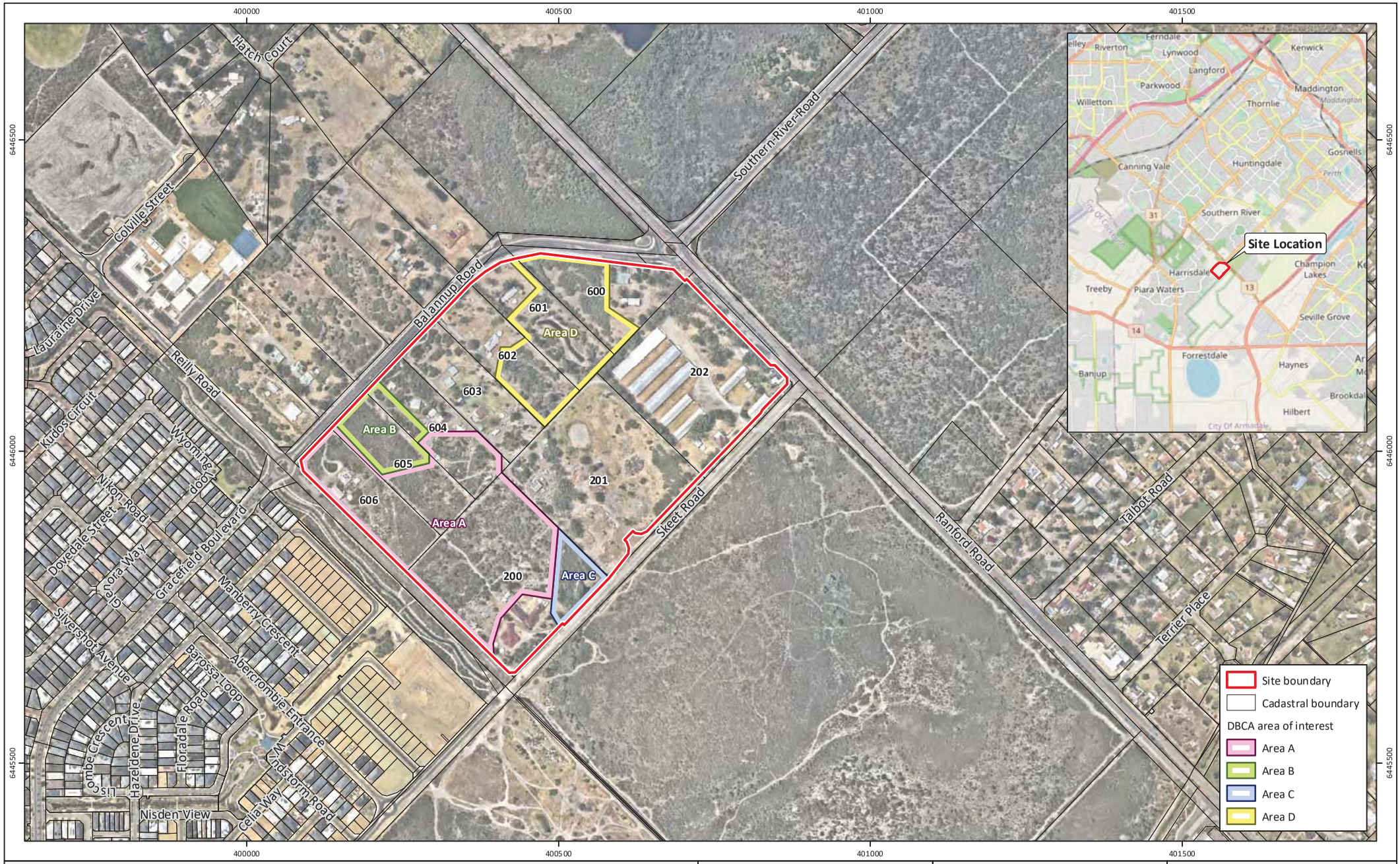


Figure 1: Site Location and DBCA Areas of Interest

Project: Wetland Assessment
Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale
Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(14)--F61
Drawn: GAR
Date: 02/06/2021
Checked: RAW
Approved: TAA
Date: 10/06/2021

N

0 100 200 300
Metres
Scale: 1:8,000@A4
GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
©Landgate (2020). Nearmap Imagery date: 03/01/2021

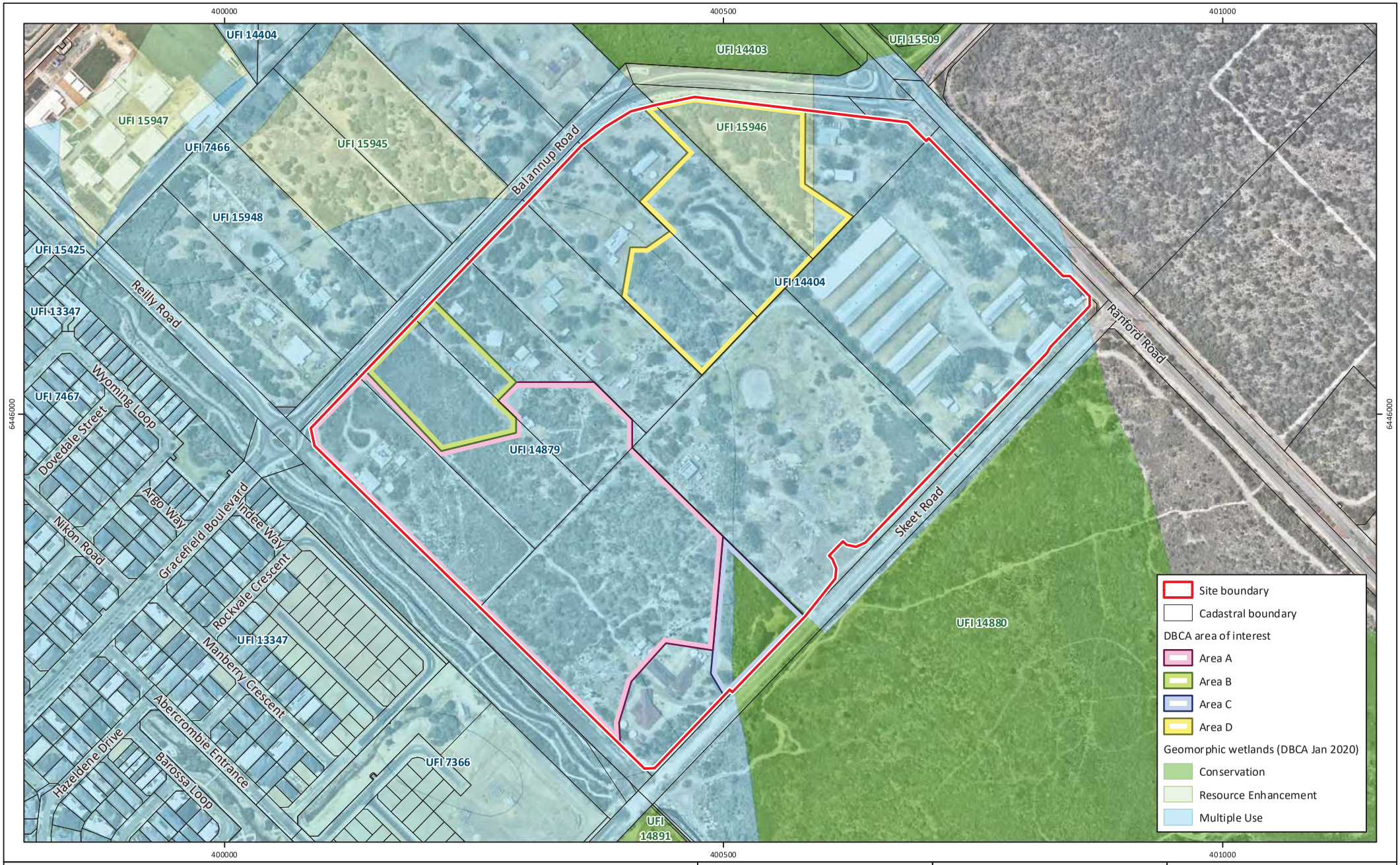


Figure 2: Current Geomorphic Wetlands

Project: Wetland Assessment
Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale
Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(14)--F62
Drawn: GAR
Date: 02/06/2021
Checked: RAW
Approved: TAA
Date: 10/06/2021

N

0 100 200
Metres
Scale: 1:5,000@A4
GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
©Landgate (2020). Nearmap Imagery date: 03/01/2021

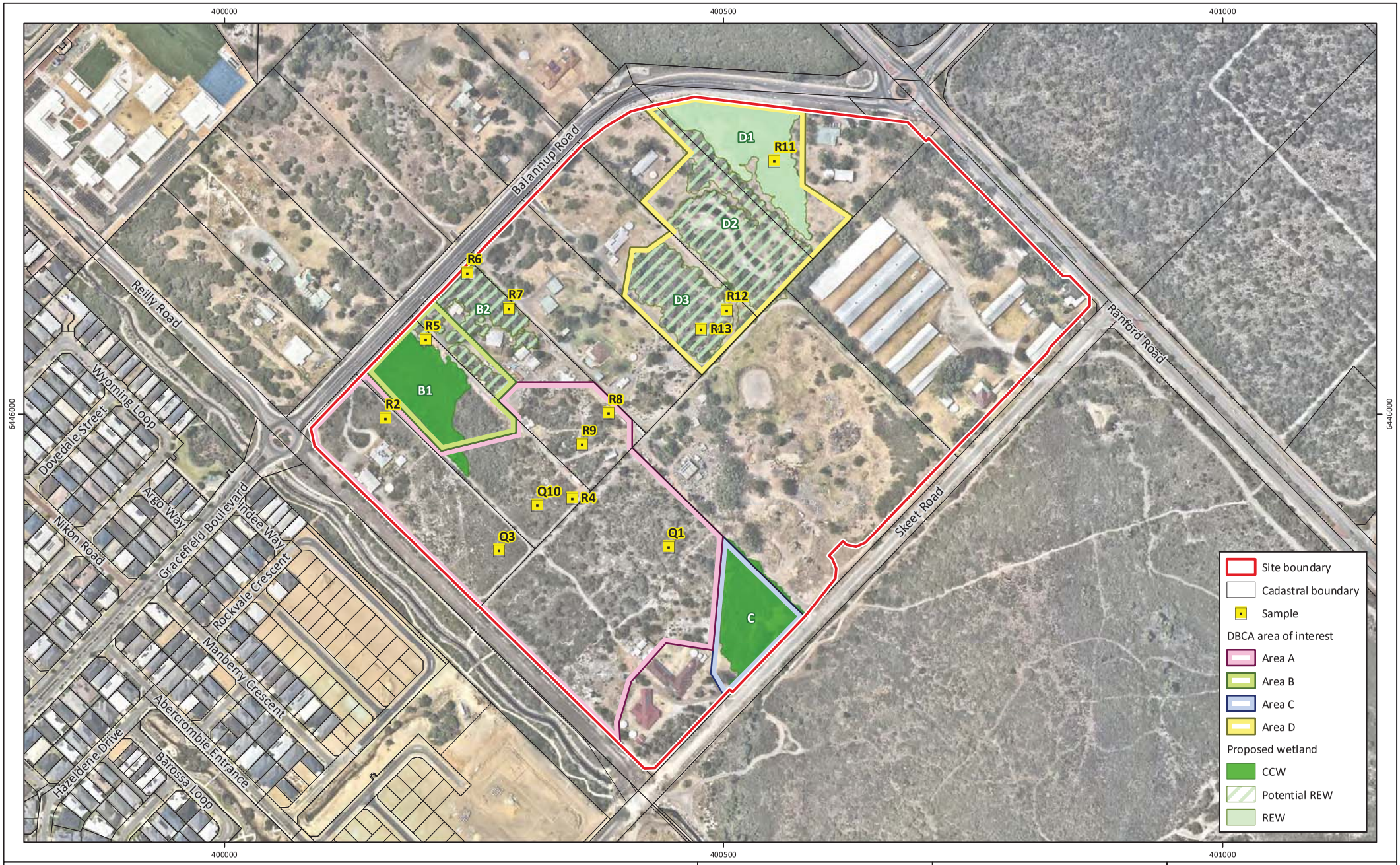


Figure 3: Proposed Geomorphic Wetlands

Project: Wetland Assessment
Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale
Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(14)--F63
Drawn: GAR
Date: 09/06/2021
Checked: RAW
Approved: TAA
Date: 10/06/2021

N

0 100 200
Metres
Scale: 1:5,000@A4
GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
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Attachment 1

Wetland Evaluation Forms

PRELIMINARY EVALUATION CRITERIA

CCW UFI No. 14880 (including area C)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	Y
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	Y
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	N
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	Y
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	Conservation category wetland

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

PRELIMINARY EVALUATION CRITERIA

Area B1 (currently mapped within MUW UFI 14879)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	Y
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	Y
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	Conservation category wetland

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

PRELIMINARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	Y
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	Conservation category wetland

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Geomorphology	Representative-ness	1	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	N	H	
		2	≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		3	≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		4	The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	N	H	
	Naturalness	5	Alteration to the wetland's geomorphology by % area: < 25% altered (=H) 25-75% altered (=I) > 75% altered. (=L)	 N N Y	 H I L	 L
	Scarcity	6	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	N	H	
		7	The wetland is the best example of its type in its consanguineous suite.	N	H	
	Representative-ness	8	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	N N Y	H I L	 L

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Wetland processes		9	The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	N	**H**	
	Naturalness	10	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	N Y N	**H** **I** **L**	**I**
	Scarcity	11	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	N	**H**	
Linkages	Representative-ness	12	The wetland is a hydrological link in a larger or more complex and intact system.	N	**H**	
	Naturalness	13	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas. The wetland is part of a fragmented ecological linkage or wildlife corridor. The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	N Y N	**H** **I** **L**	**I**
	Scarcity	14	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	N	**H**	

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Habitats	Representative-ness	15	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	N	H	
		16	The wetland contains evidence of surface water or groundwater expression that is vital for maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	N	H	
			The wetland contains evidence of surface water or groundwater expression that is important for maintaining populations of native aquatic or terrestrial flora or fauna.	N	I	
		17	The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	N	H	
	Naturalness	18	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	N	H	I
			The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated.	Y	I	
			The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	N	L	
	Scarcity	19	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	N	H	
	Representative-ness	20	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state.	N	H	
			The wetland supports a reduced diversity of native flora due to human induced disturbances.	N	I	
			The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	Y	L	L

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Flora		21	The wetland is identified in a vegetation complex (Heddle et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	 Y N	 H I	H
	Naturalness	22	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	 N Y N	 H I L	I
		23	The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	N N Y	H I L	L
	Scarcity	24	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	N	H	
		25	The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	N	I	
		26	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		27	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	N	I	
			The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.	N	H	

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Fauna	Representative-ness	28	The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	N	I	
		29	The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.	N	H	
			The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	N	I	
	Naturalness	30	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type.	N	H	
			The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	N	I	
			The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	Y	L	L
	Scarcity	31	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. EPBC Act 1999, JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	N	H	
		32	The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	N	H	
		33	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		34	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	N	I	

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Cultural	Representative-ness	35	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	N	H	
		36	The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	N	I	
		37	The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	N	H	
		38	The wetland is important to the local community either nationally or state wide for its natural values.	N	H	
		39	The wetland is or has the potential to be a site for public or private based recreation.	N	I	
		40	The wetland is the subject of a recognised ecological restoration / rehabilitation project by a community group, landowner or land manager that aims to improve the wetland's natural, heritage, cultural or social values The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant. The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	N N N	H I L	
Scientific and educational	Representative-ness	41	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics. The wetland has the potential to be used as a study or research site.	N N	H I	

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
			The wetland supports known scientific, geoheritage or geoconservation values.	N	H	

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SECONDARY EVALUATION TALLY

Area B2 (Currently mapped within MUW 14879)

Attributes / functions / values	Scores		
	High	Intermediate	Low
Geomorphology	2	0	1
Wetland processes	0	1	1
Linkages	0	1	0
Habitats	0	1	0
Flora	1	1	2
Fauna	0	0	1
Cultural	0	0	0
Scientific and educational	0	0	0
Max of High + Intermediate	2		
Total score	**3**	**4**	**5**
	5		
Defining attributes/functions/values	Geomorphology		
Applicable management category	**REW (case by case basis)**		

PRELIMINARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	N
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	**Secondary evaluation required**

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Geomorphology	Representative-ness	1	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	N	H	
		2	≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		3	≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		4	The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	N	H	
	Naturalness	5	Alteration to the wetland's geomorphology by % area: < 25% altered (=H) 25-75% altered (=I) > 75% altered. (=L)	 N Y N	 H I L	I
	Scarcity	6	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	N	H	
		7	The wetland is the best example of its type in its consanguineous suite.	N	H	
	Representative-ness	8	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	N Y N	H I L	I

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Wetland processes		9	The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	N	**H**	
	Naturalness	10	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	N Y N	**H** **I** **L**	**I**
	Scarcity	11	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	N	**H**	
Linkages	Representative-ness	12	The wetland is a hydrological link in a larger or more complex and intact system.	n	**H**	
	Naturalness	13	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas. The wetland is part of a fragmented ecological linkage or wildlife corridor. The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	N N Y	**H** **I** **L**	**L**
	Scarcity	14	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	N	**H**	

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Habitats	Representative-ness	15	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	N	H	
		16	The wetland contains evidence of surface water or groundwater expression that is vital for maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	N	H	
			The wetland contains evidence of surface water or groundwater expression that is important for maintaining populations of native aquatic or terrestrial flora or fauna.	N	I	
		17	The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	N	H	
	Naturalness	18	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	N	H	I
			The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated.	y	I	
			The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	N	L	
	Scarcity	19	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	N	H	
	Representative-ness	20	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state.	N	H	
			The wetland supports a reduced diversity of native flora due to human induced disturbances.	N	I	
			The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	Y	L	L

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Flora		21	The wetland is identified in a vegetation complex (Heddle et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	 Y n	 H I	H
	Naturalness	22	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	 N n y	 H I L	L
		23	The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	N n y	H I L	L
	Scarcity	24	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	N	H	
		25	The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	N	I	
		26	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		27	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	N	I	
			The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.	N	H	

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Fauna		28	The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	N	I	
	Representativ e-ness	29	The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.	N	H	
			The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	n	I	
	Naturalness	30	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type.	N	H	
			The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	Y	I	I
			The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	N	L	
	Scarcity	31	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. EPBC Act 1999, JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	N	H	
		32	The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	N	H	
		33	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		34	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	N	I	

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Cultural	Representative-ness	35	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	N	H	
		36	The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	N	I	
		37	The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	N	H	
		38	The wetland is important to the local community either nationally or state wide for its natural values.	N	H	
		39	The wetland is or has the potential to be a site for public or private based recreation.	N	I	
		40	The wetland is the subject of a recognised ecological restoration / rehabilitation project by a community group, landowner or land manager that aims to improve the wetland's natural, heritage, cultural or social values The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant. The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	N N N	H I L	
Scientific and educational	Representative-ness	41	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics. The wetland has the potential to be used as a study or research site.	N N	H I	

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
			The wetland supports known scientific, geoheritage or geoconservation values.	N	H	

SECONDARY EVALUATION TALLY

REW UFI 15946 (Area D1)

Attributes / functions / values	Scores		
	High	Intermediate	Low
Geomorphology	2	1	0
Wetland processes	0	2	0
Linkages	0	0	1
Habitats	0	1	0
Flora	1	0	3
Fauna	0	1	0
Cultural	0	0	0
Scientific and educational	0	0	0
Max of High + Intermediate	2		
Total score	**3**	**5**	**4**
	5		
Defining attributes/functions/values	Geomorphology		
Applicable management category	**Resource enhancement**		

Applicable management category	**Resource enhancement**

Apdated from DBCA 2017

A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia

PRELIMINARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	N
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	**Secondary evaluation required**

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Geomorphology	Representative-ness	1	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	N	H	
		2	≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		3	≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		4	The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	N	H	
	Naturalness	5	Alteration to the wetland's geomorphology by % area: < 25% altered (=H) 25-75% altered (=I) > 75% altered. (=L)	 N N Y	 H I L	 L
	Scarcity	6	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	N	H	
		7	The wetland is the best example of its type in its consanguineous suite.	N	H	
		8	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage).	N y	H I	 I

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Wetland processes	Representative-ness		The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	n	**L**	
		9	The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	N	**H**	
	Naturalness	10	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	N Y N	**H** **I** **L**	**I**
	Scarcity	11	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	N	**H**	
	Representative-ness	12	The wetland is a hydrological link in a larger or more complex and intact system.	n	**H**	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Linkages	Naturalness	13	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas.	N	**H**	**L**
			The wetland is part of a fragmented ecological linkage or wildlife corridor.	n	**I**	
			The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	y	**L**	
	Scarcity	14	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	N	**H**	
Habitats	Representativ e-ness	15	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	N	**H**	
		16	The wetland contains evidence of surface water or groundwater expression that is vital for maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	N	**H**	
			The wetland contains evidence of surface water or groundwater expression that is important for maintaining populations of native aquatic or terrestrial flora or fauna.	N	**I**	
		17	The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	N	**H**	
			The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	N	**H**	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
	Naturalness	18	The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated. The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	y N	I L	I
	Scarcity	19	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	N	H	
Flora	Representativ e-ness	20	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state. The wetland supports a reduced diversity of native flora due to human induced disturbances. The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	N N Y	H I L	L
		21	The wetland is identified in a vegetation complex (Heddle et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	Y n	H I	H
	Naturalness	22	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	N n y	H I L	L
		23	The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	N N	H I	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
			The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	Y	L	L
	Scarcity	24	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	N	H	
		25	The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	N	I	
		26	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		27	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	N	I	
	Representativ e-ness	28	The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages. The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	N N	H I	
		29	The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna. The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	N N	H I	
			The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type.	N	H	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Fauna	Naturalness	30	The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	Y	**I**	**I**
			The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	N	**L**	
	Scarcity	31	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. EPBC Act 1999, JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	N	**H**	
		32	The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	N	**H**	
		33	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	**H**	
		34	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	N	**I**	
		35	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	N	**H**	
		36	The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	N	**I**	
		37	The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	N	**H**	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Cultural	Representativ e-ness	38	The wetland is important to the local community either nationally or state wide for its natural values.	N	**H**	
		39	The wetland is or has the potential to be a site for public or private based recreation.	N	**I**	
		40	The wetland is the subject of a recognised ecological restoration / rehabilitation project by a community group, landowner or land manager that aims to improve the wetland's natural, heritage, cultural or social values	N	**H**	
			The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant.	N	**I**	
			The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	N	**L**	
Scientific and educational	Representativ e-ness	41	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics.	N	**H**	
			The wetland has the potential to be used as a study or research site.	N	**I**	
			The wetland supports known scientific, geoheritage or geoconservation values.	N	**H**	

SECONDARY EVALUATION TALLY

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions / values	Scores		
	High	Intermediate	Low
Geomorphology	2	0	1
Wetland processes	0	2	0
Linkages	0	0	1
Habitats	0	1	0
Flora	1	0	3
Fauna	0	1	0
Cultural	0	0	0
Scientific and educational	0	0	0
Max of High + Intermediate	2		
Total score	**3**	**4**	**5**
	5		
Defining attributes/functions/values	Geomorphology		
Applicable management category	**REW (case by case basis)**		

Applicable management category	**REW (case by case basis)**

Apdated from DBCA 2017

A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia

PRELIMINARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	N
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	**Secondary evaluation required**

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Geomorphology	Representative-ness	1	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	N	H	
		2	≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		3	≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		4	The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	N	H	
	Naturalness	5	Alteration to the wetland's geomorphology by % area: < 25% altered (=H) 25-75% altered (=I) > 75% altered. (=L)	 N Y N	 H I L	I
	Scarcity	6	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	N	H	
		7	The wetland is the best example of its type in its consanguineous suite.	N	H	
	Representative-ness	8	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	N y n	H I L	I

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Wetland processes		9	The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	N	**H**	
	Naturalness	10	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	N Y N	**H** **I** **L**	**I**
	Scarcity	11	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	N	**H**	
Linkages	Representative-ness	12	The wetland is a hydrological link in a larger or more complex and intact system.	n	**H**	
	Naturalness	13	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas. The wetland is part of a fragmented ecological linkage or wildlife corridor. The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	N N y	**H** **I** **L**	**L**
	Scarcity	14	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	N	**H**	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Habitats	Representative-ness	15	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	N	H	
		16	The wetland contains evidence of surface water or groundwater expression that is vital for maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	N	H	
			The wetland contains evidence of surface water or groundwater expression that is important for maintaining populations of native aquatic or terrestrial flora or fauna.	N	I	
		17	The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	N	H	
	Naturalness	18	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	N	H	I
			The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated.	y	I	
			The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	N	L	
	Scarcity	19	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	N	H	
	Representative-ness	20	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state.	N	H	
			The wetland supports a reduced diversity of native flora due to human induced disturbances.	N	I	
			The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	Y	L	L

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Flora		21	The wetland is identified in a vegetation complex (Heddle et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	 Y n	 H I	H
	Naturalness	22	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	 N N Y	 H I L	L
		23	The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	N N Y	H I L	L
	Scarcity	24	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	N	H	
		25	The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	N	I	
		26	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		27	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	N	I	
			The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.	N	H	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Fauna	Representative-ness	28	The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	N	I	
		29	The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.	N	H	
			The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	N	I	
	Naturalness	30	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type.	N	H	
			The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	N	I	
			The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	Y	L	L
	Scarcity	31	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. EPBC Act 1999, JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	N	H	
		32	The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	N	H	
		33	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		34	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	N	I	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Cultural	Representativ e-ness	35	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	N	**H**	
		36	The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	N	**I**	
		37	The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	N	**H**	
		38	The wetland is important to the local community either nationally or state wide for its natural values.	N	**H**	
		39	The wetland is or has the potential to be a site for public or private based recreation.	N	**I**	
		40	The wetland is the subject of a recognised ecological restoration / rehabilitation project by a community group, landowner or land manager that aims to improve the wetland's natural, heritage, cultural or social values The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant. The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	N N Y	**H** **I** **L**	**L**
Scientific and educational	Representativ e-ness	41	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics. The wetland has the potential to be used as a study or research site.	N N	**H** **I**	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
			The wetland supports known scientific, geoheritage or geoconservation values.	N	H	

DBCA 2017

A methodology for the evaluation of wetlands on the Swan Coastal Plain, West

SECONDARY EVALUATION TALLY

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions / values	Scores		
	High	Intermediate	Low
Geomorphology	2	1	0
Wetland processes	0	2	0
Linkages	0	0	1
Habitats	0	1	0
Flora	1	0	3
Fauna	0	0	1
Cultural	0	0	1
Scientific and educational	0	0	0
Max of High + Intermediate	2		
Total score	**3**	**4**	**6**
	6		
Defining attributes/functions/values	Geomorphology		
Applicable management category	**REW (case by case basis)**		

Applicable management category	**REW (case by case basis)**

Apdated from DBCA 2017

A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia

Attachment 2

Raw Survey Data

Vegetation Survey Data

Sample Name: Q1

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA Q1: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	400444	NW corner northing:	6445868
Altitude (m):	24	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	No evidence	Disturbance:	moderate - weeds
Soil type/texture	sand/ with organic layer	Bare ground (%):	15
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	30% (leaves,twigs,)	Vegetation condition:	very good



Soil test pit
Grey sandy soils grading to light grey with organic matter mixed through, damp to cool, dry

Vegetation Survey Data

Sample Name: Q1

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA Q1: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella	0.5
	Banksia attenuata	30
	Banksia ilicifolia	10
	Bossiaea eriocarpa	opp
*	*Briza maxima*	0.1
	Burchardia congesta	0.1
	Conostephium pendulum	0.5
	Dasypogon bromeliifolius	2
	Desmocladus flexuosus	10
*	*Ehrharta calycina*	0.5
	Pyrorchis nigricans	0.5
*	*Gladiolus caryophyllaceus*	0.1
	Haemodorum spicatum	0.5
	Arnocrinum preissii	0.5
	Gompholobium tomentosum	0.5
	Kunzea glabrescens	5
	Laxmannia ramosa subsp. ramosa	0.1
	Lepidosperma pubisquameum	0.5
	Styphelia xerophylla	1
	Lomandra hermaphrodita	0.1
	Lyginia barbata	30
	Macrozamia riedlei	15
	Melaleuca thymoides	1
	Nuytsia floribunda	opp
	Patersonia occidentalis	15
	Phlebocarya ciliata	1
	Chaetospora curvifolia	0.5
	Scholtzia involucrata	1
	Stylidium repens	0.1
	Thysanotus dichotomous	0.5
*	*Ursinia anthemoides*	0.5
	Xanthorrhoea preissii	1

Vegetation Survey Data

Sample Name: R2

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R2: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400161	NW corner northing:	6445996
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	Low - weeds
Soil type/texture	sand/	Bare ground (%):	2
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Excellent



Soil test pit
Dark grey soils with fine organic layer at top, grading to light grey sand, dry to cool, dry at depth

Vegetation Survey Data

Sample Name: R2

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia lasiocarpa	
	Calytrix flavescens	
	Dasypogon bromeliifolius	
	Eremaea pauciflora var. pauciflora	
	Hovea trisperma	
	Hypolaena exsulca	
	Kunzea glabrescens	
	Lomandra sericea	
	Lyginia barbata	
	Patersonia occidentalis	
	Bossiaea eriocarpa	
	Phlebocarya ciliata	
	Xanthorrhoea preissii	

Vegetation Survey Data

Sample Name: Q3

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA Q3: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	400274.7643	NW corner northing:	6445864.005
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	4
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Very good



Soil test pit
Soils dark grey to light grey, some organic matter mixed through, dry to cool, dry at depth

Vegetation Survey Data

Sample Name: Q3

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA Q3: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia lasiocarpa	0.5
	Calytrix flavescens	1
	Dampiera linearis	0.5
	Dasypogon bromeliifolius	5
	Eremaea pauciflora var. pauciflora	40
	Xanthorrhoea brunonis	1
	Hypolaena exsulca	5
	Hypolaena pubescens	0.5
	Lyginia barbata	20
	Nuytsia floribunda	opp
	Patersonia occidentalis	15
	Bossiaea eriocarpa	1
	Phlebocarya ciliata	10
	Adenanthos obovatus	0.1
	Hensmania turbinata	0.5
	Rytidosperma sp.	0.5
	Chaetospora curvifolia	0.1
	Scholtzia involucrata	1

Vegetation Survey Data

Sample Name: R4

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400348.0198	NW corner northing:	6445916.289
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Very good



Soil test pit
Dark grey soils with organic matter in top 50 cm then light grey with organic flecks, dry to damp

Vegetation Survey Data

Sample Name: R4

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Banksia attenuata	
	Bossiaea eriocarpa	
*	*Briza maxima*	
	Burchardia congesta	
	Conostephium pendulum	
	Dasypogon bromeliifolius	
	Kunzea glabrescens	
	Lomandra sericea	
	Melaleuca thymoides	
	Patersonia occidentalis	
	Phlebocarya ciliata	

Vegetation Survey Data

Sample Name: R5

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R5: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400201.0429	NW corner northing:	6446075.118
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	15
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Very good



Soil test pit
Soils darkish brown grey sand, whole profile damp to moist at depth

Vegetation Survey Data

Sample Name: R5

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Dasypogon bromeliifolius	
	Eremaea pauciflora var. pauciflora	
	Hypocalymma angustifolium	
	Hypolaena exsulca	
	Kunzea glabrescens	
	Phlebocarya ciliata	
	Acacia pulchella	
	Regelia ciliata	

Vegetation Survey Data

Sample Name: R6

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R6: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400242.809	NW corner northing:	6446141.828
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	20
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	very good



Soil test pit
Soils dark black at surface and then pale sand, leached damp near surface and damp at depth

Vegetation Survey Data

Sample Name: R6

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Astartea scoparia	
	Cyathochaeta avenacea	
	Hypocalymma angustifolium	
	Kunzea glabrescens	
	Lyginia barbata	
	Melaleuca preissiana	
	Regelia ciliata	

Vegetation Survey Data

Sample Name: R7

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R7: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400284.3449	NW corner northing:	6446106.284
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Good



Soil test pit
Soils grey grading to light grey, cool dry near surface and cool dry at depth

Vegetation Survey Data

Sample Name: R7

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Dasypogon bromeliifolius	
*	*Ehrharta calycina*	
	Kunzea glabrescens	
	Melaleuca preissiana	
	Regelia ciliata	

Vegetation Survey Data

Sample Name: R8

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R8: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400384.5111	NW corner northing:	6446001.583
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	10
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Very good



Soil test pit
Surface layer brown with carbon accumulated, grading to browny grey at depth, dry to damp below

Vegetation Survey Data

Sample Name: R8

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R8: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella	
	Banksia attenuata	
	Dasypogon bromeliifolius	
	Eremaea pauciflora var. pauciflora	
	Xanthorrhoea brunonis	
	Hypolaena exsulca	
	Kunzea glabrescens	
	Lepidosperma pubisquameum	
	Lyginia barbata	
	Patersonia occidentalis	

Vegetation Survey Data

Sample Name: R9

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R9: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400358.1819	NW corner northing:	6445970.347
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	10
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Very good



Soil test pit
Some organic material at surface, browny grey tending to light browny grey with flecks of organic through

Vegetation Survey Data

Sample Name: R9

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Banksia attenuata	
	Banksia menziesii	
	Dasypogon bromeliifolius	
	Eremaea pauciflora var. pauciflora	
	Gompholobium tomentosum	
	Xanthorrhoea brunonis	
	Haemodorum spicatum	
	Kunzea glabrescens	
	Adenanthos obovatus	
	Lomandra sericea	
	Lyginia barbata	
	Melaleuca thymoides	
	Melaleuca trichophylla	
	Nuytsia floribunda	
	Patersonia occidentalis	

Vegetation Survey Data

Sample Name: Q10

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA Q10: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	400313.0376	NW corner northing:	6445909.429
Altitude (m):	22	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	0
Time since fire:	No evidence	Disturbance:	moderate - weeds
Soil type/texture	sand/	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	10% (leaves,,)	Vegetation condition:	very good



Soil test pit
Light grey grading to very light grey, some organic on surface, dry to cool dry

Vegetation Survey Data

Sample Name: Q10

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia lasiocarpa	0.1
	Banksia attenuata	5
	Banksia menziesii	5
	Burchardia congesta	0.5
	Calytrix flavescens	1
	Dampiera linearis	0.5
	Eremaea pauciflora var. pauciflora	5
	Hovea trisperma	0.5
*	*Gladiolus caryophyllaceus*	0.5
	Gompholobium tomentosum	0.1
	Xanthorrhoea brunonis	5
	Hypolaena exsulca	1
	Kunzea glabrescens	1
	Lyginia barbata	10
	Melaleuca thymoides	0.5
	Nuytsia floribunda	5
	Patersonia occidentalis	70
	Phlebocarya ciliata	10
	Scholtzia involucrata	0.5
	Stylidium repens	0.5
	Eucalyptus todtiana	1

Vegetation Survey Data

Sample Name: R11

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R11: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400550.5163	NW corner northing:	6446254.494
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/ with organic layer	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	% (,,)	Vegetation condition:	Degraded



Soil test pit
Fine silty black soils over grey fine sand damp at surface and damp at depth

Vegetation Survey Data

Sample Name: R11

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name
*	*Cynodon dactylon*
	Melaleuca teretifolia
	Melaleuca viminea
	Melaleuca rhaphiophylla

Vegetation Survey Data

Sample Name: R12

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R12: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400502.6982	NW corner northing:	6446104.519
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/ with organic layer	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	% (,,)	Vegetation condition:	Degraded



Soil test pit
Brown organic rich soils grading from light grey to brown, fine sand dry to cool dry at depth

Vegetation Survey Data

Sample Name: R12

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Astartea scoparia	
*	*Cynodon dactylon*	
	Lepidosperma longitudinale	
	Melaleuca rhaphiophylla	
	Melaleuca lateritia	

Vegetation Survey Data

Sample Name: R13

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R13: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400477.3233	NW corner northing:	6446085.602
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/ with organic layer	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	% (,,)	Vegetation condition:	Degraded



Soil test pit
Brown soils over pale grey brown sand dry to damp

Vegetation Survey Data

Sample Name: R13

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
*	*Acacia longifolia*	
	Astartea scoparia	
*	*Asparagus asparagoides*	
*	*Eucalyptus grandis*	
	Kunzea glabrescens	
	Banksia littoralis	

Appendix F

DBCA Wetland Correspondence pertaining to relation to the Wetland Assessment (2021)

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Biodiversity and Conservation Science

We're working for Western Australia.

Species and Communities Program
Wetlands Conservation Section

18/11/2021

TO: Rachel Weber, Emerge Associates

Enquiries: Michael Coote, Principal Coordinator, Wetlands Section

SUBJECT: **Wetland management category upgrade from Multiple Use to Resource Enhancement and to Conservation management category for wetland of Harrisdale Lots 172, 515 and 516 Skeet Road.**

Background information

Emerge Associates (Emerge) submitted a request to re-evaluate portions of wetland UFIs-15946, 14404, 14879 and 13347 within lots 172, 515 and 516 Skeet Road, Harrisdale (Figure 1).

These wetlands are currently mapped in the Geomorphic Wetlands Swan Coastal Plain dataset (the dataset) as multiple use (MUW) and resource enhancement (REW) wetlands (Figure 1). Multiple Use wetland UFI-14404 and Resource Enhancement wetland UFI-15946 are mapped as sumplands, whereas Multiple Use wetlands UFI-13347 and UFI-14879 are mapped as damplands. Further to this, Emerge consulting provided vegetation mapping that suggested that a portion of the site has transitioned into dryland and is no longer consistent with a wetland environment.

Wetland boundaries

This site has undergone significant change from peri-urban development creating portions of wetlands with differing values and the dataset management category boundaries do not reflect the current condition. Wetland type boundaries were maintained as aerial imagery suggest that wetland UFI-14404 and wetland UFI-15946 continue to operate as a sumpland in wet years. In-line with the '*A methodology for the evaluation of wetlands of the Swan Coastal Plain (2017)*' (DBCA 2017, the wetlands evaluation methodology), section 5.3.2, category boundaries have been modified to reflect current condition and values. Wetland boundaries for wetland UFI-15946 were not altered.

Emerge provided vegetation mapping suggesting that a portion of the site contained floristics that is not consistent with a wetland environment. These areas will be amended to 'No Longer a wetland' (see figure 2). The Wetlands Section conducted two site visits and have taken the opportunity to modify wetland mapping within the project site and those polygons that intersect the project site (Figure 2).

Wetland values

Emerge evaluated the wetland portions in accordance with 'A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia' (DBCA, 2017).

Discrete areas of wetland vegetation within the site were evaluated by Emerge as being in excellent, very good and good condition using the Keighery 1994 vegetation condition scale.
Records of threatened and priority fauna including Carnaby's cockatoo (Calyptorhynchus latirostris, En) and Quenda (Isoodon fusciventer, P4) and have been recorded across the site in the last 10 years (see Figure 2).

Conservation Category wetlands.

Areas B1 and C have been evaluated as being commensurate with a wetland management category of Conservation (Figure 2).

Area B1 (part wetlands UFI-14879) meets Conservation on the preliminary evaluation with equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the Keighery 1994 vegetation condition scale.

Area C (part wetlands UFI-14879, part UFI-13347 and Part UFI-14480) wetland UFI-14880 is mapped as Conservation in the Current GWSCP mapping. The mapping has been extended up to include the wetland vegetation up to the edge of the area mapped as No Longer a Wetland as it is a small slither, and the vegetation is continuous in this area.

Resource Enhancement wetlands

Areas B2 and D3 were evaluated by the Wetlands Section, DBCA, using the wetlands evaluation methodology (DBCA 2017) as REW and will be amended to this category within the GWSCP dataset (Fig. 2).

No Longer a Wetland

Portions of wetland UFIs 14879, 13347, 14891 and 7366 have been modified to No Longer a Wetland to reflect the loss of wetland values (floristics, hydrology and morphology) to the point that they no longer support habitat or environment that is characteristic of wetlands (Fig. 2).

Summary

The Wetland Section will make the following changes in the next quarterly update of the Geomorphic Wetlands Swan Coastal Plain dataset, as reflected within Figure 2:

- Wetland portion B1 is amended from multiple use (MUW) to conservation (CCW) (Figure 2.).
- Wetland portion C is extended 5 metres west and retains a management category of Conservation (Figure 2.).
- Wetland portions B2 and D3 are amended from multiple use (MUW) to resource enhancement (REW) (Figure 2.).
- Portions of wetland UFIs 13347, 14879, 14891 and 7366 are amended from multiple use and conservation to No Longer a Wetland (Figure 2).

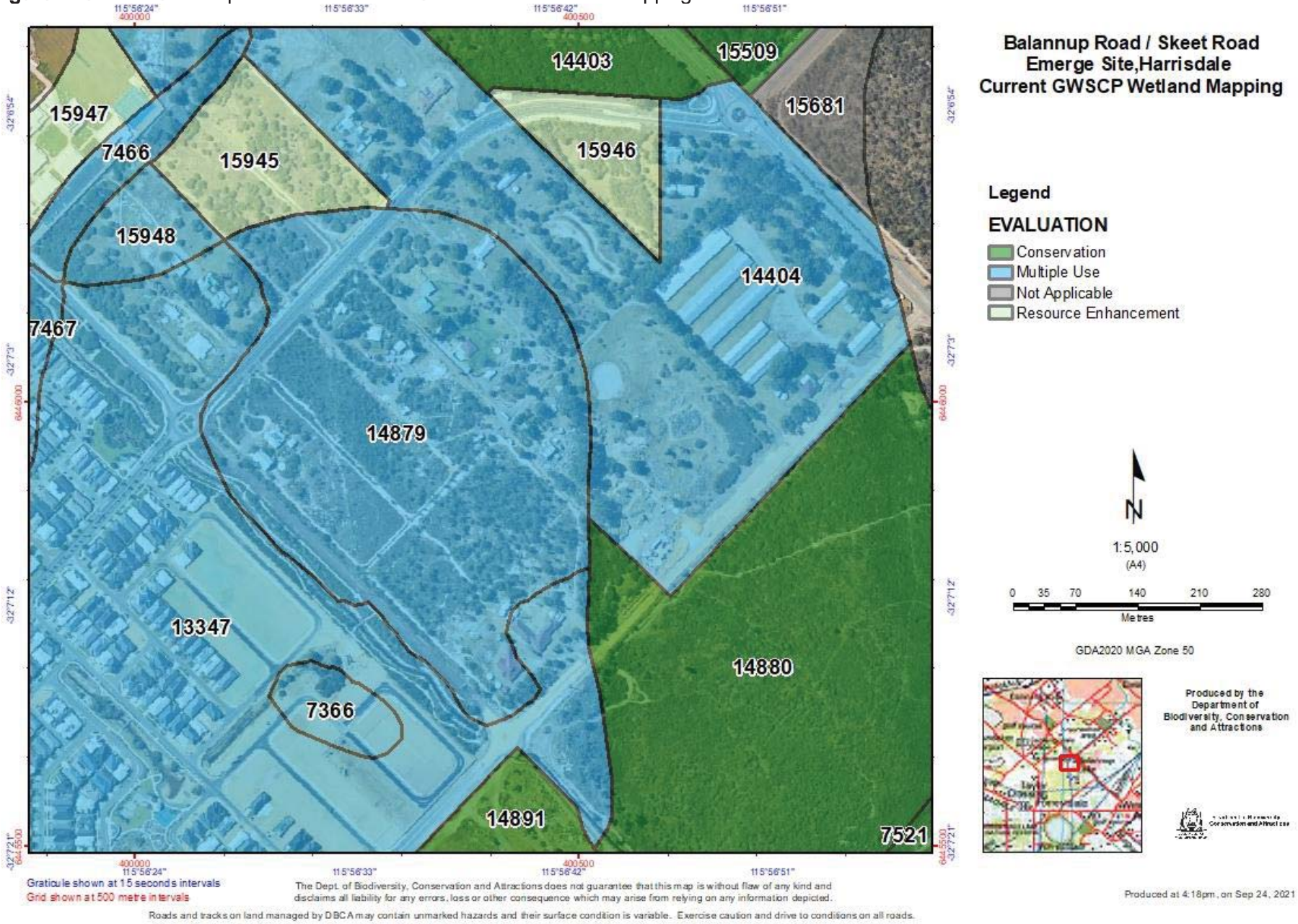
References

DBCA, 2017, *A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia*, Department of Biodiversity, Conservation and Attractions, Perth.

Figures

Figure 1 – Current Geomorphic wetland Swan Coastal Plain wetland mapping
Figure 2 – Proposed Geomorphic wetland Swan Coastal Plain mapping

Figure 1: Current Geomorphic Wetlands Swan Coastal Plain Dataset mapping



Balannup Road / Skeet Road Emerge Site,Harrisdale Current GWSCP Wetland Mapping

Legend

EVALUATION

- Conservation
- Multiple Use
- Not Applicable
- Resource Enhancement

N

1:5,000
(A4)

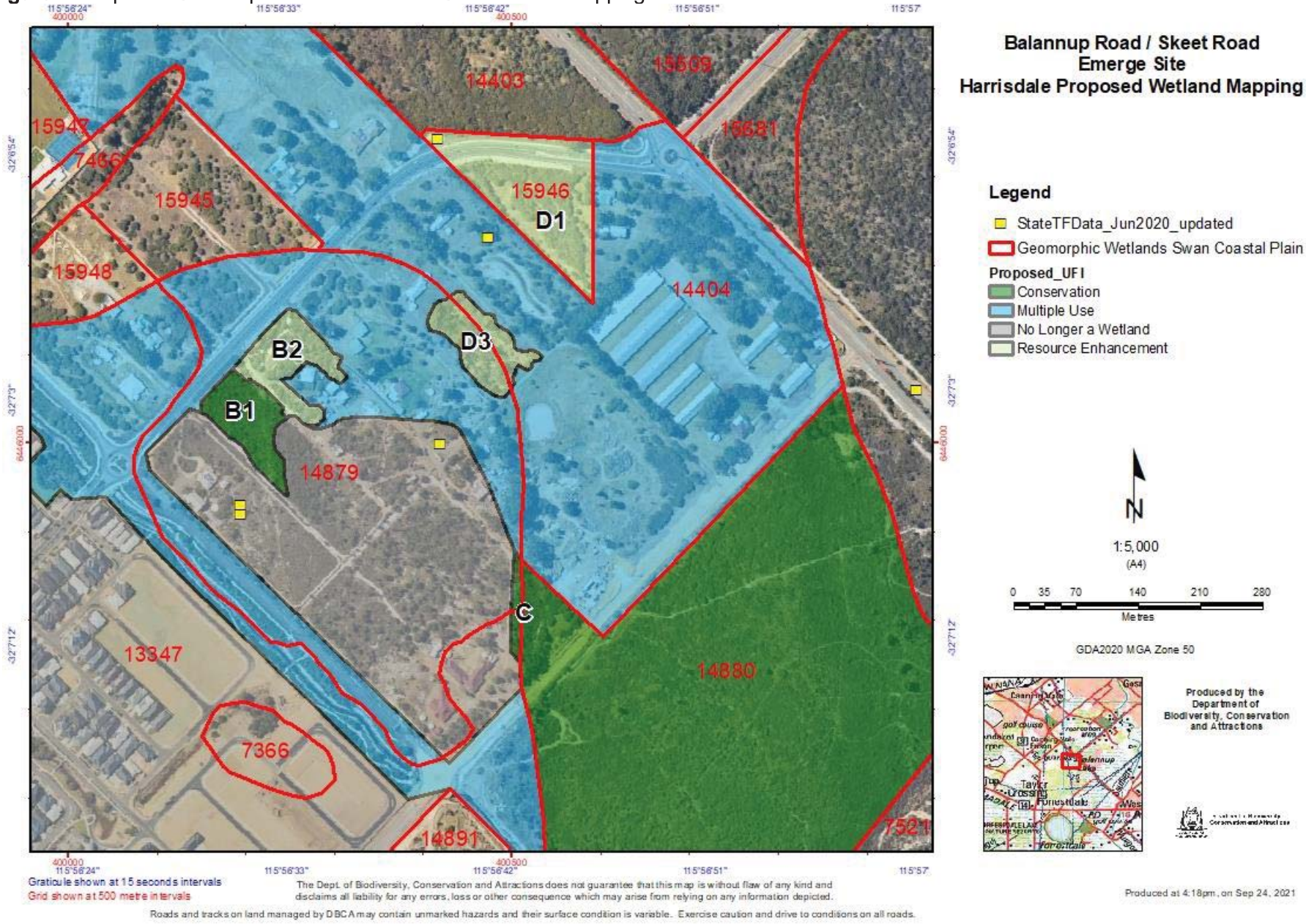
0 35 70 140 210 280
Metres

GDA2020 MGA Zone 50

Produced by the Department of Biodiversity, Conservation and Attractions

Produced at 4:18pm, on Sep 24, 2021

Figure 2: Proposed Geomorphic Wetlands Swan Coastal Plain mapping.



Balannup Road / Skeet Road
Emerge Site
Harrisdale Proposed Wetland Mapping

Legend

- StateTFData_Jun2020_updated
- Geomorphic Wetlands Swan Coastal Plain

Proposed_UFI

- Conservation
- Multiple Use
- No Longer a Wetland
- Resource Enhancement

N

1:5,000
(A4)

0 35 70 140 210 280
Metres

GDA2020 MGA Zone 50

Produced by the Department of Biodiversity, Conservation and Attractions

Produced at 4:18pm, on Sep 24, 2021

Appendix G

MRA Amendment 1274/57 EPA Advice Letter (2014)

A5032759

GOVERNMENT OF WESTERN AUSTRALIA

Environmental Protection Authority

DEPARTMENT OF PLANNING
16 JUL 2014
FILE RLS/0463

Secretary
Western Australian Planning Commission
Locked Bag
PERTH WA 6001

Your Ref: 833-2-22-71Pt1
Our Ref: 14-844215
Enquiries: Angela Coletti
Phone: 6145 0806

Attn: Mr Alex Watson

Dear Sir/Madam

DECISION UNDER SECTION 48A(1)(a)
Environmental Protection Act 1986

SCHEME AMENDMENT TITLE:	**Western Australian Planning Commission - Metropolitan Region Scheme Amendment 1274/57**
LOCATION:	**Balannup/Skeet Road Precinct**
LOCALITY:	**Harrisdale**
RESPONSIBLE AUTHORITY:	**Western Australian Planning Commission**
DECISION:	**Scheme Amendment Not Assessed – Advice Given (no appeals)**

Thank you for referring the above scheme amendment to the Environmental Protection Authority (EPA).

After consideration of the information provided by you, the Environmental Protection Authority (EPA) considers that the proposed scheme amendment should not be assessed under Part IV Division 3 of the *Environmental Protection Act 1986* (EP Act) but nevertheless provides the following advice and recommendations.

ADVICE AND RECOMMENDATIONS

1. Environmental Issues

- Human Health
- Hydrological Processes
- Flora and Vegetation
- Terrestrial Fauna

2. Advice and recommendations regarding Environmental Issues

In January 2013, the Office of the Environmental Protection Authority (OEPA) wrote to the Western Australian Planning Commission (WAPC) stating that the EPA has no objection to the initiation of the proposed amendment.

Level 4, The Atrium, 168 St Georges Terrace, Perth, Western Australia 6000
Telephone 08 6145 0800 Facsimile 08 6145 0895 Email info@epa.wa.gov.au
Locked Bag 10, East Perth WA 6892
www.epa.wa.gov.au

The OEPA notes that a number of environmental and planning issues need to be resolved prior to the lifting of Urban Deferred zone. These include: flora and fauna; wetlands; acid sulphate soils; soil contamination; and traffic noise. Arrangements to close the poultry farm located at Lot 172 Skeet Road, and appropriate buffers to the kennels and Balannup Lake also to be finalised.

The OEPA also notes that Bush Forever Site 413 is located north and Bush Forever Site 342 is located to the south and east of the subject land. The Balannup Lake is located to the north of the subject land.

The EPA recommends that additional management measures be required to ensure that that there are no negative impacts to the surrounding Bush Forever sites and Balannup Lake reserve.

3. General Advice

- For the purposes of Part IV of the EP Act, the scheme amendment is defined as an assessed scheme amendment. In relation to the implementation of the scheme amendment, please note the requirements of Part IV Division 4 of the EP Act.
- There is no appeal right in respect of the EPA's decision on the level of assessment of scheme amendments.
- A copy of this advice will be sent to the relevant authorities and will be available to the public on request.

Yours faithfully

Darren Foster
Director
Strategic Policy and Planning Division

14 July 2014

Appendix H

North Harrisdale Structure Plan Landscape Report
(Emerge Associates 2022)

Refer Appendix 8 of Structure Plan Report – Landscape Masterplan 2023

Refer Appendix 8 of Structure Plan Report – Landscape Masterplan 2023

Appendix I

Noise Impact Assessment (Lloyd George Acoustics 2021)

Refer Appendix 5 of Structure Plan Report – Acoustic Report 2023

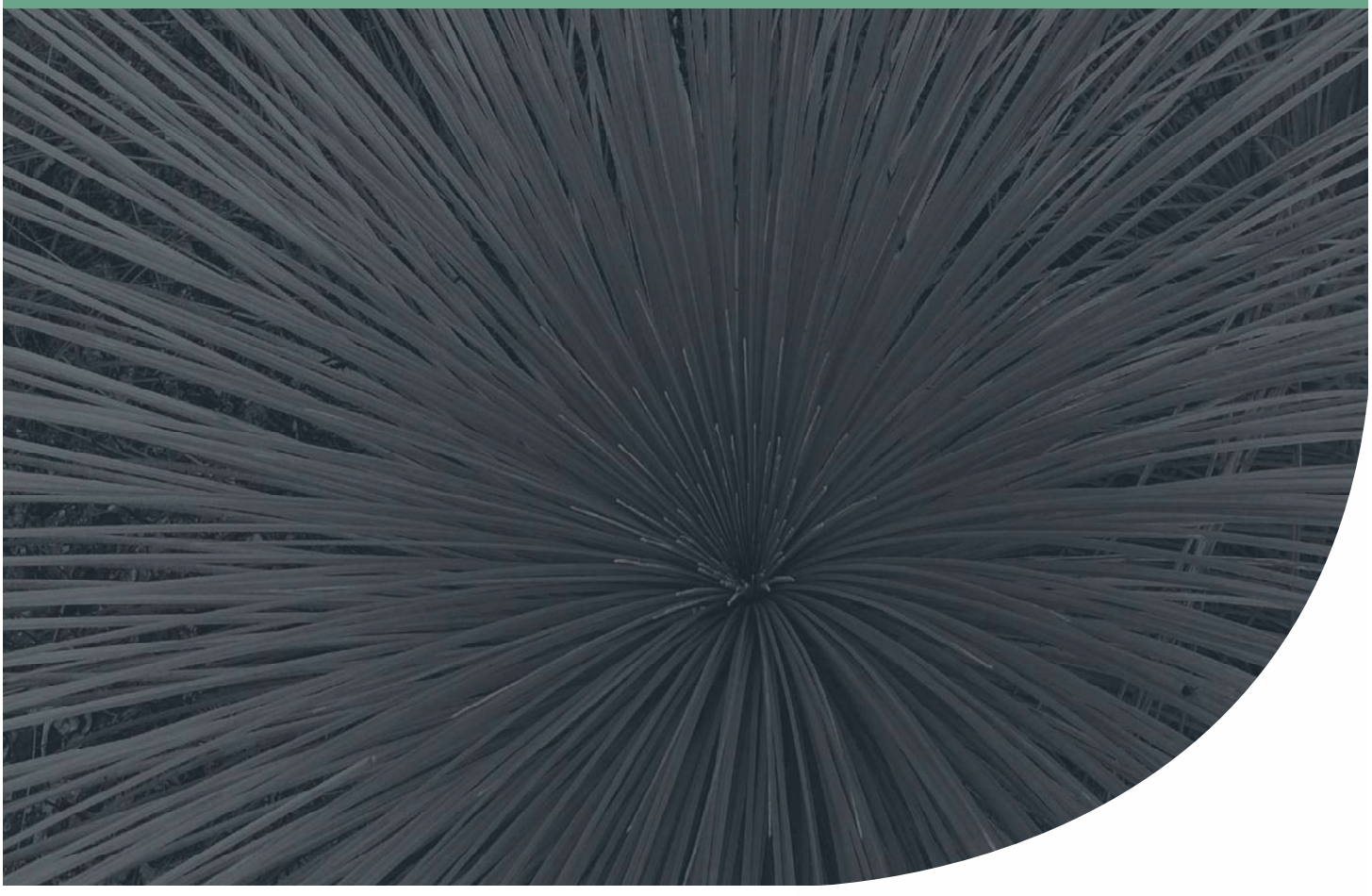
APPENDIX 3 – BASIC FAUNA AND TARGETED BLACK COCKATOO ASSESSMENT

Basic Fauna and Targeted Black Cockatoo Assessment

Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Project No: EP20-127(03)

Prepared for Yolk Property Group Pty Ltd
January 2021



Document Control

Doc name:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale				
Doc no.:	**EP20-127(03)--006 SCM**				
Version	**Date**	**Author**		**Reviewer**	
1	January 2021	Sean Moylan	SCM	Rachel Weber	RAW
	Report submitted for client review				

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Executive Summary

Emerge Associates (Emerge) were engaged to conduct a 'basic' fauna and a 'targeted' black cockatoo assessment for Lots 600 - 606 Balannup Road and Lots 200 - 202 Skeet Road, Harrisdale (referred to herein as 'the site'). The purpose of this assessment was to provide technical documentation to support the future development of the site for residential purposes.

As part of the assessment a desktop assessment of relevant background information was completed and a field survey was undertaken on 4 December 2020. During the field survey an assessment was made on the fauna habitat within the site and its suitability to provide habitat for conservation significant fauna. A targeted black cockatoo survey was also undertaken to determine the presence of habitat for threatened black cockatoo species.

Outcomes of the basic fauna survey include the following:

- The majority of the site has been impacted by historical clearing, with approximately half of the site (14.94 ha) supporting predominantly cleared areas with native vegetation.
- Seven fauna habitats were identified within the site, with the highest value habitat being in the south western portion due to the presence of relatively intact native vegetation.
- A total of 18 native fauna species were positively identified to occur within the site, including one conservation significant species, quenda (P4).
- A further 15 species of conservation significance not recorded during the field survey are considered to have potential to occur within the site. These species would primarily be associated with the **banksia woodland** habitat, and to a lesser extent, waterbody habitats, if they occur at all. Targeted surveys would need to be undertaken to confirm whether these species occur within the site.

Outcomes of the targeted black cockatoo survey include the following:

- The site is located within the modeled distribution of all three species of threatened black cockatoo and within the breeding range of forest red-tailed black cockatoo.
- No evidence of black cockatoos was recorded during the survey.
- All three species of black cockatoo may utilise the site due to the presence of suitable habitat and the records within the broader area.
- Six habitat trees were recorded in the site but none contained suitable hollows for breeding by black cockatoos. Therefore, the site is not considered to currently provide suitable breeding habitat for black cockatoos.
- No evidence of black cockatoo roosting activity was observed within the site. Potential roosting habitat that is suitable for all three species of black cockatoo occurs within the site in the form of tall native and non-native trees.
- Foraging habitat for all three species of black cockatoo was mapped within the site, primarily within the southern portion.
- A total of 1.95 ha of primary foraging habitat for Carnaby's cockatoo, less than 0.01 ha for Baudin's cockatoo and 0.09 ha for forest red-tailed black cockatoo was mapped within the site. The site also contains secondary foraging habitat for all three species of black cockatoo.

Extensive areas of additional remnant native vegetation that may provide foraging habitat for all three species of black cockatoo occur adjacent to and in the wider area of the site.

- The overall habitat score was determined to be three (low) for Carnaby's cockatoo, two (low) for Baudin's and four (moderate) for forest red-tailed black cockatoo. The site scored highest for the breeding habitat component for forest red-tailed black cockatoos due to the presence of potential habitat trees, albeit without hollows, and the presence of foraging habitat within the broader area.

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Appendices

Appendix A

Additional Information

Appendix B

Black Cockatoo Foraging Plants

Appendix C

Black Cockatoo Habitat Quality Assessment (Emerge 2020)

Appendix D

Database Search Results

Appendix E

Conservation Significant Species and Likelihood of Occurrence Assessment

Appendix F

Species List

Appendix G

Black Cockatoo Habitat Tree Data

Appendix H

Overall Habitat Quality Assessment

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
BoM	Bureau of Meteorology
CoA	City of Armadale
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DPaW	Department of Parks and Wildlife (now DBCA)
DAWE	Department of Agriculture, Water and the Environment
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environmental Regulation
WA Museum	Western Australian Museum

Table A2: Abbreviations – General terms

General terms	
AHD	Australian height datum
EN	Endangered
EX	Extinct
IA	International Agreement
MI	Migratory
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
VU	Vulnerable

Table A3: Abbreviations –Legislation

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

Table A4: Abbreviations – planning

Planning terms	
MRS	Metropolitan Region Scheme

Table A5: Abbreviations – units of measurement

Units of measurement	
DBH	Diameter at breast height
cm	Centimetre
ha	Hectare
km	Kilometre
m	Metre

1 Introduction

1.1 Project background

Lots 600 - 606 Balannup Road and Lots 200 - 202 Skeet Road, Harrisdale are proposed to be developed for residential purposes. These lots (referred to herein as 'the site') are located approximately 20 kilometres (km) south of the Perth Central Business District within the City of Armadale.

The site is approximately 29.29 hectares (ha) in size and is bound by Ranford Road to the north east, Skeet Road to the south east, Balannup Road to the north west and vacant land associated with the easement for the future continuation of Reilly Road to the south west. The location and extent of the site is shown in **Figure 1**.

1.2 Purpose and scope of work

Emerge Associates (Emerge) were engaged to provide sufficient information on the fauna values within the site to support the future development of the site for residential purposes, with particular focus on identifying habitat for threatened species of black cockatoo.

The scope of work was specifically to conduct a terrestrial vertebrate fauna assessment to the standard required of a 'basic' fauna survey and a 'targeted' black cockatoo survey in accordance with the Environmental Protection Authority's (EPA's) technical guidance (EPA 2020) and the *Environment Protection and Biodiversity Conservation Act* black cockatoo referral guidelines (DSEWPaC 2012).

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

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

2 Environmental Context

2.1 Climate

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

A total of 5 mm of rainfall was recorded in December 2020 prior to the field survey from the Forrestdale weather station (Bureau of Meteorology (BoM)) weather station number 9257), which is the closest weather station, located approximately 3.6 km south of the site. This is lower than the average rainfall of 13.8 mm for December recorded from the same weather station (BoM 2021).

Temperatures at the Jandakot Aero weather station BoM weather station number 9172, which is the closest temperature recording weather station, ranged from a mean maximum of 31.6^{o}C to a mean minimum of 16.2^{o}C in December 2020 (BoM 2021). These temperatures are slightly higher than the average maximum temperature of 29.3^{o}C and average minimum temperature of 14.8^{o}C recorded at the Jandakot Aero weather station from 1989-2020 (BoM 2021).

2.2 Geomorphology and soils

Landform and soils influence fauna habitat and species at regional and local scales. The site occurs on the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan area.

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

The Department of Primary Industries and Regional Development (DPIRD) has compiled data from various surveys to produce a soil landscape mapping dataset for Western Australia (DPIRD 2018), which places the site within the following three soil landscapes:

- ‘Bassendean B1 phase’ which occurs over the western portion of the site and is described as ‘extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than 2 m; banksia dominant.’
- ‘Bassendean B3 phase’ which occurs in a localised portion in the east of the site and is described as ‘closed depressions and poorly defined stream channels with moderately deep, poorly to very poorly drained bleached sands with an iron-organic pan, or clay subsoil. Surfaces are dark grey sand or sandy loam.’

- 'Bassendean B4 phase' which occurs over the eastern portion of the site and is described as 'broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depths generally greater than 1.5 m by clay or less frequently a strong iron-organic hardpan.'

The soil types mapped within the site are shown in **Figure 3**.

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

2.3 Topography

The elevation of the site ranges from 21 m in relation to the Australian height datum (m AHD) in the northern portion of the site, associated with a wetland feature, to 23 m AHD on the western side of the site (DoW 2008) (**Figure 3**). The site is predominantly flat, located at the 22 m AHD elevation.

2.4 Hydrology and wetlands

Wetlands include "areas of seasonally, intermittently or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh and saline, e.g. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries" (Wetlands Advisory Committee 1977). Many wetlands provide important fauna habitat and support high levels of fauna biodiversity and endemism.

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

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

No Ramsar or listed 'important wetlands' are located within or near the site. The Ramsar site 'Forrestdale and Thomsons Lakes' (ID 246) is located 3.2 km south of the site.

A review of aerial imagery indicates that there are three surface water features within the site, two wetlands located within the northern portion of the site (Lot 600 and 601 Balannup Road), with one wetland located in the central portion of the site (Lot 201). The wetland located within Lot 601 retains water year-round, whilst the other two wetlands dry out over the summer months.

On the Swan Coastal Plain the Department of Biodiversity, Conservation and Attractions (DBCA) have used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence (hydro-period) (DBCA 2017c). DBCA maintains the *Geomorphic Wetlands of the Swan Coastal Plain* dataset which further categorises geomorphic wetland features into specific wetland types and management categories to guide land use and conservation (DBCA 2020). Note that as this dataset was drafted at a regional scale the boundaries of mapped wetland features are often inconsistent with physical wetland boundaries.

A review of the *Geomorphic Wetlands of the Swan Coastal Plain* dataset indicates that the entire site is mapped as comprising geomorphic wetlands (DBCA 2020). One 'conservation' category sumpland, UFI 14880, occurs in a small area in the south-eastern portion of the site and extends across Skeet Road to the south east of the site. One 'resource enhancement' sumpland, UFI 15946, exists within Lot 600 and extends into Balannup Road. Two 'multiple use' category damplands, UFI 14879 and UFI 13347, wetlands are present within the western half of the site and one 'multiple use' sumpland, UFI 14404, is present over the eastern half of the site. The locations of the geomorphic wetlands in the vicinity of site are shown in **Figure 3**.

2.5 Regional vegetation

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

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

Variations in native vegetation within the site can be further classified based on regional vegetation associations. Heddle *et al.* (1980) mapping shows the site as comprising the 'Southern River Complex', which is described as comprising open woodland of *Corymbia calophylla - Eucalyptus marginata - Banksia* spp. with fringing woodland of *Eucalyptus rudis - Melaleuca rhaphiophylla* along creek beds.

2.6 Historic land use

Review of historical images available from 1953 (WALIA 2021) onwards shows that the site was uncleared in 1953 and the eastern half of the site was part of a large wetland. By 1961 multiple roads are present surrounding the site and by 1965 an easement across portions of Lots 604 - 606 can be seen. By 1974 Lots 201 and 202 were cleared and a large body of water is present across these lots. By 1977 Lot 200 was almost entirely cleared, with the exception of the south east corner.

Between 1965 and 1989 various small-scale clearing events are visible across Lots 604-606 and Lot 601 is entirely cleared. Between 1987 and 1989 buildings including a poultry farm were constructed in Lot 202. By 1989 much of Lot 600 and half of 602 was cleared. In 1991 a large fire scar is visible over the western portion of the site. Since 2008 most of the site has been subject to limited clearing, and areas of regrowth of native vegetation are visible, particularly in Lots 200, 600 and 604 - 606.

2.7 Significant fauna

2.7.1 Threatened fauna species

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

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

Threatened fauna species listed under the EPBC Act and/or BC Act are assigned a conservation status according to attributes such as population size and geographic distribution. Further information on threatened species and their categories is provided in **Appendix A**. An assessment of the likelihood of occurrence of conservation significant fauna within the site was undertaken (refer to **Sections 3.3.3** and **4.3.3** and **Appendix E**).

2.7.1.1 Black cockatoos

Three threatened species of black cockatoo occur on the Swan Coastal Plain (referred to herein collectively as 'black cockatoos'):

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

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

- Black cockatoos nest in hollows that form in trees which are usually more than ~200 years old. 'Breeding habitat' is therefore described as 'habitat trees' which are trees of a species known to support black cockatoo breeding and which either have a suitably large enough nest hollow or have a large enough diameter at breast height (DBH) to indicate that a suitable nest hollow could develop in time (DSEWPaC 2012). A minimum DBH for a habitat trees is defined as ≥50 centimetres (cm) for most tree species used by black cockatoos and ≥30 cm for *Eucalyptus wandoo* (wandoo) and *Eucalyptus salmonophloia* (salmon gum) (DSEWPaC 2012). Breeding habitat is also generally expected to be located within 7 km of food and water resources (Saunders 1990).
- 'Roosting habitat' consists of groups or individual tall trees that are used by black cockatoos for roosting during the day or overnight. Roosts generally comprise the tallest trees in an area and can include native and non-native trees (DSEWPaC 2012). Roosts are often located within 6 km of water and food resources, with additional foraging ranges within 12 km (Shah 2006; DSEWPaC

2012; Le Roux 2017). The use of a particular roost site may vary depending on availability of food and water resources.

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

Each black cockatoo species has a defined breeding season, with Baudin's cockatoo breeding from August/September to February/March and Carnaby's cockatoo breeding from July/August to January/February (DSEWPaC 2012). Forest red-tailed black cockatoo breeds in October/November but may breed in March/April if there is good autumn rainfall (DSEWPaC 2012). There is also evidence that forest red-tail black cockatoos breed throughout the year, with peaks in April – June and August – October (Johnstone *et al.* 2013).

Publicly available regional datasets relating to black cockatoo distribution, records and extent of habitat types were reviewed in relation to the site and surrounding area, as summarised in **Table 1**, **Table 2** and **Table 3**, and shown in **Figure 5.** Detailed information on each dataset considered as part of the desktop review is provided in **Appendix A**.

Table 1: Summary of black cockatoo background review

Category		Site context	Source
Species distribution		• Site is located within the modelled distribution of Baudin's cockatoo, but not within its known or predicted breeding range. • Site is within the modelled distribution of Carnaby's cockatoo, but not within its predicted breeding range. • Site is within the modelled distribution for forest red-tailed black cockatoo and within its known breeding range.	(DoEE 2016a, c, b)
Breeding sites		• No nesting records occur within the site. • Two confirmed forest red-tailed black cockatoo nesting locations occur within 12 km of the site. One is a natural hollow within Cockburn where a nest was recorded in 2020, with the other is an artificial hollow in Murdoch, where nesting was last confirmed in 2013.	BirdLife Australia database search (2020)
Carnaby's cockatoo breeding areas (12 km radius surrounding breeding sites)		• One confirmed breeding area intersects the site. • One possible breeding area intersects the site.	(Glossop *et al.* 2011)
Important bird areas for Carnaby's cockatoo		• None within the site. • None within 12 km of the site.	DPaW (2013)
Roost site		• None within the site. • 41 roost sites within 12 km of the site (see **Table 2** and **Table 3**): ○ 15 associated with white-tailed^ black cockatoos ○ 12 associated with forest red-tailed black cockatoos ○ 14 associated with white^ and red-tailed black cockatoos	BirdLife Australia database search (2020)
Foraging habitat	White-tailed black cockatoo^	• Potential native foraging habitat mapped within the south-western and north-western portions of the site. • Extensive areas of potential native foraging habitat mapped within the wider local area of the site, including within Bush Forever sites to the west and immediate south-east of the site.	(Emerge Associates 2020a)

Table 1: Summary of black cockatoo background review (continued)

Category		Site context	Source
	White-tailed black cockatoo^	• No pine plantations mapped within the site or within 12 km.	(Forest Products Commission 2020)
	Forest red-tailed black cockatoo	• Potential native foraging habitat mapped within the south-western and north-western portions of the site. • Extensive areas of potential native foraging habitat mapped within the wider local area of the site, including within Bush Forever sites to the west and immediate south-east of the site.	(Emerge Associates 2020b)

^Carnaby's and/or Baudin's cockatoo

Table 2: Number of white-tailed black cockatoos recorded in roosts within 12 km of the site (Birdlife Australia 2021)

Roost ID	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
ARMFORR001	NS	NS	NS	0	0	18	0	0	NS	0
ARMHARR001	NS	0	0	NS	0	1	3	0	0	0
ARMKELR001	14	0	0	0	0	NS	NS	NS	0	0
ARMKELR002	0	10	NS	0	0	0	0	0	0	NS
ARMROLR003	NS	0	0	50	0	0	0	0	0	0
ARMROLR004	NS	NS	NS	NS	0	NS	28	0	0	0
CANFERR001	NS	NS	NS	5	0	0	0	0	0	NS
CANWILR001	0	0	0	0	68	0	0	0	0	0
COCBANR001	NS	NS	NS	NS	NS	45	NS	0	20	0
COCBANR002	NS	NS	NS	NS	53	NS	0	0	0	0
COCBANR003	NS	NS	NS	NS	NS	NS	NS	6	16	0
COCSCCR001	252	0	NS	NS	NS	NS	NS	NS	NS	NS
COCSCCR002	15	3	NS	NS	NS	NS	NS	NS	NS	NS
GOSCNVR001	0	19	NS	NS	0	0	0	0	NS	80
GOSCNVR002	NS	NS	26	52	0	0	151	0	0	0
GOSMARR001	NS	NS	NS	NS	NS	NS	NS	0	120	36
GOSSOUR002	NS	NS	NS	NS	NS	NS	50	0	0	0
KWIWANR001	63	0	0	1	0	0	0	0	0	NS

Table 2: Number of white-tailed black cockatoos recorded in roosts within 12 km of the site (Birdlife Australia 2021) (continued)

Roost ID	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
KWIWANR002	NS	NS	NS	0	0	0	0	5	0	0
KWIWANR004	NS	NS	NS	NS	NS	NS	NS	73	0	0
MELBATR001	8	0	0	0	0	0	0	0	0	0
MELLEER001	0	0	12	0	70	0	0	0	15	2
MELMURR001	700	60	142	127	234	24	78	0	227	249
SERDARR001	NS	NS	NS	NS	NS	NS	8	0	0	0
SEROAKR004	45	3	0	0	50	0	26	2	33	NS
SEROAKR005	31	0	.	0	0	0	0	0	0	NS
SEROAKR007	NS	NS	NS	NS	NS	NS	NS	2	0	NS

NS = not surveyed

Table 3: Number of forest red-tailed black cockatoos recorded in roosts within 12 km of the site (Birdlife Australia 2021)

Roost ID	Year					
	2014	2015	2016	2017	2018	2019
ARMARMR002	NS	NS	17	NS	15	0
ARMARMR004	NS	NS	NS	0	6	4
ARMASHR001	NS	NS	NS	3	NS	NS
ARMBEDR001	21	0	0	0	0	13
ARMBEDR006	NS	NS	NS	14	14	15
ARMCHAR001	NS	NS	NS	11	16	0
ARMKELR004	NS	NS	NS	NS	NS	6
ARMROLR003	0	0	0	4	0	0
ARMROLR004	0	NS	35	0	0	50
CANRIVR001	NS	NS	6	11	7	16
CANROSR001	NS	NS	0	0	14	2
CANWILR001	4	7	7	5	16	82

Table 3: Number of forest red-tailed black cockatoos recorded in roosts within 12 km of the site (Birdlife Australia 2021) (continued)

Roost ID	Year					
	2014	2015	2016	2017	2018	2019
COCBANR001	NS	0	NS	6	17	0
COCBANR002	3	NS	32	24	109	15
COCCOCR001	NS	NS	NS	NS	15	102
GOSCNVR001	2	0	0	0	NS	0
GOSCNVR002	0	4	0	0	0	0
GOSGOSR004	19	NS	31	32	79	0
GOSKENR001	NS	NS	NS	51	334	35
GOSKENR002	NS	NS	NS	NS	72	0
GOSMARR001	NS	NS	NS	75	37	18
GOSSOUR002	NS	NS	0	36	208	15
MELLEER001	0	0	11	25	5	0
MELMURR001	199	33	125	209	441	214
SERBYFR003	NS	NS	6	NS	0	NS
SERDARR001	NS	NS	26	0	24	0

NS = not surveyed

2.7.2 Priority fauna species

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

2.7.3 Migratory fauna species

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

2.7.4 Specially protected fauna species

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

2.7.5 Pest fauna species

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

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

2.8 Bush Forever

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

No *Bush Forever* sites are present within the site. *Bush Forever* Site 413 (Balannup Lake and Adjacent Bushland, Southern River/Forestdale) is present to the north east of the site. *Bush Forever* Site 342 (Anstey/Keane Dampland and Adjacent Bushland, Forestdale) is present to the south-east of the site. The location of *Bush Forever* Sites 413 and 342 are shown in **Figure 4**.

2.9 Environmentally sensitive areas

'Environmentally sensitive areas' (ESAs) are prescribed under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* and have been identified to protect native vegetation values of areas surrounding values such as significant wetlands, threatened flora, threatened communities and *Bush Forever* sites. Within an ESA none of the exemptions under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* apply. However, exemptions under Schedule 6 of the EP Act still apply, which includes any clearing in accordance with a subdivision approval under the *Planning and Development Act 2005* (a recognised exemption under the Schedule 6 of the EP Act).

An ESA is present over the entirety of the site. The location of this ESA is shown in **Figure 4**.

2.10 DBCA managed or legislated lands

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

No DBCA legislated lands or water occur within the site. Balannup Lake Nature Reserve is located to the immediate north of the site, whilst freehold land managed by DBCA is located to the immediate north-east of the site. The location of the DBCA managed lands is shown in **Figure 4**.

2.11 Ecological linkages

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

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

No ecological linkages are present in close proximity to the site.

2.12 Previous surveys

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

3 Methods

3.1 Desktop assessment

A search was conducted for fauna species that have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020), *NatureMap* (DBCA 2021), DBCA's conservation significant fauna database (reference no. FAUNA6492) and literature references.

3.2 Field survey

Four ecologists from Emerge visited the site on the 4 December 2020 during the day to conduct the basic fauna survey and targeted black cockatoo field survey. The survey was conducted from approximately 10:30 AM until 3:30 PM.

3.2.1 Basic fauna

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

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

3.2.2 Targeted black cockatoo

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

3.2.2.1 Breeding habitat

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

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

- have an entrance opening of at least 10 cm but preferably 20-30 cm (Saunders *et al.* 1982; Groom 2010; Johnstone *et al.* 2013) (Groom 2010; Saunders et al. 1982; Johnstone et al 2013)
- be located at least 3 m from the ground (Saunders 1979b; Johnstone and Storr 1998; Groom 2010; Saunders 2014)

- be located in a trunk or branch that is generally large enough to contain a hollow that has a floor diameter of at least 40 cm and depth of 50-200 cm such that it could house an adult black cockatoo and nestlings (Saunders 1979a; Johnstone and Storr 1998; Saunders 2014; DPaW 2015)
- have vertical or near vertical orientation (Johnstone and Kirkby 2008; Johnstone *et al.* 2013).

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

Habitat trees were individually identified, tagged and the attributes outlined in **Table 4** were recorded for each tree.

Table 4: Attributes recorded for each habitat tree in the site

Attribute	Description
Tag	Unique identifier on a metal tag was nailed to each habitat tree
Image	Each habitat tree was individually photographed
GPS location	The location of each habitat tree was recorded using a handheld GPS unit
Tree species	Species and common name were identified
Diameter at breast height (DBH) (cm)	DBH was measured at breast height (1.3 metres) using a diameter tape
Hollows potentially suitable for breeding by a black cockatoo	Number of hollows potentially suitable for breeding by a black cockatoo (assessed from ground level only)

Hollows that appeared potentially suitable for use by a black cockatoo from the ground were further inspected using a drone and/or a pole-mounted camera. During the hollow inspection the internal dimensions of the hollow were confirmed, if possible, and an assessment was made for signs of use such as chew marks around the hollow entrance, nesting material, feathers or the presence of birds within the hollow.

All recorded habitat trees were assigned to a category listed in **Table 5**.

Table 5: Habitat tree categories

Category	Specifications
Nest	The tree contains a hollow used by black cockatoos for breeding as confirmed by records of black cockatoos, their eggs or fledglings or other evidence of recent nesting activity by black cockatoos
Potential nest	The tree contains one or more hollows that are suitable for use by black cockatoos as breeding habitat as confirmed by internal hollow inspection^ and evidence of use by an unidentified bird such as feathers, chew marks or nest material has been recorded within a hollow
Suitable hollow(s)	The tree contains one or more hollows that are suitable for use by black cockatoos as breeding habitat as confirmed by internal hollow inspection^

Table 5: Habitat tree categories (continued)

Category	Specifications
Potentially suitable hollow(s)	The tree contains or is suspected to contain one or more hollows that have the potential to be suitable for use by black cockatoos when either viewed from the ground or following an internal hollow inspection that was inconclusive^
No suitable hollow(s)	The tree does not contain hollow(s) that have the potential to be suitable for use by black cockatoos when viewed from the ground or contains hollows that were determined to be unsuitable for use by black cockatoos by internal inspection^

^Hollow determined to be suitable for use as breeding habitat by black cockatoos as listed above in **Section 3.1.1**.

3.2.2.2 Roosting habitat

The site was assessed for the presence of active or historical roosts and its potential to provide roosting habitat for black cockatoos. Groups of large native and non-native trees were generally assumed to provide potential roosting habitat.

No evening roost survey was undertaken within the site. The site was searched during the daytime survey for secondary evidence of roosting activity, such as branch clippings, droppings or moulted feathers.

3.2.2.3 Foraging habitat

Foraging habitat was identified by comparing the literature on plant species known to be foraged upon by black cockatoos (Davies 1966; Saunders 1980; Johnstone and Storr 1998; Johnstone and Kirkby 1999; Groom 2011; Johnstone *et al.* 2011; DSEWPaC 2012) against the vegetation within the site.

Foraging habitat was then further classified as primary or secondary foraging habitat. Primary foraging plants were defined as those with historical and contemporary records of regular consumption by black cockatoos. Secondary foraging plants were defined as plants that black cockatoos have been recorded consuming occasionally or that, based on their limited extent or agricultural origin, should not be considered a sustaining resource. Each patch of foraging habitat was assigned a percentage cover of primary and secondary foraging plants. Where plants that had no foraging value occurred amongst foraging plants, they were also assigned a cover value if practicable. A list of plant species classified as primary or secondary foraging plants is provided as **Appendix B.**

Secondary evidence of black cockatoo foraging, such as chewed marri, jarrah, tuart or banksia fruits, was searched for within the site and allocated to a species where possible. The locations of black cockatoo foraging evidence within the site were mapped using a hand-held GPS unit.

3.3 Data analysis, presentation and mapping

3.3.1 Desktop assessment

A total number of species within the desktop assessment search area was calculated by adding the total count of non-conservation significant species provided by *NatureMap* to the combined number of conservation significant species provided by *NatureMap* and *Protected Matters Search Tool*.

Habitat requirements of conservation significant vertebrate fauna was specifically reviewed in relation to habitat within the site to determine a total number of conservation significant fauna species with potential to occur. Fauna species with no potential to occur within the site were excluded from this count (e.g. marine mammals and marine fish).

3.3.2 Fauna habitat

Fauna habitats were described according to the dominant flora species and vegetation type present, as determined from observations made during the field survey and information provided in the '*Spring Flora and Vegetation Assessment*' (Emerge Associates 2021). The identified fauna habitats were mapped on aerial photography with the boundaries interpreted from aerial photography, previously identified plant communities (Emerge Associates 2021) and notes taken in the field.

3.3.3 Likelihood of occurrence

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

Based on the results of the desktop assessment and information recorded during the field survey, an assessment of the likelihood of occurrence of conservation significant fauna within the site was undertaken using the categories outlined in **Table 6**.

Table 6: Likelihood of occurrence assessment categories and definitions

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

3.3.4 Black cockatoo habitat

Habitat trees were classified according to the scheme outlined in **Table 5** and mapped on aerial imagery. A complete summary of the recorded attributes of habitat trees was compiled in a tabular format.

Foraging habitat was mapped on aerial photography with the boundaries interpreted from aerial photography and notes taken in the field.

Foraging habitat was described according to the dominant flora species and vegetation type present, as determined from observations made during the field survey. Primary and secondary foraging habitat was mapped on aerial photography with the boundaries interpreted from aerial photography and notes taken in the field. Patches of vegetation comprising a combination of primary and secondary foraging plants were mapped as 'mixed' foraging habitat. As it was not always possible to

separate non-foraging plants from foraging plants, some of the mapped foraging habitat also include a proportion of non-foraging plant species.

3.3.4.1 Overall black cockatoo habitat quality

As part of environmental impact assessment and offset calculation, the Department of Agriculture, Water and the Environment (DAWE) requires that a score out of ten is provided for the overall quality of back cockatoo habitat (DAWE 2020). DAWE does not provide a methodology for scoring habitat quality but instead specifies that an assessment of quality should be undertaken by an experienced technical expert (DSEWPaC 2012).

Emerge have developed a method to provide a systematic assessment of overall back cockatoo habitat quality. The method assesses and scores the quality of breeding, roosting and foraging habitat separately and then provides an overall quality score out of ten based on the highest score determined for the respective habitat categories. The assessment methodology is detailed in **Appendix C.**

3.4 Nomenclature and sources of information

Taxonomy and nomenclature of scientific and common names for fauna species follow the *Western Australian Museum* (WAM) *Checklist of the Terrestrial Vertebrate Fauna of Western Australia* (WAM 2020). This is contrary to the recent EPA (2020) advice to follow the *Australian Faunal Directory* (DAWE 2021) nomenclature for birds. Nomenclature may be adapted once the EPA (2020) technical guidance is further established and generally accepted within the professional community. Where common names were not provided by Western Australian Museum (2019); (WAM 2020), these have been derived from other sources.

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

3.5 Survey limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard constraints outlined in the EPA's document *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020) is provided in **Table 7**.

Table 7: Evaluation of survey methodology against standard constraints outlined in the EPA's Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020)

Constraint	Degree of limitation	Details
Level of survey	No limitation	A basic survey (desktop study and field survey) in combination with a targeted black cockatoo survey was undertaken. The level of survey and survey effort are considered adequate to assess the fauna and black cockatoo habitat values within the site.
Scope	No limitation	The survey focused on vertebrate fauna and habitat values, with particular focus on black cockatoos and other conservation significant taxa with potential to occur within the site.

Table 7: Evaluation of survey methodology against standard constraints outlined in the EPA's Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020) (continued)

Constraint	Degree of limitation	Details
Proportion of fauna identified, recorded and/or collected.	No limitation	All observed vertebrate fauna were identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	No limitation	Adequate information was available from database searches and previous surveys. The guidance currently available from Commonwealth and State agencies on the assessment of black cockatoo habitat is of limited value and relies heavily on technical experts preparing their own assessment methodology.
The proportion of the task achieved and further work which might be needed.	No limitation	The task was achieved in its entirety.
Experience level of personnel	No limitation	This fauna assessment was led by qualified ecologists with 12- and three-years' experience. Technical review was undertaken by a senior environmental consultant with over 10 years' experience in environmental science in Western Australia.
Suitability of timing, weather and season	Minor limitation	Survey timing is not considered to be of great importance for basic fauna assessments. Nonetheless, the day time survey limits the ability to detect nocturnal species.
Completeness	No limitation	The desktop assessment, field survey and targeted black cockatoo components of the survey were completed comprehensively.
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged).
	Minor limitation	Lot 202 was not accessible at the time of the survey. Observations were made from the road and surrounding lots, and from photographs taken within the lot during an earlier flora survey.
Survey intensity	No limitation	The intensity of the survey was adequate given the size of the site.
Influence of disturbance	No limitation	Portions of the site are modified due to historical disturbance. However, no recent disturbance was noted that may have affected outcomes of the survey.
Adequacy of resources	No limitation	All resources required to perform the survey were available. The guidance currently available from Commonwealth and State agencies on the assessment of black cockatoo habitat is limited and relies heavily on technical experts preparing their own methodology. This assessment applies an internally developed methodology that is considered to provide a systematic and balanced characterisation of black cockatoo habitat.
Compliance with EPA (2020) guidance	Minor limitation	The EPA guidance requires that a full list of all fauna species with potential to occur within the site is compiled. As part of this assessment a comprehensive list of fauna species of conservation significance was compiled. Non-conservation taxa with potential to occur within the site were not compiled into a list but are provided as raw data in **Appendix D**. Given that all species with potential to occur within the site are still identified within the relevant appendices this is not considered to affect the outcomes of this assessment. The EPA guidance recommends that *the Australian Faunal Directory* (DAWE 2021) nomenclature is used for bird species. This assessment uses the WAM *Checklist of the Terrestrial Vertebrate Fauna of Western Australia* (WAM 2020) nomenclature for birds and therefore does not strictly comply.

4 Results

4.1 General site conditions

Most of the site has been subject to intensive historical disturbance and comprised cleared land and planted non-native vegetation, particularly in the eastern portion. The western half of the site supported more intact native vegetation. The eastern portion of the site is slightly lower lying then the western portion and evidence of previous inundation was observed.

4.2 Fauna habitat

Seven fauna habitats were identified within the site: '**woodland**', '**woodland – limited understorey**', '**open melaleuca woodland**', '**closed melaleuca forest**', '**native and non-native eucalypts**' '**waterbody**' and '**predominantly cleared area**'.

A description and the area of each habitat is provided in **Table 8** and representative photographs of each are provided in **Plate 1** to **Plate 7**. The location of each habitat is shown on **Figure 6**.

Table 8: Fauna habitats identified within the site.

Fauna habitat classification	Description	Area (ha)
Woodland	Low open woodland generally consisting of overstorey trees of *Banksia* spp., *Eucalyptus todtiana*, *Nuytsia floribunda*, *Melaleuca preissiana*, **Eucalyptus camaldulensis*, over shrubland of *Kunzea glabrescens, Xanthorrhoea spp, Macrozamia riedlei* and *Melaleuca thymoides* and forbland species including *Dasypogon bromeliifolius* and *Hypolaena exsulca* (or understorey absent in degraded areas) (**Plate 1**).	7.84
Woodland – limited understorey	Low open woodland of *Banksia* spp. and closed tall shrubland of *Kunzea glabrescens* over low sparse shrubland of *Xanthorrhoea brunonis, Hibbertia subvaginata* and *Bossiaea eriocarpa* over open forbland of *Dasypogon bromeliifolius, Patersonia occidentalis, Lyginia imberbis* and *Phlebocarya ciliata* (**Plate 2**).	0.57
Open melaleuca woodland	Open to closed tall shrubland of *Melaleuca rhaphiophylla* and *Melaleuca teretifolia* with open vineland of *Cassytha racemosa* over closed tussock grassland of *Typha domingensis* and pasture weeds (**Plate 3**).	1.21
Closed melaleuca forest	Open forest of *Melaleuca preissiana, Eucalyptus rudis* and/or **Eucalyptus camaldulensis* over open to closed shrubland of *Melaleuca rhaphiophylla, M. lateritia* and *M. teretifolia* over grassland to closed grassland of pasture weeds (**Plate 4**).	2.25
Native and non-native eucalypts	Scattered native eucalypts including *Eucalyptus rudis* and planted non-native eucalypts including *E. camaldulensis* and *E. botryoides* (**Plate 5**).	2.02
Waterbody	Temporary or permanent areas of water within wetlands (**Plate 6**).	0.45
Predominantly cleared area	Heavily disturbed areas comprising weeds with occasional native shrubs and forbs and planted vegetation (**Plate 7**)**.**	14.94



Plate 1: ***Woodland***



Plate 2: ***Woodland – limited understorey***



Plate 3: ***Open melaleuca woodland***



Plate 4: ***Closed melaleuca forest***



Plate 5: ***Scattered native and non-native eucalypts***



Plate 6: ***Waterbody***



Plate 7: ***Predominantly cleared areas***

4.3 Fauna

4.3.1 Desktop assessment

A total number of 523 fauna species were identified from database searches as occurring or potentially occurring within 10 km of the site[1] as listed in **Appendix D**.

Of these species, 78 are conservation significant, including 33 threatened, 17 priority, 26 migratory fauna and 2 other specially protected species as listed in **Appendix E**.

4.3.2 Species inventory

A total of 18 native and three introduced fauna species were recorded during the field survey, including one species of conservation significance, *Isoodon fusciventer* (quenda) (P4). A complete species list is provided in **Appendix F**.

4.3.3 Conservation significant fauna

One conservation significant fauna species was recorded within the site during the field survey, a single quenda (P4).

In addition, four threatened, six priority, three migratory and one specially protected fauna species were considered to possibly occur within the site as listed in **Table 9**.

The remainder of the conservation significant fauna species identified in the desktop assessment (63 species) are considered unlikely to occur in the site due to lack of suitable habitat or because the

[1] Includes native and non-native species

site lies outside of the species known distribution. Fauna species classed as unlikely to occur are listed in **Appendix F**.

Table 9: Summary of conservation significant fauna species recorded or deemed possible or likely to occur within the site

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
Birds					
Apus pacificus	Pacific swift	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Johnstone and Storr 1998).	**Possible:** May opportunistically occur in or fly over the site on commute or while searching for prey.
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU	Eucalypt and Corymbia forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding *Corymbia calophylla*, *Eucalyptus marginata*, introduced **Melia azedarach* and *Eucalyptus* spp. trees (Johnstone and Storr 1998).	**Likely:** Several records of the species in close proximity (<2 km) to the site and there is foraging habitat within the site.
Calyptorhynchus baudinii	Baudin's cockatoo	EN	EN	Mainly eucalypt forests. Attracted to seeding *Corymbia calophylla*, *Banksia* spp., *Hakea* spp., and to fruiting apples and pears (Johnstone and Storr 1998).	**Possible:** Species known to occur within the broader area and there is limited foraging habitat within the site.
Calyptorhynchus latirostris	Carnaby's cockatoo	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of *Pinus* spp. Attracted to seeding *Banksia* spp., *Dryandra* spp., *Hakea* spp., *Eucalyptus* spp., *Corymbia calophylla, Grevillea* spp., and *Allocasuarina* spp. (Johnstone and Storr 1998).	**Likely:** Historical records within and adjacent to the site and there are areas of foraging habitat within the site.
Falco peregrinus	*Peregrine falcon*	OS	-	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	**Possible:** May opportunistically occur in or fly over the site on commute or while searching for prey.

Table 9: Summary of conservation significant fauna species recorded or deemed possible or likely to occur within the site (continued)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
Oxyura australis	*Blue-billed duck*	P4	-	Mainly deeper freshwater swamps and lakes; occasionally saltlakes and estuaries freshened by flood waters (Johnstone and Storr 1998).	**Possible:** May utilise the wetlands within the site whilst water is present.
Plegadis falcinellus	*Glossy Ibis*	MI	MI	Well-vegetated wetlands, wet pasture, ricefields, floodwaters, floodplains, brackish or occasionally saline wetlands, mangroves, mudflats and occasionally dry grassland (Pizzey & Knight 2012).	**Possible:** May utilise the wetlands within the site whilst water is present.
Tringa hypoleucos	*Common sandpiper*	MI	MI	Edge of sheltered waters salt or fresh, e.g. estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations where low perches are available (Johnstone & Storr 1998).	**Possible:** Small numbers of occasional transient individuals may utilise the site when wetlands have water.
Invertebrates					
Idiosoma sigillatum	*Swan Coastal Plain shield-backed trapdoor spider*	P3	-	Widely distributed in sandy areas on the Swan Coastal Plain and on Rottnest Island (Prince 2003).	**Possible:** Suitable habitat present
Leioproctus contrarius	*a short-tongued bee*	P3	-	Life history and habits are poorly documented/ unknown. It has been recorded only on flowers of Goodeniaceae and possibly Lechenaultia stenosepala (Bamford 2003).	**Possible:** Historic records within the broader area and one Goodeniaceae species present within the site
Neopasiphae simplicior	*a short-tongued bee*	EN	CR	This species of native bee has been collected on flowers of *Goodenia filiformis, Lobelia tenuior, Angianthus preissianus* and *Velleia* sp. (Houston 2000).	**Possible** Historic records within the broader area, and *Lobelia tenuior* present within the site
Mammals					
Isoodon fusciventer	*Quenda*	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012).	**Recorded**

Table 9: Summary of conservation significant fauna species recorded or deemed possible or likely to occur within the site (continued)

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
Notamacropus irma	*Western brush wallaby*	P4	-	Dry sclerophyll forest, *Banksia* spp. woodlands and shrublands, typically favouring dense low vegetation that provides dense cover (Christensen and Strahan 1983).	**Possible** Recent records of a population within the broader area
Reptiles					
Lerista lineata	Perth slider	P3	-	Sandy coastal heath and low scrubland. *Banksia* spp. woodland, *Eucalyptus gomphocephala* open woodland over deep sands, and coastal dunes immediately adjacent to the beach.	**Possible:** Historic records adjacent to the site and there is potentially suitable habitat within the site.
Neelaps calonotos	Black-striped snake	P3	-	Coastal and near-coastal dunes, sandplains supporting heathlands and *Banksia* spp. woodlands.	**Possible:** Historic records adjacent to the site and there is habitat within the site.

4.3.1 Declared pests

One species listed as a declared pest (C3) pursuant to the BAM Act, **Oryctolagus cuniculus* (rabbit) was identified from scats within the site.

4.4 Black cockatoos

4.4.1 Habitat

4.4.1.1 Breeding

A total of six black cockatoo habitat trees were recorded within the site as shown in **Figure 7**. The habitat trees were all *Eucalyptus rudis* (flooded gum). None of the habitat trees present within the site contain hollows that are suitable for use for breeding by black cockatoos and no internal hollow inspection was undertaken.

A summary of the habitat trees recorded within the site is provided in **Table 10** and an inventory in **Appendix G.**

Table 10: Habitat trees recorded within the site

Category	No. trees	No. suitable hollows
Confirmed nest	0	0
Potential nest	0	0
Suitable hollow(s)	0	0
Potentially suitable hollow(s)	0	0
No suitable hollow(s)	6	0
Total	**6**	**0**

4.4.1.2 Roosting

Tall native and non-native trees within the site have the potential to provide roosting habitat for black cockatoos.

No roosts or secondary evidence of roosting, such as droppings, moulted feathers or branch clippings were observed within the site during the survey.

4.4.1.3 Foraging

No foraging evidence attributed to black cockatoos was recorded within the site.

The site contains potential foraging habitat for Carnaby's cockatoo, Baudin's cockatoo and forest red-tailed black cockatoo. The main primary foraging plants recorded within the site were *Banksia attenuata* (slender banksia) and *B. menziesii* (firewood banksia). Secondary foraging plants included **Eucalyptus camaldulensis* (river red gum), *Eucalyptus todtiana* (coastal blackbutt) and *Xanthorrhoea preissii* (grasstree). A summary of the dominant foraging plants within the site is provided in **Table 11**.

Table 11: Dominant primary and secondary black cockatoo foraging plants recorded within the site

Common name	Foraging habitat category and black cockatoo species		
	Carnaby's	Baudin's	Forest red-tailed
Slender banksia	Primary	-	-
Firewood banksia	Primary	-	-
River red gum	-	-	Secondary
Coastal blackbutt	Secondary	-	-
Grasstree	Secondary	Secondary	-

A total of 7.1 ha of foraging habitat was mapped for Carnaby's cockatoo, 6.91 ha for Baudin's and 5.52 ha for forest red-tailed black cockatoos within the site. A total of 1.95 ha of primary foraging habitat was mapped for Carnaby's cockatoo. The amount of primary foraging species mapped within the site was very low (less than 0.1 ha) for both Baudin's cockatoo and forest red-tailed black cockatoo. Secondary foraging habitat was greater for both forest red-tailed black cockatoo and Baudin's cockatoo.

The proportion of primary, secondary and non-foraging plants within the mapped foraging habitat for each black cockatoo species is provided in **Table 12**. A large percentage of the foraging plants within the site occur as scattered trees and small patches of vegetation. Therefore, it was not always possible to separate the foraging habitat from non-foraging plants which resulted in a relatively high cover of non-foraging plants within patches mapped as foraging habitat as outlined in **Table 12.**

The location of foraging habitat mapped within the site is shown in **Figure 8** to **Figure 10**.

Table 12: Proportion of primary, secondary and non-foraging plants within patches of foraging habitat

	Area of foraging habitat (ha) and black cockatoo species		
	Carnaby's	Baudin's	Forest red-tailed
Primary foraging plants	1.95	0.002	0.09
Secondary foraging plants	0.47	2.22	3.31
Non-foraging plants	4.68	4.69	2.12
Total	**7.1**	**6.91**	**5.52**

4.4.1.4 Overall quality

The outcome of the overall black cockatoo habitat quality assessment is provided in **Table 13** and summarised in **Table 14**.

The site was determined to have an overall habitat score of four out of a maximum possible score of 10 for forest red-tailed black cockatoo, which is 'moderate' using the scale provided in **Appendix C**. The site was determined to have an overall habitat score of two for Baudin's cockatoo and three for Carnaby's cockatoo which is both low'.

The full results of the quality assessment are provided in **Appendix H**.

Table 13: Habitat quality assessment scores

Habitat category	Score		
	Carnaby's	Baudin's	Forest red-tailed
Breeding	N/A^	N/A^	4
Roosting	2	2	2
Foraging	3	2	2
Overall Score	**3 Low**	**2 Low**	**4 Moderate**

^ No breeding score was assigned as the site is located outside of the species breeding range.

Table 14: Summary of attributes contributing to black cockatoo habitat quality scores

Habitat category	Quality component category	Attributes and black cockatoo species		
		Carnaby's	Baudin's	Forest red-tailed
Breeding	Site condition	N/A – site is located outside of its predicted breeding range.	N/A – site is located outside of its known and predicted breeding range.	The site supports habitat trees without suitable hollows.
	Site context			No confirmed forest-red-tailed nest tree occurs within 6 km of the site and 2,435 ha of potential forest red-tailed black cockatoo foraging habitat is mapped within 6 km of the site as shown in **Figure 5**.
	Species stocking rate			N/A – no evidence of breeding was recorded within the site.
Roosting	Site condition	The site supports potential roosting habitat.	The site supports potential roosting habitat.	The site supports potential roosting habitat.
	Site context	The site is located more than 1 km from a large roost and more than 500 m from a small roost.	The site is located more than 1 km from a large roost and more than 500 m from a small roost.	The site is located more than 1 km from a large roost and more than 500 m from a small roost.
	Species stocking rate	N/A - no evidence of roosting was recorded within the site.	N/A - no evidence of roosting was recorded within the site.	N/A - no evidence of roosting was recorded within the site.
Foraging	Site condition	The site supports foraging habitat that is proportionally of 27.51% primary foraging plants.	The site supports foraging habitat that is proportionally of 0.96% primary foraging plants.	The site supports foraging habitat that is proportionally of 1.55% primary foraging plants.
	Site context	Confirmed white-tailed black cockatoo roosts occur within 6 km of the site, indicating the foraging habitat within the site could potentially be used by the birds utilising the roosts.	Confirmed white-tailed black cockatoo roosts occur within 6 km of the site, indicating the foraging habitat within the site could potentially be used by the birds utilising the roosts.	Confirmed forest red-tailed black cockatoo roosts occur within 6 km of the site, indicating the foraging habitat within the site could potentially be used by the birds utilising the roosts.
	Species stocking rate	No evidence of Carnaby's cockatoo foraging was observed in the site.	No evidence of Baudin's cockatoo foraging was observed in the site.	No evidence of forest red-tailed black cockatoo foraging was observed in the site.

5 Discussion

5.1 Fauna and fauna habitat values

The 18 native and three non-native fauna opportunistically recorded within the site are all generally common and widespread across the Swan Coastal Plain.

Habitat values within the site are highest within the south-western portion of the site within the **woodland** and **woodland – limited understorey** habitats**.** In particular, where vegetation occurs in 'good' or better condition as mapped by Emerge Associates (2021), it provides a cover of native trees, shrubs and ground cover and contains microhabitats such as logs, rocks and leaf litter.

The **scattered native and non-native eucalypts** provide varying value to native fauna depending on the plant species and density present, noting that the northern portion of the site contains continuous canopy coverage, which may support avian species.

The remainder of the site supports degraded vegetation mapped as **open melaleuca woodland** and **closed melaleuca forest** habitats, in addition to highly modified habitats associated with historical clearing such as the **waterbody** and **predominantly cleared area**. These habitats provide varying value to native fauna depending on the plant species and density present but are likely to be primarily be used by common and widespread native and non-native fauna with non-specific habitat requirements.

5.2 Conservation significant fauna

One species of conservation significance, quenda, was recorded within the site. This species is likely to persist in the **woodland** habitat where the understorey shrubland layer is present, as it provides suitable cover for the species. This species is likely to utilise the site as part of a larger home range, extending to the south-east where areas of contiguous native vegetation are present.

An additional 15 species of conservation significance are considered to have potential to occur in the site.

Apus pacificus (pacific swift) and *Falco peregrinus* (peregrine falcon) may opportunistically fly over or utilise habitat within the site as part of a much larger home range but the site is considered unlikely to provide important habitat for these species.

Carnaby's cockatoo and forest red-tailed black cockatoo are considered likely to use the site. Historic records of Carnaby's cockatoo utilising the site have been recorded, whilst there are several records of forest red-tailed black cockatoo within close proximity to the site. Baudin's cockatoo may possibly utilise the site for foraging and there are three records of the species within 10 km of the site. The site supports primary and secondary foraging habitat for all three species.

The **waterbody** and adjacent **closed melaleuca forest** provide potential habitat for *Oxyura australis* (blue-billed duck), *Plegadis falcinellus* (glossy ibis) and *Tringa hypoleucos* (common sandpiper), which may utilise the site when there is water present within the wetlands, albeit in small, transient numbers.

The **banksia woodland** provides potential habitat for *Idiosoma sigillatum* (Swan Coastal Plain shield-backed trapdoor spider), *Leioproctus contrarius* (a short-tongued bee) and *Neopasiphae simplicior* (a short-tongued bee), with known host plants for the bee species recorded within the site. The **banksia woodland** also represents potential habitat for *Lerista lineata* (Perth slider) and *Neelaps calonotos* (black-striped snake), with historic records adjacent to the site.

Banksia woodland, **kunzea, melaleuca and banksia woodland** and **kunzea and banksia woodland – limited understorey** may represent potential habitat for *Notamacropus irma* (western brush wallaby), as there are numerous records surrounding the site. However, this species is likely to utilise the site as part of a larger home range and it is unlikely that a population would reside within the site permanently, given the human activity present within the site.

Targeted surveys would need to be undertaken to confirm whether other conservation significant fauna species occur within the site.

5.3 Black cockatoos

No black cockatoos were observed during the survey and no evidence of foraging, roosting or nesting was recorded. The site is located within the expected range of all three species and suitable habitat occurs within the site and local area, so it is possible that all three species may utilise the site at varying times. A historic record from 2013 for Carnaby's cockatoo is present within the central portion of the site.

5.3.1 Habitat

5.3.1.1 Breeding

The site lies within the known breeding range of forest red-tailed black cockatoo only. No hollows suitable for breeding by black cockatoos were observed in the habitat trees within the site. Therefore, the site does not currently support breeding habitat for black cockatoos. While all of the habitat trees within the site have the potential to form hollows in the future, based on their age and size, it would likely take many years for hollows to form that are suitable for use by black cockatoos.

5.3.1.2 Roosting

No evidence suggesting that roosting occurs within the site was observed during the field survey and the BirdLife Australia dataset does not include any roost records within the site. Therefore, there is no reason to suspect that roosting occurs within the site. Nevertheless, the site contains tall trees and groups of tall trees that have the potential to provide roosting habitat for black cockatoos.

5.3.1.3 Foraging

Given the historic use of the local area by Carnaby's cockatoo and the forest red-tailed black cockatoos, and the presence of foraging habitat within the site, the lack of foraging evidence was notable, although not necessarily evidence that foraging has not occurred recently.

Whilst the site supports black cockatoo foraging habitat, the majority of the habitat comprises non-foraging plants (75% for Carnaby's cockatoo, 76% for Baudin's cockatoo and 81% for forest red-tailed

black cockatoo). Given the high percentage of non-foraging plants, and the amount of foraging habitat within the broader area (as shown in **Figure 5**), it is possible the foraging habitat within the site is less favoured compared to that in the surrounding area.

5.3.1.4 Overall quality

The overall habitat score was determined to be three (low) for Carnaby's cockatoo, two (low) for Baudin's and four (moderate) for forest red-tailed black cockatoo.

The vegetation within the site scored highest in the foraging habitat value for Carnaby's cockatoo (three out of 10), due to the presence of a higher proportion of primary foraging habitat plants compared to the low amount of foraging available for Baudin's cockatoo and forest red-tailed black cockatoo (both two out of 10). No evidence of foraging by any species was recorded within the site.

As the site is located outside of the known breeding range of Carnaby's cockatoo and Baudin's cockatoo, no score was attributed to these species. Due to the presence of potential breeding habitat trees, albeit without suitable hollows, and the presence of large areas of foraging habitat surrounding the site, the site was determined to have a moderate (four) value for breeding habitat for forest red-tailed black cockatoo.

The roosting score was consistent between all three species and, as no evidence of roosting was recorded within the site, roosting quality was determined from basic habitat condition attributes (tall trees).

6 Conclusions

6.1 Fauna and fauna habitat

Approximately one third of the site (36.5%) contains native vegetation with high fauna habitat values. The remainder of the site has been subject to historical disturbance and is dominated by cleared areas, open waterbodies or planted non-native vegetation.

A total of 18 native and three introduced fauna species were positively identified to occur within the site, including one conservation significant species, quenda (P4). The site contains habitat for all three species of black cockatoo but no individuals were recorded within the site.

A further 12 species of conservation significance not recorded during the field survey are also considered to have potential to occur within the site. These species would primarily be associated with the **banksia woodland** and to a lesser extent **waterbody** habitats, if they occur at all. Targeted surveys would need to be undertaken to confirm whether these species occur within the site.

6.2 Black cockatoos

The site occurs within the modelled distribution of all three species of black cockatoo and within the breeding range of forest red-tailed black cockatoo.

No evidence of any of the three black cockatoo species was recorded within the site. All three species may utilise the site due to the presence of suitable habitat and the records within the broader area.

Six habitat trees were recorded in the site of which none contain hollows that are suitable for breeding by black cockatoos. Therefore, the site does not currently provide breeding habitat for black cockatoos. Some of the habitat trees are large enough that they may form hollows in the future that provide breeding habitat for forest red-tailed black cockatoo. The site lies outside of the known and predicted breeding range of Carnaby's cockatoo and so is not considered to have the potential to provide breeding habitat for these species in the future.

No evidence of black cockatoo roosting activity was observed within the site. Potential roosting habitat that is suitable for all three species of black cockatoo occurs within the site in the form of tall native and non-native trees.

Foraging habitat for all three species of black cockatoo was mapped within the site, primarily within the southern portion. A total of 1.95 ha of primary foraging habitat for Carnaby's cockatoo, less than 0.01 ha for Baudin's cockatoo and 0.09 ha for forest red-tailed black cockatoo was mapped within the site. The site also contains secondary foraging habitat for all three species of black cockatoo. Extensive areas of additional remnant native vegetation that may provide foraging habitat for all three species of black cockatoo occur adjacent to and in the wider area of the site.

The overall habitat score was determined to be three (low) for Carnaby's cockatoo, two (low) for Baudin's and four (moderate) for forest red-tailed black cockatoo. The site scored highest for the breeding habitat component for forest red-tailed black cockatoos due to the presence of potential habitat trees, albeit without hollows, and the presence of foraging habitat within the broader area.

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Figures

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Figure 3: Wetlands

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Figure 5: Black Cockatoo Context

Figure 6: Fauna Habitat

Figure 7: Black Cockatoo Habitat Trees

Figure 8: Potential Baudin's Cockatoo Foraging Habitat

Figure 9: Potential Carnaby's Cockatoo Foraging Habitat

Figure 10: Potential Forest Red-tailed Black Cockatoo Foraging Habitat



Figure 1: Site Location

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F29

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

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Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

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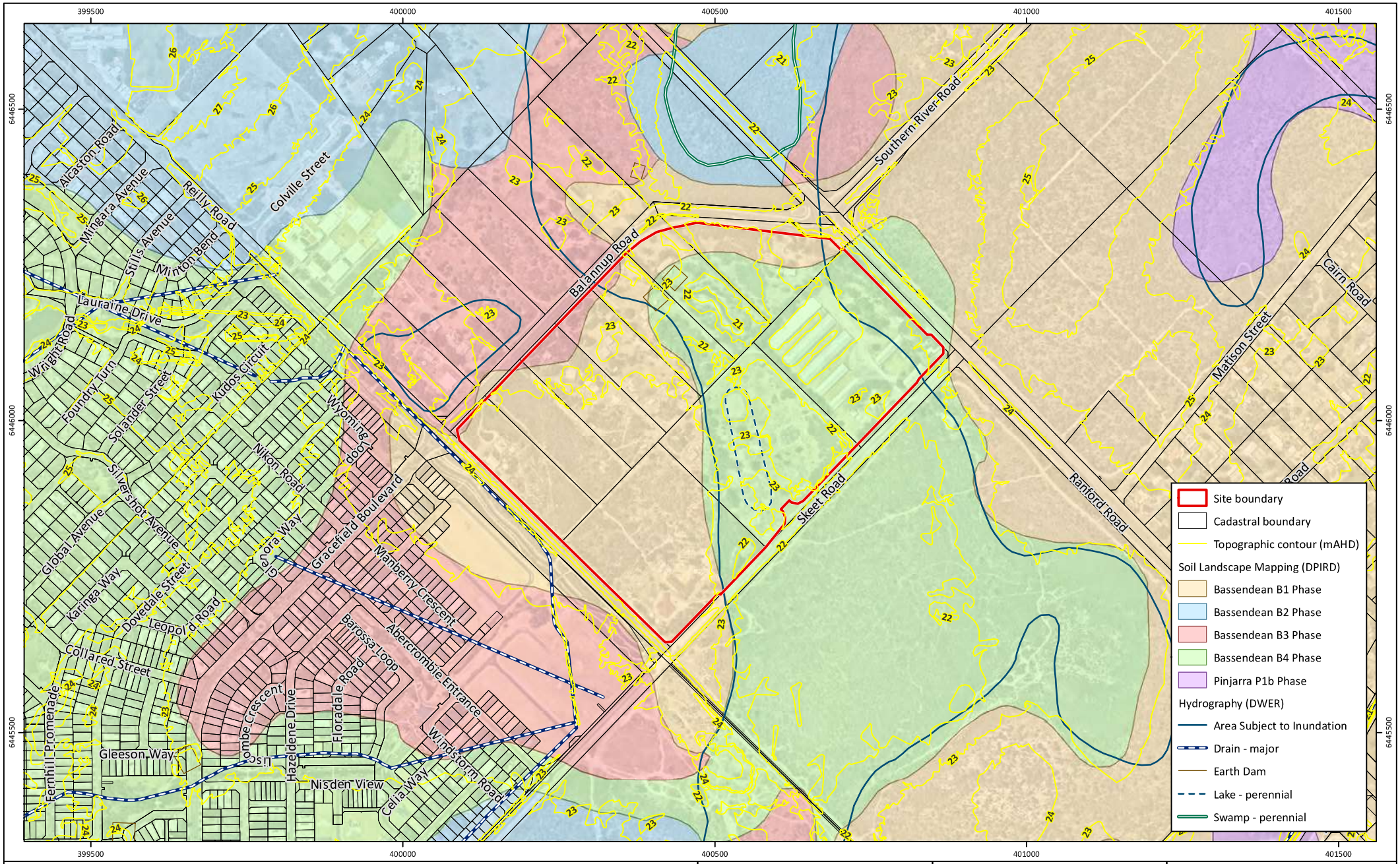


Figure 2: Hydrography, Soils and Topography

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F30

Drawn:	GAR
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Scale: 1:8,000@A4

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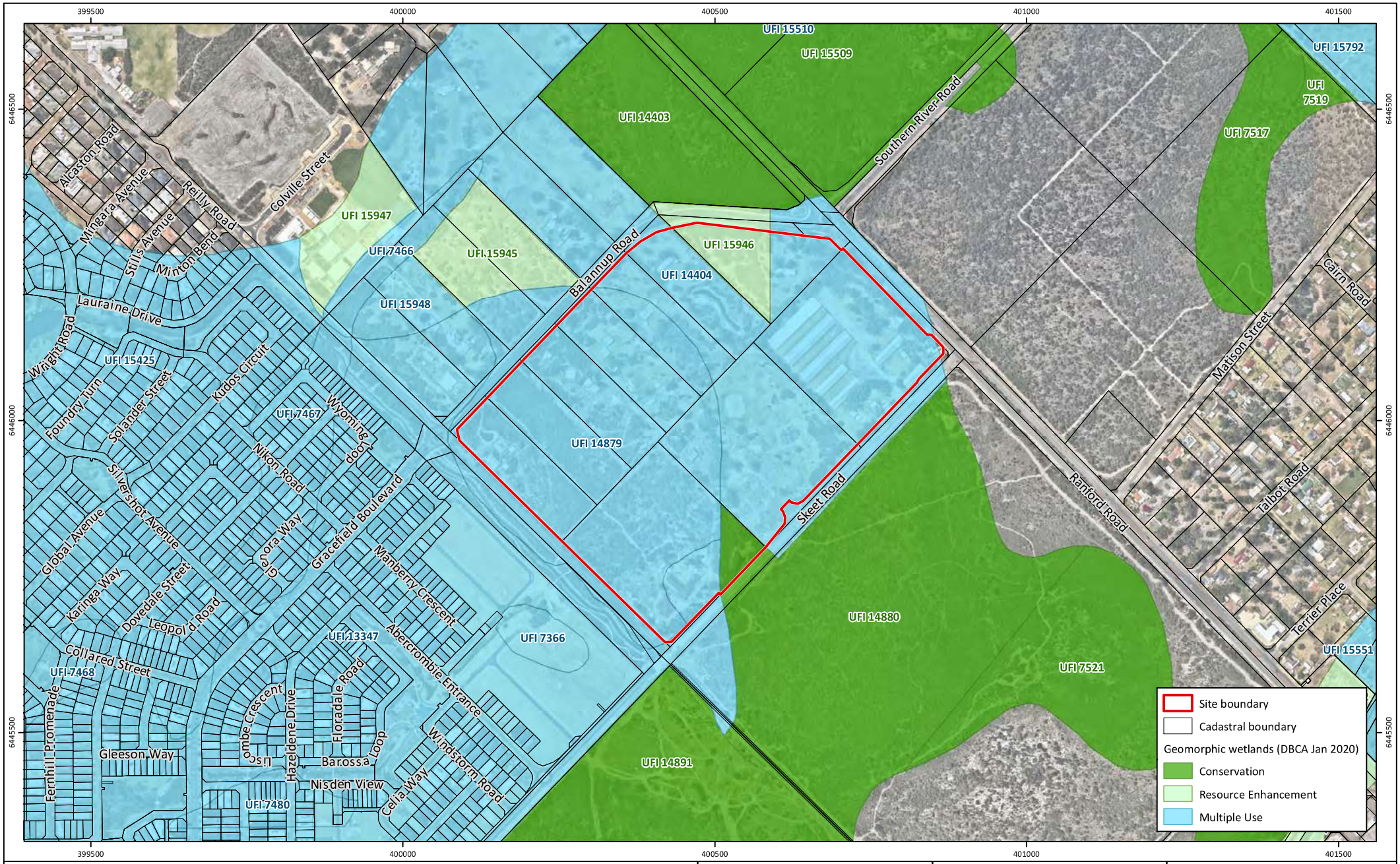


Figure 3: Wetland Features

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Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F31

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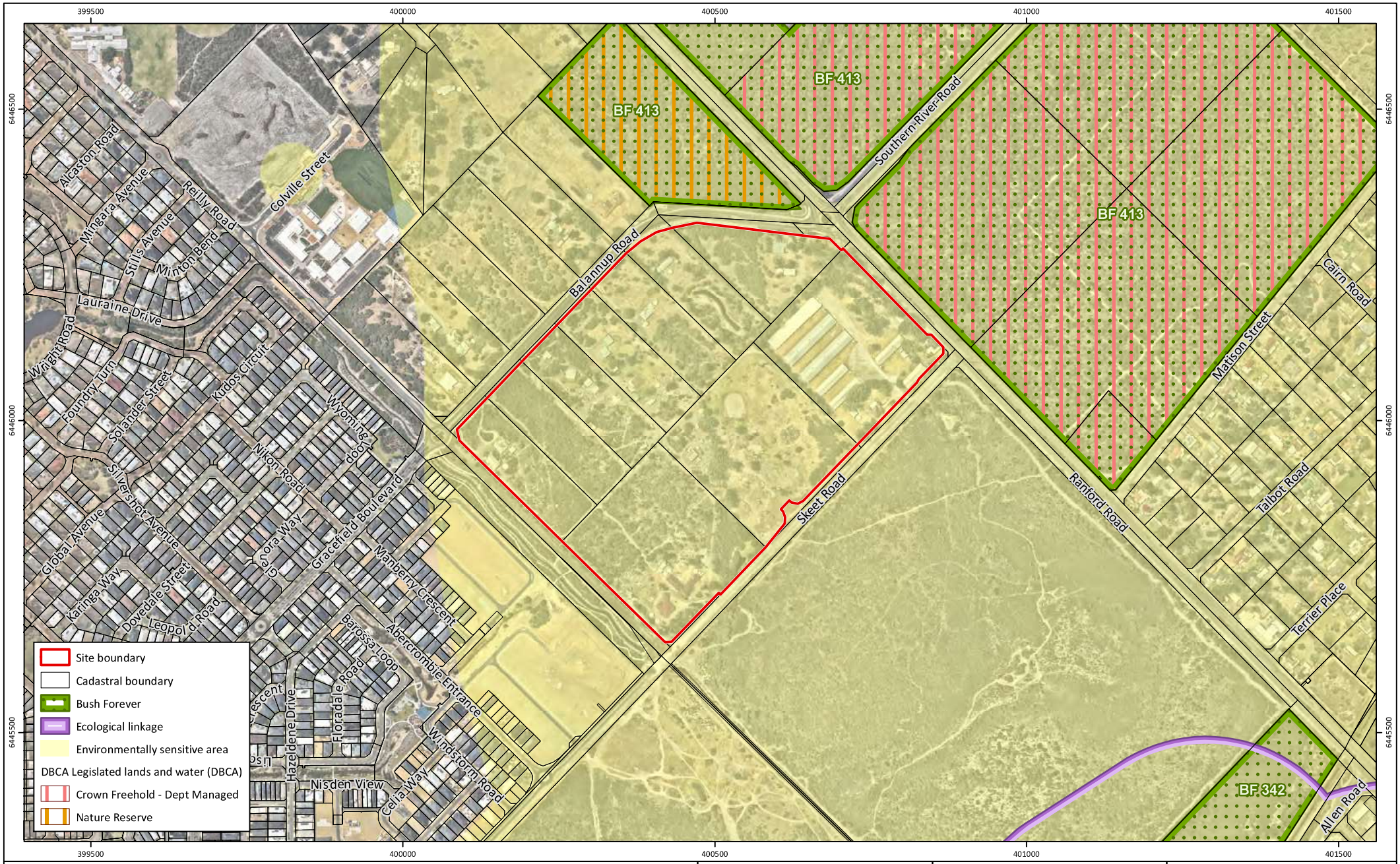


Figure 4: Environmental Features

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Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F32

Drawn:	GAR
Date:	27/01/2021
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Date:	29/01/2021

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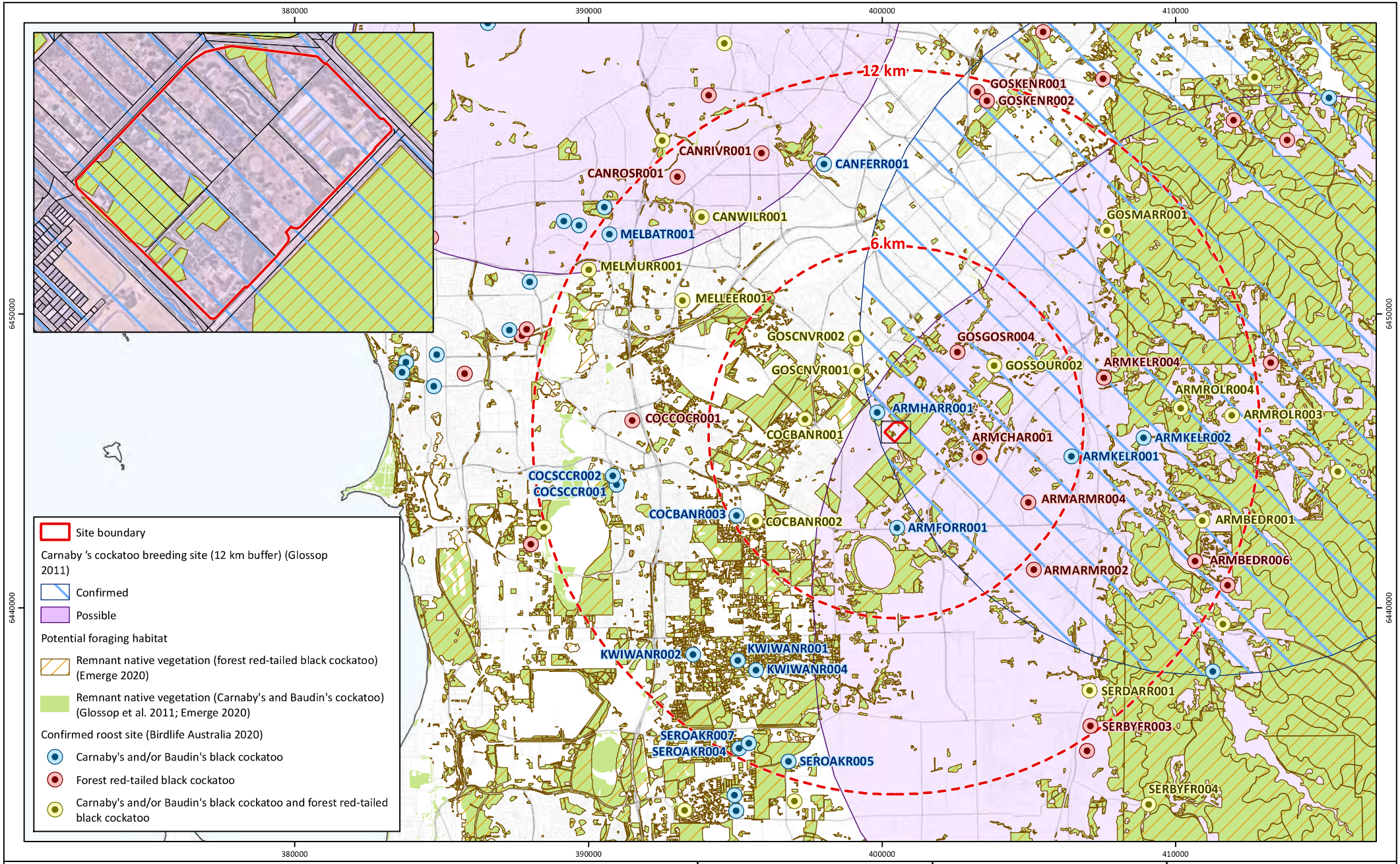


Figure 5: Black Cockatoo Habitat Context

Project: Basic Fauna and Targeted Black Cockatoo Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F33

Drawn:	GAR
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Checked:	SCM
Approved:	RAW
Date:	29/01/2021

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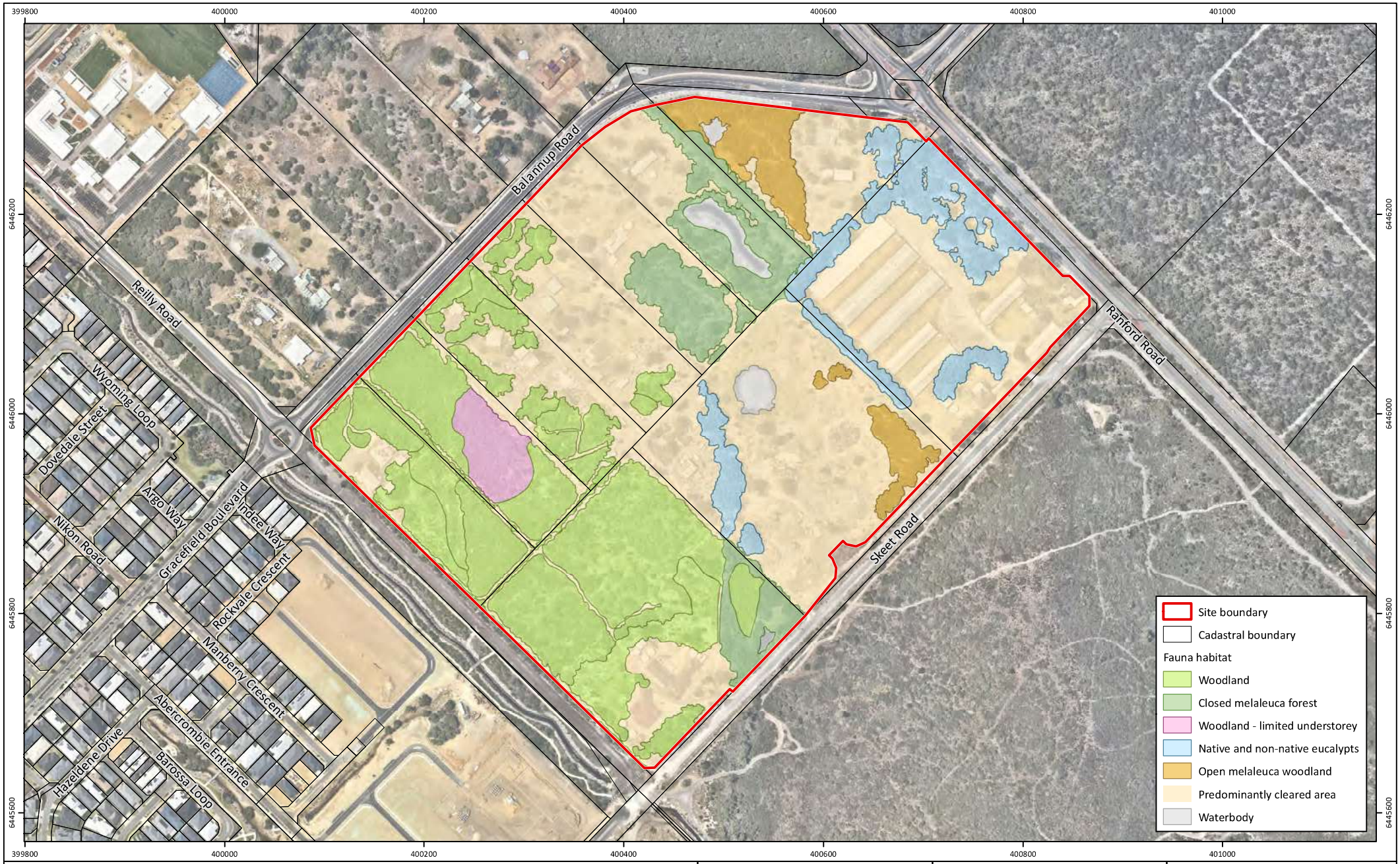


Figure 6: Fauna Habitat

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F34

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

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Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

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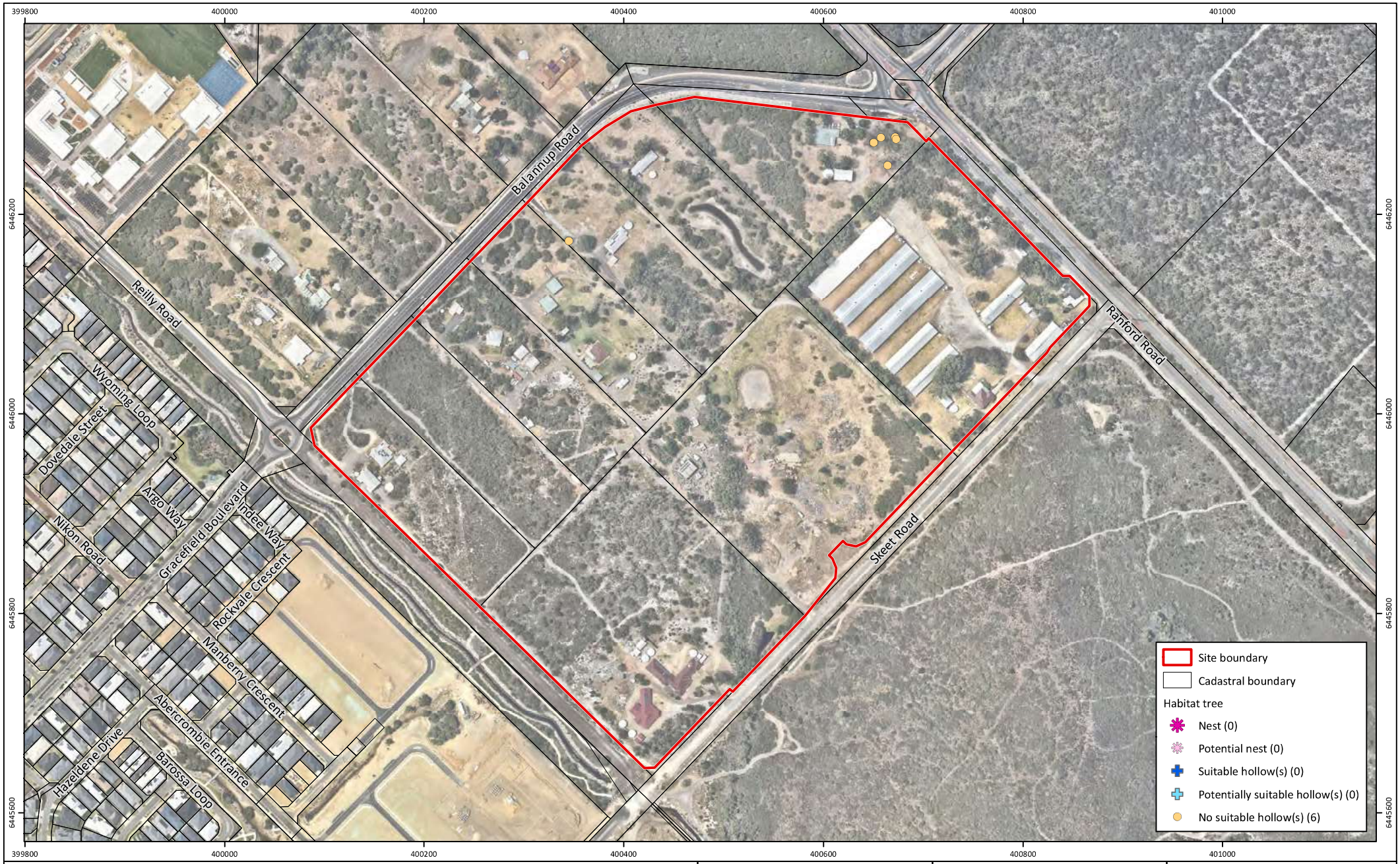


Figure 7: Black Cockatoo Habitat Trees

Project: Basic Fauna and Targeted Black Cockatoo Assessment
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F39

Drawn:	GAR
Date:	28/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

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Metres

Scale: 1:5,000@A4

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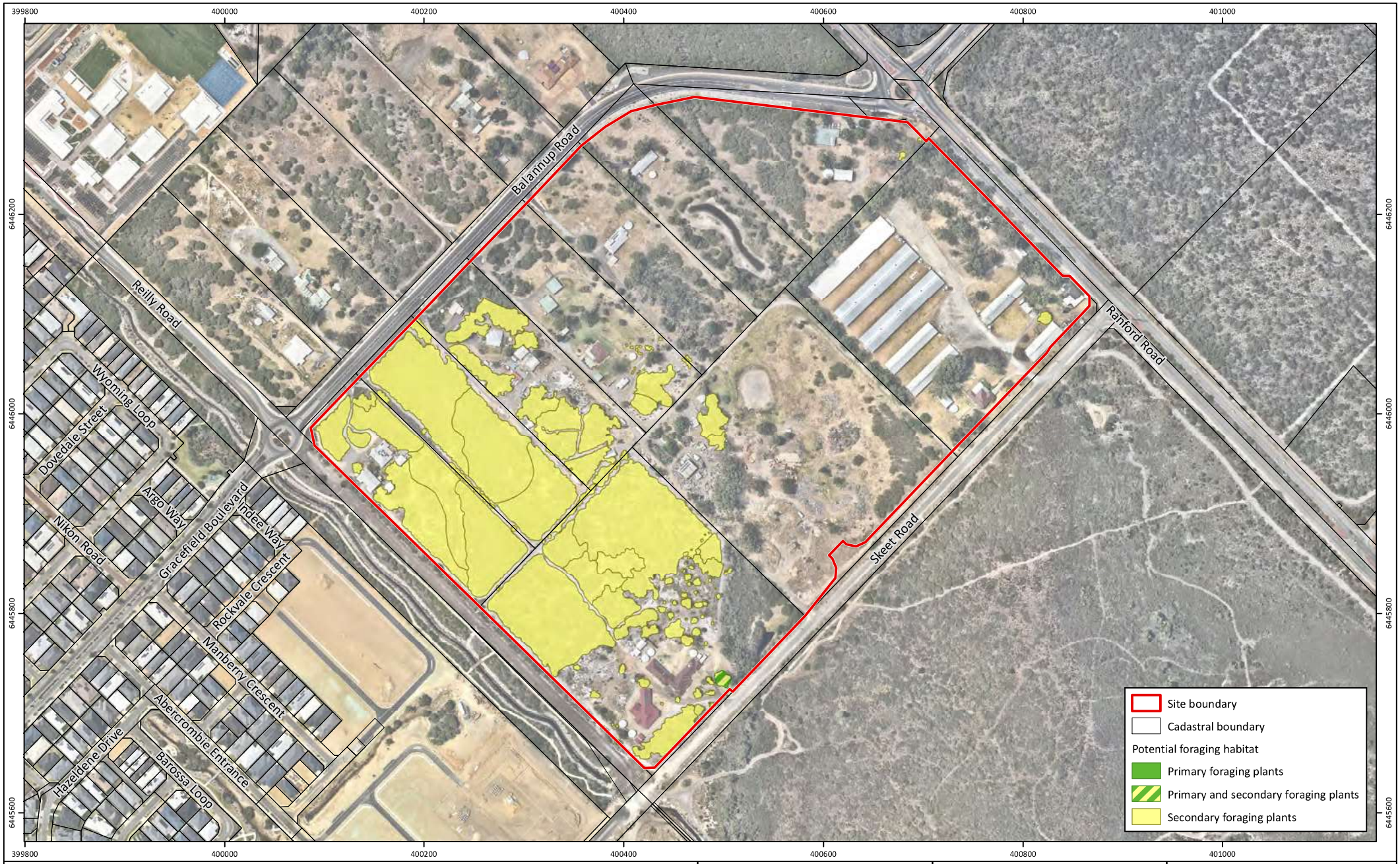


Figure 8: Potential Baudin's Cockatoo Foraging Habitat

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F35

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

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Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

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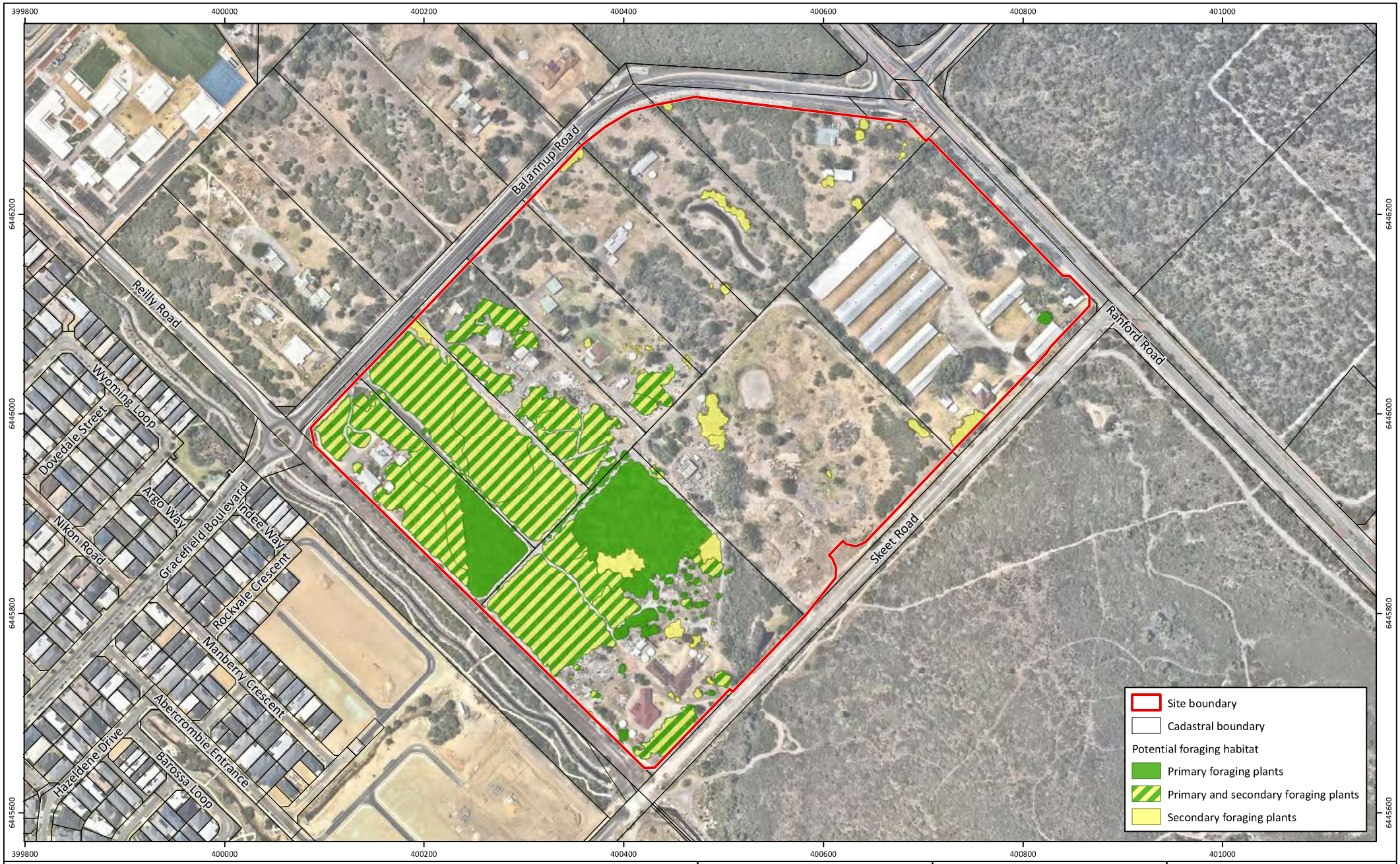


Figure 9: Potential Carnaby's Cockatoo Foraging Habitat

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F36

Drawn:	GAR
Date:	27/01/2021
Checked:	SCM
Approved:	RAW
Date:	29/01/2021

N

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Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

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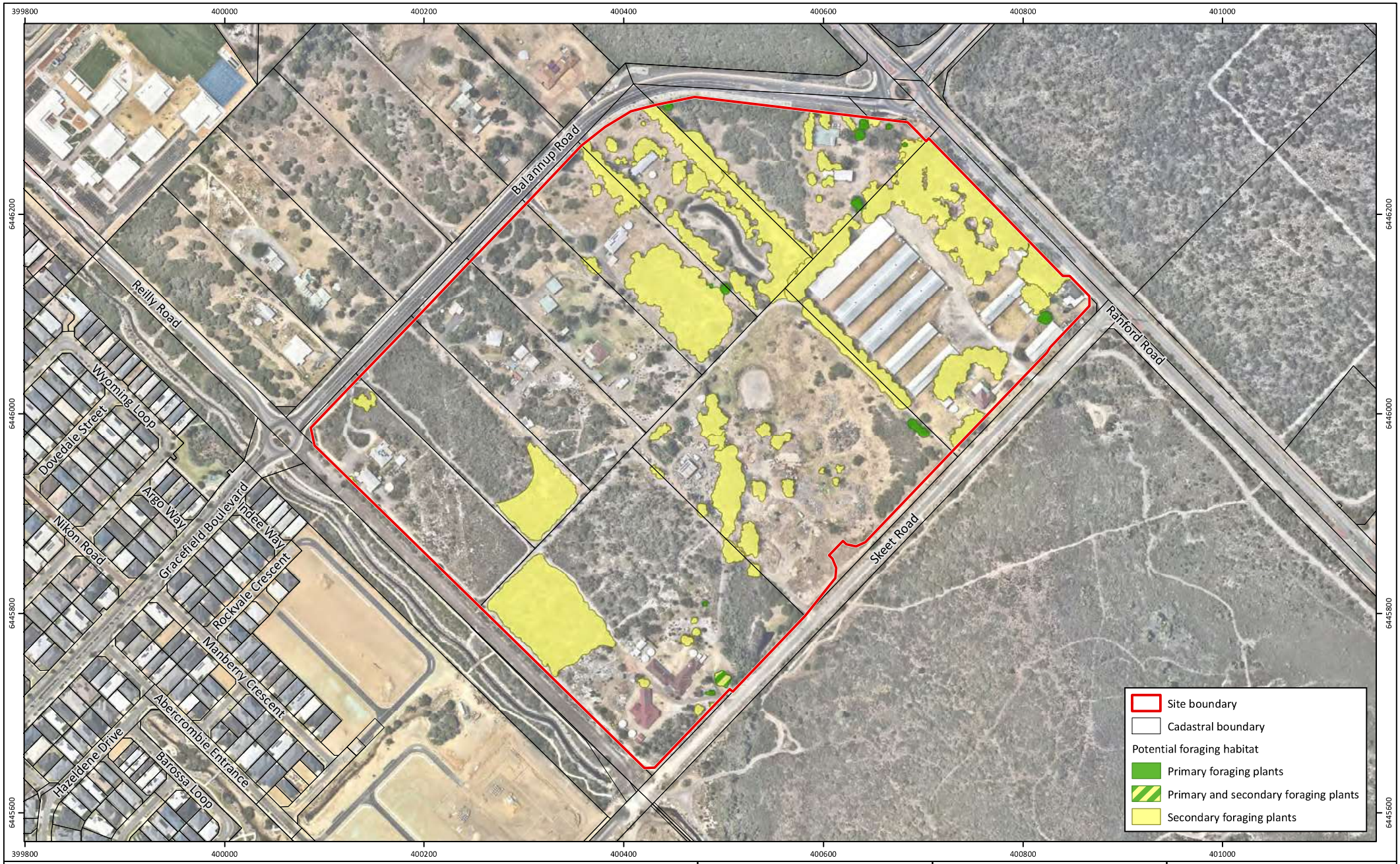


Figure 10: Potential Forest Red-tailed Black Cockatoo Foraging Habitat

Project:	Basic Fauna and Targeted Black Cockatoo Assessment Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(03)--F37

Drawn:	GAR
Date:	27/01/2021
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Approved:	RAW
Date:	29/01/2021

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Metres

Scale: 1:5,000@A4

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Appendix A

Additional Information

Conservation Significant Fauna

Threatened and priority fauna

Fauna species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, fauna species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Migratory birds may be recognised under international treaties including:

- *Japan Australia Migratory Bird Agreement 1981* (JAMBA)
- *China Australia Migratory Bird Agreement 1998* (CAMBA)
- *Republic of Korea-Australia Migratory Bird Agreement 2007* (ROKAMBA)
- *Bonn Convention 1979* (The Convention on the Conservation of Migratory Species of Wild Animals).

All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as 'matters of national environmental significance' (MNES) under the EPBC Act. Fauna species considered 'threatened' pursuant to Schedule 1 of the EPBC Act are assigned categories as outlined in **Table 1**.

Table 1: Definitions of conservation significant fauna species pursuant to the EPBC Act

Conservation Code	Category
X	Threatened Fauna –Extinct There is no reasonable doubt that the last member of the species has died.
EW[#]	Threatened Fauna –Extinct in the Wild Taxa which are known only to survive in cultivation, captivity or as a naturalised population outside its past range, or taxa which have not been recorded in its known and/or expected habitat despite appropriate exhaustive surveys.
CR[#]	Threatened Fauna – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN[#]	Threatened Fauna – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU[#]	Threatened Fauna – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
Migratory[#]	Migratory Fauna All migratory species that are: (i) native species; and (ii) from time to time included in the appendices to the Bonn Convention; and (b) all migratory species from time to time included in annexes established under JAMBA, CAMBA and ROKAMBA; and All native species from time to time identified in a list established under, or an instrument made under, an international agreement approved by the Minister.
Ma	Marine Fauna Species in the list established under s248 of the EPBC Act

[#]matters of national environmental significance (MNES) under the EPBC Act

In Western Australia, fauna taxa may be classed as 'threatened', 'extinct', or 'specially protected' under the *Biodiversity Conservation Act 2016* (BC Act), which is enforced by Department of Biodiversity Conservation and Attractions (DBCA) (DBCA 2019a). The definitions of these categories are provided in **Table 2**.

Table 2: Definitions of fauna categories listed under the BC Act (DBCA 2019a)

Category	Conservation Code	Definition
Threatened	CR	Critically endangered Threatened species considered to be facing an extremely high risk of extinction in the wild in the immediate future.
	EN	Endangered Threatened species considered to be facing a very high risk of extinction in the wild in the near future.
	VU	Vulnerable Threatened species considered to be facing a high risk of extinction in the wild in the medium-term future.
Extinct	EX	Extinct Species where there is no reasonable doubt that the last member of the species has died.
	EW	Extinct in the wild Species that is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form. Note that no species are currently listed as EW.
Specially protected	MI	Migratory species Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth Includes birds that subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds.
	CD	Species of special conservation interest (conservation dependent fauna) Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
	OS	Other specially protected species Fauna otherwise in need of special protection to ensure their conservation.

Fauna species that may be threatened or near threatened but lack sufficient information to be legislatively listed may be added to the DBCA's *Priority Fauna List* (DBCA 2018). Species listed under priorities 1-3 comprise possible threatened species that do not meet survey criteria or are otherwise data deficient. Species listed under priority 4 are those that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons (DBCA 2019a).

Priority fauna species are considered during State approval processes. Priority fauna categories and definitions are listed in **Table 3** (DBCA 2019a).

Table 3: Definitions of priority fauna categories on DBCA's Priority Fauna List (DBCA 2019a)

Conservation Code	Category
P1	Priority 1 – Poorly known Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	Priority 2 – Poorly known Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	Priority 3 – Poorly known Species that are known from several locations and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4	(a) Priority 4 – Rare species Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Priority 4 – Near Threatened Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Priority 4 – Other Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Black cockatoos

Three threatened species of black cockatoo occur on the Swan Coastal Plain (referred to herein collectively as 'black cockatoos'):

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

There are a range of regional studies and spatial datasets available which provide information on black cockatoo records and potential habitat mapping. These are detailed below.

Species distribution and breeding range

Broad-scale maps are available for the modelled distribution of Baudin's cockatoo, Carnaby's cockatoo and forest red-tailed black cockatoo (DSEWPaC 2011; DoEE 2016a, b).

The modelled distribution maps also include 'known breeding areas' and 'predicted breeding range' for Baudin's cockatoo and 'breeding range' and 'non-breeding range' for Carnaby's cockatoo.

No breeding range modelling is available for forest red-tailed black cockatoo but the species is known to breed mainly in the jarrah forest region (DBCA 2017) and in small populations on the Swan Coastal Plain within the Baldivis, Stake Hill, Lake McLarty and Capel area and increasingly in the Perth metropolitan area (DAWE 2020).

Breeding habitat

Department of Environment and Conservation (DEC, now Department of Biodiversity, Conservation and Attractions (DBCA)) and fauna experts, have identified and mapped Carnaby's cockatoo habitat on the Swan Coastal Plain and Jarrah Forest regions (Glossop *et al.* 2011). This dataset includes mapping of Carnaby's cockatoo breeding sites based on point records of breeding from a range of sources. Breeding sites were classified as 'confirmed' where eggs or chicks were recorded and 'possible' where observations relating to Carnaby's cockatoo breeding that did not include actual records of eggs or chicks (e.g. chewed hollows or records of breeding or nesting behaviour by an expert observer).

A 12 km buffer applies to each site to 'reflect the flexible use of these areas by cockatoos and to indicate the important zone for access to potential feeding habitat' (Glossop *et al.* 2011). Glossop *et al.* (2011) state that the areas mapped in the dataset are not a comprehensive record of Carnaby's cockatoo breeding and that many nesting sites are not known.

While this dataset only applies to Carnaby's cockatoo, the information it contains is also applicable for Baudin's cockatoo and forest red-tailed black cockatoo as they have similar breeding habitat requirements. That is, breeding sites that are suitable for Carnaby's cockatoo may also be suitable for

Baudin's cockatoo and forest red-tailed black cockatoo, if located within their distribution/breeding ranges.

BirdLife Australia also maintain a database of confirmed black cockatoo breeding sites which is accessible via a paid search system. BirdLife Australia have advised that their database is comprised of data collected during surveys by staff and volunteers of which most (>99%) surveys are of Carnaby's cockatoo. They have also advised that the dataset is not comprehensive and that an absence of known nests does not necessarily indicate a lack of breeding activity.

The Carnaby's cockatoo recovery plan also identifies 13 'important bird areas' for Carnaby's cockatoo, which are identified as 'sites of global bird conservation importance' (DPaW 2013). These 'important bird areas' comprise sites supporting at least 20 breeding pairs or 1% of the population regularly utilising an area in the non-breeding part of the range.

Confirmed roost sites

BirdLife Australia undertakes annual monitoring of black cockatoo overnight roost sites as part of the annual 'Great Cocky Count' community-based survey. Information gathered from these monitoring events provides roost locations and recorded black cockatoo numbers (Peck *et al.* 2019).

Native foraging habitat

Glossop et al. (2011) also mapped 'areas requiring investigation as Carnaby's cockatoo feeding habitat' for the Swan Coastal Plain and Jarrah Forest regions, based on regional vegetation mapping that may contain plant species known to be foraged upon by Carnaby's cockatoo. Note that this dataset does not include observations or point records of Carnaby's cockatoo feeding. This dataset represents areas of vegetation that may potentially provide foraging habitat for Carnaby's cockatoo.

Given this dataset was created in 2011 and in order to account for clearing of native vegetation that has occurred since this time, Emerge have updated this dataset using the current native vegetation extent as provided by DPIRD (2019a) to only show potential foraging habitat that currently exists (Emerge Associates 2020a).

Pine plantations also provide an important food source for Carnaby's cockatoo, but were not included in the Glossop et al. (2011) dataset. Mapping of pine plantations is available from the Forest Products Commission (Forest Products Commission 2020).

The Glossop et al. (2011) dataset is broadly applicable to other black cockatoos as many plant species that are foraged upon by Carnaby's cockatoo are also consumed by Baudins' cockatoo (e.g. fruit of *Banksia* spp., *Corymbia calophylla* (marri) and *Eucalyptus marginata* (jarrah)) and forest red-tailed black cockatoo (e.g. jarrah and marri fruit). However, using the Glossop et al. (2011) potential foraging habitat dataset for forest red-tailed cockatoos likely overestimates available foraging habitat as it includes multiple plant species that are not consumed by this species (e.g. *Banksia* spp.), and to a lesser extent the foraging value is also over-estimated for Baudin's cockatoo.

Emerge Associates (2020b) have used a similar methodology to Glossop et al. (2011) to define potential foraging habitat for forest-red tailed cockatoos. Specifically, DBCA (2019b) regional vegetation complex mapping has been used to determine which areas of remnant vegetation

support plant species known to be foraged upon by forest red-tailed cockatoos, including *Allocasuarina fraseriana* (sheoak), *Corymbia calophylla* (marri), *Eucalyptus gomphocephala* (tuart) and *Eucalyptus marginata* (jarrah). Where these vegetation complexes intersect remnant vegetation mapped by DPIRD (2019b) they were considered to represent potential foraging habitat for forest red-tailed cockatoos.

Pest fauna

A number of legislative and policy documents exist in relation to pest fauna management at state and national levels. The *Biosecurity and Agriculture Management Act 2007* (BAM Act) is the principle legislation guiding pest fauna management in Western Australia and lists declared pest species.

Declared Pests

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

Under the BAM Act, all declared pests are assigned a legal status, as described in **Table 4**. Species assigned to the 'declared pest, prohibited - s12' category are placed in one of three control categories, as described in **Table 5**.

The *Biosecurity and Agriculture Management Regulations 2013* specify keeping categories for species assigned to the 'declared pest - s22(2)' category, which relate to the purposes of which species can be kept, as well as the entities that can keep them. The categories are described in **Table 6**.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DAFWA 2016).

Table 4: Legal status of declared pest species listed under the BAM Act (DAFWA 2016)

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

Table 5: Control categories of declared pest species listed under the BAM Act (DAFWA 2016)

Category	Description
C1	Exclusion Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	Eradication Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	Management Established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Table 6: Keeping categories of declared pest species listed under the BAM Act (DAFWA 2016)

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

Literature

The main literature used for identifying fauna and fauna habitats is listed in **Table 7** below.

Table 7: Standard literature used for identifying fauna species and habitats.

Conservation Code	Category
Birds	Johnstone and Storr (1998b), Johnstone and Storr (1998a), Pizzey and Knight (2012), Slater *et al.* (2003)
Mammals	Menkhorst and Knight (2011), Triggs (2003)
Amphibia	Tyler and Doughty (2009), Bush *et al.* (2002)
Reptiles	Bush *et al.* (2002)

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Department of Biodiversity Conservation and Attractions (DBCA) 2019b, *Vegetation Complexes - South West forest region of Western Australia (DBCA-047)*, Kensington.

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Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2011, *Modelled distribution of Carnaby's black cockatoo (Calyptorhynchus latirostris)*, Commonwealth of Australia, Canberra, Australian Capital Territory.

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Pizzey, G. and Knight, F. 2012, *The Fieldguide to the Birds of Australia*, Harper Collins Publishers, Sydney, Australia.

Slater, P., Slater, P. and Slater, R. 2003, *The Slater Field Guide to Australian Birds*, Reed New Holland, Australia.

Triggs, B. 2003, *Tracks, Scats and Other Traces A Field Guide to Australian Mammals*, Oxford University Press Australia, Melbourne, Victoria.

Tyler, M. J. and Doughty, P. 2009, *Field Guide to Frogs of Western Australia*, Western Australian Museum, Perth, Western Australia.

Appendix B

Black Cockatoo Foraging Plants

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Acacia baileyana	Cootamundra wattle	Secondary			Groom 2011
Acacia pentadenia	Karri wattle	Secondary			Groom 2011
Acacia saligna	Orange wattle	Secondary			Groom 2011
Agonis flexuosa	Peppermint tree	Secondary			Groom 2011
Allocasuarina fraseriana	Sheoak		Secondary	Secondary	Johnstone & Storr 1998; Johnstone et al. 2010; Johnstone 2017; DoEE 2017
Allocasuarina spp.		Secondary		Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Anigozanthos flavidus	Tall kangaroo paw		Secondary		Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Araucaria heterophylla	Norfolk island pine	Secondary			Groom 2011; DoEE 2017
Banksia ashbyi	Ashby's banksia	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Banksia attenuata	Slender banksia	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia baxteri	Baxter's banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia carlinoides	Pink dryandra	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia coccinea	Scarlet banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia dallanneyi	Couch honeypot dryandra	Primary	Secondary		Groom 2011; DoEE 2017
Banksia ericifolia	Heath-leaved banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia fraseri		Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia gardneri	Prostrate banksia	Primary	Secondary		Groom 2011; DoEE 2017
Banksia grandis	Bull banksia	Primary	Secondary		Saunders 1980; Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia hookeriana	Hooker's banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia ilicifolia	Holly banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; Johnstone & Storr 1998; DoEE 2017
Banksia kippistiana		Primary	Secondary		Groom 2011; DoEE 2017
Banksia leptophylla		Primary	Secondary		Groom 2011; DoEE 2017
Banksia lindleyana	Porcupine banksia	Primary	Secondary		Johnstone et al. 2010; DoEE 2017

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Banksia littoralis	Swamp banksia	Primary	Secondary		Saunders 1980; Groom 2011Johnstone & Storr 1998; Johnstone et al. 2010; DoEE 2017
Banksia menziesii	Firewood banksia	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia mucronulata	Swordfish dryandra	Primary	Secondary		Groom 2011; DoEE 2017
Banksia nivea	Honeypot dryandra	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Banksia nobilis	Golden dryandra	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Banksia praemorsa	Cut-leaf banksia	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia prionotes	Acorn banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia prolata		Primary	Secondary		Johnstone et al. 2010; DoEE 2017
Banksia quercifolia	Oak-leaved banksia	Primary	Secondary		Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia sessilis	Parrot bush	Primary	Secondary		Saunders 1980; Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia speciosa	Showy banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia spp.		Primary	Secondary		Saunders 1979; DSEWPaC 2012; DoEE 2017
Banksia squarrosa	Pingle	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia tricuspis	Pine banksia	Primary	Secondary		Groom 2011; DoEE 2017
Banksia undata	Urchin dryandra	Primary	Secondary		Groom 2011; DoEE 2017
Banksia verticillata	Granite banksia	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Brassica campestris	Canola	Secondary			Groom 2011; DoEE 2017
Callistemon spp.		Secondary	Secondary		Johnstone et al. 2010; DoEE 2017
Callistemon viminalis	Captain cook bottlebrush	Secondary			Groom 2011
Callitris sp.		Secondary			Johnstone et al. 2010; Groom 2011
Carya illnoinensis	Pecan	Primary	Secondary		Johnstone et al. 2010; Groom 2011; Groom 2014; DoEE 2017
Casuarina cunninghamiana	River sheoak	Secondary			Groom 2011
Citrullus lanatus	Pie or afghan melon	Secondary			Johnstone et al. 2010; Groom 2011

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Corymbia calophylla	Marri	Primary	Primary	Primary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone 2017; Saunders 1979; Johnstone & Kirkby 2008
Corymbia citriodora	Lemon scented gum	Secondary	Secondary	Secondary	Johnstone et al. 2010; DSEWPaC 2012; Groom 2011; Johnstone 2017
Corymbia ficifolia	Red flowering gum	Secondary			Groom 2011
Corymbia haematoxylon	Mountain marri	Secondary		Secondary	Groom 2011; DoEE 2012; DoEE 2017
Corymbia maculata	Spotted gum	-	-	-	-
Darwinia citriodora	Lemon-scented darwinia	Secondary	Secondary		Groom 2011; Johnstone et al. 2010
Diospryros sp.	Sweet persimmon	Secondary	Secondary		Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eremophila glabra	Tarbush	Secondary			Groom 2011
Erodium aureum		Secondary			Groom 2011
Erodium botrys	Long storksbill	Secondary	Secondary		Groom 2011; Johnstone & Storr 1998; Johnstone et al. 2010
Erodium spp.		Secondary	Secondary		Johnstone et al. 2010; DoEE 2017
Eucalyptus accedens	Powderbark	-	-	-	-
Eucalyptus caesia	Silver princess	Secondary		Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017; Johnstone 2017
Eucalyptus camaldulensis	River red gum			Secondary	DoEE 2012; DoEE 2017
Eucalyptus decipiens	Red heart/moit			Secondary	Johnstone 2017
Eucalyptus diversicolor	Karri			Primary	Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone & Storr 1998
Eucalyptus erythrocorys	Illyarrie	Secondary		Secondary	DSEWPaC 2012; DoEE 2017; Johnstone 2017, Johnstone et al. 2010
Eucalyptus globulus	Tasmanian blue gum	-	-	-	-
Eucalyptus gomphocephala	Tuart	Secondary		Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eucalyptus grandis	Flooded gum, rose gum			Secondary	DoEE 2012; DoEE 2017

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Eucalyptus lehmannii	Bushy yate			Secondary	Johnstone 2017
Eucalyptus leucoxylon	Yellow gum	Secondary			Groom 2014
Eucalyptus longicornis	Red morrell	-	-	-	-
Eucalyptus loxophleba	York gum	Secondary			Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eucalyptus marginata	Jarrah	Primary	Secondary	Primary	Saunders 1980; Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017; Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone 2017
Eucalyptus megacarpa	Bullich	-	-	-	-
Eucalyptus occidentalis	Swamp yate	-	-	-	-
Eucalyptus patens	Blackbutt	Primary		Primary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone 2017; Groom 2011
Eucalyptus pleurocarpa	Tallerack	Secondary			Groom 2011
Eucalyptus preissiana	Bell-fruited mallee	Secondary			Groom 2011
Eucalyptus robusta	Swamp mahogany	Secondary			Johnstone et al. 2010; Groom 2011
Eucalyptus rudis	Flooded gum	-	-	-	-
Eucalyptus salmonophloia	Salmon gum	Primary			Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DSEWPaC 2012; DoEE 2017
Eucalyptus salubris	Gimlet	-	-	-	-
Eucalyptus staeri	Albany blackbutt			Secondary	Johnstone & Storr 1998
Eucalyptus todtiana	Coastal blackbutt	Secondary			Saunders 1980; Johnstone et al. 2010; Groom 2011; Johnstone & Kirkby 2008
Eucalyptus wandoo	Wandoo	Primary	Secondary	Primary	Saunders 1980; Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Ficus sp.	Fig	Secondary			Groom 2011
Grevillea armigera	Prickly toothbrushes	Primary			Groom 2011
Grevillea bipinnatifida	Fuschia grevillea	Primary			Groom 2011

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Grevillea hookeriana	Red toothbrushes	Primary			Groom 2011
Grevillea hookeriana subsp. apic	Black toothbrushes	Primary			Groom 2011
Grevillea paniculata	Kerosene bush	Primary			Groom 2011
Grevillea paradoxa	Bottlebrush grevillea	Primary			Groom 2011
Grevillea petrophiloides	Pink poker	Primary			Groom 2011
Grevillea robusta	Silky oak	Primary			Johnstone et al. 2010; Groom 2011
Grevillea spp.		Primary			Saunders 1979; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Grevillea wilsonii	Native fuchsia		Secondary		Johnstone et al. 2010
Hakea auriculata		Primary			Saunders 1980; Groom 2011
Hakea candolleana		Primary			Groom 2011
Hakea circumalata	Coastal hakea	Primary			Groom 2011
Hakea commutata		Primary			Groom 2011
Hakea conchifolia	Shell-leaved hakea	Primary			Groom 2011
Hakea costata	Ribbed hakea	Primary			Groom 2011
Hakea cristata	Snail hakea	Primary	Secondary		Groom 2011; Johnstone et al. 2010
Hakea cucullata	Snail hakea	Primary			Groom 2011
Hakea cyclocarpa	Ramshorn	Primary			Saunders 1980; Groom 2011
Hakea eneabba		Primary			Groom 2011
Hakea erinacea	Hedgehog hakea	Primary	Secondary		Johnstone et al. 2010; Groom 2011
Hakea falcata	Sickle hakea	Primary			Groom 2011
Hakea flabellifolia	Fan-leaved hakea	Primary			Groom 2011
Hakea gilbertii		Primary			Saunders 1980; Groom 2011
Hakea incrassata	Golfball or marble hakea	Primary			Johnstone et al. 2010; Groom 2011
Hakea lasiantha	Woolly flowered hakea	Primary			Johnstone et al. 2010; Groom 2011
Hakea lasianthoides		Primary	Secondary		Johnstone et al. 2010; Groom 2011
Hakea laurina	Pin-cushion hakea	Primary			Johnstone et al. 2010; Groom 2011
Hakea lissocarpha	Honeybush	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea marginata			Secondary		Johnstone et al. 2010

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Hakea megalosperma	Lesueur hakea	Primary			Groom 2011
Hakea multilineata	Grass leaf hakea	Primary			Groom 2011
Hakea neospathulata		Primary			Groom 2011
Hakea obliqua	Needles and corks	Primary			Saunders 1980; Groom 2011
Hakea oleifolia	Dungyn	Primary			Groom 2011
Hakea pandanicarpa subsp. crassifolia	Thick-leaved hakea	Primary			Groom 2011
Hakea petiolaris	Sea urchin hakea	Primary			Groom 2011
Hakea polyanthema		Primary			Groom 2011
Hakea preissii	Needle tree	Primary			Groom 2011
Hakea prostrata	Harsh hakea	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea psilorrhyncha		Primary			Groom 2011
Hakea ruscifolia	Candle hakea	Primary	Secondary		Saunders 1980; Groom 2011; Johnstone et al. 2010
Hakea scoparia	Kangaroo bush	Primary			Groom 2011
Hakea smilacifolia		Primary			Groom 2011
Hakea spp.		Primary	Secondary		Saunders 1979; DSEWPaC 2012; DoEE 2017
Hakea stenocarpa	Narrow-fruited hakea	Primary	Secondary		Johnstone et al. 2010; Groom 2011
Hakea sulcata	Furrowed hakea	Primary			Groom 2011
Hakea trifurcata	Two-leaved hakea	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea undulata	Wavy-leaved hakea	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea varia	Variable-leaved hakea	Primary	Secondary		Saunders 1980; Groom 2011
Harpephyllum caffrum	Kaffir plum			Secondary	Johnstone 2017
Helianthus annuus	Sunflower	Secondary			Johnstone et al. 2010; Groom 2011
Hibiscus sp.	Hibiscus	Secondary			Groom 2011
Isopogon scabriusculus		Secondary			Groom 2011
Jacaranda mimosifolia	Jacaranda	Secondary	Secondary		Johnstone et al. 2010; Groom 2011

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Jacksonia furcellata	Grey stinkwood	Secondary			Groom 2011
Kingia australis	Kingia		Secondary		Johnstone et al. 2010
Lambertia inermis	Chittick	Secondary			Johnstone & Storr 1998; Groom 2011
Lambertia multiflora	Many-flowered honeysuckle	Secondary			Saunders 1980; Groom 2011
Liquidamber styraciflua	Liquid amber	Primary		Secondary	Johnstone et al. 2010; Groom 2011; Groom 2014; Personal observation
Lupinus sp.	Lupin	Secondary			Saunders 1980; Groom 2011
Macadamia integrifolia	Macadamia	Primary	Secondary		Johnstone et al. 2010; Grooms 2011; Groom 2014
Malus domestica	Apple	Secondary	Secondary		Johnstone et al. 2010; Johnstone & Storr 1998; DSEWPaC 2012; DoEE 2017; Groom 2011
Melaleuca leuropoma		Secondary			Saunders 1980; Groom 2011
Melia azedarach	Cape lilac or white cedar	Secondary		Primary	Johnstone et al. 2010; Groom 2011
Mesomeleana spp.		Secondary			Johnstone et al. 2010; Groom 2011
Olea europea	Olive			Secondary	Johnstone 2017
Persoonia longifolia	Snottygobble			Secondary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Pinus canariensis	Canary island pine	Primary			Johnstone et al. 2010; Groom 2011
Pinus caribea	Caribbean pine	Primary			Johnstone et al. 2010; Groom 2011
Pinus pinaster	Pinaster or maritime pine	Primary			Groom 2011
Pinus radiata	Radiata pine	Primary	Secondary		Johnstone et al. 2010; Groom 2011
Pinus spp.		Primary	Secondary		Johnstone & Storr 1998; Saunders 1979; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Protea 'Pink Ice'		Secondary			Groom 2011
Protea repens		Secondary			Groom 2011
Protea spp.		Secondary			Johnstone et al. 2010

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Prunus amygdalus	Almond tree	Secondary			Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Pyrus communis	European pear		Secondary		Johnstone & Storr 1998; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Quercus spp.	Oak		Secondary		Johnstone et al. 2010
Raphanus raphanistrum	Wild radish	Secondary			Groom 2011; DoEE 2017
Reedia spathacea			Secondary		Johnstone et al. 2010
Rumex hypogaeus	Doublegee	Secondary			Saunders 1980
Stenocarpus sinuatus		Secondary			Johnstone et al. 2010
Syzygium smithii	Lilly pilly	Secondary			Groom 2014
Tipuana tipu	Tipu or rosewood tree	Primary			Groom 2011, Groom 2014
Xanthorrhoea preissii	Grass tree	Secondary	Secondary		Groom 2011; Johnstone et al. 2010
Xylomelum occidentale	Woody pear	Secondary			Groom 2014

CBC=Carnaby's cockatoo, BBC=Baudin's cockatoo and FRTBC=Forest red-tailed black cockatoo

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Appendix C

Black Cockatoo Habitat Quality Assessment (Emerge 2020)

Introduction

As part of environmental impact assessment and offset calculation, the Department of Agriculture, Water and the Environment (DAWE) requires that a score out of ten is provided for the overall quality of back cockatoo habitat within a site (DAWE 2020). DAWE does not provide a methodology for scoring habitat quality, specifying instead that an assessment of quality should be undertaken by an experienced technical expert (DSEWPaC 2012).

Emerge Associates (Emerge) have developed this method to provide a systematic assessment of overall black cockatoo habitat quality. Black cockatoo habitat is conventionally separated into breeding, roosting and foraging categories. Our method assesses and scores the quality of breeding, roosting and foraging habitat separately and then provides an overall quality score (out of ten) based on the highest score determined for the respective habitat categories.

Methodology

The International Organization for Standardization defines 'quality' as the "*degree to which a set of inherent characteristics fulfils requirements*" (ISO 9000 2020). Developing an objective scoring system for quality is therefore challenging, as quality is both relative and, to some extent, subjective. An ecological value like habitat may also have a wide range of characteristics, with varying relevance to the requirements of a species and that may be independent, interdependent or contrasting with other characteristics, such that habitat quality must be assessed holistically to be properly understood.

The three categories of black cockatoo habitat are intrinsically linked in that breeding and roosting activity is directly related to the availability of foraging and watering resources surrounding nests or roosts (Saunders 1990; Shah 2006; Le Roux 2017). Black cockatoos can also move over large distances within their range to access breeding and foraging habitat and will not necessarily return to the same locations within a year or across years (Saunders 1980; Johnstone and Kirkby 2008; Johnstone *et al.* 2017; Peck *et al.* 2019). Therefore, evaluating the overall quality of black cockatoo habitat requires acknowledgement of the relationships between the different habitat categories and the potential for use of all habitats within a site, given the condition of each habitat, the sites' location and the history of use of habitat within a site by black cockatoos.

While breeding, roosting and foraging habitat are interrelated, we suggest that the different habitat categories should not be scored cumulatively as this can overestimate quality. That is, if a site contains multiple categories of habitat it does not necessarily contain greater quality habitat. For example, a site that contains a roost is not necessarily of higher overall quality if it also contains breeding habitat.

Alternatively, averaging the scores from all three habitat categories can act to underestimate habitat, since certain types of habitat are recorded less frequently than others and therefore their absence would act to devalue quality. For example, the likelihood of recording a roost is generally low compared to recording foraging or breeding habitat but a site that lacks a roost is not necessarily of lower overall quality.

Hence, our scoring system selects the highest habitat category score to represent overall habitat quality. Adopting the highest score from any habitat category within a site avoids over or under estimating habitat quality because the most important value always drives, or is reflected in, the overall score.

To provide a score for each habitat category, the following three 'quality components' are considered as recommended by DAWE (DAWE 2020):

- Site condition which is the "*condition of a site in relation to the ecological requirements of a threatened species or ecological community. This includes considerations such as vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features".*
- Site context which is the "*relative importance of a site in terms of its position in the landscape, taking into account the connectivity needs of a threatened species or ecological community. This includes considerations such as movement patterns of the species, the proximity of the site in relation to other areas of suitable habitat, and the role of the site in relation to the overall population or extent of a species or community*".
- Species stocking rate which is the "*usage and/or density of a species at a particular site...It includes considerations such as survey data for a site in regards to a particular species population or, in the case of a threatened ecological community this may be a number of different populations. It also includes consideration of the role of the site population in regards to the overall species population viability or community extent*".

A habitat quality assessment should aim to combine current information on the status of black cockatoos and habitat characteristics within a site with the best available information regarding the status of black cockatoo populations and black cockatoo habitat within areas surrounding a site. Black cockatoo habitat assessments for a given site don't typically allow scope for physical survey of areas surrounding a site and so the ability to obtain new information is usually limited to that which can be obtained within a site. Therefore, we considered that, when assessing the above components, site condition is best defined from a current survey, site context is best defined from literature and relevant databases (Glossop *et al.* 2011; DPaW 2013; DoEE 2016a, c, b; Peck *et al.* 2019) and information on species stocking rate is best obtained from a combination of current survey, previous survey or databases (Glossop *et al.* 2011; DPaW 2013; DoEE 2016a, c, b; Peck *et al.* 2019).

Method

The *Habitat Quality Scale* provided as **Plate 1** outlines the attributes measured within each habitat category and quality component. It also shows the associated quality classification (low, moderate or high) and score (1-10).

As shown in the *Habitat Quality Scale*, the highest scores are reserved for habitat that has active or historical roosts or nests as it is considered that the presence of black cockatoos provides the best indication of the quality of habitat. Foraging habitat is weighted lower than breeding and roosting habitat as the occurrence of roost or nests provides the best confirmation that foraging habitat surrounding a site is adequate and therefore worthy of a higher quality score. Therefore, a maximum

total of ten is achievable for breeding habitat and a total of eight is achievable for both roosting and foraging habitat (refer **Plate 1**).

The *Habitat Scoring Tool* provided as **Plate 2** is an *Excel* spreadsheet document that is used to determine a quality score for each habitat category component by answering queries about habitat within and surrounding the site. A quality score is calculated for each habitat category by summing maximum scores for each query. Because maximum scores are selected, multiple answers may be provided for any query where appropriate without exaggerating the quality score. For key confirmed habitat such as roosts or nests, the scoring tool ensures that relevant, higher scores are achieved irrespective of whether all preceding queries have been answered positively (for example a roost always scores 7 or 8 irrespective of whether other quality criteria have been met).

The highest score from any of the three habitat categories is then adopted as the overall score for black cockatoo habitat quality within the site.

Emerge Black Cockatoo Habitat Quality Assessment - Scale

		Habitat Quality Score									
		Low			Moderate			Moderate - High	High		
	Quality Component	1	2	3	4	5	6	7	8	9	10
Breeding habitat	Site condition	Habitat trees with suitable hollows occur within the site AND / OR habitat trees without suitable hollows occur within the site					Habitat trees with suitable hollows occur within the site			N/A	
	Site context	No nest has been recorded within 12 km of the site AND <100 ha of potential foraging habitat occurs within 6 km of the site	A nest(s) (active, historical or potential) has been recorded within 12 km of the site AND / OR >100 ha of potential native foraging habitat occurs within 6 km of the site				A nest(s) (active, historical or potential) has been recorded within 6 km of the site AND / OR >1000 ha of potential native foraging habitat occurs within 6 km of the site				
	Species stocking rate	No evidence of black cockatoos nesting has been recorded within the site						A potential nest(s) occurs within the site OR a historical nest(s) has been recorded within the site	A Potential nest(s) occurs within the site AND a historical nest(s) has been recorded within the site	An active nest(s) occurs within the site	An active nest(s) occurs within the site AND a historical nest(s) has been recorded within the site
Roosting habitat	Site condition	Trees potentially suitable for roosting occur within the site						N/A			
	Site context	No water source occurs within or nearby the site	A water source occurs within or nearby the site OR no water source occurs within or nearby the site								
		No roost has been recorded within 1 km of the site	A small roost (active or historical) has been recorded within 500 m of the site OR a large roost (active or historical) has been recorded within 1 km of the site OR no roost has been recorded within 1 km of the site								
	Species stocking rate	No roost has been recorded within the site				A small roost (active or historical) has been recorded within the site	A large roost (active or historical) has been recorded within the site	An active small roost occurs within the site	An active large roost occurs within the site		
	Site condition	Foraging habitat with 1-10% primary foraging plants occurs within the site	Foraging habitat with 1-50% primary foraging plants occurs within the site		Foraging habitat with 1-100% primary foraging plants occurs within the site		Foraging habitat with 10-100% primary foraging plants occurs within the site	Foraging habitat with 50-100% primary foraging plants occurs within the site		N/A	
	Site context	No nest or roost has been recorded within 12 km of the site	A nest(s) (active, potential or historical) AND / OR a roost(s) (active or historical) has been recorded within 12 km of the site					A nest(s) (active, potential or historical) has been recorded within 6 km of the site			
	Species stocking rate	No evidence of foraging by black cockatoos has been recorded within the site	Evidence of foraging by black cockatoos may have been recorded within the site (limted or abundant)						Abundant evidence of foraging by black cockatoos has been recorded in the site		

Note that breeding, roosting and foraging habitat are assessed separately and the highest score is the overall quality score.

Black Cockatoo Habitat Scale definitions

'**Habitat tree**' is a native eucalypt that is typically known to support black cockatoo breeding such as marri, jarrah, blackbutt, tuart, wandoo, salmon gum or to a lesser extent flooded gum, with a DBH ≥50 cm or D3H ≥30 cm for wandoo or salmon gum (DSEWPaC 2012).

'**Nest**' is a hollow in which black cockatoo breeding has been recorded. A nest is '**active**' if breeding was recorded within the last 2 years and '**historical**' if breeding was recorded more than 2 years ago. A hollow with potential secondary signs of breeding (e.g. chew marks) or a hollow with potential signs of breeding that could not be attributed to a bird species is a '**potential**' nest.

'**Roost**' is a black cockatoo roost site confirmed by a roost survey (e.g. BirdLife Australia Great Cocky Count). A roost is considered '**large**' if more than 150 individuals were recorded and '**small**' if less than 150 individuals were recorded (BirdLife Australia 2019). A roost is '**active**' if roosting was

'**Primary foraging plants**' are plants with historical and/or contemporary records of regular consumption by black cockatoos, including native and non-native plant species.

Plate 1: Black Cockatoo Habitat Quality Scale

Black Cockatoo Habitat Quality Assessment - Scoring Tool (Carnaby's cockatoo)
<insert site name>

		Query		Answer	Potential score	Site score	Sum
Breeding habitat	Site condition	1.1	The site contains:				
			habitat tree(s) with suitable hollow(s)		2.0	0.0	0.0
			habitat tree(s) without suitable hollow(s)		1.0	0.0	
	Site context	1.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)		1.0	0.0	0.0
			6-12 km from a nest(s) (active, historical or potential)		0.5	0.0	
		1.3	The site is located within 6 km of:				
			>1000 ha of potential foraging habitat		3.0	0.0	0.0
			100 to 1000 ha of potential foraging habitat		1.0	0.0	
	Species stocking rate	1.4	The site contains:				
			historical nest(s)		1.0	0	0.0
			The site contains:				
			active nest(s)		3.0	0	
			potential nest(s)		1.0	0	0.0
			Score	0	10.0		
Roosting habitat	Site condition	2.1	The site contains trees potentially suitable for roosting		1.0	0.0	0.0
		2.2	The site contains a water source or one exists nearby		1.0	0.0	
	Site context	2.3	The site is located:				
			within 1 km of a large roost (≥150 individuals) (active or historical)		1.0	0.0	0.0
			within 500 m of a small roost (< 150 individuals) (active or historical)		1.0	0.0	
	Species stocking rate	2.4	The site contains:				
			a historical record of a large roost (≥150 individuals)		2.0	0	
			a historical record of a small roost (<150 individuals)		1.0	0	0.0
			The site contains:				
			an active record of a large roost (≥150 individuals)		2.0	0.0	0.0
			an active record of a small roost (<150 individuals)		1.0	0.0	
			Score	0	7.0		
Foraging habitat	Site condition	3.1	The site contains foraging habitat comprising:				
			≥50% primary foraging plants		4.0	0.0	0.0
			≥10% to <50% primary foraging plants		2.0	0.0	
			<10% primary foraging plants		1.0	0.0	
	Site context	3.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)		2.0	0.0	0.0
			6-12 km from a nest(s) (active, historical or potential)		1.00	0.0	
		3.3	The site is located:				
			within 6 km of a roost(s) (active or historical)		1.0	0.0	
			6-12 km from a roost(s) (active or historical)		0.5	0.0	
	Species stocking rate	3.4	The site contains:				
			abundant evidence of foraging		2.0	0.0	0.0
			limited evidence of foraging		1.0	0.0	
			Score	0	8.0		

SUMMARY		
Habitat category	**Score**	**Habitat quality**
Breeding	0	No habitat
Roosting	0	No habitat
Foraging	0	No habitat
Overall habitat quality score	**0**	No habitat

Note:
1. Within the breeding category, a score of 9 applies if an active nest(s) occurs within the site and a score of 10 applies if an active nest(s) and a historical nest(s) occurs within the site, regardless of the answer to other queries in this category
2. Within the roosting category, a score of 7 applies if a small roost occurs within the site and a score of 8 applies if a large roost occurs within the site, regardless of the answer to other queries in this category.
3. The final score consists of the highest score from each habitat category

Plate 2: Black Cockatoo Habitat Scoring Tool

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Appendix D

Database Search Results

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 22/01/2021

Kingdom Animalia
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 56' 42" E,32° 07' 04" S
Buffer 10km
Group By Conservation Status

Conservation Status	Species	Records
Non-conservation taxon	440	50037
Other specially protected fauna	3	37
Priority 1	1	4
Priority 2	1	1
Priority 3	7	107
Priority 4	7	471
Protected under international agreement	17	293
Rare or likely to become extinct	12	2599
TOTAL	**488**	**53549**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Rare or likely to become extinct					
1.	24345	*Botaurus poiciloptilus (Australasian Bittern)*		T	
2.	24784	*Calidris ferruginea (Curlew Sandpiper)*		T	
3.	24731	*Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black Cockatoo)*		T	
4.	24733	*Calyptorhynchus baudinii (Baudin's Cockatoo, White-tailed Long-billed Black Cockatoo)*		T	
5.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)*		T	
6.	48400	*Calyptorhynchus sp. (white-tailed black cockatoo)*		T	
7.	25575	*Charadrius leschenaultii (Greater Sand Plover)*		T	
8.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
9.	33983	*Leioproctus douglasiellus (a short-tongued bee)*		T	
10.	24146	*Myrmecobius fasciatus (Numbat, Walpurti)*		T	
11.	33984	*Neopasiphae simplicior (a short-tongued bee)*		T	
12.	34113	*Westralunio carteri (Carter's Freshwater Mussel)*		T	
Protected under international agreement					
13.	41323	*Actitis hypoleucos (Common Sandpiper)*		IA	
14.	25554	*Apus pacificus (Fork-tailed Swift, Pacific Swift)*		IA	
15.	25736	*Arenaria interpres (Ruddy Turnstone)*		IA	
16.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
17.	24786	*Calidris melanotos (Pectoral Sandpiper)*		IA	
18.	24788	*Calidris ruficollis (Red-necked Stint)*		IA	
19.	24789	*Calidris subminuta (Long-toed Stint)*		IA	
20.	47954	*Gelochelidon nilotica (Gull-billed Tern)*		IA	
21.	25741	*Limosa limosa (Black-tailed Godwit)*		IA	
22.	48591	*Pandion cristatus (Osprey, Eastern Osprey)*		IA	
23.	24843	*Plegadis falcinellus (Glossy Ibis)*		IA	
24.	24382	*Pluvialis fulva (Pacific Golden Plover)*		IA	
25.	24383	*Pluvialis squatarola (Grey Plover)*		IA	
26.	24516	*Stercorarius longicaudus (long-tailed jaeger, long-tailed skua)*		IA	
27.	24806	*Tringa glareola (Wood Sandpiper)*		IA	
28.	24808	*Tringa nebularia (Common Greenshank, greenshank)*		IA	
29.	24809	*Tringa stagnatilis (Marsh Sandpiper, little greenshank)*		IA	
Other specially protected fauna					
30.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
31.	24475	*Falco peregrinus subsp. macropus (Australian Peregrine Falcon)*		S	
32.	48070	*Phascogale tapoatafa subsp. wambenger (South-western Brush-tailed Phascogale, Wambenger)*		S	

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Priority 1					
33.	33994	*Throscodectes xiphos (Stylet Bush Cricket, Stylet Trosco (Jandakot))*		P1	Y
Priority 2					
34.	33971	*Austroconops mcmillani (McMillan's biting midge (Swan Coastal Plain), biting midge (southwest))*		P2	
Priority 3					
35.	25242	*Acanthophis antarcticus (Southern Death Adder)*		P3	
36.	41641	*Ctenotus ora (Coastal Plains Skink)*		P3	
37.	48579	*Euoplos inornatus (inornate trapdoor spider (northern Jarrah Forest))*		P3	
38.	48935	*Idiosoma sigillatum (Swan Coastal Plain shield-backed trapdoor spider)*		P3	
39.	33982	*Leioproctus contrarius (a short-tongued bee)*		P3	
40.	25147	*Lerista lineata (Perth Slider, Lined Skink)*		P3	
41.	25249	*Neelaps calonotos (Black-striped Snake, black-striped burrowing snake)*		P3	
Priority 4					
42.	25035	*Ctenotus delli (Dell's skink, Darling Range southwest Ctenotus)*		P4	
43.	24215	*Hydromys chrysogaster (Water-rat, Rakali)*		P4	
44.	48588	*Isoodon fusciventer (Quenda, southwestern brown bandicoot)*		P4	
45.	47975	*Ixobrychus dubius (Australian Little Bittern)*		P4	
46.	48022	*Notamacropus irma (Western Brush Wallaby)*		P4	
47.	24328	*Oxyura australis (Blue-billed Duck)*		P4	
48.	33992	*Synemon gratiosa (Graceful Sunmoth)*		P4	
Non-conservation taxon					
49.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
50.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
51.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
52.	24262	*Acanthiza inornata (Western Thornbill)*			
53.	24560	*Acanthorhynchus superciliosus (Western Spinebill)*			
54.		*Acariformes sp.*			
55.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
56.	24281	*Accipiter cirrocephalus subsp. cirrocephalus (Collared Sparrowhawk)*			
57.	25536	*Accipiter fasciatus (Brown Goshawk)*			
58.	24283	*Accipiter fasciatus subsp. didimus (Brown Goshawk)*			
59.	24282	*Accipiter fasciatus subsp. fasciatus (Brown Goshawk)*			
60.	42368	*Acritoscincus trilineatus (Western Three-lined Skink)*			
61.	25755	*Acrocephalus australis (Australian Reed Warbler)*			
62.	24831	*Acrocephalus australis subsp. gouldi (Australian Reed Warbler)*			
63.	24301	*Aegotheles cristatus subsp. cristatus (Australian Owlet-nightjar)*			
64.		*Akamptogonus novarae*			
65.		*Aname mainae*			
66.		*Aname tepperi*			
67.	24310	*Anas castanea (Chestnut Teal)*			
68.	24312	*Anas gracilis (Grey Teal)*			
69.	24313	*Anas platyrhynchos (Mallard)*			
70.		*Anas platyrhynchos subsp. domesticus*			
71.	24315	*Anas rhynchotis (Australasian Shoveler)*			
72.	24316	*Anas superciliosa (Pacific Black Duck)*			
73.		*Ancylidae sp.*			
74.	47414	*Anhinga novaehollandiae (Australasian Darter)*			
75.	44629	*Anilios australis*			
76.		*Anser anser*			
77.	25241	*Antaresia stimsoni subsp. stimsoni (Stimson's Python)*			
78.	25449	*Antechinus flavipes (Yellow-footed Antechinus)*			
79.	24088	*Antechinus flavipes subsp. leucogaster (Yellow-footed Antechinus, Mardo)*			
80.	24561	*Anthochaera carunculata (Red Wattlebird)*			
81.	24562	*Anthochaera lunulata (Western Little Wattlebird)*			
82.	24990	*Aprasia pulchella (Granite Worm-lizard)*			
83.	24991	*Aprasia repens (Sand-plain Worm-lizard)*			
84.	24285	*Aquila audax (Wedge-tailed Eagle)*			
85.		*Arachnura higginsi*			
86.		*Araneus senicaudatus*			
87.	24337	*Ardea garzetta subsp. nigripes (Little Egret)*			
88.	25558	*Ardea ibis (Cattle Egret)*			
89.	41324	*Ardea modesta (great egret, white egret)*			
90.	24340	*Ardea novaehollandiae (White-faced Heron)*			
91.	24341	*Ardea pacifica (White-necked Heron)*			
92.		*Argiope protensa*			
93.		*Argiope trifasciata*			
94.	25566	*Artamus cinereus (Black-faced Woodswallow)*			

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95.	24352	*Artamus cinereus subsp. melanops (Black-faced Woodswallow)*			
96.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
97.	24356	*Artamus personatus (Masked Woodswallow)*			
98.		*Artamus sordidus*			
99.		*Artoria flavimana*			
100.		*Artoria linnaei*			
101.		*Artoria taeniifera*			
102.		*Asadipus kunderang*			
103.		*Atherinosoma wallacei*			
104.		*Austracantha minax*			
105.	47713	*Austronomus australis (White-striped Free-tailed Bat)*			
106.	24318	*Aythya australis (Hardhead)*			
107.		*Backobourkia heroine*			
108.		*Baetidae sp.*			
109.		*Ballarra longipalpus*			
110.		*Barnardius zonarius*			
111.	24319	*Biziura lobata (Musk Duck)*			
112.		*Bostockia porosa*			
113.	42381	*Brachyurophis semifasciatus (Southern Shovel-nosed Snake)*			
114.	24359	*Burhinus grallarius (Bush Stone-curlew)*			
115.	25713	*Cacatua galerita (Sulphur-crested Cockatoo)*			
116.	25714	*Cacatua pastinator (Western Long-billed Corella)*			
117.	25715	*Cacatua roseicapilla (Galah)*			
118.	25716	*Cacatua sanguinea (Little Corella)*			
119.	24729	*Cacatua tenuirostris (Eastern Long-billed Corella)*	Y		
120.	25598	*Cacomantis flabelliformis (Fan-tailed Cuckoo)*			
121.	24427	*Cacomantis flabelliformis subsp. flabelliformis (Fan-tailed Cuckoo)*			
122.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
123.		*Caenidae sp.*			
124.	25717	*Calyptorhynchus banksii (Red-tailed Black-Cockatoo)*			
125.		*Celaenia excavata*			
126.		*Ceratopogonidae sp.*			
127.	24086	*Cercartetus concinnus (Western Pygmy-possum, Mundarda)*			
128.		*Cercophonius sulcatus*			
129.		*Ceryerda cursitans*			
130.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
131.	24187	*Chalinolobus morio (Chocolate Wattled Bat)*			
132.	24377	*Charadrius ruficapillus (Red-capped Plover)*			
133.	43380	*Chelodina colliei (South-western Snake-necked Turtle)*			
134.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
135.	47909	*Cheramoeca leucosterna (White-backed Swallow)*			
136.	33939	*Cherax cainii (Marron)*			
137.		*Cherax destructor*			
138.		*Cherax preissii*			
139.		*Cherax quinquecarinatus*			
140.		*Cherax sp.*			
141.		*Chironominae sp.*			
142.	24980	*Christinus marmoratus (Marbled Gecko)*			
143.		*Chroicocephalus novaehollandiae*			
144.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
145.	25601	*Chrysococcyx lucidus (Shining Bronze Cuckoo)*			
146.	24432	*Chrysococcyx lucidus subsp. plagosus (Shining Bronze Cuckoo)*			
147.	24288	*Circus approximans (Swamp Harrier)*			
148.	24289	*Circus assimilis (Spotted Harrier)*			
149.	24774	*Cladorhynchus leucocephalus (Banded Stilt)*			
150.		*Clynotis severus*			
151.		*Coenagrionidae sp.*			
152.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
153.	24399	*Columba livia (Domestic Pigeon)*	Y		
154.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
155.	24362	*Coracina novaehollandiae subsp. novaehollandiae (Black-faced Cuckoo-shrike)*			
156.		*Corixidae sp.*			
157.		*Cormocephalus aurantiipes*			
158.		*Cormocephalus rubriceps*			
159.	24416	*Corvus bennetti (Little Crow)*			
160.	25592	*Corvus coronoides (Australian Raven)*			
161.	24417	*Corvus coronoides subsp. perplexus (Australian Raven)*			
162.	24671	*Coturnix pectoralis (Stubble Quail)*			
163.	25701	*Coturnix ypsilophora (Brown Quail)*			
164.	24673	*Coturnix ypsilophora subsp. australis (Brown Quail)*			

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165.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
166.	25595	*Cracticus tibicen (Australian Magpie)*			
167.	24422	*Cracticus tibicen subsp. dorsalis (White-backed Magpie)*			
168.	24423	*Cracticus tibicen subsp. tibicen (Black-backed Magpie)*			
169.	25596	*Cracticus torquatus (Grey Butcherbird)*			
170.	24424	*Cracticus torquatus subsp. torquatus (Grey Butcherbird)*			
171.	24918	*Crenadactylus ocellatus subsp. ocellatus (Clawless Gecko)*			
172.	25398	*Crinia georgiana (Quacking Frog)*			
173.	25399	*Crinia glauerti (Clicking Frog)*			
174.	25400	*Crinia insignifera (Squelching Froglet)*			
175.	25401	*Crinia pseudinsignifera (Bleating Froglet)*			
176.	30893	*Cryptoblepharus buchananii*			
177.	25020	*Cryptoblepharus plagiocephalus*			
178.		*Cryptoerithus quobba*			
179.	30899	*Ctenophorus adelaidensis (Southern Heath Dragon, Western Heath Dragon)*			
180.	24883	*Ctenophorus ornatus (Ornate Crevice-Dragon)*			
181.	25027	*Ctenotus australis*			
182.	25039	*Ctenotus fallens*			
183.	25040	*Ctenotus gemmula (Jewelled South-west Ctenotus (Swan Coastal Plain subpop P3), skink)*			
184.	25047	*Ctenotus impar*			
185.	25049	*Ctenotus labillardieri*			
186.		*Cyclosa trilobata*			
187.	24322	*Cygnus atratus (Black Swan)*			
188.	24323	*Cygnus olor (Mute Swan)*	Y		
189.	30901	*Dacelo novaeguineae (Laughing Kookaburra)*	Y		
190.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
191.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
192.	24999	*Delma grayii*			
193.	25468	*Demansia psammophis (Yellow-faced Whipsnake)*			
194.	25296	*Demansia psammophis subsp. reticulata (Yellow-faced Whipsnake)*			
195.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
196.		*Dingosa serrata*			
197.		*Dinocambala ingens*			
198.	24929	*Diplodactylus granariensis subsp. granariensis*			
199.	44654	*Diplodactylus lateroides (Speckled Stone Gecko)*			
200.	24939	*Diplodactylus polyophthalmus*			
201.	24940	*Diplodactylus pulcher*			
202.		*Dytiscidae sp.*			
203.	25251	*Echiopsis curta (Bardick)*			
204.	25096	*Egernia kingii (King's Skink)*			
205.	25100	*Egernia napoleonis*			
206.		*Egretta garzetta*			
207.		*Egretta novaehollandiae*			
208.		*Elanus axillaris*			
209.	25540	*Elanus caeruleus (Black-shouldered Kite)*			
210.	24290	*Elanus caeruleus subsp. axillaris (Australian Black-shouldered Kite)*			
211.	25250	*Elapognathus coronatus (Crowned Snake)*			
212.	47937	*Elseyornis melanops (Black-fronted Dotterel)*			
213.		*Eodelena convexa*			
214.		*Eodelena lapidicola*			
215.		*Eolophus roseicapillus*			
216.	24652	*Eopsaltria georgiana (White-breasted Robin)*			
217.	24567	*Epthianura albifrons (White-fronted Chat)*			
218.		*Eriophora biapicata*			
219.		*Erythracarus decoris*			
220.	24379	*Erythrogonys cinctus (Red-kneed Dotterel)*			
221.		*Eucyrtops latior*			
222.	24368	*Eurostopodus argus (Spotted Nightjar)*			
223.	25621	*Falco berigora (Brown Falcon)*			
224.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
225.	24472	*Falco cenchroides subsp. cenchroides (Australian Kestrel, Nankeen Kestrel)*			
226.	25623	*Falco longipennis (Australian Hobby)*			
227.	24474	*Falco longipennis subsp. longipennis (Australian Hobby)*			
228.	24041	*Felis catus (Cat)*	Y		
229.	25727	*Fulica atra (Eurasian Coot)*			
230.	24761	*Fulica atra subsp. australis (Eurasian Coot)*			
231.	30916	*Funambulus pennanti (Indian Palm Squirrel)*	Y		
232.	34028	*Galaxias occidentalis (Western Minnow)*			
233.	25729	*Gallinula tenebrosa (Dusky Moorhen)*			

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234.	24763	*Gallinula tenebrosa subsp. tenebrosa (Dusky Moorhen)*			
235.	25730	*Gallirallus philippensis (Buff-banded Rail)*			
236.	24765	*Gallirallus philippensis subsp. mellori (Buff-banded Rail)*			
237.		*Gallus gallus*			
238.	42314	*Gavicalis virescens (Singing Honeyeater)*			
239.		*Gea theridioides*			
240.	24959	*Gehyra variegata*			
241.	25404	*Geocrinia leai (Ticking Frog)*			
242.	25530	*Gerygone fusca (Western Gerygone)*			
243.	24271	*Gerygone fusca subsp. fusca (Western Gerygone)*			
244.		*Glossiphoniidae sp.*			
245.	47962	*Glyciphila melanops (Tawny-crowned Honeyeater)*			
246.		*Gomphidae sp.*			
247.	24443	*Grallina cyanoleuca (Magpie-lark)*			
248.		*Gripopterygidae sp.*			
249.		*Gyrinidae sp.*			
250.	24487	*Haematopus longirostris (Pied Oystercatcher)*			
251.	24293	*Haliaeetus leucogaster (White-bellied Sea-Eagle)*			
252.	24295	*Haliastur sphenurus (Whistling Kite)*			
253.	25410	*Heleioporus eyrei (Moaning Frog)*			
254.	25412	*Heleioporus psammophilus (Sand Frog)*			
255.	25115	*Hemiergis initialis subsp. initialis*			
256.	25119	*Hemiergis quadrilineata*			
257.		*Henicops dentatus*			
258.	47965	*Hieraaetus morphnoides (Little Eagle)*			
259.	25734	*Himantopus himantopus (Black-winged Stilt)*			
260.	24491	*Hirundo neoxena (Welcome Swallow)*			
261.		*Hydrometridae sp.*			
262.		*Hydrophilidae sp.*			
263.		*Hydropsychidae sp.*			
264.		*Hydroptilidae sp.*			
265.		*Hyriidae sp.*			
266.		*Idiommata blackwalli*			
267.		*Isometroides vescus*			
268.		*Isopeda leishmanni*			
269.		*Ixodes australiensis*			
270.		*Karaops ellenae*			
271.	24367	*Lalage tricolor (White-winged Triller)*			
272.		*Lampona cylindrata*			
273.	24511	*Larus novaehollandiae subsp. novaehollandiae (Silver Gull)*			
274.		*Latrodectus hasseltii*			
275.		*Leiopotherapon unicolor*			
276.		*Leptoceridae sp.*			
277.		*Leptophlebiidae sp.*			
278.	25131	*Lerista distinguenda*			
279.	25133	*Lerista elegans*			
280.	25005	*Lialis burtonis*			
281.		*Libellulidae sp.*			
282.	25661	*Lichmera indistincta (Brown Honeyeater)*			
283.	25415	*Limnodynastes dorsalis (Western Banjo Frog)*			
284.	25378	*Litoria adelaidensis (Slender Tree Frog)*			
285.	25388	*Litoria moorei (Motorbike Frog)*			
286.	25683	*Lonchura castaneothorax (Chestnut-breasted Mannikin)*			
287.		*Longepi woodman*			
288.		*Longrita insidiosa*			
289.		*Lophoictinia isura*			
290.		*Lycosa ariadnae*			
291.		*Lycosa gilberta*			
292.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
293.	24326	*Malacorhynchus membranaceus (Pink-eared Duck)*			
294.	25650	*Malurus elegans (Red-winged Fairy-wren)*			
295.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
296.	25654	*Malurus splendens (Splendid Fairy-wren)*			
297.	24583	*Manorina flavigula (Yellow-throated Miner)*			
298.		*Maratus pavonis*			
299.		*Marsupiopus antechinus*			
300.	25758	*Megalurus gramineus (Little Grassbird)*			
301.	47997	*Melanodryas cucullata (Hooded Robin)*			
302.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
303.	24586	*Melithreptus brevirostris subsp. leucogenys (Brown-headed Honeyeater)*			

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304.	24587	*Melithreptus chloropsis (Western White-naped Honeyeater)*			
305.	24736	*Melopsittacus undulatus (Budgerigar)*			
306.	25184	*Menetia greyii*			
307.	24598	*Merops ornatus (Rainbow Bee-eater)*			
308.		*Microcarbo melanoleucos*			
309.	25693	*Microeca fascinans (Jacky Winter)*			
310.	25542	*Milvus migrans (Black Kite)*			
311.		*Missulena granulosa*			
312.		*Missulena hoggi*			
313.		*Missulena occatoria*			
314.		*Mituliodon tarantulinus*			
315.		*Mitzoruga insularis*			
316.	25240	*Morelia spilota subsp. imbricata (Carpet Python)*			
317.	25191	*Morethia lineoocellata*			
318.	25192	*Morethia obscura*			
319.	24223	*Mus musculus (House Mouse)*	Y		
320.	25610	*Myiagra inquieta (Restless Flycatcher)*			
321.	25420	*Myobatrachus gouldii (Turtle Frog)*			
322.		*Nannoperca vittata*			
323.	25248	*Neelaps bimaculatus (Black-naped Snake)*			
324.	25686	*Neochmia temporalis (Red-browed Finch)*	Y		
325.	24738	*Neophema elegans (Elegant Parrot)*			
326.		*Nephila edulis*			
327.		*Nicodamus mainae*			
328.	25747	*Ninox connivens (Barking Owl)*			
329.	25252	*Notechis scutatus (Tiger Snake)*			
330.		*Notiasemus glauerti*			
331.		*Notonectidae sp.*			
332.		*Nunciella aspera*			
333.	25564	*Nycticorax caledonicus (Rufous Night Heron)*			
334.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
335.	41424	*Nyctophilus major (Greater Long-eared Bat)*			
336.	24742	*Nymphicus hollandicus (Cockatiel)*			
337.		*Ocrisiona leucocomis*			
338.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
339.		*Oligochaeta sp.*			
340.		*Ommatoiulus moreleti*			
341.		*Ommatoiulus moreletii*			
342.		*Orthocladiinae sp.*			
343.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
344.		*Oxidus gracilis*			
345.		*Oxyopes gracilipes*			
346.		*Oxyopes punctatus*			
347.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
348.	24624	*Pachycephala rufiventris subsp. rufiventris (Rufous Whistler)*			
349.		*Palaemonidae sp.*			
350.		*Paralampona marangaroo*			
351.		*Parastacidae sp.*			
352.	25253	*Parasuta gouldii*			
353.	25255	*Parasuta nigriceps*			
354.	25681	*Pardalotus punctatus (Spotted Pardalote)*			
355.	24625	*Pardalotus punctatus subsp. punctatus (Spotted Pardalote)*			
356.	25682	*Pardalotus striatus (Striated Pardalote)*			
357.	24630	*Pardalotus striatus subsp. westraliensis (Striated Pardalote)*			
358.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
359.	48060	*Petrochelidon ariel (Fairy Martin)*			
360.	48061	*Petrochelidon nigricans (Tree Martin)*			
361.	48066	*Petroica boodang (Scarlet Robin)*			
362.	24659	*Petroica goodenovii (Red-capped Robin)*			
363.	25697	*Phalacrocorax carbo (Great Cormorant)*			
364.	25698	*Phalacrocorax melanoleucos (Little Pied Cormorant)*			
365.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
366.	25699	*Phalacrocorax varius (Pied Cormorant)*			
367.	24409	*Phaps chalcoptera (Common Bronzewing)*			
368.	25587	*Phaps elegans (Brush Bronzewing)*			
369.		*Phenasteron longiconductor*			
370.		*Phryganoporus candidus*			
371.	48071	*Phylidonyris niger (White-cheeked Honeyeater)*			
372.	24596	*Phylidonyris novaehollandiae (New Holland Honeyeater)*			
373.		*Physidae sp.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
374.		*Pinkfloydia harveii*			
375.		*Planorbidae sp.*			
376.	24841	*Platalea flavipes (Yellow-billed Spoonbill)*			
377.	24842	*Platalea regia (Royal Spoonbill)*			
378.	25720	*Platycercus icterotis (Western Rosella)*			
379.	24745	*Platycercus icterotis subsp. icterotis (Western Rosella)*			
380.	24747	*Platycercus spurius (Red-capped Parrot)*			
381.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
382.	24750	*Platycercus zonarius subsp. semitorquatus (Twenty-eight Parrot)*			
383.	24751	*Platycercus zonarius subsp. zonarius (Port Lincoln Parrot)*			
384.	25509	*Pletholax gracilis (Keeled Legless Lizard)*			
385.	25007	*Pletholax gracilis subsp. gracilis (Keeled Legless Lizard)*			
386.	25703	*Podargus strigoides (Tawny Frogmouth)*			
387.	24679	*Podargus strigoides subsp. brachypterus (Tawny Frogmouth)*			
388.	25704	*Podiceps cristatus (Great Crested Grebe)*			
389.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
390.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
391.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
392.		*Poltys laciniosus*			
393.		*Polygonarea repanda*			Y
394.	25722	*Polytelis anthopeplus (Regent Parrot)*			
395.	25731	*Porphyrio porphyrio (Purple Swamphen)*			
396.	24767	*Porphyrio porphyrio subsp. bellus (Purple Swamphen)*			
397.	24769	*Porzana fluminea (Australian Spotted Crake)*			
398.	25732	*Porzana pusilla (Baillon's Crake)*			
399.	24770	*Porzana pusilla subsp. palustris (Baillon's Crake)*			
400.	24771	*Porzana tabuensis (Spotless Crake)*			
401.		*Prionosternum scutatum*			
402.	25261	*Pseudechis australis (Mulga Snake)*			
403.	25511	*Pseudonaja affinis (Dugite)*			
404.	25259	*Pseudonaja affinis subsp. affinis (Dugite)*			
405.	42416	*Pseudonaja mengdeni (Western Brown Snake)*			
406.	25433	*Pseudophryne guentheri (Crawling Toadlet)*			
407.	48085	*Psittacula krameri (Indian Ringnecked Parrot, Rose-ringed Parakeet)*	Y		
408.	24702	*Pterodroma brevirostris (Kerguelen Petrel)*			
409.	24703	*Pterodroma lessonii (White-headed Petrel)*			
410.	25710	*Pterodroma macroptera (Great-winged Petrel)*			
411.	24173	*Pteropus scapulatus (Little Red Flying-fox)*			
412.	24711	*Puffinus assimilis subsp. assimilis (Little Shearwater)*			
413.		*Purpureicephalus spurius*			
414.	25008	*Pygopus lepidopodus (Common Scaly Foot)*			
415.	24245	*Rattus rattus (Black Rat)*	Y		
416.		*Raveniella cirrata*			
417.		*Raveniella peckorum*			
418.	24776	*Recurvirostra novaehollandiae (Red-necked Avocet)*			
419.	48096	*Rhipidura albiscapa (Grey Fantail)*			
420.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
421.	24454	*Rhipidura leucophrys subsp. leucophrys (Willie Wagtail)*			
422.		*Richardsonianidae sp.*			
423.		*Scolopendra laeta*			
424.		*Scolopendra morsitans*			
425.	25534	*Sericornis frontalis (White-browed Scrubwren)*			
426.	24279	*Sericornis frontalis subsp. maculatus (White-browed Scrubwren)*			
427.	25266	*Simoselaps bertholdi (Jan's Banded Snake)*			
428.		*Simuliidae sp.*			
429.	30948	*Smicrornis brevirostris (Weebill)*			
430.	24111	*Sminthopsis gilberti (Gilbert's Dunnart)*			
431.		*Sminthopsis murina*			
432.		*Sphaerotrichopus ramosus*			
433.	24645	*Stagonopleura oculata (Red-eared Firetail)*			
434.		*Steatoda grossa*			
435.	24329	*Stictonetta naevosa (Freckled Duck)*			
436.		*Storena formosa*			
437.	25597	*Strepera versicolor (Grey Currawong)*			
438.	25589	*Streptopelia chinensis (Spotted Turtle-Dove)*	Y		
439.	30951	*Streptopelia chinensis subsp. tigrina (Spotted Turtle-Dove)*	Y		
440.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
441.	30950	*Streptopelia senegalensis subsp. senegalensis (Laughing Turtle-Dove)*	Y		
442.	24943	*Strophurus spinigerus subsp. inornatus*			
443.		*Supunna funerea*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
444.		*Supunna picta*			
445.		*Synothele durokoppin*			
446.		*Synothele rastelloides*			
447.		*Tabanidae sp.*			
448.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
449.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
450.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
451.	24331	*Tadorna tadornoides (Australian Shelduck, Mountain Duck)*			
452.		*Tamopsis perthensis*			
453.		*Tandanus bostocki*			
454.		*Tanypodinae sp.*			
455.	24167	*Tarsipes rostratus (Honey Possum, Noolbenger)*			
456.		*Tasmanicosa leuckartii*			
457.		*Tetragnatha demissa*			
458.	48136	*Threskiornis moluccus (Australian White Ibis)*			
459.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
460.	25203	*Tiliqua occipitalis (Western Bluetongue)*			
461.	25519	*Tiliqua rugosa*			
462.	25204	*Tiliqua rugosa subsp. aspera*			
463.	25207	*Tiliqua rugosa subsp. rugosa*			
464.		*Tipulidae sp.*			
465.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
466.	24309	*Todiramphus sanctus subsp. sanctus (Sacred Kingfisher)*			
467.	48141	*Tribonyx ventralis (Black-tailed Native-hen)*			
468.	25723	*Trichoglossus haematodus (Rainbow Lorikeet)*			
469.	24755	*Trichoglossus haematodus subsp. moluccanus (Rainbow Lorikeet)*	Y		
470.	25521	*Trichosurus vulpecula (Common Brushtail Possum)*			
471.	24158	*Trichosurus vulpecula subsp. vulpecula (Common Brushtail Possum)*			
472.	48147	*Turnix varius (Painted Button-quail)*			
473.	24852	*Tyto alba subsp. delicatula (Barn Owl)*			
474.	24983	*Underwoodisaurus milii (Barking Gecko)*			
475.		*Urocampus carinirostris*			
476.		*Urodacus novaehollandiae*			
477.		*Urodacus planimanus*			
478.		*Urodacus woodwardii*			
479.	25577	*Vanellus miles (Masked Lapwing)*			
480.	24386	*Vanellus tricolor (Banded Lapwing)*			
481.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
482.	25225	*Varanus rosenbergi (Heath Monitor)*			
483.	25526	*Varanus tristis (Racehorse Monitor)*			
484.		*Venator immansueta*			
485.	24206	*Vespadelus regulus (Southern Forest Bat)*			
486.	24040	*Vulpes vulpes (Red Fox)*	Y		
487.		*Withius piger*			
488.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

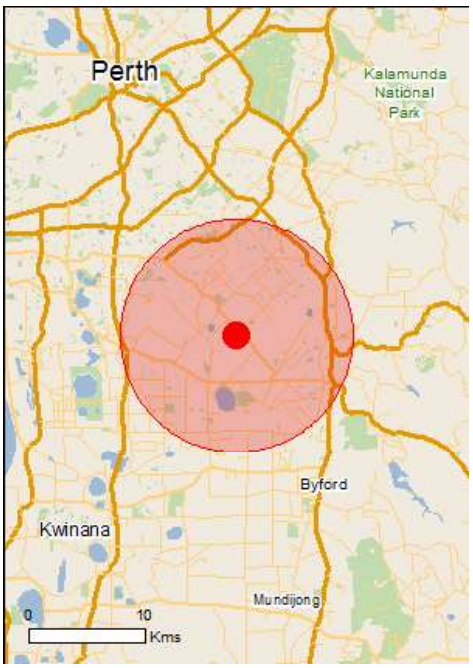
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 14/10/20 15:04:16

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	64
Listed Migratory Species:	36

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	46
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	9
Regional Forest Agreements:	1
Invasive Species:	44
Nationally Important Wetlands:	3
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Forrestdale and thomsons lakes	Within Ramsar site
Peel-yalgorup system	40 - 50km upstream

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area
Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain	Endangered	Community known to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Roosting known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Insects		
Leioproctus douglasiellus a short-tongued bee [66756]	Critically Endangered	Species or species habitat known to occur within area
Neopasiphae simplicior A native bee [66821]	Critically Endangered	Species or species habitat likely to occur within area
Mammals		
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat may occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat likely to occur within area
Other		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat known to occur within area
Anthocercis gracilis Slender Tailflower [11103]	Vulnerable	Species or species habitat may occur within area
Austrostipa bronwenae [87808]	Endangered	Species or species habitat may occur within area
Austrostipa jacobsiana [87809]	Critically Endangered	Species or species habitat known to occur within area
Banksia mimica Summer Honeypot [82765]	Endangered	Species or species habitat likely to occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area
Calytrix breviseta subsp. breviseta Swamp Starflower [23879]	Endangered	Species or species habitat likely to occur within area
Conospermum undulatum Wavy-leaved Smokebush [24435]	Vulnerable	Species or species habitat likely to occur within area
Darwinia apiculata Scarp Darwinia [8763]	Endangered	Species or species habitat known to occur within area
Diplolaena andrewsii [6601]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat known to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat known to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat known to occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved	Endangered	Species or species

Name	Status	Type of Presence
Hammer Orchid, Warty Hammer Orchid [16753]		habitat known to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat known to occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat known to occur within area
Eremophila glabra subsp. chlorella [84927]	Endangered	Species or species habitat likely to occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat known to occur within area
Goodenia arthrotricha [12448]	Endangered	Species or species habitat likely to occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat may occur within area
Grevillea thelemanniana Spider Net Grevillea [32835]	Critically Endangered	Species or species habitat known to occur within area
Lasiopetalum pterocarpum Wing-fruited Lasiopetalum [64922]	Endangered	Species or species habitat may occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat known to occur within area
Macarthuria keigheryi Keighery's Macarthuria [64930]	Endangered	Species or species habitat likely to occur within area
Ptilotus pyramidatus Pyramid Mulla-mulla [18216]	Critically Endangered	Species or species habitat known to occur within area
Synaphea sp. Fairbridge Farm (D. Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat likely to occur within area
Synaphea sp. Pinjarra Plain (A.S. George 17182) [86878]	Endangered	Species or species habitat likely to occur within area
Synaphea sp. Serpentine (G.R. Brand 103) [86879]	Critically Endangered	Species or species habitat known to occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat may occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Migratory Marine Species		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area

Name	Threatened	Type of Presence
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat likely to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Mammals		
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Balannup Lake	WA
Canning River	WA
Forrestdale Lake	WA
Gibbs Road	WA
Kenwick Wetlands	WA
Piara	WA
Unnamed WA42044	WA
Unnamed WA49299	WA
Unnamed WA49363	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur

Name	Status	Type of Presence within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Brixton Street Swamps	WA
Forrestdale Lake	WA
Gibbs Road Swamp System	WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-32.11764 115.94507

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix E

Conservation Significant Species and Likelihood of Occurrence Assessment

Species	Common name	Level of		Habitat	Likelihood of occurrence
		BC Act	EPBC Act		
Birds					
Anous tenuirostris melanops	*Australian lesser noddy*	EN	VU	Very common in blue-water seas around the Abrolhos (endemic to this area, accidental occurrences on lower west coast of Australia) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Apus pacificus	*Pacific swift*	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Pizzey & Knight 2012).	**Possible** May opportunistically occur in or fly over the site on commute or while searching for prey.
Arenaria interpres	*Ruddy turnstone*	MI	MI	Tidal mud and reef flats, sheltered rocky coasts, stony and seaweedy beaches and sandpits, dry coral ridges (Abrolhos) and pebbly shores of near-coastal saltlakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Botaurus poiciloptilus	*Australasian bittern*	EN	EN	In or over water, in tall reedbeds, sedges, rushes, cumbungi, lignum. Also occurs in ricefields, drains in tussocky paddocks and occasionally in saltmarshes and brackish wetlands.	**Unlikely** No suitable habitat
Calidris acuminata	*Sharp-tailed sandpiper*	MI	MI	Occurs in tidal mudflats, saltmarshes and mangroves, as well as, shallow fresh,brackish or saline inland wetlands. It is also known from floodwaters, irrigated pastures and crops, sewage ponds, saltfields.	**Unlikely** No suitable habitat
Calidris canutus	*Red knot*	EN	EN (MI)	Mud and sand flats in estuaries and on sheltered coasts. Also near-coastal saltlakes, including saltwork ponds.	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Calidris ferruginea	*Curlew sandpiper*	CR	CR (MI)	Mainly shallows of estuaries and near-coastal saltlakes (including saltwork ponds) and drying near-coastal freshwater lakes and swamps. Also beaches and near-coastal sewage ponds.	**Unlikely** No suitable habitat
Calidris melanotos	*Pectoral sandpiper*	MI	MI	Mainly fresh waters (swamps, lagoons, river pools, irrigation channels and sewage ponds); also samphire flats around estuaries and saltlakes (Johnstone & Storr 1998).	**Unlikely** No suitable habitat
Calidris ruficollis	*Red-necked stint*	MI	MI	Tidal mudflats, saltmarshes, sandy or shelly beaches, saline and freshwater wetlands (coastal and inland), saltfields, sewage ponds (Pizzey and Knight 2012).	**Unlikely** No suitable habitat
Calidris subminuta	*Long-toed stint*	MI	MI	Mainly freshwater swamps (especially when drying and where vegetation is short), river pools, lagoons and claypans; also brackish pools, sewage ponds and samphire flats around estuaries and saltlakes.	**Unlikely** No suitable habitat
Calidris tenuirostris	*Great knot*	CR	CR (MI)	Mud or sand flats in estuaries and on sheltered coasts. Also near-coastal saltlakes, including saltwork ponds.	**Unlikely** No suitable habitat
Calyptorhynchus banksii naso	*Forest red-tailed black cockatoo*	VU	VU	Eucalypt and Corymbia forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding Corymbia calophylla, Eucalyptus marginata, introduced Melia azdarach and Eucalyptus spp. trees.	**Likely** Several records of the species in close proximity (<2 km) to the site and there is foraging habitat present within the site.

		BC Act	EPBC Act		
Calyptorhynchus baudinii	*Baudin's cockatoo*	EN	EN	Mainly eucalypt forests. Attracted to seeding Corymbia calophylla, Banksia spp., Hakea spp., and to fruiting apples and pears (Johnstone and Storr 1998).	**Possible** Species known to occur within the broader area and there is limited foraging habitat within the site.
Calyptorhynchus latirostris	*Carnaby's cockatoo*	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of Pinus spp. Attracted to seeding Banksia spp., Dryandra spp., Hakea spp., Eucalyptus spp., Corymbia calophylla, Grevillea spp., and Allocasuarina spp. (Johnstone and Storr 1998).	**Likely** Historical records within and adjacent to the site and there are areas of foraging habitat present within the site.
Charadrius dubius	*Little ringed plover*	MI	MI	Open, muddy or sandy shores of lakes, swamps, tidal areas, sewage ponds or farm dams. Rare but regular summer migrant to Australia (Pizzey & Knight 2012).	**Unlikely** Limited habitat present
Charadrius leschenaultii	*Great sand plover*	VU	VU (MI)	Wide sandy or shelly beaches, sandpits, tidal mudflats, reefs, sand cays, mangroves, saltmarsh, dune wilderness, bare paddocks, seldom far inland (Pizzey & Knight 2012).	**Unlikely** No suitable habitat
Diomedea amsterdamensis	*Amsterdam albatross*	CR	EN (MI)	The Amsterdam albatross is a marine, pelagic seabird. It nests in open patchy vegetation (among tussocks, ferns or shrubs) near exposed ridges or hillocks (Weimerskirch et al. 1985). It sleeps and rests on ocean waters when not breeding (Marchant and Higgins 1990)	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Diomedea epomophora	*Southern royal albatross*	VU	VU (MI)	Rare visitor to Western Australian seas; it breeds on subantarctic islands south of New Zealand (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Diomedea exulans	*Wandering albatross*	VU	VU (MI)	Marine, pelagic and aerial species. It breeds on Macquarie Island and feeds in Australian portions of the Southern Ocean (DoE 2018).	**Unlikely** No suitable habitat
Diomedea sanfordi	*Northern royal albatross*	EN	EN	Species is marine, pelagic and aerial. Habitat includes subantarctic, subtropical, and occasionally Antarctic waters (Marchant & Higgins 1990). Rare visitors to south Western Australian waters.	**Unlikely** No suitable habitat
Elanus scriptus	*Letter-winged kite*	P4	-	Open to sparsely wooded country and grassland near tree-lined streams or watercourses (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Falco peregrinus	*Peregrine falcon*	OS	-	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	**Possible** May opportunistically occur in or fly over the site on commute or while searching for prey.
Gallinago megala	*Swinhoe's snipe*	MI	MI	Wet, grassy ground; edges of reedy swamps (Pizzey & Knight 2012).	**Unlikely** Limited habitat present
Gallinago stenura	*Pin-tailed snipe*	MI	MI	Boggy edges of vegetated wetlands; sewage and other ponds; stubbles, grasslands with shrubs, pastures (Pizzey & Knight 2012).	**Unlikely** Limited habitat present
Glareola maldivarum	*Oriental pratincole*	MI	MI	Plains, shallow wet and dry edges of open bare wetlands, tidal mudflats and beaches (Pizzey & Knight 2012).	**Unlikely** Limited habitat present

		BC Act	EPBC Act		
Ixobrychus dubius	*Australian little bittern*	P4	-	Dense vegetation surrounding/within freshwater pools, swamps and lagoons, well screened with trees. Shelters in dense beds of Typha spp., Baumea spp. and tall rushes in freshwater swamps around lakes and along rivers (Johnstone and Storr 1998).	**Unlikely** Limited habitat present
Leipoa ocellata	*Mallefowl*	VU	VU	Scrubs and thickets of Eucalyptus spp., Melaleuca lanceolata and Acacia linophylla; also other dense litter-forming shrublands. Attracted to fallen wheat in stubbles and along roads (Johnstone and Storr 1998).	**Unlikely** Locally extinct
Limosa lapponica	*Bar-tailed godwit*	MI	MI	Estuarine sand and mudflats and sandy beaches with loads of seaweed; also reef flats and near-coastal saltlakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely** Limited habitat present
Limosa limosa	*Black-tailed godwit*	MI	MI	Tidal mudflats, estuaries, sewage ponds, shallow river margins, brackish or saline inland lakes, flooded pastures, airfields (Pizzey & Knight 2012).	**Unlikely** Limited habitat present
Macronectes giganteus	*Southern giant-petrel*	MI	EN (MI)	Breeds on southern subantarctic and antarctic islands. May visit Western Australian waters from February to December (mostly June to September) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Macronectes halli	*Northern giant petrel*	MI	VU (MI)	Breeds on subantarctic islands. May visit Western Australian water from February to September (Johnstone and Storr 1998).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Motacilla cinerea	*Grey wagtail*	MI	MI	In Australia mostly near running water in disused quarries, sandy and rocky streams in escarpments and rainforests, sewage ponds, ploughed fields and airfields (Pizzey & Knight 2012).	**Unlikely** Rarely occurs in general area.
Numenius madagascariensis	*Eastern curlew*	CR	CR (MI)	Mainly tidal mudflats; also reef flats, sandy beaches and rarely near-coastal lakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Numenius minutus	*Little curlew*	MI	MI	Dry grasslands, floodplains, margins of drying swamps; tidal mudflats, airfields, playing fields, crops, commercial saltfields, sewage ponds (Pizzey & Knight 2012).	**Unlikely** No suitable habitat
Oxyura australis	*Blue-billed duck*	P4	-	Mainly deeper freshwater swamps and lakes; occasionally saltlakes and estuaries freshened by flood waters (Johnstone and Storr 1998).	**Possible** May utilise the wetlands within the site whilst water is present
Pachyptila turtur subantarctica	*Fairy prion*	-	VU	Breeds on subantarctic islands and is presumed to frequent subtropical waters during non-breeding period (TSSC 2015).	**Unlikely** No suitable habitat
Pandion haliaetus	*Osprey*	MI	MI	Coasts, estuaries, bays, inlets, islands, and surrounding waters; coral atolls, reefs, lagoons, rock cliffs, stacks (Pizzey & Knight 2012).	**Unlikely** No suitable habitat
Philomachus pugnax	*Ruff*	MI	MI	Fresh, brackish and saline wetlands; tidal mudflats, saltfields, sewage ponds (Pizzey & Knight 2012).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Plegadis falcinellus	*Glossy Ibis*	MI	MI	Well-vegetated wetlands, wet pasture, ricefields, floodwaters, floodplains, brackish or occasionally saline wetlands, mangroves, mudflats and occasionally dry grassland (Pizzey & Knight 2012).	**Possible** May utilise the wetlands within the site whilst water is present
Pluvialis fulva	*Pacific golden plover*	MI	MI	Estuaries, mudflats, saltmarshes, mangroves; rocky reefs and stranded seaweed on ocean shores; margins of shallow open inland swamps; sewage ponds, short-grass paddocks, sportsgrounds, airfields, ploughed land (Pizzey & Knight 2012).	**Unlikely** Limited habitat present
Pluvialis squatarola	*Grey Plover*	MI	MI	Mudflats, saltmarsh, tidal reefs and estuaries, rarely inland (Pizzey and Knight 2012).	**Unlikely** No suitable habitat
Rostratula australis	*Australian painted snipe*	EN	EN	Mainly shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans (Marchant and Higgins 1993).	**Unlikely** Limited habitat present
Stercorarius longicaudus	*Long-tailed skua*	MI	MI	Marine, migratory species that rarely occurs in south-western Australia (Pizzey & Knight 2012)	**Unlikely** No suitable habitat
Sterna bergii	*Crested tern*	MI	MI	Mainly blue-water seas (especially within 3 km of land), including southern estuaries in summer and autumn (when free of silt); also tidal creeks in north, but not penetrating far into larger estuaries.	**Unlikely** No suitable habitat
Sterna nilotica	*Gull-billed tern*	MI	MI	Beaches, mudflats; fresh, brackish wetlands, including far inland; grasslands, crops, ploughed fields, airfields (Pizzey & Knight 2012).	**Unlikely** No suitable habitat
Sternula nereis nereis	*Australian fairy tern*	VU	VU	Sheltered blue-water seas close to land, estuaries (when free of silt) and near-coastal lakes (Johnstone and Storr 1998).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Thalassarche cauta cauta	*Shy albatross*	VU	VU (MI)	Scarce visitor (late May to mid-October) to southwestern and western seas. Breeds on islands off Tasmania and south New Zealand (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Thalassarche chrysostoma	*Grey-headed albatross*	VU	E (MI)	Very common in blue-water seas around the Abrolhos (endemic to this area, accidental occurrences on lower west coast of Australia) (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Thalassarche melanophris	*Black-browed albatross*	EN	VU (MI)	Seas of south and west coasts. Visitor to Western Australian mainland from January to early November (mostly May to September). Breeds on southern subantarctic and antarctic islands (Johnstone and Storr 1998).	**Unlikely** No suitable habitat
Thalassarche melanophris impavida	*Campbell albatross*	VU	VU (MI)	Scarce visitor to south western and western seas. Breeds on Campbell island.	**Unlikely** No suitable habitat
Thalassarche steadi	*White-capped albatross*	VU	VU (MI)	Marine species that occurs in subantarctic and subtropical waters. It reaches tropical areas associated with the cool Humboldt Current off South America (Marchant & Higgins 1990). The species has been noted in shelf-waters around breeding islands and over adjacent rises. During the non-breeding season, birds have been observed over continental shelves around continents. The species occurs both inshore and offshore (Marchant 1977) and enters harbours and bays (Jehl 1973). Birds gather to scavenge at commercial fishing grounds.	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Tringa glareola	*Wood sandpiper*	MI	MI	Mainly shallow fresh waters (lagoons, swamps, claypans, river pools, dams, bore overflows and sewage ponds); occasionally brackish swamps, rarely saltlakes and estuaries (Pizzey & Knight).	**Unlikely** No suitable habitat
Tringa hypoleucos	*Common sandpiper*	MI	MI	Edge of sheltered waters salt or fresh, e.g. estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations wherelow perches are available (Johnstone & Storr 1998).	**Possible** Small numbers of occasional transient individuals may utilise the site when wetlands have water
Tringa nebularia	*Common greenshank*	MI	MI	Mudflats, estuaries, saltmarshes, margins of lakes, wetlands, claypans (fresh amd saline), commercial saltfields, sewage ponds (Pizzey & Knight 2012).	**Unlikely** No suitable habitat
Tringa stagnatilis	*Marsh sandpiper*	MI	MI	Mainly shallow fresh or brackish waters: swamps, lakes, river pools, soaks, sewage ponds and bore overflows. Occasionally estuaries and salt ponds, and rarely coasts.	**Unlikely** No suitable habitat
Invertebrates					
Austroconops mcmillani	*McMillan's biting midge*	P2	-	Unknown.	**Unlikely** No suitable habitat
Euoplos inornatus	*Inornate trapdoor spider*	P3	-	Has previously been recorded in jarrah forest, including near clay banks and granite outcrop. Most records are from the Darling scarp/Jarrah Forest Region, with limited records from the Swan Coastal Plain (DBCA 2020).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Idiosoma sigillatum	*Swan Coastal Plain shield-backed trapdoor spider*	P3	-	Widely distributed in sandy areas on the Swan Coastal Plain and on Rottnest Island (Prince 2003).	**Possible** Suitable habitat present
Leioproctus contrarius	*a short-tongued bee*	P3	-	Life history and habits are poorly documented/ unknown. It has been recorded only on flowers of Goodeniaceae and possibly Lechenaultia stenosepala (Bamford 2003).	**Possible** Historic records within the broader area, and one Goodeniaceae species present within the site
Leioproctus douglasiellus	*a short-tongued bee*	EN	CR	Life history and habits are poorly documented/ unknown. It has been recorded only on the flowers of Goodenia filiformis and Anthotium junctiforme (Houston 2000).	**Unlikely** Host species not recorded within site
Neopasiphae simplicior	*a short-tongued bee*	EN	CR	This species of native bee has been collected on flowers of Goodenia filiformis, Lobelia tenuior, Angianthus preissianus and Velleia sp. (Houston 2000).	**Possible** Historic records within the broader area, and Lobelia tenuior present within the site
Synemon gratiosa	*Graceful sunmoth*	P4	-	Coastal heathland on Quindalup dunes where it is restricted to secondary sand dunes due to the abundance of the preferred host plant Lomandra maritima. Banksia woodland on Spearwood and Bassendean dunes, where the second known host plant L. hermaphrodita is widespread (DEC 2011).	**Unlikely** No suitable habitat
Throscodectes xiphos	*Stylet bush cricket*	P1	-	Species poorly understood and documented. Known from Jandacot area, where it was originally collected in the axial leaf bases of grass trees (Xanthorrhoea preissei) (Invertebrate Solutions 2019).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Westralunio carteri	*Carter's freshwater mussel*	VU	VU	Occurs in greatest abundance in slower flowing streams with stable sediments that are soft enough for burrowing amongst woody debris and exposed tree roots. Also occupies lentic systems including large water supply dams and even on-stream farm dams. Salinity tolerance quite low (Morgan et al. 2011).	**Unlikely** No suitable habitat
Mammals					
Bettongia penicillata ogilbyi	*Woylie*	CR	EN	Woodlands and adjacent heaths with a dense understorey of shrubs, particularly Gastrolobium spp. (TSSC 2018).	**Unlikely** Locally extinct
Dasyurus geoffroii	*Chuditch*	VU	VU	Wide range of habitats from woodlands, dry sclerophyll forests, riparian vegetation, beaches and deserts. Appears to utilise native vegetation along road sides in the wheatbelt (DEC 2012b).	**Unlikely** No suitable habitat
Hydromys chrysogaster	*Rakali*	P4	-	Areas with permanent water, fresh, brackish or marine. Likely to occur in all major rivers and most of the larger streams as well as bodies of permanent water in the lower south west (Christensen et al. 1985).	**Unlikely** No suitable habitat
Isoodon fusciventer	*Quenda*	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012)	**Recorded**
Myrmecobius fasciatus	*Numbat*	EN	EN	Generally dominated by Eucalyptus spp. that provide hollow logs and branches for shelter and termites for food (van Dyck & Strahan 2008).	**Unlikely** Locally extinct

		BC Act	EPBC Act		
Notamacropus irma	*Western brush wallaby*	P4	-	Dry sclerophyll forest, Banksia spp. woodlands and shrublands, typically favouring dense low vegetation that provides dense cover (Christensen and Strahan 1983).	**Possible** Recent records of a population within the broader area
Phascogale tapoatafa wambenger	*South-western brush-tailed phascogale*	CD	-	Dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover (Triggs 2003).	**Unlikely** No suitable habitat
Pseudocheirus occidentalis	*Western ringtail possum*	CR	CR	Dense stands of Agonis flexuosa, as well as Eucalyptus gomphocephala, Corymbia calophylla and Eucalyptus marginata forests (DBCA 2017b).	**Unlikely** Outside species known range
Setonix brachyurus	*Quokka*	VU	VU	On the mainland mostly dense streamside vegetation or shrubland and heath areas, particularly around swamps (Cronin 2007).	**Unlikely** Locally extinct
Reptiles					
Acanthophis antarcticus	*Southern death adder*	P3	-	Mostly in woodlands, grasslands and heaths. In the Darling Range this species is typically found within Eucalyptus marginata woodlands adjacent to granite outcrops and along densely vegetated creeks (Bush et al. 2007).	**Unlikely** No suitable habitat
Ctenotus delli	*Dell's skink*	P4	-	Jarrah and marri woodland with a shrub dominated understorey, sheltering in dense vegetation, inside grass trees and beneath rocks, sometimes in burrows (Nevill 2005).	**Unlikely** No suitable habitat
Ctenotus ora	*Coastal plains skink*	P3	-	Sandy substrates with low vegetation (including heath) in open Eucalyptus spp. and Corymbia calophylla woodland over Banksia spp. (Kay and Keogh 2012).	**Unlikely** No suitable habitat

		BC Act	EPBC Act		
Lerista lineata	*Perth slider*	P3	-	Sandy coastal heath and low scrubland. Banksia spp. woodland, Eucalyptus gomphocephala open woodland over deep sands, and coastal dunes immediately adjacent to the beach (Wilson and Swan 2017).	**Possible** Historic records adjacent to the site and there is potentially suitable habitat present within the site
Neelaps calonotos	*Black-striped snake*	P3	-	Coastal and near-coastal dunes, sandplains supporting heathlands and Banksia spp. woodlands (Bush et al. 2002).	**Possible** Historic records adjacent to the site and there is habitat present within the site

Note: CE=critically endangered, EN=endangered, VU=vulnerable, CD=conservation dependent, MI=migratory, OS=other specially protected, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4. Species recorded or considered to potentially occur within the site are shaded green.

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Appendix F

Species List

Fauna List

Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Category	Status	Species name	Common name	Record type
Birds		*Anas superciliosa*	Pacific black duck	Sight
		Anthochaera carunculata	Red wattlebird	Sight, call
		Coracina novaehollandiae	Black-faced cuckoo-shrike	Sight
		Corvus coronoides	Australian raven	Sight
		Cracticus tibicen	Australian magpie	Sight, call
		Grallina cyanoleuca	Magpie-lark	Sight, call
		Lichmera indistincta	Brown honeyeater	Call
		Merops ornatus	Rainbow bee-eater	Sight
		Ocyphaps lophotes	Crested pigeon	Sight
		Pachycephala occidentalis	Western whistler	Call
		Platycercus zonarius semitorquatos	Twenty-eight parrot	Sight
		Porphyrio porphyrio	Purple swamphen	Sight
		Rhipidura leucophrys	Willie wagtail	Sight, call
		Smicronis brevirostris	Weebill	Call
	*	*Spilopelia chinensis*	Spotted turtle dove	Sight
		Threskiornis moluccus	Australian white ibis	Sight
	*	*Trichoglossus moluccanus*	Rainbow lorikeet	Sight
Mammals	P4	*Isoodon fusciventer*	Quenda	Sight (dead individual)
		Macropus fuliginosus	Western grey kangaroo	Scats
	* DP	*Oryctolagus cuniculus*	Rabbit	Scats
Reptiles		*Varanus gouldii*	Sand goanna	Sight

Note: * denotes introduced fauna species, DP=declared pest under the BAM Act, EN=Endangered under the EPBC Act,VU=Vulnerable under the EPBC Act

Appendix G

Black Cockatoo Habitat Tree Data

Black Cockatoo Habitat Tree Inventory
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
371	400657.47	6446277.20	50	*Eucalyptus rudis*	No suitable hollows	
-	400650.44	6446272.03	51	*Eucalyptus rudis*	No suitable hollows	
-	400344.90	6446173.46	63	*Eucalyptus rudis*	No suitable hollows	
-	400671.99	6446277.56	91	*Eucalyptus rudis*	No suitable hollows	Small hollow present
-	400664.23	6446249.44	67	*Eucalyptus rudis*	No suitable hollows	
-	400672.86	6446275.68	51	*Eucalyptus rudis*	No suitable hollows	

Appendix H

Overall Habitat Quality Assessment

Black Cockatoo Habitat Quality Assessment - Scoring Tool (Baudin's cockatoo)
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

		Query		Answer	Potential score	Site score	Sum
Breeding habitat	**Site condition**	1.1	The site contains:				
			habitat tree(s) with suitable hollow(s)	N/A	2.0	0.0	0.0
			habitat tree(s) without suitable hollow(s)	N/A	1.0	0.0	
	Site context	1.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N/A	1.0	0.0	0.0
			6-12 km from a nest(s) (active, historical or potential)	N/A	0.5	0.0	
		1.3	The site is located within 6 km of:				
			>1000 ha of potential foraging habitat	N/A	3.0	0.0	0.0
			100 to 1000 ha of potential foraging habitat	N/A	1.0	0.0	
	Species stocking rate	1.4	The site contains:				
			historical nest(s)	N/A	1.0	0	0.0
			The site contains:				
			active nest(s)	N/A	3.0	0	
			potential nest(s)	N/A	1.0	0	0.0
			Score	0	10.0		

Roosting habitat	**Site condition**	2.1	The site contains trees potentially suitable for roosting	Y	1.0	1.0	2.0
		2.2	The site contains a water source or one exists nearby	Y	1.0	1.0	
	Site context	2.3	The site is located:				
			within 1 km of a large roost (≥150 individuals) (active or historical)	N	1.0	0.0	0.0
			within 500 m of a small roost (< 150 individuals) (active or historical)	N	1.0	0.0	
	Species stocking rate	2.4	The site contains:				
			a historical record of a large roost (≥150 individuals)	N	2.0	0	
			a historical record of a small roost (<150 individuals)	N	1.0	0	0.0
			The site contains:				
			an active record of a large roost (≥150 individuals)	N	2.0	0.0	0.0
			an active record of a small roost (<150 individuals)	N	1.0	0.0	
			Score	2	7.0		

Foraging habitat	**Site condition**	3.1	The site contains foraging habitat comprising:				
			≥50% primary foraging plants	N	4.0	0.0	
			≥10% to <50% primary foraging plants	N	2.0	0.0	1.0
			<10% primary foraging plants	Y	1.0	1.0	
	Site context	3.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N	2.0	0.0	
			6-12 km from a nest(s) (active, historical or potential)	N	1.00	0.0	1.0
		3.3	The site is located:				
			within 6 km of a roost(s) (active or historical)	Y	1.0	1.0	
			6-12 km from a roost(s) (active or historical)	Y	0.5	0.5	
	Species stocking rate	3.4	The site contains:				
			abundant evidence of foraging	N	2.0	0.0	0.0
			limited evidence of foraging	N	1.0	0.0	
			Score	2	8.0		

SUMMARY		
Habitat category	**Score**	**Habitat quality**
Breeding	0	No habitat
Roosting	2	Low
Foraging	2	Low

Overall habitat quality score	**2**	Low

Note:
1. Within the breeding category, a score of 9 applies if an active nest(s) occurs within the site and a score of 10 applies if an active nest(s) and a historical nest(s) occurs within the site, regardless of the answer to other queries in this category
2. Within the roosting category, a score of 7 applies if a small roost occurs within the site and a score of 8 applies if a large roost occurs within the site, regardless of the answer to other queries in this category.
3. The final score consists of the highest score from each habitat category

Black Cockatoo Habitat Quality Assessment - Scoring Tool (Carnaby's cockatoo)
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

		Query		Answer	Potential score	Site score	Sum
Breeding habitat	**Site condition**	1.1	The site contains:				
			habitat tree(s) with suitable hollow(s)	N/A	2.0	0.0	0.0
			habitat tree(s) without suitable hollow(s)	N/A	1.0	0.0	
	Site context	1.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N/A	1.0	0.0	0.0
			6-12 km from a nest(s) (active, historical or potential)	N/A	0.5	0.0	
		1.3	The site is located within 6 km of:				
			>1000 ha of potential foraging habitat	N/A	3.0	0.0	0.0
			100 to 1000 ha of potential foraging habitat	N/A	1.0	0.0	
	Species stocking rate	1.4	The site contains:				
			historical nest(s)	N/A	1.0	0	0.0
			The site contains:				
			active nest(s)	N/A	3.0	0	
			potential nest(s)	N/A	1.0	0	0.0
			Score	0	10.0		

Roosting habitat	**Site condition**	2.1	The site contains trees potentially suitable for roosting	Y	1.0	1.0	2.0
		2.2	The site contains a water source or one exists nearby	Y	1.0	1.0	
	Site context	2.3	The site is located:				
			within 1 km of a large roost (≥150 individuals) (active or historical)	N	1.0	0.0	0.0
			within 500 m of a small roost (< 150 individuals) (active or historical)	N	1.0	0.0	
	Species stocking rate	2.4	The site contains:				
			a historical record of a large roost (≥150 individuals)	N	2.0	0	
			a historical record of a small roost (<150 individuals)	N	1.0	0	0.0
			The site contains:				
			an active record of a large roost (≥150 individuals)	N	2.0	0.0	0.0
			an active record of a small roost (<150 individuals)	N	1.0	0.0	
			Score	2	7.0		

Foraging habitat	**Site condition**	3.1	The site contains foraging habitat comprising:				
			≥50% primary foraging plants	N	4.0	0.0	
			≥10% to <50% primary foraging plants	Y	2.0	2.0	2.0
			<10% primary foraging plants	N	1.0	0.0	
	Site context	3.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N	2.0	0.0	
			6-12 km from a nest(s) (active, historical or potential)	N	1.00	0.0	1.0
		3.3	The site is located:				
			within 6 km of a roost(s) (active or historical)	Y	1.0	1.0	
			6-12 km from a roost(s) (active or historical)	Y	0.5	0.5	
	Species stocking rate	3.4	The site contains:				
			abundant evidence of foraging	N	2.0	0.0	0.0
			limited evidence of foraging	N	1.0	0.0	
			Score	3	8.0		

SUMMARY		
Habitat category	**Score**	**Habitat quality**
Breeding	0	No habitat
Roosting	2	Low
Foraging	3	Low

Overall habitat quality score	**3**	Low

Note:
1. Within the breeding category, a score of 9 applies if an active nest(s) occurs within the site and a score of 10 applies if an active nest(s) and a historical nest(s) occurs within the site, regardless of the answer to other queries in this category
2. Within the roosting category, a score of 7 applies if a small roost occurs within the site and a score of 8 applies if a large roost occurs within the site, regardless of the answer to other queries in this category.
3. The final score consists of the highest score from each habitat category

Black Cockatoo Habitat Quality Assessment - Scoring Tool (Forest red-tailed black cockatoo)
Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale

		Query		Answer	Potential score	Site score	Sum
Breeding habitat	**Site condition**	1.1	The site contains:				
			habitat tree(s) with suitable hollow(s)	N	2.0	0.0	1.0
			habitat tree(s) without suitable hollow(s)	Y	1.0	1.0	
	Site context	1.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N	1.0	0.0	0.5
			6-12 km from a nest(s) (active, historical or potential)	Y	0.5	0.5	
		1.3	The site is located within 6 km of:				
			>1000 ha of potential foraging habitat	Y	3.0	3.0	3.0
			100 to 1000 ha of potential foraging habitat	N	1.0	0.0	
	Species stocking rate	1.4	The site contains:				
			historical nest(s)	N	1.0	0	0.0
			The site contains:				
			active nest(s)	N	3.0	0	
			potential nest(s)	N	1.0	0	0.0
			Score	4	10.0		
Roosting habitat	**Site condition**	2.1	The site contains trees potentially suitable for roosting	Y	1.0	1.0	2.0
		2.2	The site contains a water source or one exists nearby	Y	1.0	1.0	
	Site context	2.3	The site is located:				
			within 1 km of a large roost (≥150 individuals) (active or historical)	N	1.0	0.0	0.0
			within 500 m of a small roost (< 150 individuals) (active or historical)	N	1.0	0.0	
	Species stocking rate	2.4	The site contains:				
			a historical record of a large roost (≥150 individuals)	N	2.0	0	
			a historical record of a small roost (<150 individuals)	N	1.0	0	0.0
			The site contains:				
			an active record of a large roost (≥150 individuals)	N	2.0	0.0	0.0
			an active record of a small roost (<150 individuals)	N	1.0	0.0	
			Score	2	7.0		
Foraging habitat	**Site condition**	3.1	The site contains foraging habitat comprising:				
			≥50% primary foraging plants	N	4.0	0.0	
			≥10% to <50% primary foraging plants	N	2.0	0.0	1.0
			<10% primary foraging plants	Y	1.0	1.0	
	Site context	3.2	The site is located:				
			within 6 km of a nest(s) (active, historical or potential)	N	2.0	0.0	
			6-12 km from a nest(s) (active, historical or potential)	N	1.00	0.0	1.0
		3.3	The site is located:				
			within 6 km of a roost(s) (active or historical)	Y	1.0	1.0	
			6-12 km from a roost(s) (active or historical)	Y	0.5	0.5	
	Species stocking rate	3.4	The site contains:				
			abundant evidence of foraging	N	2.0	0.0	0.0
			limited evidence of foraging	N	1.0	0.0	
			Score	2	8.0		

SUMMARY		
Habitat category	**Score**	**Habitat quality**
Breeding	4	Moderate
Roosting	2	Low
Foraging	2	Low

Overall habitat quality score	**4**	Moderate

Note:

1. Within the breeding category, a score of 9 applies if an active nest(s) occurs within the site and a score of 10 applies if an active nest(s) and a historical nest(s) occurs within the site, regardless of the answer to other queries in this category
2. Within the roosting category, a score of 7 applies if a small roost occurs within the site and a score of 8 applies if a large roost occurs within the site, regardless of the answer to other queries in this category.
3. The final score consists of the highest score from each habitat category

Appendix D

DPAW advice pertaining to wetland mapping review (DPaW 2015)

Government of **Western Australia**
Department of **Parks and Wildlife**
Science and Conservation Division

Your ref:
Our ref: 2015/000227-1
Enquiries: Adam Turnbull
Phone: 08 9219 8788
Email: adam.turnbull@dpaw.wa.gov.au

Rachel Halton
360 Environmental
PO Box 14
WEST PERTH WA 6872

Dear Ms Halton

APPLICATION TO REVIEW THE WETLAND MAPPING DISPLAYED WITHIN THE *GEOMORPHIC WETLANDS SWAN COASTAL PLAIN* DATASET

I refer to your correspondence dated 27 January 2015 requesting the Department of Parks and Wildlife to review the wetland mapping within the Geomorphic Wetlands Swan Coastal Plain dataset (the dataset) for Lots 116, 117, 118, 119, 172, 179, 180, 500, 501, 502, 503, 504, 505, 509, 510, 515 and 516 bound by Skeet Road, Balannup Road and Hatch Court, Harrisdale (the site).

The wetland area at the site is currently identified in the dataset as UFI 14404 a Resource Enhancement management category sumpland (Figure 1). Parks and Wildlife has reviewed all the available information and has partially accepted the proposed changes to the dataset based upon the following assessment of the request.

Clearing of the site began between 1965 and 1974. By 1985 all of the current lots had been visibly subdivided with fire breaks fragmenting the vegetation and by 1995 the lots had been mostly cleared of vegetation. The site has been used for rural residential and rural industrial. Surrounding the site is mostly native vegetation with residential development to the west.

The wetland is recognised in the Directory of Important Wetlands and a small portion is also recognised by the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992. The site is located within the Bennet Brook consanguineous suite of which approximately 7.7 per cent of the dampland area is identified as Conservation category. The site is located within the Southern River Heddle vegetation complex of which 19.69 per cent of the pre-European extent is remaining. The areas of wetland within the site which have been used for residential purposes have become degraded to the extent that they no longer retain representative aspects of sumpland within the Bennet Brook suite or vegetation of Southern River complex.

360 Environmental considers the area of wetland on the site to range from Very Good to Completely Degraded condition in accordance with the *Bush Forever* vegetation condition scale (Government of Western Australia 2000). 360 Environmental describes the remnant vegetation of within the dampland area as supporting woodland of *Eucalyptus rudis*, *Melaleuca rhaphiophylla* and/or *Melaleuca preissiana* over shrubland or sedgeland. The flora and vegetation survey conducted by 360 Environmental

identified three Priority flora species within the vegetated portions at the site *Jacksonia gracillima* (P3), *Verticordia lindleyi* subsp. *lindleyi* (P3) and *Meeboldina decipiens* (P4).

There are two regional ecological linkages nearby, one 500m to the northwest and another 600m to the southeast. The wetland area that is completely degraded is unlikely to provide any significant linkage role as it does not retain viable habitat.

Recommendations

360 Environmental has provided sufficient information to warrant a reclassification for the majority of UFI 14404 on the site from Resource Enhancement to Multiple Use management category. Given the presence of conservation significant flora and areas of greater vegetation condition the vegetated portions within the site were assessed separately. The vegetated portion in the western portion of UFI 14404, dominated by *M. rhaphiophylla* and *M. preissiana* low open woodland over *Melaleuca teretifolia, Melaleuca viminea, Kunzea micrantha* subsp. *micrantha* and *Regelia ciliata* shrubland over *Lepidosperma longitudinale* and *Chaetanthus aristatus* open sedgeland, was commensurate with Resource Enhancement management category. The vegetated portion in the southern portion of UFI 14404, dominated by *M. preissiana* low woodland over *R. ciliata* and *A. scoparia* heath over *L. longitudinale* open sedgeland, was commensurate with Conservation management category and will be incorporated into UFI 14880 (Figure 2).

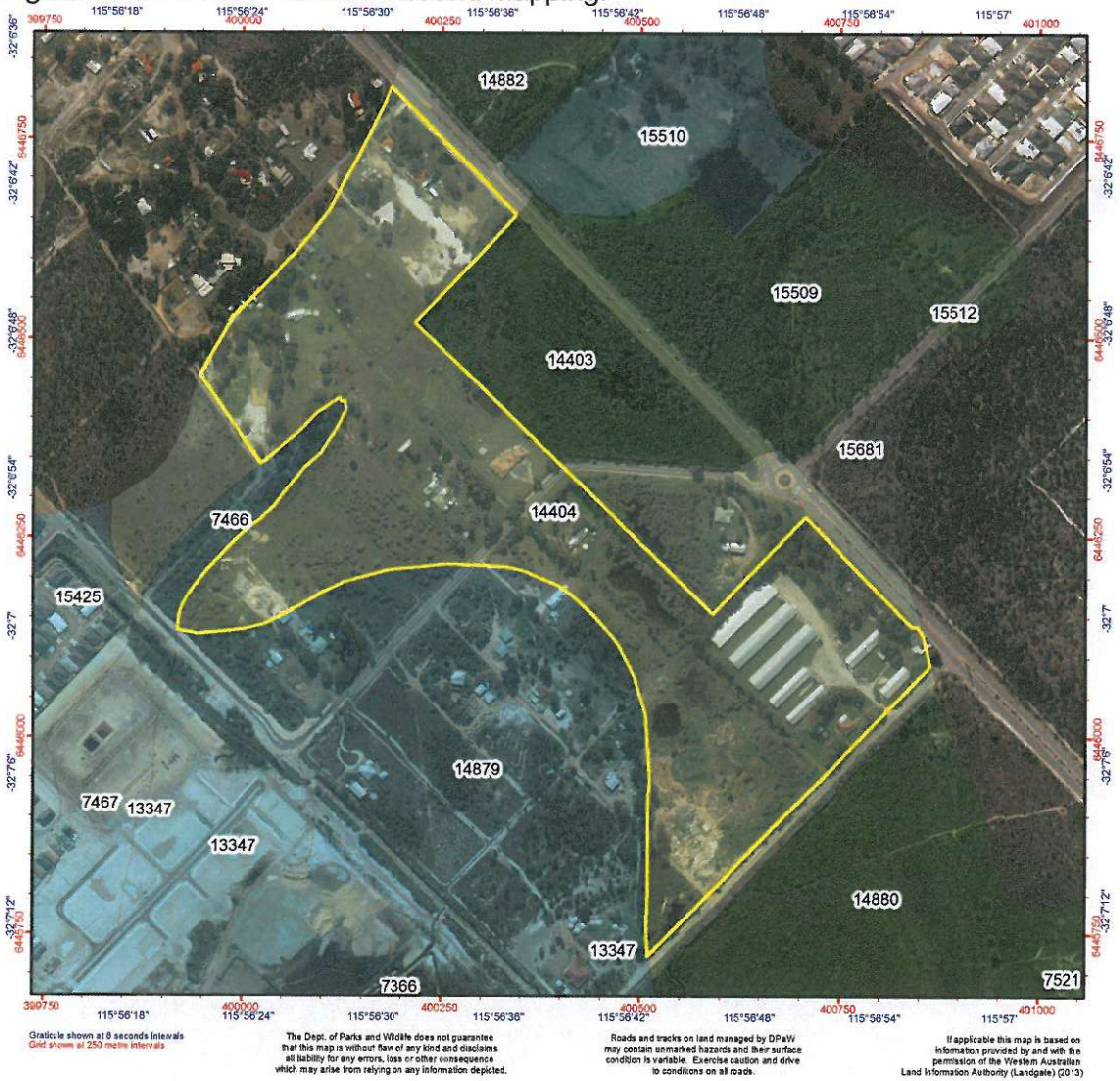
The dataset will be updated and revised wetland mapping will be available from the WA Atlas (Landgate) when the next version of the dataset is publicly released. Please contact Adam Turnbull on 9219 8788 if you require further information on this matter.

Yours sincerely

Michael Coote
Principal Coordinator
Wetland Section

30 January 2015

Figure 1. UFI 14404 – current wetland mapping.



Graticule shown at 0 seconds intervals
Grid shown at 250 metre intervals

The Dept. of Parks and Wildlife does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Roads and tracks on land managed by DPaW may contain unmarked hazards and their surface condition is variable. Exercise caution and drive to conditions on all roads.

If applicable this map is based on information provided by and with the permission of the Western Australian Land Information Authority (Landgate) (2013)

Various lots bound by Skeet Road, Balannup Road and Hatch Court, Harrisdale

Legend

- Site boundary

Geomorphic Wetlands Swan Coastal Plain (Management)

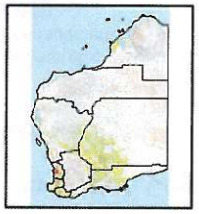
- Conservation
- Multiple Use
- Not Applicable
- Not Assessed
- Resource Enhancement

N

(A4)
1:6,500

0 45 90 180 270 360
Metres

Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94

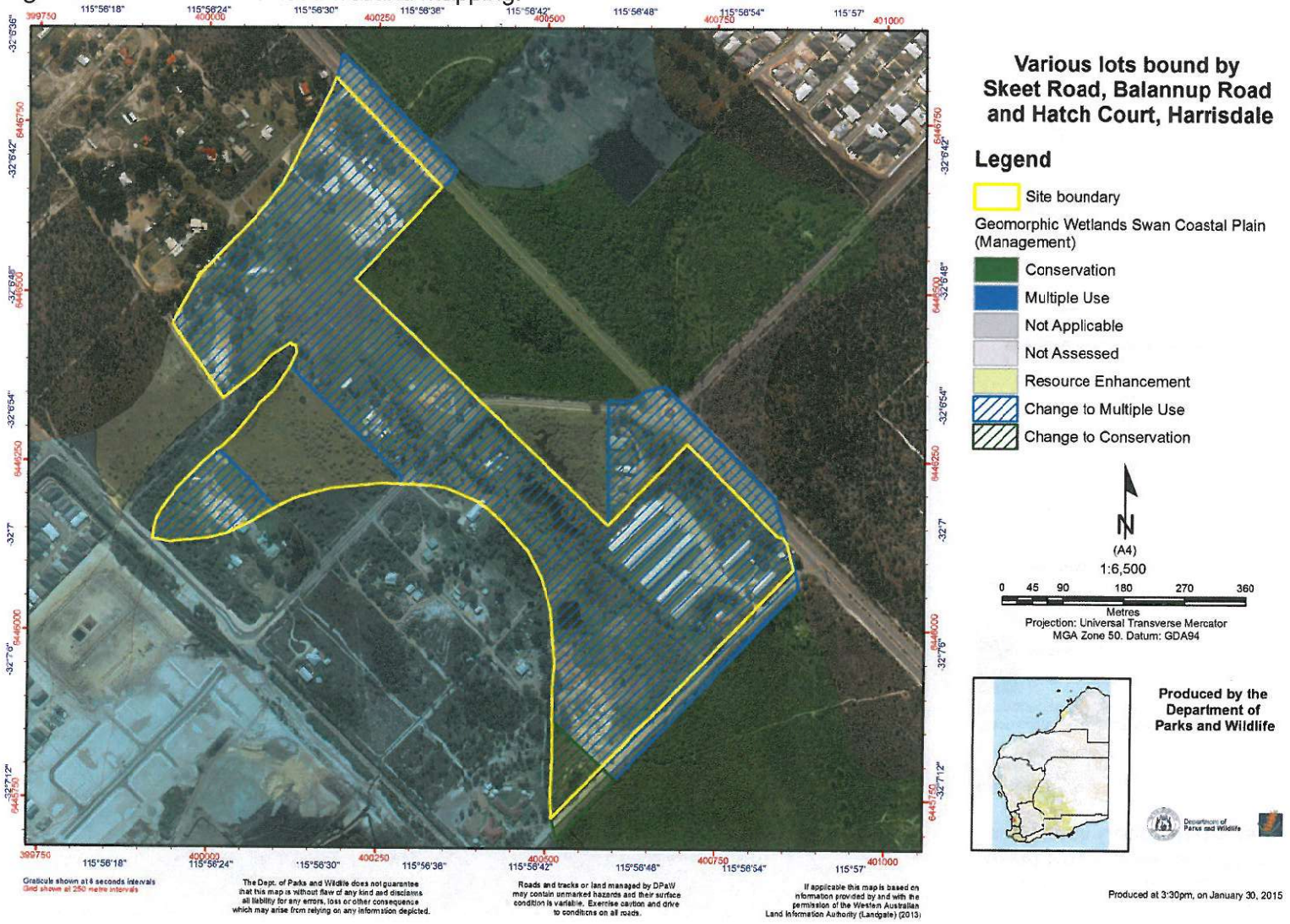


Produced by the Department of Parks and Wildlife

Produced at 3:30pm, on January 30, 2015

Environmental Management Branch
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
www.dpaw.wa.gov.au

Figure 2. UFI 14404 – revised wetland mapping.



APPENDIX 4 – WETLAND ASSESSMENT

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Emerge Environmental Services Pty Ltd ABN 57144772510 trading as Emerge Associates

Document Reference: EP20-127(14)—013 SKP

Emerge contact: Rachel Weber

10 June 2021

Attention: Tao Burton
Yolk Property Group Pty Ltd
4/1 High Street Fremantle 6061

Delivered by email to: tao@yolkpropertygroup.com.au

Dear Tao,

WETLAND ASSESSMENT – LOTS 600-606 BALANNUP ROAD AND 200-202 SKEET ROAD, HARRISDALE

1 INTRODUCTION

1.1 Project background

Yolk Property Group Pty Ltd (Yolk) are seeking to lift the urban deferred zoning of Lots 600-606 Balannup Road and Lots 200-202 Skeet Road in Harrisdale (referred to herein as the 'site'). As part of the application process the Department of Biodiversity Conservation and Attractions (DBCA) reviewed the *Detailed Flora and Vegetation Assessment* previously prepared for the site (Emerge Associates 2021). The wetlands branch of DBCA indicated the current DBCA (2020) *Geomorphic Wetlands of the Swan Coastal Plain* dataset may not align with on-ground values.

At the request of DBCA, representatives from the wetlands branch and a botanist from Emerge conducted a site visit on 23 March 2021. The purpose of the site visit was for DBCA to confirm the vegetation condition mapping previously provided by Emerge Associates (2021) and consider whether a wetland evaluation was required to be conducted. Following the site visit DBCA identified four 'areas of interest' within the site which are referred to as areas A-D, as shown on **Figure 1**. DBCA requested that a 'wetland survey and evaluation' is undertaken for the areas of interest.

Yolk engaged Emerge to undertake a wetland assessment of the areas of interest to provide additional information to DBCA.

1.2 Purpose and scope of work

This letter has been prepared to document the wetland values present within the areas of interest (collectively referred to as the 'survey area').

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

- A review of relevant background information.
- A field survey to record flora species and assess and map vegetation type.
- Floristic community type (FCT) analysis of the survey data using the Gibson *et al.* (1994) dataset.
- Evaluation of wetlands using the DBCA (2017) evaluation methodology.
- Documentation of the survey methodology and results into a letter report.

2 ENVIRONMENTAL CONTEXT

2.1 Geomorphic wetlands

The *Geomorphic Wetlands, Swan Coastal Plain* dataset shows that wetlands are mapped across the whole site and survey area (DBCA 2020). The details of the wetland features within each area of interest are provided in **Table 1**.

The locations of the mapped wetlands in the vicinity of site are shown in **Figure 2.**

Table 1: Geomorphic wetlands mapped within areas of interest (DBCA 2020)

Area of interest	Unique feature identifier (UFI)	Management category
A	14879	Multiple use wetland (MUW)
	13347	MUW
B	14879	MUW
C	14880	Conservation category wetland (CCW)
	13347	MUW
	14879	MUW
D	15946	Resource enhancement wetland (REW)
	14404	MUW
	14879	MUW

2.2 Historical land use

Review of historical images available from 1953 onwards shows that the site was undisturbed in 1953, with the western portion supporting a sandy rise and the eastern portion supporting part of a large wetland referred to as Balannup Lake, as shown in **Plate 1** (WALIA 2021). By 1974 Lots 201 and 202 were cleared and a large body of water is visible across these lots (**Plate 2**). In 1989 additional clearing is visible, particularly in the eastern portion of the site. Lots 201, 600 and 601 support considerable areas of standing water in imagery from 1989 and there is an oval dam within Lot 201 (**Plate 3**). Since 2008 most of the site has been subject to some form of clearing and areas of regrowth of native vegetation are visible, particularly in Lots 200, 600 and 604-606 (**Plate 4**).



Plate 1: Historical aerial photography from 1953 showing the large wetland present over the eastern portion of the site and the sandy rise over the western portion of the site (red outline represents Lot 200 in the south-western corner of the site) (WALIA 2021).



Plate 2: Historical aerial photography from 1974 showing clearing within the eastern portion of the site (red outline represents Lot 200 in the south-western corner of the site) (WAILIA 2021).



Plate 3: Historical aerial photography from 1989 showing disturbance within the site (red outline represents Lot 200 in the south-western corner of the site) (WALIA 2021).



Plate 4: Historical aerial photography from 2020 showing scattered patches of native vegetation and disturbed areas (red outline represents Lot 200 in the south-western corner of the site) (WALIA 2021).

3 METHODS

3.1 Field surveys

A botanist and an ecologist from Emerge visited the survey area on 5 May 2021 to conduct the field survey. The survey consisted of flora and vegetation sampling and wetland data collection.

3.1.1 Flora and vegetation

Sampling of the vegetation was undertaken using a combination of non-permanent 10 m x 10 m quadrats and relevés. The quadrats were established using fence droppers bound by measuring tape. The relevés were completed over an equivalent 10 m x 10 m area without the use of physical markers and were included to provide a more rapid sample of patches of vegetation in poorer condition and/or of smaller size. The position of each sample was recorded with a hand-held GPS unit.

The data recorded within each sample included:

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

'Foliage projective cover' of each species was also recorded within quadrats. Photographs were taken throughout the field survey to show particular conditions.

3.1.2 Wetlands

As the survey area was traversed data required for undertaking the DBCA (2017) evaluation methodology was collected. Other wetland characteristics, such as size, shape and boundary were also recorded.

3.2 Data analysis

3.2.1 Floristic community type assignment

The samples were compared to the regional 'floristic community type' (FCT) dataset *A floristic survey of the southern Swan Coastal Plain* by Gibson *et al.* (1994). The sample data (presence/absence) was reconciled with Gibson *et al.* (1994) by standardising the names of taxa with those used in the earlier study. This was

necessary due to changes in nomenclature in the intervening period. Taxa that were only identified to genus level were excluded, while some infra-species that have been identified since 1994 were reduced to species level. The combined dataset was then imported into the statistical analysis package PRIMER v6 (Clarke and Gorley 2006).

As data from a localised survey is often spatially correlated, each sample was compared to Gibson *et al.* (1994) separately which removes the influence of spatial correlation when assigning an FCT. The analysis included the compilation of a resemblance matrix using the Bray-Curtis distance measure which provided the percentage similarity between all pairs of samples. Subsequently, a cluster analysis was undertaken using the resemblance matrix and hierarchical agglomerative clustering, to produce a dendrogram.

Where the sample tended to cluster with a grouping of different FCTs, samples were assessed separately to differentiate between FCTs. Ultimately the cluster analysis, as well as contextual information relating to the soils, landforms and known locations of FCTs within the region, was considered in the final determination of an FCT for vegetation within the survey area.

3.2.2 Wetland evaluation

Wetlands on the Swan Coastal Plain are assigned management categories using the DBCA (2017) methodology. Each area of interest was evaluated using the DBCA (2017) methodology to determine its appropriate management category.

4 RESULTS

4.1 Flora and vegetation

A total of 13 locations were sampled, comprised of three quadrats and ten relevés, as shown in **Figure 3**.

Samples were located within areas A, B and D. No samples were located within area C as it was not considered to require additional FCT analysis.

The raw sample data is provided in **Attachment 2**.

4.2 Floristic community type assignment

The results of the floristic community type assessment are summarised in **Table 1**.

Table 2: Sampling units and likely FCT represented within the survey area

DBCA area of interest	Sample	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Most likely floristic community type (FCT)
Area A	Q1	NINE-2 (FCT 21a)	47	FCT 21a: central *Banksia attenuata* – *Eucalyptus marginata* woodlands / FCT 23a: central *Banksia attenuata* – *B. menziesii* woodlands
		HARRY-4 (FCT 23a)	46	
	R2	MODO-5 (FCT 23a)	36	
		NINE-2 (FCT 21a)	36	
	Q3	HARRY-4 (FCT 23a)	34	
		MODO-5 (FCT 23a)	34	
	R4	RUAB-2 (FCT 21b)	39	
		CARD7 (FCT 21a)	34	
	R8	NINE-2 (FCT 21a)	25	
		RIVD-2 (FCT 21a)	24	
	R9	NINE-2 (FCT 21a)	32	
		LOW01 (FCT 21c)	31	
	Q10	HARRY-4 (FCT 23a)	44	
		NINE-2 (FCT 21a)	43	

Table 1: Sampling units and likely FCT represented within the survey area (continued)

DBCA area of interest	Sample	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Most likely floristic community type (FCT)
Area B	R5	CARD4 (FCT 6)	14	FCT 4: *Melaleuca preissiana* damplands
		ROWE01 (FCT 11)	12	
		KOOLJ-1 (FCT 4)	9	
	R6	KOOLJ-1 (FCT 4)	36	
		MELA-1 (FCT 4)	33	
		BANKS-1A (FCT 13)	32	
	R7	MILT-5 (FCT 14)	32	
		MELA-1 (FCT 4)	30	
Area D	R12	WATER-1 (FCT 13)	29	FCT 13: deeper wetlands on heavy soils
		WATER2 (FCT 12)	29	
	R13	MILT-5 (FCT 14)	22	FCT 11: wet forests and woodlands / FCT 14: deeper wetlands on sandy soils
		MODO-3 (FCT 11)	21	

4.3 Wetland evaluation

The results of the wetland evaluation using the DBCA (2017) methodology are summarised in **Table 2**. Some areas of interest were divided due to differences in vegetation condition and/or level of intactness.

The completed wetland evaluation documents are provided in **Attachment 1** and the proposed boundaries and management categories are shown on **Figure 3**.

Table 3: Summary of wetland evaluation for areas of interest

DBCA area of interest	Management category		
	Current (DBCA 2020)	Preliminary evaluation	Secondary evaluation
Area A	MUW	N/A – does not support wetland vegetation	
Area B1	MUW	CCW	Not required
Area B2	MUW	CCW^	REW (case-by-case basis)
Area C	CCW/MUW	CCW	Not required
Area D1	REW/MUW	-	REW
Area D2	MUW	-	REW (case-by-case basis)
Area D3	MUW	-	REW (case-by-case basis)

^due solely to the area meeting the criterion '≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)'.

5 DISCUSSION

5.1 Area A

Area A supports banksia woodland vegetation that represents either FCT 21a or FCT 23a. This aligns with the previous FCT analysis which indicated the vegetation represented FCT 23a (Emerge Associates 2021). These FCTs are not associated with wetland landforms and so this area is not considered to represent a wetland.

5.2 Area B

Area B supports woodland vegetation with *Banksia* spp. and *Melaleuca preissiana* that represents FCT 4. This aligns with the previous FCT analysis (Emerge Associates 2021). FCT 4 is a shrub-rich dampland wetland community (Gibson *et al.* 1994). Therefore, area B is considered to be a wetland.

5.2.1 Area B1

Area B1 supports vegetation in excellent condition and meets the DBCA criteria to comprise a CCW. This management category is considered appropriate due to the condition of the vegetation.

5.2.2 Area B2

Area B2 is more fragmented and disturbed than area B1. It supports patches of remnant vegetation within a developed landscape with driveways, houses and sheds. The vegetation ranges from 'completely degraded' to 'very good' condition. The preliminary evaluation indicated that the area comprises a CCW because 8.4% of all wetlands within the Bennett Brook consanguineous suite are classified as CCWs. In accordance with the DBCA (2017) methodology this wetland was not considered to be commensurate with the values of a CCW and so the secondary evaluation was undertaken. The secondary evaluation, which looks at a larger variety of attributes, indicated that a management category of REW (case-by-case basis) was applicable.

5.3 Area C

Area C supports vegetation in 'very good' and degraded' condition and was previously determined to represent FCT 11 and FCT 4. These FCTs are wetland communities and so area C is considered to be a wetland.

In the current DBCA (2020) dataset, area C supports part of a large CCW (UFI 14880) which extends beyond the site. In accordance with the DBCA methodology, UFI 14880 was assessed as a whole (rather than dividing the feature into two parts). The wetland evaluation confirmed that the conservation management category is still applicable. However, the boundary of UFI 14880 within the site is recommended to be extended to the west to align with the edge of the wetland vegetation.

5.4 Area D

Area D supports *Melaleuca* spp. woodland vegetation in varying levels of intactness. Where it is most intact, it represents FCT 11 or FCT 14, which are both wetland communities.

5.4.1 Area D1

Area D1 supports the most intact vegetation within area D but is still highly disturbed, being in 'degraded' condition with a dense layer of non-native grasses. Since the vegetation represents a wetland community and is low-lying, this area is considered to be a wetland. The wetland evaluation indicates that it comprises an REW which is considered appropriate based on the values and condition of vegetation.

5.4.2 Area D2

Area D2 comprises a small artificial lake surrounded by a mixture of native wetland species (particularly *Baumea articulata* and scattered *Melaleuca viminea*, *Melaleuca rhaphiophylla* and *M. teretifolia* plants) with planted **Eucalyptus* spp. and other non-native garden plantings over dense non-native grasses. This area likely previously supported vegetation similar to area D1 but has been subject to long-term historical disturbance.

The wetland evaluation indicated that area D2 represents an REW (case-by-case basis).

5.4.3 Area D3

Area D3 supports an open forest of *Eucalyptus rudis*, **Eucalyptus* spp. and *Melaleuca preissiana* with scattered *Banksia littoralis* over a closed tall shrubland of *Kunzea glabrescens* and **Acacia longifolia* over a non-native grasses and bare ground. This area also likely previously supported vegetation similar to area D1 but has been subject to long-term historical disturbance.

The wetland evaluation indicated that area D3 represents an REW (case-by-case basis).

6 RECOMMENDATIONS AND CLOSING

The wetland assessment was conclusive in determining whether the areas of interest currently comprise wetlands. This was based primarily on vegetation classification using FCT analysis.

Area A is not considered to represent a wetland and is recommended to be excluded from the geomorphic wetland database.

Area B1 represents a CCW rather than its currently mapped MUW. Area C aligns with its current listing as a CCW, albeit with an extension recommended to the mapped boundary.

Area D1 aligns with its current listing as a REW and remapping of the wetland boundary is recommended.

Under the preliminary evaluation criteria area B2 represents a CCW, due to one attribute. Using the secondary evaluation criteria this area represents a REW (case-by-case basis). The applicable management category and retention value of this wetland requires discussion with DBCA.

For areas D2 and D3, the REW (case-by-case) management category indicates that these areas could comprise REW or MUW wetlands. Due to the level of disturbance rehabilitation would be challenging and discussions with the DBCA regarding the appropriate management category are required.

We trust that this letter provides a comprehensive summary of the wetland values within the areas of interest. Should you have any questions regarding the content of this letter, please do not hesitate to contact the undersigned.

Yours sincerely
Emerge Associates



Rachel Weber
SENIOR ENVIRONMENTAL CONSULTANT, ECOLOGY TEAM LEADER

cc: Carolyn Harding, DBCA
Catherine Prideaux, DBCA
Michael Coote, DBCA

Encl: Figure 1 – Site Location and DBCA Areas of Interest
Figure 2 – Current Geomorphic Wetlands
Figure 2 – Proposed Geomorphic Wetlands
Attachment 1 – Wetland evaluation forms
Attachment 2 – Raw survey data

General References

Clarke, K. R. and Gorley, R. N. 2006, *PRIMER v6: User Manual/Tutorial*, PRIMER-E, Plymouth.

Department of Biodiversity, Conservation and Attractions (DBCA) 2017, *A methodology for the evaluation of wetlands on the Swan Coastal Plain*, draft prepared by the Wetlands Section of the Department of Biodiversity, Conservation and Attractions and the Urban Water Branch of the Department of Water and Environmental Regulation, Perth.

Department of Biodiversity, Conservation and Attractions (DBCA) 2020, *Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)*.

Emerge Associates 2021, *Detailed Flora and Vegetation Assessment - Lots 600-606 Balannup Road and 200-202 Skeet Road Harrisdale*, EP20-127(02)--003 SKP, Version 1.

Gibson, N., Keighery, B., Keighery, G., Burbidge, A. and Lyons, M. 1994, *A Floristic survey of the southern Swan Coastal Plain*, Department of Conservation and Land Management and the Conservation Council of Western Australia, Perth.

Online References

West Australian Land Information Authority (WALIA) 2021, *Landgate Map Viewe*r, viewed 27 May 2021, <http://landgate.wa.gov.au>.

Figures

Figure 1: Site Location and DBCA Areas of Interest

Figure 2: Current Geomorphic Wetlands

Figure 3: Proposed Geomorphic Wetlands

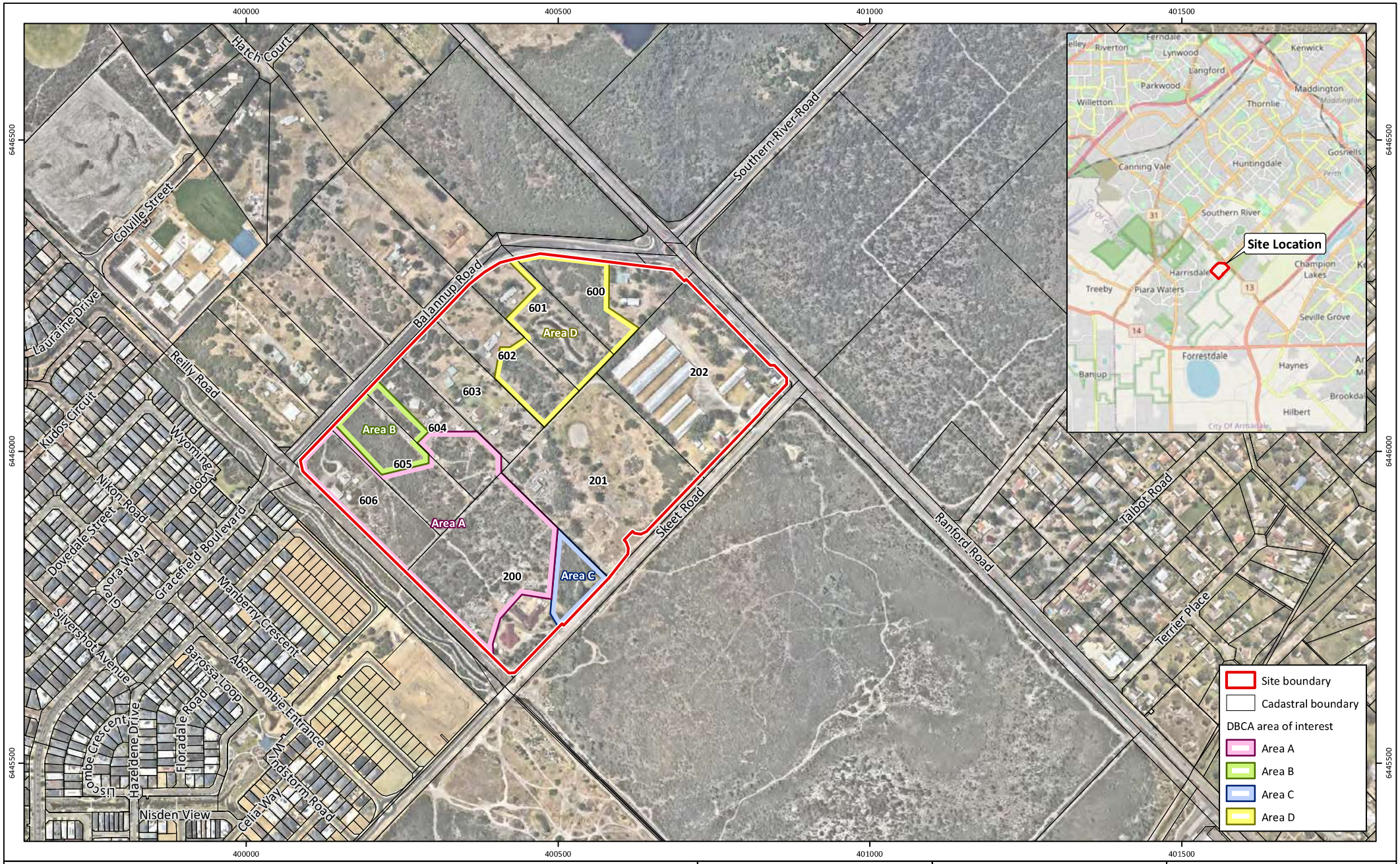


Figure 1: Site Location and DBCA Areas of Interest

Project:	Wetland Assessment Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(14)--F61

Drawn:	GAR
Date:	02/06/2021
Checked:	RAW
Approved:	TAA
Date:	10/06/2021

N

0 100 200 300
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
©Landgate (2020). Nearmap Imagery date: 03/01/2021

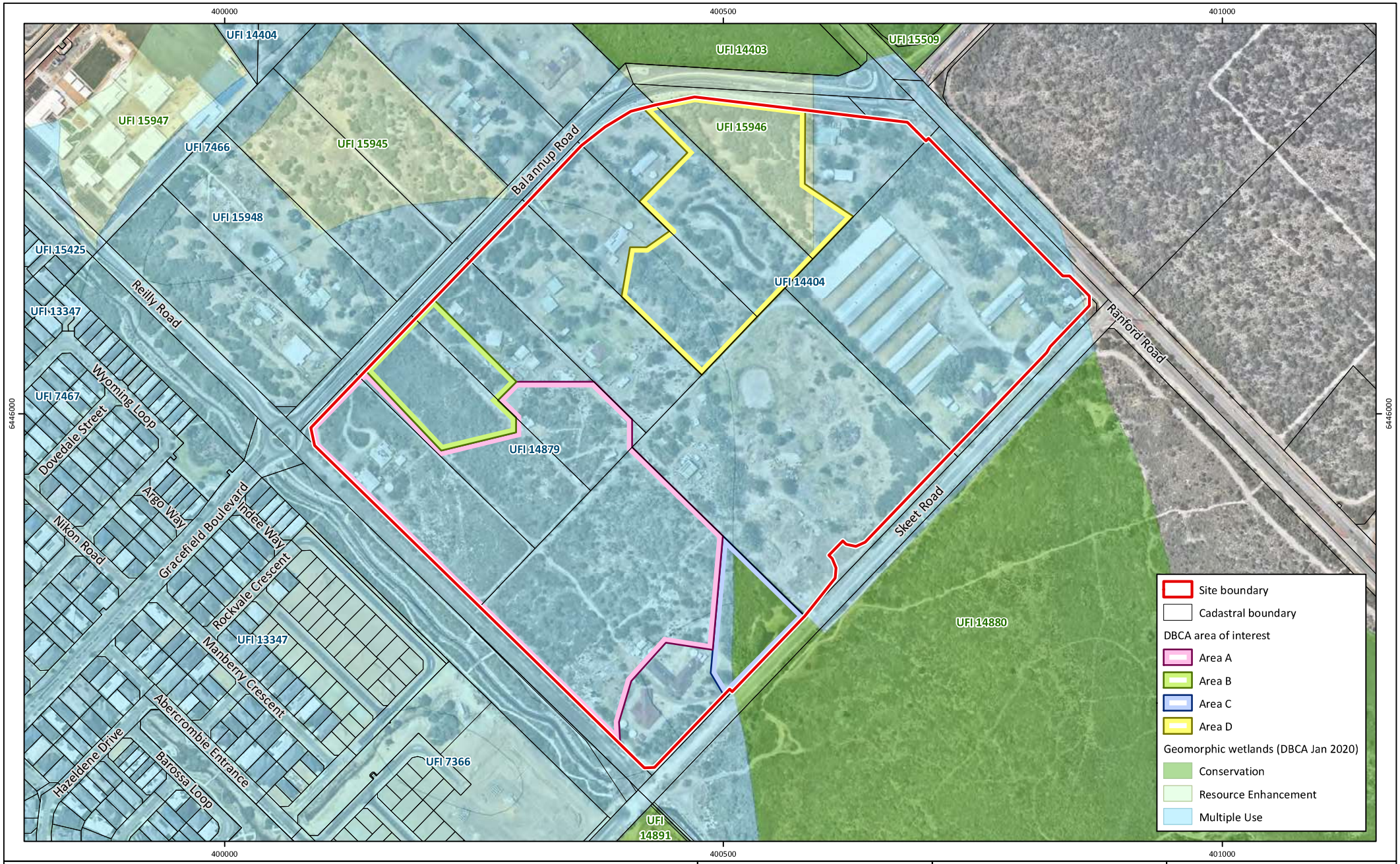


Figure 2: Current Geomorphic Wetlands

Project: Wetland Assessment
Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale
Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(14)--F62
Drawn: GAR
Date: 02/06/2021
Checked: RAW
Approved: TAA
Date: 10/06/2021

N

0 100 200
Metres
Scale: 1:5,000@A4
GDA 1994 MGA Zone 50

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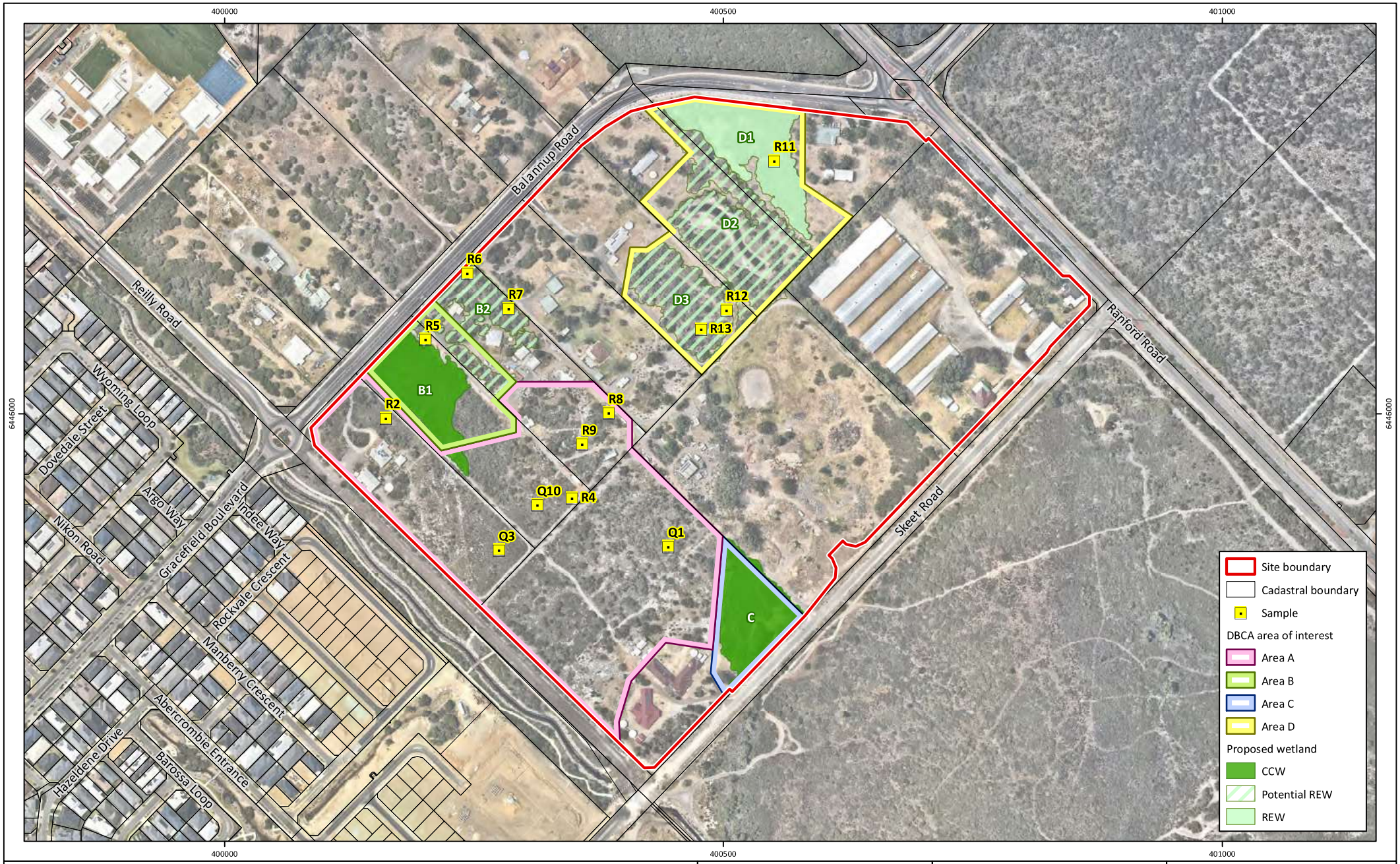


Figure 3: Proposed Geomorphic Wetlands

Project:	Wetland Assessment Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(14)--F63

Drawn:	GAR
Date:	09/06/2021
Checked:	RAW
Approved:	TAA
Date:	10/06/2021

N

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Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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©Landgate (2020). Nearmap Imagery date: 03/01/2021

Attachment 1

Wetland Evaluation Forms

PRELIMINARY EVALUATION CRITERIA

CCW UFI No. 14880 (including area C)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	Y
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	Y
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	N
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	Y
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	Conservation category wetland

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

PRELIMINARY EVALUATION CRITERIA

Area B1 (currently mapped within MUW UFI 14879)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	Y
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	Y
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	Conservation category wetland

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

PRELIMINARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	Y
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	Conservation category wetland

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Geomorphology	Representative-ness	1	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	N	H	
		2	≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		3	≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		4	The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	N	H	
	Naturalness	5	Alteration to the wetland's geomorphology by % area: < 25% altered (=H) 25-75% altered (=I) > 75% altered. (=L)	 N N Y	 H I L	L
	Scarcity	6	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	N	H	
		7	The wetland is the best example of its type in its consanguineous suite.	N	H	
	Representative-ness	8	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	N N Y	H I L	L

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Wetland processes		9	The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	N	**H**	
	Naturalness	10	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	N Y N	**H** **I** **L**	**I**
	Scarcity	11	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	N	**H**	
Linkages	Representative-ness	12	The wetland is a hydrological link in a larger or more complex and intact system.	N	**H**	
	Naturalness	13	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas. The wetland is part of a fragmented ecological linkage or wildlife corridor. The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	N Y N	**H** **I** **L**	**I**
	Scarcity	14	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	N	**H**	

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Habitats	Representative-ness	15	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	N	H	
		16	The wetland contains evidence of surface water or groundwater expression that is vital for maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	N	H	
			The wetland contains evidence of surface water or groundwater expression that is important for maintaining populations of native aquatic or terrestrial flora or fauna.	N	I	
		17	The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	N	H	
	Naturalness	18	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	N	H	I
			The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated.	Y	I	
			The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	N	L	
	Scarcity	19	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	N	H	
	Representative-ness	20	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state.	N	H	L
			The wetland supports a reduced diversity of native flora due to human induced disturbances.	N	I	
			The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	Y	L	

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Flora		21	The wetland is identified in a vegetation complex (Heddle et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	 Y N	 H I	H
	Naturalness	22	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	 N Y N	 H I L	I
		23	The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	N N Y	H I L	L
	Scarcity	24	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	N	H	
		25	The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	N	I	
		26	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		27	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	N	I	
			The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.	N	H	

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Fauna	Representative-ness	28	The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	N	I	
		29	The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.	N	H	
			The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	N	I	
	Naturalness	30	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type.	N	H	
			The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	N	I	
			The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	Y	L	L
	Scarcity	31	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. EPBC Act 1999, JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	N	H	
		32	The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	N	H	
		33	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		34	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	N	I	

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Cultural	Representative-ness	35	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	N	H	
		36	The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	N	I	
		37	The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	N	H	
		38	The wetland is important to the local community either nationally or state wide for its natural values.	N	H	
		39	The wetland is or has the potential to be a site for public or private based recreation.	N	I	
		40	The wetland is the subject of a recognised ecological restoration / rehabilitation project by a community group, landowner or land manager that aims to improve the wetland's natural, heritage, cultural or social values	N	H	
			The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant.	N	I	
			The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	N	L	
Scientific and educational	Representative-ness	41	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics.	N	H	
			The wetland has the potential to be used as a study or research site.	N	I	

SECONDARY EVALUATION CRITERIA

Area B2 (Currently mapped within MUW 14879)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
			The wetland supports known scientific, geoheritage or geoconservation values.	N	H	

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A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia

SECONDARY EVALUATION TALLY

Area B2 (Currently mapped within MUW 14879)

Attributes / functions / values	Scores		
	High	Intermediate	Low
Geomorphology	2	0	1
Wetland processes	0	1	1
Linkages	0	1	0
Habitats	0	1	0
Flora	1	1	2
Fauna	0	0	1
Cultural	0	0	0
Scientific and educational	0	0	0
Max of High + Intermediate	2		
Total score	**3**	**4**	**5**
	5		
Defining attributes/functions/values	Geomorphology		
Applicable management category	**REW (case by case basis)**		

PRELIMINARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	N
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	**Secondary evaluation required**

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SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Geomorphology	Representative-ness	1	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	N	H	
		2	≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		3	≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		4	The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	N	H	
	Naturalness	5	Alteration to the wetland's geomorphology by % area: < 25% altered (=H) 25-75% altered (=I) > 75% altered. (=L)	 N Y N	 H I L	I
	Scarcity	6	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	N	H	
		7	The wetland is the best example of its type in its consanguineous suite.	N	H	
	Representative-ness	8	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	N Y N	H I L	I

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Wetland processes		9	The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	N	**H**	
	Naturalness	10	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	N Y N	**H** **I** **L**	**I**
	Scarcity	11	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	N	**H**	
Linkages	Representative-ness	12	The wetland is a hydrological link in a larger or more complex and intact system.	n	**H**	
	Naturalness	13	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas. The wetland is part of a fragmented ecological linkage or wildlife corridor. The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	N N Y	**H** **I** **L**	**L**
	Scarcity	14	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	N	**H**	

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Habitats	Representative-ness	15	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	N	H	
		16	The wetland contains evidence of surface water or groundwater expression that is vital for maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	N	H	
			The wetland contains evidence of surface water or groundwater expression that is important for maintaining populations of native aquatic or terrestrial flora or fauna.	N	I	
		17	The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	N	H	
	Naturalness	18	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	N	H	I
			The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated.	y	I	
			The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	N	L	
	Scarcity	19	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	N	H	
	Representative-ness	20	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state.	N	H	L
			The wetland supports a reduced diversity of native flora due to human induced disturbances.	N	I	
			The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	Y	L	

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Flora		21	The wetland is identified in a vegetation complex (Heddle et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	 Y n	 H I	 H
	Naturalness	22	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	 N n y	 H I L	 L
		23	The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	N n y	H I L	 L
	Scarcity	24	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	N	H	
		25	The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	N	I	
		26	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		27	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	N	I	
			The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.	N	H	

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Fauna	Representative-ness	28	The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	N	I	
		29	The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.	N	H	
			The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	n	I	
	Naturalness	30	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type.	N	H	
			The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	Y	I	I
			The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	N	L	
	Scarcity	31	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. EPBC Act 1999, JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	N	H	
		32	The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	N	H	
		33	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		34	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	N	I	

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Cultural	Representative-ness	35	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	N	**H**	
		36	The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	N	**I**	
		37	The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	N	**H**	
		38	The wetland is important to the local community either nationally or state wide for its natural values.	N	**H**	
		39	The wetland is or has the potential to be a site for public or private based recreation.	N	**I**	
		40	The wetland is the subject of a recognised ecological restoration / rehabilitation project by a community group, landowner or land manager that aims to improve the wetland's natural, heritage, cultural or social values The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant. The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	N N N	**H** **I** **L**	
Scientific and educational	Representative-ness	41	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics. The wetland has the potential to be used as a study or research site.	N N	**H** **I**	

SECONDARY EVALUATION CRITERIA

REW UFI 15946 (Area D1)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
			The wetland supports known scientific, geoheritage or geoconservation values.	N	H	

DBCA 2017

A methodology for the evaluation of wetlands on the Swan Coastal Plain, West

SECONDARY EVALUATION TALLY

REW UFI 15946 (Area D1)

Attributes / functions / values	Scores		
	High	Intermediate	Low
Geomorphology	2	1	0
Wetland processes	0	2	0
Linkages	0	0	1
Habitats	0	1	0
Flora	1	0	3
Fauna	0	1	0
Cultural	0	0	0
Scientific and educational	0	0	0
Max of High + Intermediate	2		
Total score	**3**	**5**	**4**
	5		
Defining attributes/functions/values	Geomorphology		
Applicable management category	**Resource enhancement**		

Applicable management category	**Resource enhancement**

Apdated from DBCA 2017

A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia

PRELIMINARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	N
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	**Secondary evaluation required**

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Geomorphology	Representative-ness	1	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	N	H	
		2	≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		3	≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		4	The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	N	H	
	Naturalness	5	Alteration to the wetland's geomorphology by % area: < 25% altered (=H) 25-75% altered (=I) > 75% altered. (=L)	 N N Y	 H I L	 L
	Scarcity	6	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	N	H	
		7	The wetland is the best example of its type in its consanguineous suite.	N	H	
		8	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage).	N y	H I	 I

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Wetland processes	Representative-ness		The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	n	**L**	
		9	The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	N	**H**	
	Naturalness	10	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	N Y N	**H** **I** **L**	**I**
	Scarcity	11	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	N	**H**	
	Representative-ness	12	The wetland is a hydrological link in a larger or more complex and intact system.	n	**H**	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Linkages	Naturalness	13	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas.	N	**H**	**L**
			The wetland is part of a fragmented ecological linkage or wildlife corridor.	n	**I**	
			The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	y	**L**	
	Scarcity	14	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	N	**H**	
Habitats	Representativ e-ness	15	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	N	**H**	
		16	The wetland contains evidence of surface water or groundwater expression that is vital for maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	N	**H**	
			The wetland contains evidence of surface water or groundwater expression that is important for maintaining populations of native aquatic or terrestrial flora or fauna.	N	**I**	
		17	The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	N	**H**	
			The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	N	**H**	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
	Naturalness	18	The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated. The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	y N	I L	I
	Scarcity	19	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	N	H	
Flora	Representative-ness	20	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state. The wetland supports a reduced diversity of native flora due to human induced disturbances. The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	N N Y	H I L	L
		21	The wetland is identified in a vegetation complex (Heddle et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	Y n	H I	H
	Naturalness	22	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	N n y	H I L	L
		23	The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	N N	H I	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
			The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	Y	L	L
	Scarcity	24	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	N	H	
		25	The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	N	I	
		26	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		27	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	N	I	
	Representativ e-ness	28	The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages. The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	N N	H I	
		29	The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna. The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	N N	H I	
			The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type.	N	H	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Fauna	Naturalness	30	The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	Y	**I**	**I**
			The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	N	**L**	
	Scarcity	31	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. EPBC Act 1999, JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	N	**H**	
		32	The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	N	**H**	
		33	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	**H**	
		34	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	N	**I**	
		35	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	N	**H**	
		36	The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	N	**I**	
		37	The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	N	**H**	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Cultural	Representativ e-ness	38	The wetland is important to the local community either nationally or state wide for its natural values.	N	**H**	
		39	The wetland is or has the potential to be a site for public or private based recreation.	N	**I**	
		40	The wetland is the subject of a recognised ecological restoration / rehabilitation project by a community group, landowner or land manager that aims to improve the wetland's natural, heritage, cultural or social values	N	**H**	
			The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant.	N	**I**	
			The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	N	**L**	
Scientific and educational	Representativ e-ness	41	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics.	N	**H**	
			The wetland has the potential to be used as a study or research site.	N	**I**	
			The wetland supports known scientific, geoheritage or geoconservation values.	N	**H**	

SECONDARY EVALUATION TALLY

Portion of MUW UFI No. 14404 (Area D2)

Attributes / functions / values	Scores		
	High	Intermediate	Low
Geomorphology	2	0	1
Wetland processes	0	2	0
Linkages	0	0	1
Habitats	0	1	0
Flora	1	0	3
Fauna	0	1	0
Cultural	0	0	0
Scientific and educational	0	0	0
Max of High + Intermediate	2		
Total score	**3**	**4**	**5**
	5		
Defining attributes/functions/values	Geomorphology		
Applicable management category	**REW (case by case basis)**		

Applicable management category	**REW (case by case basis)**

Apdated from DBCA 2017

A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia

PRELIMINARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include:	
	The Ramsar Convention on Wetlands	N
	State government endorsed candidate sites for the Ramsar Convention on Wetlands	N
	Directory of Important Wetlands in Australia	N
	National Heritage List	N
	Or equivalent.	
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following:	
	Conservation Reserves for Western Australia Systems 1, 2, 3, 5	N
	Conservation Reserves for Western Australia, The Darling System – System 6	N
	A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region	N
	The Environmental Significance of Wetlands in the Perth to Bunbury Region	N
	Bush Forever, Swan Bioplan (including *Peel Regionally Significant Natural Area* s) or equivalent.	N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, *Environment Protection and Biodiversity Conservation Act 1999* , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, threatened and specially protected fauna listed under the *Wildlife Conservation Act 1950*).	N
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following:	
	An occurrence of a Threatened Ecological Community	N
	A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community	N
	A confirmed occurrence of a Declared Rare (Threatened) flora species.	N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	N
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following:	
	≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area)	N
	≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area)	N
	≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area)	N
	best representative of its type within its consanguineous suite domain.	N

Note: If a wetland does not satisfy any of the above preliminary evaluation criteria or, does satisfy the preliminary evaluation criteria but is not considered to be commensurate with the values of a Conservation management category wetland then a secondary evaluation including a full site assessment is required. Refer to Step 3 and 4 of the evaluation procedure which indicates the process for conducting a secondary evaluation.

Result	**Secondary evaluation required**

DBCA *A methodology for the evaluation of wetlands on the Swan Coastal Plain, WA* (December 2017)

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Geomorphology	Representative-ness	1	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	N	H	
		2	≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		3	≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	Y	H	H
		4	The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	N	H	
	Naturalness	5	Alteration to the wetland's geomorphology by % area: < 25% altered (=H) 25-75% altered (=I) > 75% altered. (=L)	 N Y N	 H I L	I
	Scarcity	6	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	N	H	
		7	The wetland is the best example of its type in its consanguineous suite.	N	H	
	Representative-ness	8	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	N y n	H I L	I

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Wetland processes		9	The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	N	**H**	
	Naturalness	10	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	N Y N	**H** **I** **L**	**I**
	Scarcity	11	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	N	**H**	
Linkages	Representativ e-ness	12	The wetland is a hydrological link in a larger or more complex and intact system.	n	**H**	
	Naturalness	13	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas. The wetland is part of a fragmented ecological linkage or wildlife corridor. The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	N N y	**H** **I** **L**	**L**
	Scarcity	14	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	N	**H**	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Habitats	Representative-ness	15	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	N	H	
		16	The wetland contains evidence of surface water or groundwater expression that is vital for maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	N	H	
			The wetland contains evidence of surface water or groundwater expression that is important for maintaining populations of native aquatic or terrestrial flora or fauna.	N	I	
		17	The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	N	H	
	Naturalness	18	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained.	N	H	I
			The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated.	y	I	
			The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	N	L	
	Scarcity	19	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	N	H	
	Representative-ness	20	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state.	N	H	L
			The wetland supports a reduced diversity of native flora due to human induced disturbances.	N	I	
			The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	Y	L	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Flora		21	The wetland is identified in a vegetation complex (Heddle et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	 Y n	 H I	H
	Naturalness	22	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	 N N Y	 H I L	L
		23	The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation. The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	N N Y	H I L	L
	Scarcity	24	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	N	H	
		25	The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	N	I	
		26	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		27	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	N	I	
			The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.	N	H	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Fauna	Representativ e-ness	28	The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	N	I	
		29	The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.	N	H	
			The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	N	I	
	Naturalness	30	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type.	N	H	
			The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	N	I	
			The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	Y	L	L
	Scarcity	31	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. EPBC Act 1999, JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the Wildlife Conservation Act 1950).	N	H	
		32	The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	N	H	
		33	The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	N	H	
		34	The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	N	I	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
Cultural	Representative-ness	35	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	N	**H**	
		36	The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	N	**I**	
		37	The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	N	**H**	
		38	The wetland is important to the local community either nationally or state wide for its natural values.	N	**H**	
		39	The wetland is or has the potential to be a site for public or private based recreation.	N	**I**	
		40	The wetland is the subject of a recognised ecological restoration / rehabilitation project by a community group, landowner or land manager that aims to improve the wetland's natural, heritage, cultural or social values The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant. The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	N N Y	**H** **I** **L**	**L**
Scientific and educational	Representative-ness	41	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics. The wetland has the potential to be used as a study or research site.	N N	**H** **I**	

SECONDARY EVALUATION CRITERIA

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions/ values	General criteria	Number	Criteria	Y/N	Score if true	Score
			The wetland supports known scientific, geoheritage or geoconservation values.	N	H	

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A methodology for the evaluation of wetlands on the Swan Coastal Plain, West

SECONDARY EVALUATION TALLY

Portion of MUW UFI No. 14404 (Area D3)

Attributes / functions / values	Scores		
	High	Intermediate	Low
Geomorphology	2	1	0
Wetland processes	0	2	0
Linkages	0	0	1
Habitats	0	1	0
Flora	1	0	3
Fauna	0	0	1
Cultural	0	0	1
Scientific and educational	0	0	0
Max of High + Intermediate	2		
Total score	**3**	**4**	**6**
	6		
Defining attributes/functions/values	Geomorphology		
Applicable management category	**REW (case by case basis)**		

Applicable management category	**REW (case by case basis)**

Apdated from DBCA 2017

A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia

Attachment 2

Raw Survey Data

Vegetation Survey Data

Sample Name: Q1

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA Q1: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	400444	NW corner northing:	6445868
Altitude (m):	24	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	No evidence	Disturbance:	moderate - weeds
Soil type/texture	sand/ with organic layer	Bare ground (%):	15
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	30% (leaves,twigs,)	Vegetation condition:	very good



Soil test pit
Grey sandy soils grading to light grey with organic matter mixed through, damp to cool, dry

Vegetation Survey Data

Sample Name: Q1

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA Q1: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella	0.5
	Banksia attenuata	30
	Banksia ilicifolia	10
	Bossiaea eriocarpa	opp
*	*Briza maxima*	0.1
	Burchardia congesta	0.1
	Conostephium pendulum	0.5
	Dasypogon bromeliifolius	2
	Desmocladus flexuosus	10
*	*Ehrharta calycina*	0.5
	Pyrorchis nigricans	0.5
*	*Gladiolus caryophyllaceus*	0.1
	Haemodorum spicatum	0.5
	Arnocrinum preissii	0.5
	Gompholobium tomentosum	0.5
	Kunzea glabrescens	5
	Laxmannia ramosa subsp. ramosa	0.1
	Lepidosperma pubisquameum	0.5
	Styphelia xerophylla	1
	Lomandra hermaphrodita	0.1
	Lyginia barbata	30
	Macrozamia riedlei	15
	Melaleuca thymoides	1
	Nuytsia floribunda	opp
	Patersonia occidentalis	15
	Phlebocarya ciliata	1
	Chaetospora curvifolia	0.5
	Scholtzia involucrata	1
	Stylidium repens	0.1
	Thysanotus dichotomous	0.5
*	*Ursinia anthemoides*	0.5
	Xanthorrhoea preissii	1

Vegetation Survey Data

Sample Name: R2

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R2: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400161	NW corner northing:	6445996
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	Low - weeds
Soil type/texture	sand/	Bare ground (%):	2
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Excellent



Soil test pit
Dark grey soils with fine organic layer at top, grading to light grey sand, dry to cool, dry at depth

Vegetation Survey Data

Sample Name: R2

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia lasiocarpa	
	Calytrix flavescens	
	Dasypogon bromeliifolius	
	Eremaea pauciflora var. pauciflora	
	Hovea trisperma	
	Hypolaena exsulca	
	Kunzea glabrescens	
	Lomandra sericea	
	Lyginia barbata	
	Patersonia occidentalis	
	Bossiaea eriocarpa	
	Phlebocarya ciliata	
	Xanthorrhoea preissii	

Vegetation Survey Data

Sample Name: Q3

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA Q3: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	400274.7643	NW corner northing:	6445864.005
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	4
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Very good



Soil test pit
Soils dark grey to light grey, some organic matter mixed through, dry to cool, dry at depth

Vegetation Survey Data

Sample Name: Q3

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia lasiocarpa	0.5
	Calytrix flavescens	1
	Dampiera linearis	0.5
	Dasypogon bromeliifolius	5
	Eremaea pauciflora var. pauciflora	40
	Xanthorrhoea brunonis	1
	Hypolaena exsulca	5
	Hypolaena pubescens	0.5
	Lyginia barbata	20
	Nuytsia floribunda	opp
	Patersonia occidentalis	15
	Bossiaea eriocarpa	1
	Phlebocarya ciliata	10
	Adenanthos obovatus	0.1
	Hensmania turbinata	0.5
	Rytidosperma sp.	0.5
	Chaetospora curvifolia	0.1
	Scholtzia involucrata	1

Vegetation Survey Data

Sample Name: R4

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R4: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400348.0198	NW corner northing:	6445916.289
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Very good



Soil test pit
Dark grey soils with organic matter in top 50 cm then light grey with organic flecks, dry to damp

Vegetation Survey Data

Sample Name: R4

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R4: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Banksia attenuata	
	Bossiaea eriocarpa	
*	*Briza maxima*	
	Burchardia congesta	
	Conostephium pendulum	
	Dasypogon bromeliifolius	
	Kunzea glabrescens	
	Lomandra sericea	
	Melaleuca thymoides	
	Patersonia occidentalis	
	Phlebocarya ciliata	

Vegetation Survey Data

Sample Name: R5

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R5: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400201.0429	NW corner northing:	6446075.118
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	15
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Very good



Soil test pit
Soils darkish brown grey sand, whole profile damp to moist at depth

Vegetation Survey Data

Sample Name: R5

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Dasypogon bromeliifolius	
	Eremaea pauciflora var. pauciflora	
	Hypocalymma angustifolium	
	Hypolaena exsulca	
	Kunzea glabrescens	
	Phlebocarya ciliata	
	Acacia pulchella	
	Regelia ciliata	

Vegetation Survey Data

Sample Name: R6

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R6: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400242.809	NW corner northing:	6446141.828
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	20
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	very good



Soil test pit
Soils dark black at surface and then pale sand, leached damp near surface and damp at depth

Vegetation Survey Data

Sample Name: R6

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Astartea scoparia	
	Cyathochaeta avenacea	
	Hypocalymma angustifolium	
	Kunzea glabrescens	
	Lyginia barbata	
	Melaleuca preissiana	
	Regelia ciliata	

Vegetation Survey Data

Sample Name: R7

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R7: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400284.3449	NW corner northing:	6446106.284
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Good



Soil test pit
Soils grey grading to light grey, cool dry near surface and cool dry at depth

Vegetation Survey Data

Sample Name: R7

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Dasypogon bromeliifolius	
*	*Ehrharta calycina*	
	Kunzea glabrescens	
	Melaleuca preissiana	
	Regelia ciliata	

Vegetation Survey Data

Sample Name: R8

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R8: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400384.5111	NW corner northing:	6446001.583
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	10
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Very good



Soil test pit
Surface layer brown with carbon accumulated, grading to browny grey at depth, dry to damp below

Vegetation Survey Data

Sample Name: R8

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R8: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella	
	Banksia attenuata	
	Dasypogon bromeliifolius	
	Eremaea pauciflora var. pauciflora	
	Xanthorrhoea brunonis	
	Hypolaena exsulca	
	Kunzea glabrescens	
	Lepidosperma pubisquameum	
	Lyginia barbata	
	Patersonia occidentalis	

Vegetation Survey Data

Sample Name: R9

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R9: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400358.1819	NW corner northing:	6445970.347
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/	Bare ground (%):	10
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	% (,,)	Vegetation condition:	Very good



Soil test pit
Some organic material at surface, browny grey tending to light browny grey with flecks of organic through

Vegetation Survey Data

Sample Name: R9

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Banksia attenuata	
	Banksia menziesii	
	Dasypogon bromeliifolius	
	Eremaea pauciflora var. pauciflora	
	Gompholobium tomentosum	
	Xanthorrhoea brunonis	
	Haemodorum spicatum	
	Kunzea glabrescens	
	Adenanthos obovatus	
	Lomandra sericea	
	Lyginia barbata	
	Melaleuca thymoides	
	Melaleuca trichophylla	
	Nuytsia floribunda	
	Patersonia occidentalis	

Vegetation Survey Data

Sample Name: Q10

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA Q10: Page 1 of 2

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	400313.0376	NW corner northing:	6445909.429
Altitude (m):	22	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	0
Time since fire:	No evidence	Disturbance:	moderate - weeds
Soil type/texture	sand/	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	grey/brown
Litter:	10% (leaves,,)	Vegetation condition:	very good



Soil test pit
Light grey grading to very light grey, some organic on surface, dry to cool dry

Vegetation Survey Data

Sample Name: Q10

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia lasiocarpa	0.1
	Banksia attenuata	5
	Banksia menziesii	5
	Burchardia congesta	0.5
	Calytrix flavescens	1
	Dampiera linearis	0.5
	Eremaea pauciflora var. pauciflora	5
	Hovea trisperma	0.5
*	*Gladiolus caryophyllaceus*	0.5
	Gompholobium tomentosum	0.1
	Xanthorrhoea brunonis	5
	Hypolaena exsulca	1
	Kunzea glabrescens	1
	Lyginia barbata	10
	Melaleuca thymoides	0.5
	Nuytsia floribunda	5
	Patersonia occidentalis	70
	Phlebocarya ciliata	10
	Scholtzia involucrata	0.5
	Stylidium repens	0.5
	Eucalyptus todtiana	1

Vegetation Survey Data

Sample Name: R11

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R11: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400550.5163	NW corner northing:	6446254.494
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/ with organic layer	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	% (,,)	Vegetation condition:	Degraded



Soil test pit
Fine silty black soils over grey fine sand damp at surface and damp at depth

Vegetation Survey Data

Sample Name: R11

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name
*	*Cynodon dactylon*
	Melaleuca teretifolia
	Melaleuca viminea
	Melaleuca rhaphiophylla

Vegetation Survey Data

Sample Name: R12

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R12: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400502.6982	NW corner northing:	6446104.519
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/ with organic layer	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	% (,,)	Vegetation condition:	Degraded



Soil test pit
Brown organic rich soils grading from light grey to brown, fine sand dry to cool dry at depth

Vegetation Survey Data

Sample Name: R12

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Astartea scoparia	
*	*Cynodon dactylon*	
	Lepidosperma longitudinale	
	Melaleuca rhaphiophylla	
	Melaleuca lateritia	

Vegetation Survey Data

Sample Name: R13

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA R13: Page 1 of 2

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	400477.3233	NW corner northing:	6446085.602
Altitude (m):	0	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	0	Landform:	0
Time since fire:	No evidence	Disturbance:	- weeds
Soil type/texture	sand/ with organic layer	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	% (,,)	Vegetation condition:	Degraded



Soil test pit
Brown soils over pale grey brown sand dry to damp

Vegetation Survey Data

Sample Name: R13

Project no.: EP20-127(14)
Date: 3/05/2021 **Status** Non-permanent
Author: RAO,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
*	*Acacia longifolia*	
	Astartea scoparia	
*	*Asparagus asparagoides*	
*	*Eucalyptus grandis*	
	Kunzea glabrescens	
	Banksia littoralis	

Appendix F

DBCA Wetland Correspondence pertaining to relation to the Wetland Assessment (2021)

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Biodiversity and Conservation Science

We're working for Western Australia.

Species and Communities Program
Wetlands Conservation Section

18/11/2021

TO: Rachel Weber, Emerge Associates

Enquiries: Michael Coote, Principal Coordinator, Wetlands Section

SUBJECT: **Wetland management category upgrade from Multiple Use to Resource Enhancement and to Conservation management category for wetland of Harrisdale Lots 172, 515 and 516 Skeet Road.**

Background information

Emerge Associates (Emerge) submitted a request to re-evaluate portions of wetland UFIs-15946, 14404, 14879 and 13347 within lots 172, 515 and 516 Skeet Road, Harrisdale (Figure 1).

These wetlands are currently mapped in the Geomorphic Wetlands Swan Coastal Plain dataset (the dataset) as multiple use (MUW) and resource enhancement (REW) wetlands (Figure 1). Multiple Use wetland UFI-14404 and Resource Enhancement wetland UFI-15946 are mapped as sumplands, whereas Multiple Use wetlands UFI-13347 and UFI-14879 are mapped as damplands. Further to this, Emerge consulting provided vegetation mapping that suggested that a portion of the site has transitioned into dryland and is no longer consistent with a wetland environment.

Wetland boundaries

This site has undergone significant change from peri-urban development creating portions of wetlands with differing values and the dataset management category boundaries do not reflect the current condition. Wetland type boundaries were maintained as aerial imagery suggest that wetland UFI-14404 and wetland UFI-15946 continue to operate as a sumpland in wet years. In-line with the '*A methodology for the evaluation of wetlands of the Swan Coastal Plain (2017)*' (DBCA 2017, the wetlands evaluation methodology), section 5.3.2, category boundaries have been modified to reflect current condition and values. Wetland boundaries for wetland UFI-15946 were not altered.

Emerge provided vegetation mapping suggesting that a portion of the site contained floristics that is not consistent with a wetland environment. These areas will be amended to 'No Longer a wetland' (see figure 2). The Wetlands Section conducted two site visits and have taken the opportunity to modify wetland mapping within the project site and those polygons that intersect the project site (Figure 2).

Wetland values

Emerge evaluated the wetland portions in accordance with 'A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia' (DBCA, 2017).

Discrete areas of wetland vegetation within the site were evaluated by Emerge as being in excellent, very good and good condition using the Keighery 1994 vegetation condition scale.
Records of threatened and priority fauna including Carnaby's cockatoo (Calyptorhynchus latirostris, En) and Quenda (Isoodon fusciventer, P4) and have been recorded across the site in the last 10 years (see Figure 2).

Conservation Category wetlands.

Areas B1 and C have been evaluated as being commensurate with a wetland management category of Conservation (Figure 2).

Area B1 (part wetlands UFI-14879) meets Conservation on the preliminary evaluation with equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the Keighery 1994 vegetation condition scale.

Area C (part wetlands UFI-14879, part UFI-13347 and Part UFI-14480) wetland UFI-14880 is mapped as Conservation in the Current GWSCP mapping. The mapping has been extended up to include the wetland vegetation up to the edge of the area mapped as No Longer a Wetland as it is a small slither, and the vegetation is continuous in this area.

Resource Enhancement wetlands

Areas B2 and D3 were evaluated by the Wetlands Section, DBCA, using the wetlands evaluation methodology (DBCA 2017) as REW and will be amended to this category within the GWSCP dataset (Fig. 2).

No Longer a Wetland

Portions of wetland UFIs 14879, 13347, 14891 and 7366 have been modified to No Longer a Wetland to reflect the loss of wetland values (floristics, hydrology and morphology) to the point that they no longer support habitat or environment that is characteristic of wetlands (Fig. 2).

Summary

The Wetland Section will make the following changes in the next quarterly update of the Geomorphic Wetlands Swan Coastal Plain dataset, as reflected within Figure 2:

- Wetland portion B1 is amended from multiple use (MUW) to conservation (CCW) (Figure 2.).
- Wetland portion C is extended 5 metres west and retains a management category of Conservation (Figure 2.).
- Wetland portions B2 and D3 are amended from multiple use (MUW) to resource enhancement (REW) (Figure 2.).
- Portions of wetland UFIs 13347, 14879, 14891 and 7366 are amended from multiple use and conservation to No Longer a Wetland (Figure 2).

References

DBCA, 2017, *A methodology for the evaluation of wetlands on the Swan Coastal Plain, Western Australia*, Department of Biodiversity, Conservation and Attractions, Perth.

Figures

Figure 1 – Current Geomorphic wetland Swan Coastal Plain wetland mapping
Figure 2 – Proposed Geomorphic wetland Swan Coastal Plain mapping

Figure 1: Current Geomorphic Wetlands Swan Coastal Plain Dataset mapping

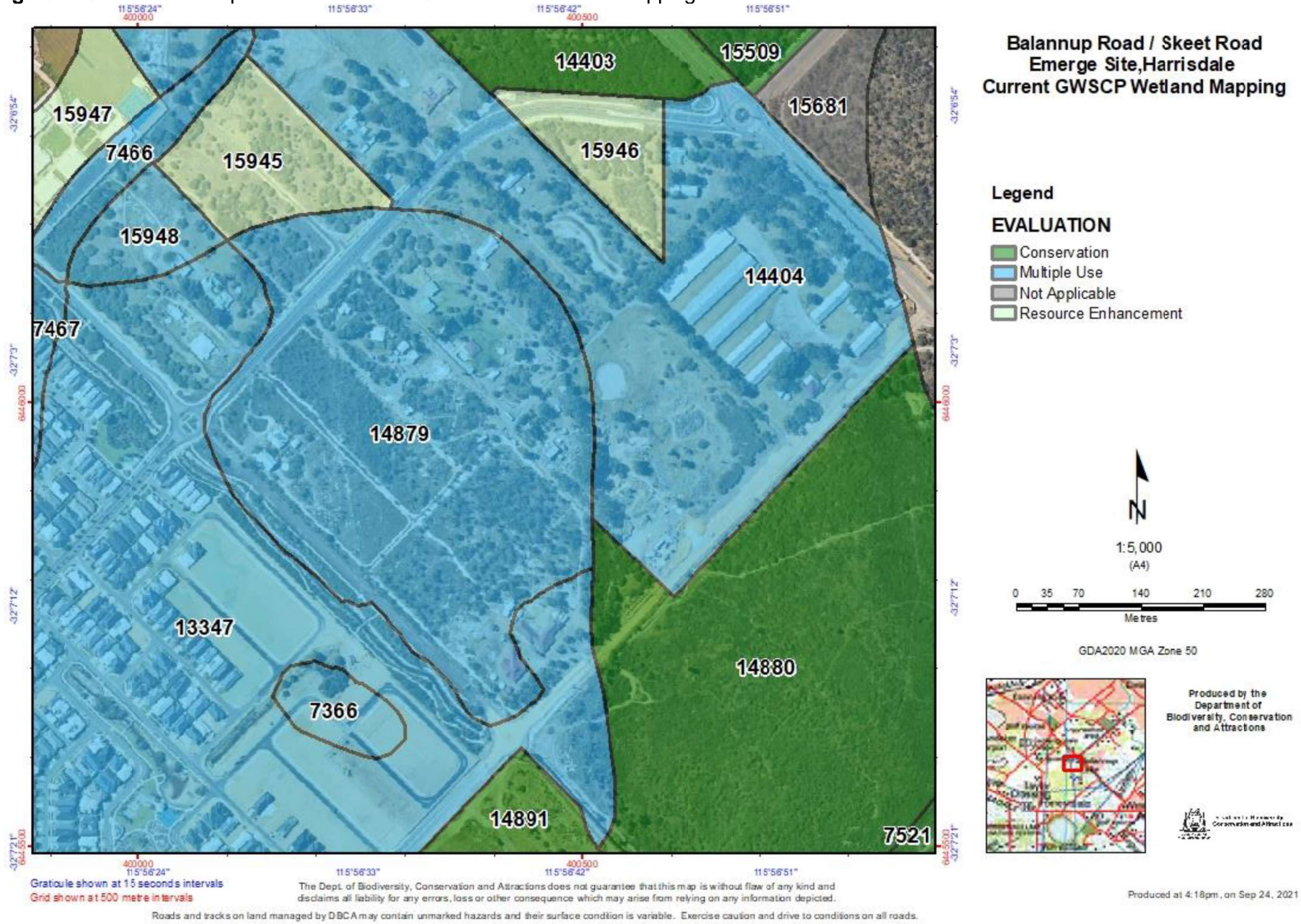
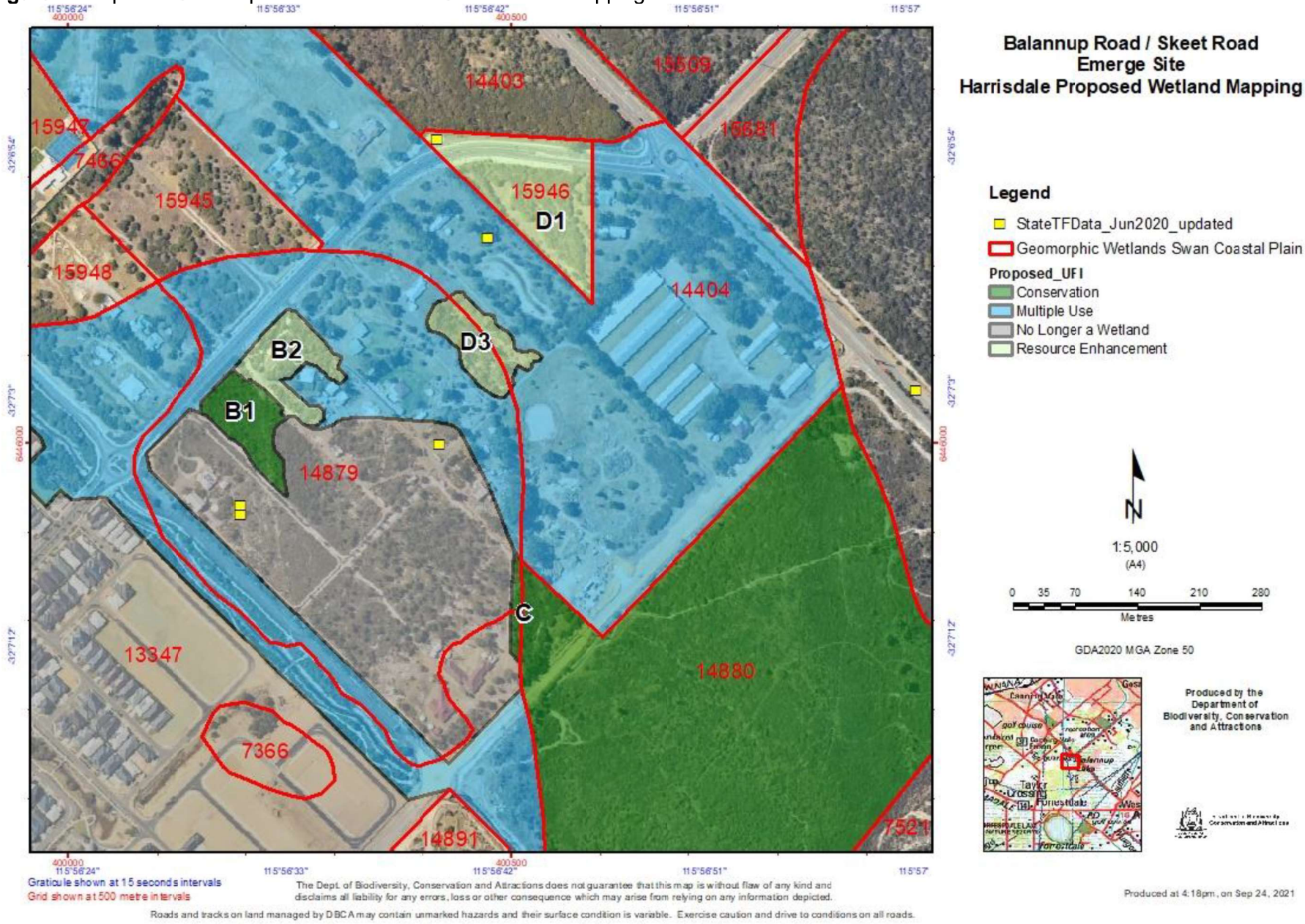


Figure 2: Proposed Geomorphic Wetlands Swan Coastal Plain mapping.



Appendix G

MRA Amendment 1274/57 EPA Advice Letter (2014)

A5032759

GOVERNMENT OF WESTERN AUSTRALIA

Environmental Protection Authority

DEPARTMENT OF PLANNING
16 JUL 2014
FILE RLS/0463

Secretary
Western Australian Planning Commission
Locked Bag
PERTH WA 6001

Your Ref: 833-2-22-71Pt1
Our Ref: 14-844215
Enquiries: Angela Coletti
Phone: 6145 0806

Attn: Mr Alex Watson

Dear Sir/Madam

DECISION UNDER SECTION 48A(1)(a)
Environmental Protection Act 1986

SCHEME AMENDMENT TITLE:	**Western Australian Planning Commission - Metropolitan Region Scheme Amendment 1274/57**
LOCATION:	**Balannup/Skeet Road Precinct**
LOCALITY:	**Harrisdale**
RESPONSIBLE AUTHORITY:	**Western Australian Planning Commission**
DECISION:	**Scheme Amendment Not Assessed – Advice Given (no appeals)**

Thank you for referring the above scheme amendment to the Environmental Protection Authority (EPA).

After consideration of the information provided by you, the Environmental Protection Authority (EPA) considers that the proposed scheme amendment should not be assessed under Part IV Division 3 of the *Environmental Protection Act 1986* (EP Act) but nevertheless provides the following advice and recommendations.

ADVICE AND RECOMMENDATIONS

1. Environmental Issues

- Human Health
- Hydrological Processes
- Flora and Vegetation
- Terrestrial Fauna

2. Advice and recommendations regarding Environmental Issues

In January 2013, the Office of the Environmental Protection Authority (OEPA) wrote to the Western Australian Planning Commission (WAPC) stating that the EPA has no objection to the initiation of the proposed amendment.

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The OEPA notes that a number of environmental and planning issues need to be resolved prior to the lifting of Urban Deferred zone. These include: flora and fauna; wetlands; acid sulphate soils; soil contamination; and traffic noise. Arrangements to close the poultry farm located at Lot 172 Skeet Road, and appropriate buffers to the kennels and Balannup Lake also to be finalised.

The OEPA also notes that Bush Forever Site 413 is located north and Bush Forever Site 342 is located to the south and east of the subject land. The Balannup Lake is located to the north of the subject land.

The EPA recommends that additional management measures be required to ensure that that there are no negative impacts to the surrounding Bush Forever sites and Balannup Lake reserve.

3. General Advice

- For the purposes of Part IV of the EP Act, the scheme amendment is defined as an assessed scheme amendment. In relation to the implementation of the scheme amendment, please note the requirements of Part IV Division 4 of the EP Act.
- There is no appeal right in respect of the EPA's decision on the level of assessment of scheme amendments.
- A copy of this advice will be sent to the relevant authorities and will be available to the public on request.

Yours faithfully

Darren Foster
Director
Strategic Policy and Planning Division

14 July 2014

APPENDIX 5 – ACOUSTIC REPORT

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Noise Assessment

Proposed Subdivision, Harrisdale

Reference: 21066443-01A

Prepared for:
Emerge / Yolk Property

Report: 21066443-01A

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This report has been prepared in accordance with the scope of services described in the contract or agreement between Lloyd George Acoustics Pty Ltd and the Client. The report relies upon data, surveys, measurements and results taken at or under the particular times and conditions specified herein. Any findings, conclusions or recommendations only apply to the aforementioned circumstances and no greater reliance should be assumed or drawn by the Client. Furthermore, the report has been prepared solely for use by the Client, and Lloyd George Acoustics Pty Ltd accepts no responsibility for its use by other parties.

Date:	Rev	Description	Prepared By	Verified
30-Jul-21	0	Issued to Client	Terry George	Matt Moyle
16-Aug-23	A	Updated with new subdivision and updated kennel monitoring	Terry George	-

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1 INTRODUCTION

It is proposed to subdivide a number of lots bound by Ranford Road, Balannup Road, Reilly Road and Skeet Road in Harrisdale, as generally located in *Figure 1-1*. Shown on *Figure 1-2* is the proposed subdivision concept whereby commercial would be located towards Ranford Road and the remainder being residential and public open space.



Figure 1-1 Proposed Subdivision Locality

In accordance with *State Planning Policy No. 5.4 Road and Rail Noise* (SPP 5.4), Ranford Road is considered a Strategic Freight/Major Traffic Route and therefore an assessment of road traffic noise is required. SPP 5.4 provides a trigger distance of 300 metres for such a road and this has been shown on *Figure 1-3*.

In addition to road traffic, dog kennels exist to the northwest in Hatch Court, Harrisdale and to the southeast of Matison Street, Southern River. Dog kennels are provided with a 500 metre buffer and this is also shown on *Figure 1-3*.

Being within the trigger/buffer distances does not mean that land cannot be developed for residential purposes, but rather a noise assessment is required and appropriate noise management incorporated, being the purpose of this report.

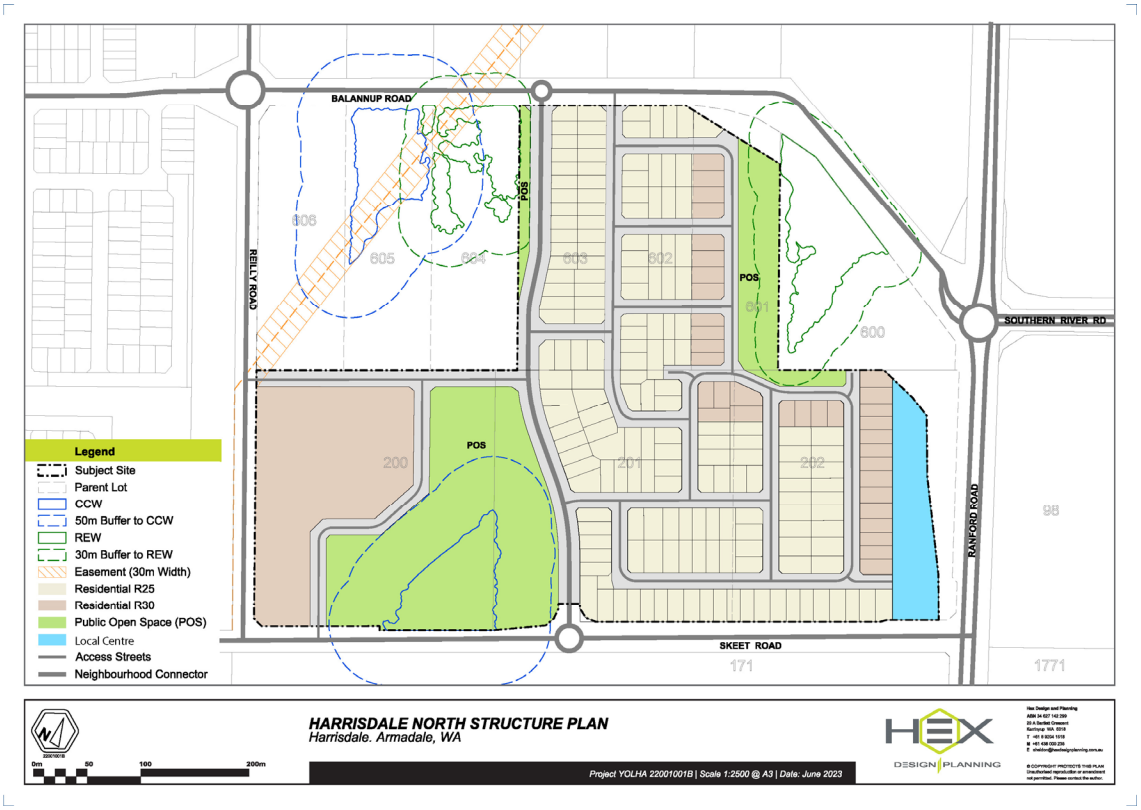


Figure 1-2 Proposed Subdivision Plan

Appendix B contains a description of some of the terminology used throughout this report.

Figure 1-3



Signs and symbols

- Subject Site
- 500m Kennel Buffer
- 300m Road Trigger
- Active Kennel License
- Logger Locations - Short 2021
- Logger Locations - Long 2023

N

Length Scale 1:10000

0 50 100 200 300 400 m

Proposed Subdivision Harrisdale -
Ranford Road Trigger and Kennel Buffers Across Site

SoundPLAN v8.2

14 August 2023

Lloyd George Acoustics
PO Box 717
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2 CRITERIA

2.1 Road Traffic Noise

The criteria relevant to this assessment is provided in *State Planning Policy No. 5.4 Road and Rail Noise* (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC). The objectives of SPP 5.4 are to:

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

Table 2-1 sets out noise targets that are to be achieved by proposals under which SPP 5.4 applies. Where the targets are exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

Table 2-1 Noise Targets for Noise-Sensitive Land-Use

Outdoor Noise Target		Indoor Noise Target	
55 dB $L_{Aeq(Day)}$	50 dB $L_{Aeq(Night)}$	40 dB $L_{Aeq(Day)}$ (Living and Work Areas)	35 dB $L_{Aeq(Night)}$ (Bedrooms)

Notes:

- Day period is from 6am to 10pm and night period from 10pm to 6am.
- The outdoor noise target is to be measured at 1-metre from the most exposed, habitable[1] facade of the noise sensitive building.
- For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonable drawn from Table 1 of Australian Standard/New Zealand Standard AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors (as amended) for each relevant time period.
- Outdoor targets are to be met at all outdoor areas as far as is reasonable and practicable to do so using the various noise mitigation measures outlined in the Guidelines.

The application of SPP 5.4 is to consider anticipated traffic volumes for the next 20 years from when the noise assessment is undertaken.

[1] A habitable room is defined in State Planning Policy 3.1 as a room used for normal domestic activities that includes a bedroom, living room, lounge room, music room, sitting room, television room, kitchen, dining room, sewing room, study, playroom, sunroom, gymnasium, fully enclosed swimming pool or patio.

In the application of the noise targets, the objective is to achieve:

- indoor noise levels specified in *Table 2-1* in noise-sensitive areas (e.g. bedrooms and living rooms of houses and school classrooms); and
- a reasonable degree of acoustic amenity for outdoor living areas on each residential lot. For non-residential noise-sensitive developments, for example schools and childcare centres, the design of outdoor areas should take into consideration the noise target.

2.2 Kennel Noise

Noise from kennels is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

Regulation 7 defines the prescribed standard for noise emissions as follows:

"7. (1) Noise emitted from any premises or public place when received at other premises –

(a) *Must not cause or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind; and*

(b) *Must be free of –*

i. tonality;

ii. impulsiveness; and

iii. modulation,

when assessed under regulation 9"

A *"…noise emission is taken to significantly contribute to a level of noise if the noise emission … exceeds a value which is 5 dB below the assigned level…"*

Tonality, impulsiveness and modulation are defined in Regulation 9. Noise is to be taken to be free of these characteristics if:

(a) The characteristics cannot be reasonably and practicably removed by techniques other than attenuating the overall level of noise emission; and

(b) The noise emission complies with the standard prescribed under regulation 7 after the adjustments of *Table 2-2* are made to the noise emission as measured at the point of reception.

Table 2-2 Adjustments Where Characteristics Cannot Be Removed

Where Noise Emission is Not Music			Where Noise Emission is Music	
Tonality	Modulation	Impulsiveness	No Impulsiveness	Impulsiveness
+ 5 dB	+ 5 dB	+ 10 dB	+ 10 dB	+ 15 dB

Note: The above are cumulative to a maximum of 15dB.

The baseline assigned levels (prescribed standards) are specified in Regulation 8 and are shown in *Table 2-3*.

Table 2-3 Baseline Assigned Noise Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Commercial	All hours	60	75	80
Industrial	All hours	65	80	90

1. ***highly sensitive area*** means that area (if any) of noise sensitive premises comprising —
   (a) a building, or a part of a building, on the premises that is used for a noise sensitive purpose; and
   (b) any other part of the premises within 15 metres of that building or that part of the building.

The influencing factor, applicable at the future noise sensitive premises within the proposed development varies from 0, 2 or 6 dB, depending on a residences proximity to Ranford Road, being considered a major road (29,337 vehicles per day (vpd) 2019/20 MRWA Site #4775).

Table 2-4 shows the assigned noise levels including the influencing factor at the receiving locations.

Table 2-4 Assigned Noise Levels

Noise sensitive premises: highly sensitive area[1]	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Greater than 450m from Ranford Road	0700 to 1900 hours Monday to Saturday (Day)	45	55	65
	0900 to 1900 hours Sunday and public holidays (Sunday)	40	50	65
	1900 to 2200 hours all days (Evening)	40	50	55
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35	45	55
Within 450m But Greater than 100m from Ranford Road	0700 to 1900 hours Monday to Saturday (Day)	47	57	67
	0900 to 1900 hours Sunday and public holidays (Sunday)	42	52	67
	1900 to 2200 hours all days (Evening)	42	52	57
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	37	47	57
Within 100m from Ranford Road	0700 to 1900 hours Monday to Saturday (Day)	51	61	71
	0900 to 1900 hours Sunday and public holidays (Sunday)	46	56	71
	1900 to 2200 hours all days (Evening)	46	56	61
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	41	51	61

1. ***highly sensitive area*** means that area (if any) of noise sensitive premises comprising —
   (a) a building, or a part of a building, on the premises that is used for a noise sensitive purpose; and
   (b) any other part of the premises within 15 metres of that building or that part of the building.

It is noted the assigned noise levels are statistical levels and therefore the period over which they are determined is important. The Regulations define the Representative Assessment Period (RAP) as *a period of time of not less than 15 minutes, and not exceeding 4 hours*, which is determined by an *inspector* or *authorised person* to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission. An *inspector* or *authorised person* is a person appointed under Sections 87 & 88 of the *Environmental Protection Act 1986* and include Local Government Environmental Health Officers and Officers from the Department of Environment Regulation. Acoustic consultants or other environmental consultants are not appointed as an *inspector* or *authorised person*. Therefore, whilst this assessment is based on a 4 hour RAP, which is assumed to be appropriate given the nature of the operations, this is to be used for guidance only.

3 METHODOLOGY

3.1 Road Traffic

Noise measurements and modelling have been undertaken generally in accordance with the requirements of SPP 5.4 and associated Guidelines[2] as described in *Section 3.1.1* and *Section 3.1.2*.

3.1.1 Site Measurements

Noise monitoring was undertaken 11 metres from Ranford Road in 2021 in order to:

- Quantify the existing noise levels;
- Determine the differences between different acoustic parameters ($L_{A10,18hour}$, $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$); and
- Calibrate the noise model for existing conditions.

The instrument used was an ARL Type 316 noise data logger (S/N: 15-301-468), with the microphone 1.4 metres above ground level (refer *Figure 3-1*). The logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. This instrument complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger was field calibrated before and after the measurement session and found to be accurate to within +/- 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificate for the loggers.

[2] Road and Rail Noise Guidelines, September 2019



Figure 3-1 Photograph of Noise Logger on Site

3.1.2 Noise Modelling

The computer programme *SoundPLAN 8.2* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Classes 1 & 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two sources, at heights of 1.5 metres and 3.6 metres above road level, to represent the engine and exhaust respectively. By splitting the noise source into three, allows for less barrier attenuation for high level sources where barriers are to be considered;
- Note that a -8.0 dB correction is applied to the exhaust and -0.8 dB to the engine (based on Transportation Noise Reference Book, Paul Nelson, 1987), so as to provide consistent results with the CoRTN algorithms for the no barrier scenario.

Predictions are made at heights of 1.4 m above ground floor level for single storey houses and 4.2 m for double storey houses. The noise is predicted at 1.0 metre from an assumed building facade resulting in a + 2.5 dB correction due to reflected noise.

Various input data are included in the modelling such as ground topography, road design, traffic volumes etc. These model inputs are discussed in the following sections.

Ground Topography

Topographical and road design data for this project was a combination of survey data and spot heights taken from publicly available data e.g. *Google*. The concept design levels have also been incorporated into the model, as provided by Porter Consulting Engineers on 14 August 2023.

Buildings have also been included as these can provide barrier attenuation when located between a source and receiver, in much the same way as a hill or wall provides noise shielding. All buildings are modelled as single storey with a height of 3.5 metres. This means where calculations are undertaken for upper floors, the noise is going over the top of the single storey buildings.

Traffic Data

Traffic data includes:

- Road Surface – The noise relationship between different road surface types is shown in *Table 3-1*.

Table 3-1 Noise Relationship Between Different Road Surfaces

Road Surfaces							
Chip Seal				Asphalt			
14mm	10mm	5mm	Slurry	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	+1.0 dB	0.0 dB	-0.2 dB	-1.5 dB	-2.5 dB

The existing road surface is dense graded asphalt and is expected to remain unchanged into the future.

- Vehicle Speed – The existing and future posted speeds are 80km/hr.

- Traffic Volumes – Existing traffic volumes were obtained from the Main Roads WA Traffic Map (Site #4775). At the time of the report, forecast traffic volumes were not provided by Main Roads WA, such that these were estimated to be around 20,000 vehicles per day in each direction with the percentage heavy assumed unchanged based on general information provided by Porter Consulting Engineers. *Table 3-2* provides the traffic volume input data in the model.

Table 3-2 Traffic Information Used in the Modelling

Parameter	Scenario			
	Existing – 2019/20		Future - 2041	
	Northbound	Southbound	Northbound	Southbound
24 Hour Volume	14,976	14,361	20,000	20,000
% Heavy	8.5	7.5	8.5	7.5

Ground Attenuation

The ground attenuation has been assumed to be 0.0 (0%) for the road and commercial area, 0.6 (60%) throughout the subdivision, except for the public open spaces, which were set to 1.00 (100%). Note 0.0 represents hard reflective surfaces such as water and 1.0 represents absorptive surfaces such as grass.

Parameter Conversion

The CoRTN algorithms used in the *SoundPlan* modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. SPP 5.4 however uses $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$. The relationship between the parameters varies depending on the composition of traffic on the road (volumes in each period and percentage heavy vehicles).

As noise monitoring was undertaken, the relationship between the parameters is based on the results of the monitoring – refer *Section 4.1*.

3.2 Kennel Noise

3.2.1 Site Measurements

Under the Regulations, there are certain requirements that must be satisfied when undertaking measurements and are defined in Regulations 19, 20, 22 and 23 and Schedule 4. In undertaking the measurements, these have been satisfied, specifically noting the following:

- The sound level meter used was a Bruel & Kjaer Type 2250 (S/N: 3011946). This was used to undertake roving measurements throughout the kennel area around Matison Street, Talbot Road and Cairn Road on Sunday 11 July 2021, between 6.00am and 9.00am. This period was chosen to coincide with the critical night period of the Regulations and the school holiday period, where kennel occupancy is likely to be at its maximum.
- Two noise data loggers were used during the same session as above to provide further analysis at a fixed point. The noise data loggers used were:
    - ARL Type Ngara (S/N: 878210) on Matison Street, approximately 70m east of Ranford Road; and
    - ARL Type Ngara (S/N: 87803E) at the eastern end of the newly constructed road alongside North Harrisdale Primary School (Colville Street).
- At the request of the local government, longer term noise monitoring was undertaken over a 1-week period between 28 July to 4 August 2023 as follows:
    - ARL Type Ngara (S/N: 878210) on Matison Street, approximately 200m northeast of Ranford Road and 35 metres northwest of Matison Street in the bushland; and
    - ARL Type Ngara (S/N: 8781CA) towards the northern end of the private property of #30 Balannup Road, Harrisdale and approximately 200 metres southwest of Ranford Road. Note that the resident has lived on this property for over 10 years and stated she rarely hears any dog barking.

  These logger locations are shown on *Figure 1-3*.

- All equipment holds current laboratory certificates of calibration that are available upon request. The equipment was also field calibrated before and after and found to be within +/- 0.5 dB.
- Each microphone was fitted with a standard wind screen.
- The microphones were at least 1.2 metres above ground level and at least 3.0 metres from reflecting facades (other than the ground plane).

For the 2021 measurements were recorded on 11 July 2021 between 6.00am and 9.00am. Meteorological conditions at the time, recorded at the Bureau of Meteorology's Jandakot site, were:

- Temperature 13°C
- Humidity 77%
- Wind Speed 4.7m/s
- Wind Direction East-North-Easterly
- Rainfall 0

For the 2023 measurements, the focus was on the early morning period prior to 7.00am. Whilst rooster calling and dog barking were audible, by 6.00am there was significant traffic that dog noise could not be quantified. The Sunday morning period from 5.00am (30 July 2023) through to 9.00am became the focus, which is night-time in the Noise Regulations. Again, by 6.00am road traffic noise became dominant. Between 5.00am and 6.00am, the weather conditions were:

- Temperature 13°C
- Humidity 99%
- Wind Speed Calm
- Wind Direction N/A
- Rainfall 0

In both cases, background noise was dominated by road traffic, with intermittent noise from birds as well as some aircraft noise. Also, rooster calling occurred at the Matison Street area, which was not removed from the data set.

3.2.2 Noise Modelling

As described in *Section 3.1.2*, the software used to predict noise levels to the site was *SoundPLAN 8.2* with the CONCAWE (ISO 17534-3 improved method) algorithms selected. These algorithms have been selected as they include the influence of wind and atmospheric stability. Input data required in the model are:

- Meteorological Information;
- Topographical data;
- Ground Absorption; and
- Source sound power levels.

Meteorological Information

Meteorological information utilised is provided in *Table 3-3* and is considered to represent worst-case conditions for noise propagation. At wind speeds greater than those shown, sound propagation may be further enhanced, however background noise from the wind itself and from local vegetation is likely to be elevated and dominate the ambient noise levels.

Table 3-3 Modelling Meteorological Condition

Parameter	Night (1900-0700)
Temperature (°C)	15
Humidity (%)	50
Wind Speed (m/s)	3
Wind Direction*	All
Pasquil Stability Factor	F

* Note that the modelling package used allows for all wind directions to be modelled simultaneously.

It is generally considered that compliance with the assigned noise levels needs to be demonstrated for 98% of the time, during the day and night periods, for the month of the year in which the worst-case weather conditions prevail. In most cases, the above conditions occur for more than 2% of the time and therefore must be satisfied.

Topographical Data and Ground Absorption

As described previously in *Section 3.1.2*.

3.2.3 Source Sound Levels

The critical sound power levels used in the modelling are provided in *Table 3-4*. These were derived from the measurements as described in *Section 4.2*, noting barking in the Hatch Court area was less frequent, albeit louder than that at Matison Street, which was more continuous but at a lower level. Dog barking is modelled as 1-metre above ground level.

Table 3-4 Kennel Source Sound Power Levels, dB(A)

Description	Octave Band Centre Frequency (Hz)								Overall
	63	125	250	500	1k	2k	4k	8k	
Hatch Court Kennels – L_{A1}	81	85	96	113	103	87	71	63	**114**
Matison Street Kennels – L_{A10}	68	72	83	100	90	74	58	50	**101**

4 RESULTS

4.1 Road Traffic

The results of the noise monitoring are summarised in *Table 4-1* and shown graphically in *Figure 4-1*.

Table 4-1 Measured Average Noise Levels

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
Thu 24-Jun-21	70.8	66.8	68.1	62.0
Fri-25-Jun-21	71.3	67.1	68.4	62.3
Sat 26-Jun-21	*70.9*	*66.4*	*67.7*	*61.1*
Sun 27-Jun-21	*70.4*	*66.1*	*67.7*	*58.3*
Mon 28-Jun-21	*70.8*	*67.1*	*68.3*	*62.4*
Tue 29-Jun-21	*69.9*	*66.2*	*67.3*	*62.0*
Wed 30-Jun-21	*69.5*	*65.7*	*67.0*	*61.0*
Thu 1-Jul-21	*69.6*	*66.1*	*67.4*	*60.7*
Weekday Average	**71.1**	**67.0**	**68.2**	**62.1**

Italics results not used in average

Note the average shown is for the 24 and 25 June 2021 only as the following week, from Sunday midday, Western Australia went into a Covid-19 related lockdown.

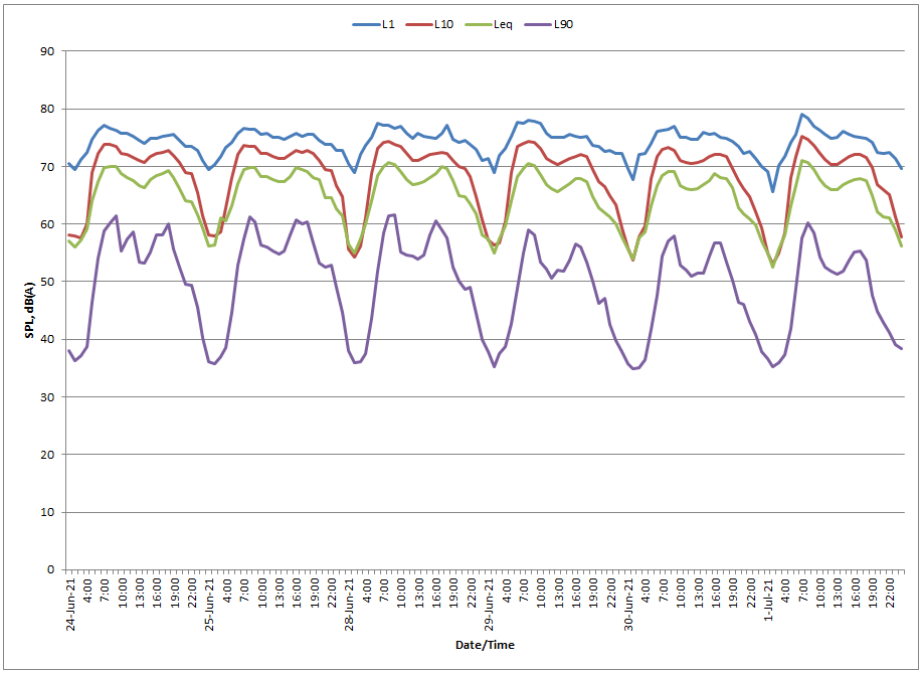


Figure 4-1 Road Traffic Noise Monitoring Results

The average differences between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 6.1 dB and this conversion has been used in the modelling. This same difference has been assumed to exist in future years. As such, it is the daytime noise levels that will dictate compliance since these are at least 5 dB more than night-time levels.

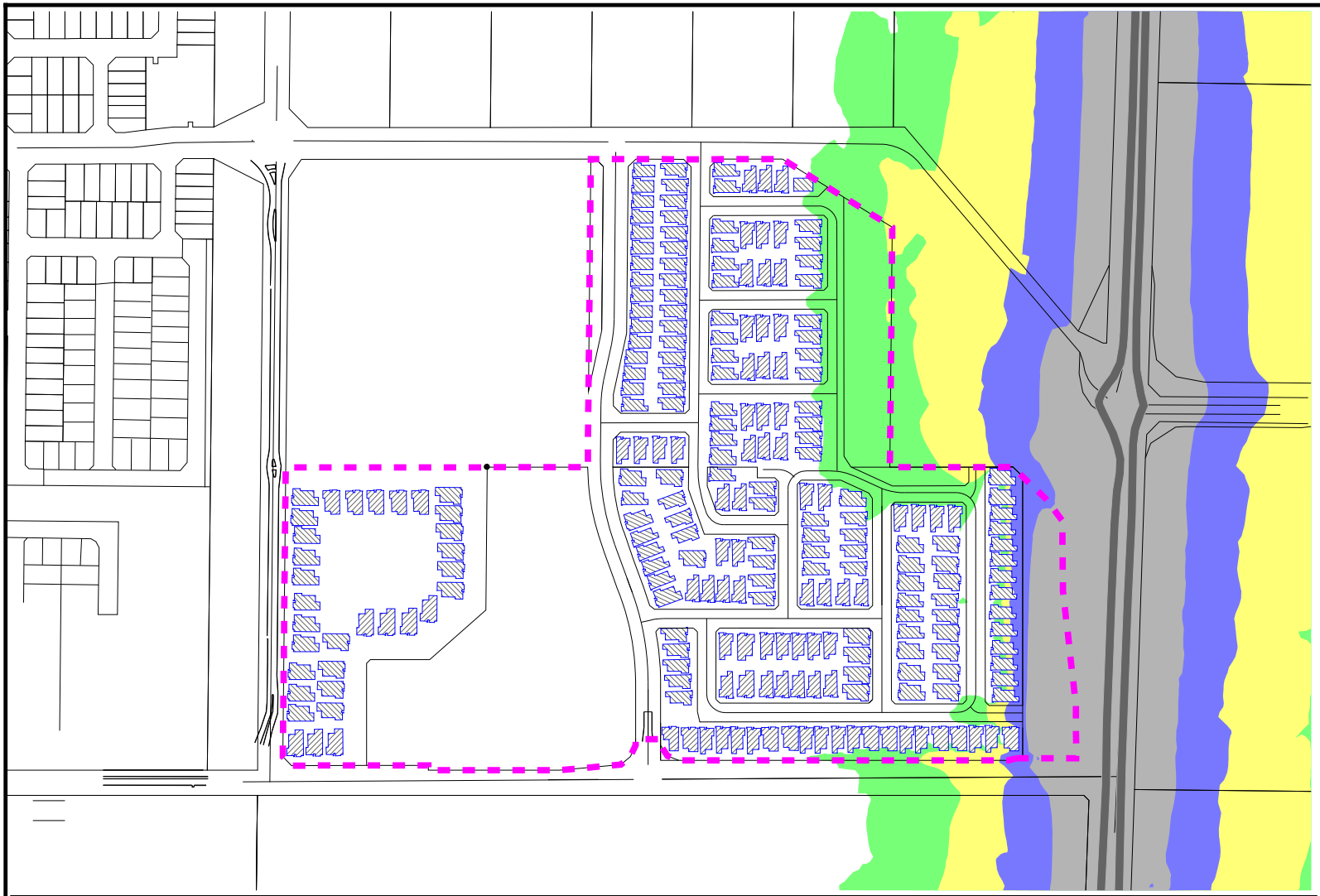
The noise model is initially set-up and calibrated for existing conditions. It is then updated to reflect future conditions incorporating the proposed development and future traffic volumes with the results provided in *Figure 4-2* as an $L_{Aeq(Day)}$ noise level contour plot. It can be seen that noise levels will be above the outdoor noise target at some residences and therefore noise control must be implemented with the following recommended:

- Construct a noise wall as shown in *Figure 4-3* to *Figure 4-6*. The noise wall is to be solid, free of gaps and of minimum surface mass 15 kg/m^2. The noise contours to ground floor and a potential upper floor are provided in *Figure 4-3* and *Figure 4-4* respectively. The wall ranges in height from 2.0m to 2.4m (relative to finished lot level). A portion of standard fencing is also required along Skeet Road.
- Where lots are still above the outdoor noise target, the following Packages (refer *Appendix A*) are required as shown on *Figure 4-5* and *Figure 4-6* for ground and upper floor respectively:
    - Package A where noise levels are between 56 dB and 58 dB $L_{Aeq(Day)}$;
    - Package B where noise levels are between 59 dB and 62 dB $L_{Aeq(Day)}$;
    - Package C where noise levels are between 63 dB and 66 dB $L_{Aeq(Day)}$;

      Alternative constructions from the deemed to satisfy packages may be acceptable if supported by a report undertaken by a suitably qualified acoustical consultant (member firm of the Association of Australasian Acoustical Consultants (AAAC)), once the lots specific building plans are available.
- All affected lots are to have notifications on lot titles as per SPP 5.4 requirements – refer *Appendix A*.

Note that the proposed noise walls and architectural packages will also provide acoustic mitigation of the dog kennel noise, as well as providing a visual and acoustic barrier to separate the commercial land and residential land.

Figure 4-2



Noise levels
$L_{Aeq(Day)}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

Signs and symbols
- Ranford Road
- Indicative Building
- Subject Site

Length Scale 1:5000

0 25 50 100 150 200 m

Proposed Subdivision Harrisdale -
Future $L_{Aeq(Day)}$ Noise Level Contours - Ground Floor

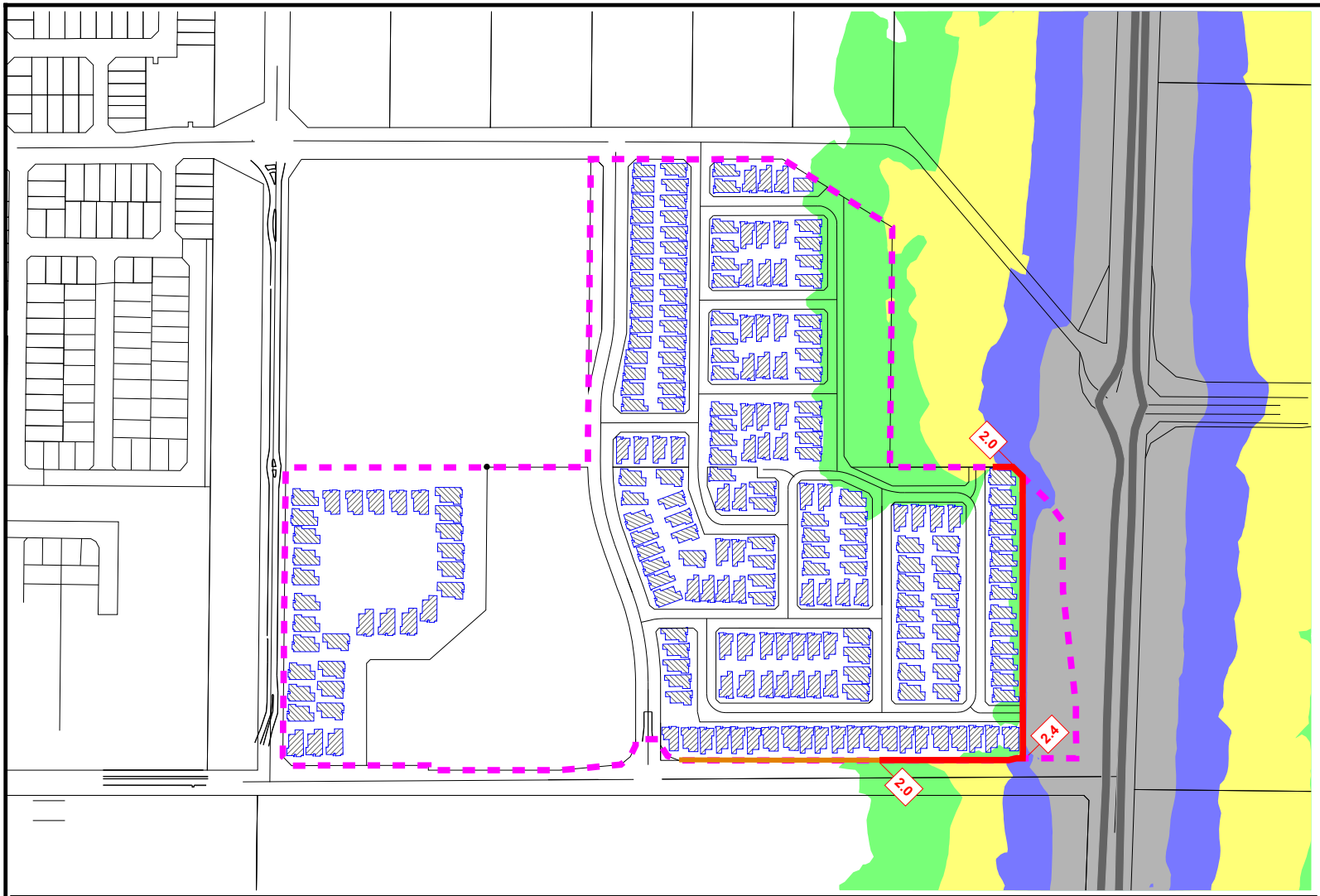
Assumed 40,000 vpd on Ranford Road for 2041

SoundPLAN v8.2
CoRTN Algorithms

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Figure 4-3



Noise levels
$L_{Aeq(Day)}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

Signs and symbols
- Ranford Road
- Indicative Building
- Std Fence
- Noise Wall
- Subject Site

N

Length Scale 1:5000

0 25 50 100 150 200 m

Proposed Subdivision Harrisdale -
Future $L_{Aeq(Day)}$ Noise Level Contours - Ground Floor (With Wall)

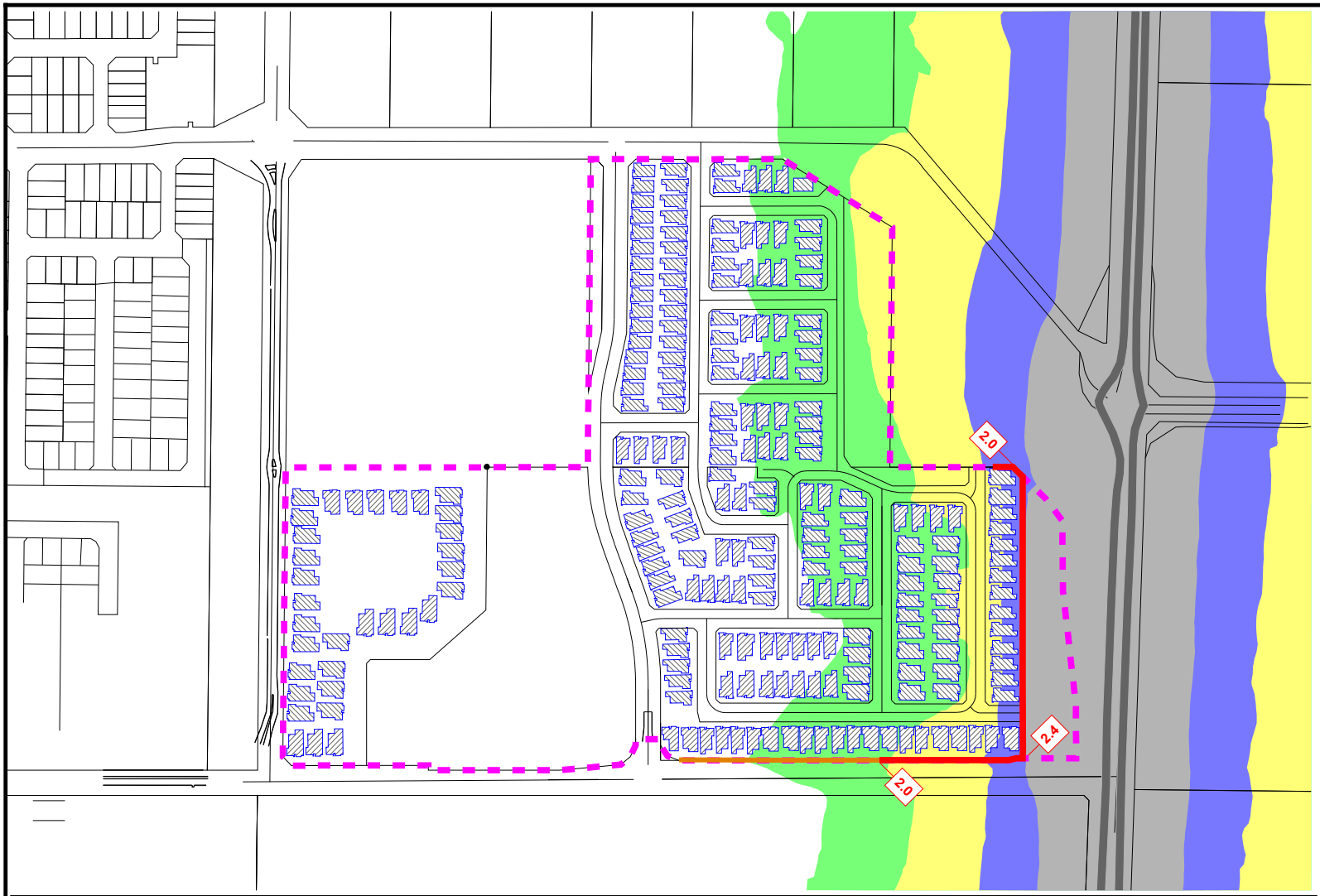
Includes Fence and Wall for Road Traffic Mitigation (Read Left to Right Down to Up)
Assumed 40,000 vpd on Ranford Road for 2041

SoundPLAN v8.2
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Figure 4-4



Noise levels
$L_{Aeq(Day)}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

Signs and symbols
- Ranford Road
- Indicative Building
- Std Fence
- Noise Wall
- Subject Site

N

Proposed Subdivision Harrisdale -
Future $L_{Aeq(Day)}$ Noise Level Contours - Upper Floor (With Wall)

Includes Fence and Wall for Road Traffic Mitigation (Read Left to Right Down to Up)
Assumed 40,000 vpd on Ranford Road for 2041

SoundPLAN v8.2
CoRTN Algorithms

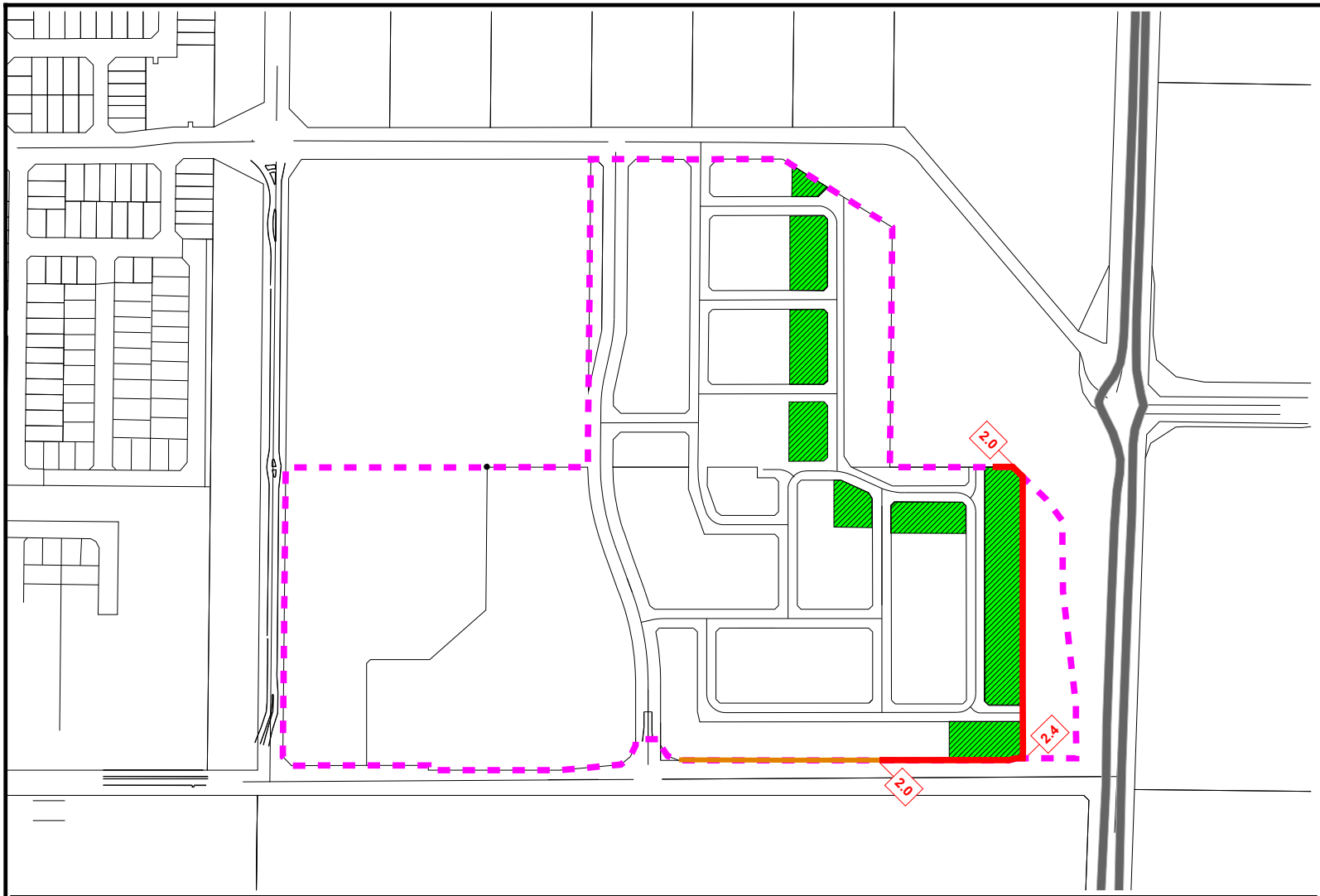
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Length Scale 1:5000

0 25 50 100 150 200 m

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Figure 4-5



Signs and symbols
- Ranford Road
- Std Fence
- Noise Wall
- Subject Site
- Package A
- Package B
- Package C

Length Scale 1:5000

0 25 50 100 150 200 m

Proposed Subdivision Harrisdale - Mitigation Requirements - Ground Floor (With Wall)

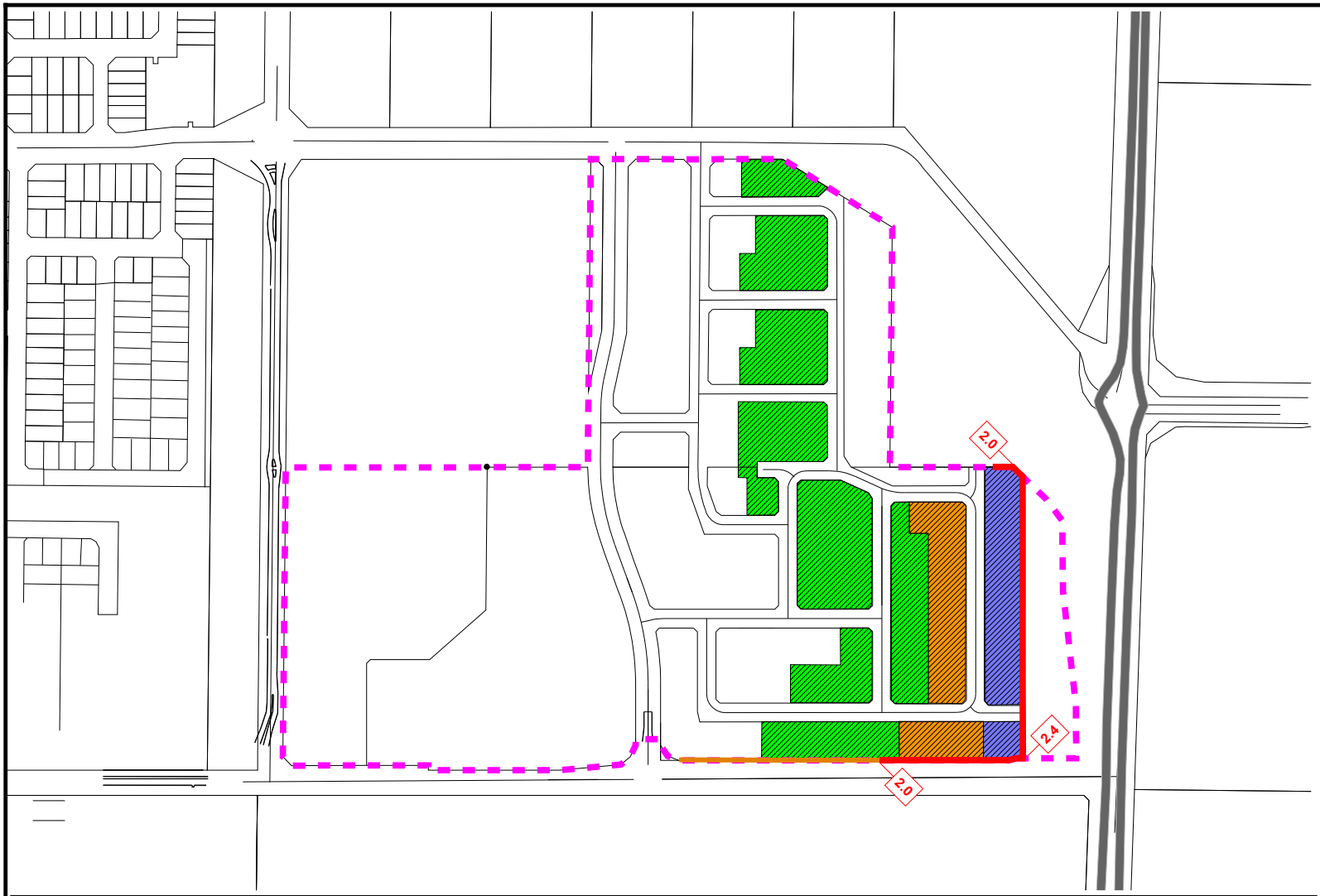
Includes Fence and Wall for Road Traffic Mitigation (Read Left to Right Down to Up)
Assumed 40,000 vpd on Ranford Road for 2041

SoundPLAN v8.2
CoRTN Algorithms

15 Aug 2023

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Figure 4-6



Signs and symbols
- Ranford Road
- Std Fence
- Noise Wall
- Subject Site
- Package A
- Package B
- Package C

Proposed Subdivision Harrisdale -
Mitigation Requirements - Upper Floor (With Wall)

Includes Fence and Wall for Road Traffic Mitigation (Read Left to Right Down to Up)
Assumed 40,000 vpd on Ranford Road for 2041

SoundPLAN v8.2
CoRTN Algorithms

15 August 2023

Length Scale 1:5000

0 25 50 100 150 200 m

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4.2 Kennel Noise

4.2.1 Hatch Court Analysis – Short Term (2021)

The audio files recorded in 2021 near the Hatch Court kennels were reviewed in order to quantify dog barking noise and assess how often barking occurred. The most consistent noise source is from road traffic, resulting in the background noise level generally being around 40 dB L_{A90}. Other intermittent noises were associated with birds mostly, as well as rooster calling. For much of the time, noise from dog barking would blend into background noise, however it began to increase at around 6.25am. From 6.30am to 6.45am, the noise levels were assessed as 49 dB L_{Amax} and 47 dB L_{A1}. No L_{A10} value was recorded for dog barking as the significant barking was present for less than 10% of the time (less than 1-½ minutes in 15-minutes). Between 6.45am and 7.00am the results were similar, albeit slightly quieter. Between 7.00am and 7.15am there was negligible dog barking. From 7.15am to 7.30am, the amount of dog barking was similar to earlier, although at a higher level with results of 56 dB L_{Amax} and 52 dB L_{A1}. The time history for this period is provided in *Figure 4-7* with the red dots indicating times of dog barking events. From 7.30am dog barking was still occurring, however bird noise became significant and traffic noise increased such that quantifying dog barking alone became more difficult, with the exception of 8.30am to 8.45am where there were periods where dog barking noise was above background noise, resulting in calculated levels of 58 dB L_{Amax} and 55 dB L_{A1}.

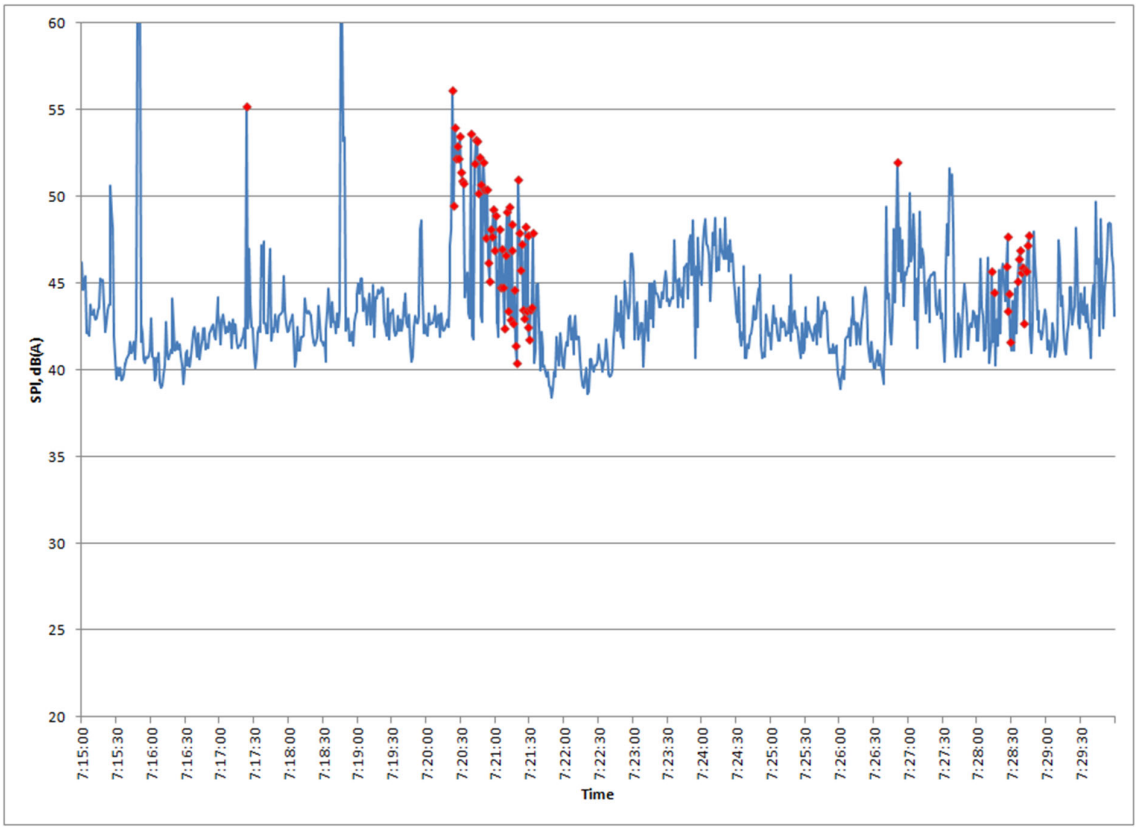


Figure 4-7 Typical Hatch Court Noise Level Measurements

Whilst the L_{A10} level was not quantified, it may be that dog barking at times does occur for more than 10% of the time. However, the level of the dog barking noise becomes difficult to separate from background noise and therefore it is considered the L_{A1} becomes a more representative parameter for intrusiveness.

Using the worst-case 15-minute period, the L_{Amax} and L_{A1} sound power levels are calculated to be 112 dB L_{Amax} and 109 dB L_{A1} respectively. Given the L_{A1} sound power level is within 3 dB of the L_{Amax}, it is the L_{A1} that will determine compliance. The octave band sound power level is provided in *Table 4-2* with the one-third octave band sound pressure level provided in *Figure 4-8*. As the noise is present for less than 10% of the time, it is the 8 dB tonality rule that is applicable rather than the 3 dB rule and as such, the noise is not considered tonal. Impulsiveness is also not considered to be present at the proposed subdivision and barking is not considered to be modulating such that no adjustments for intrusiveness are applicable.

Table 4-2 Hatch Court 2021 Determined Sound Power Level, dB(A)

Description	Octave Band Centre Frequency (Hz)								Overall
	63	125	250	500	1k	2k	4k	8k	
2021 Hatch Court Dog Barking – L_{A1}	76	80	91	108	98	82	66	58	**109**

The above sound power level was positioned in the noise model on each of the Hatch Court Kennels with an active kennel license.

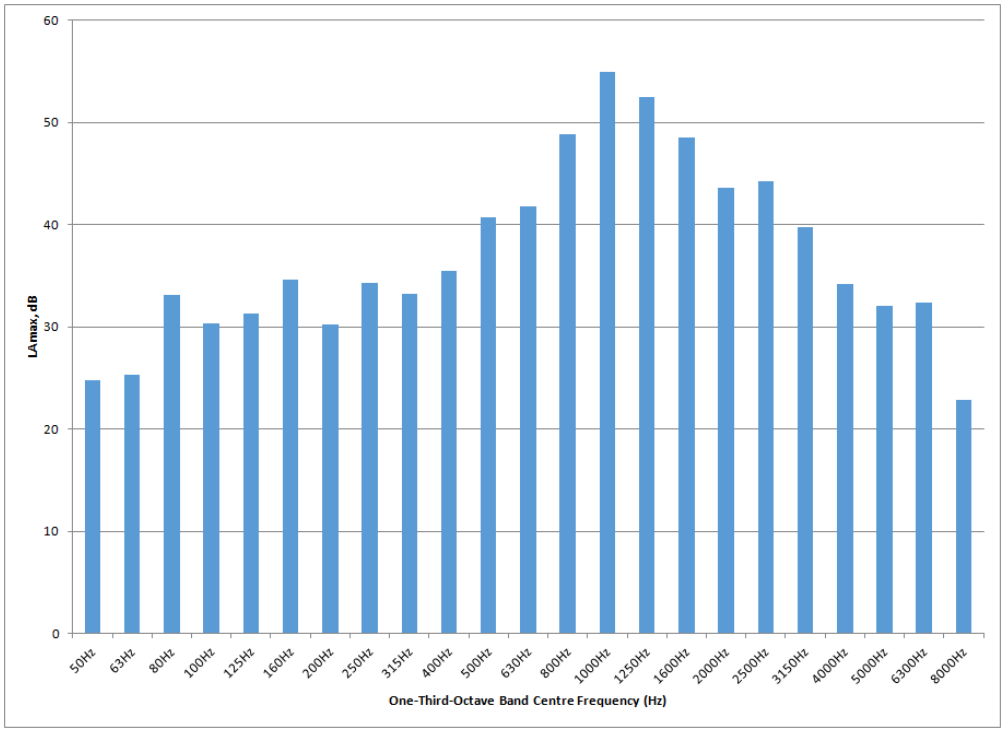


Figure 4-8 Typical Hatch Court Noise Level Measurements

4.2.2 Hatch Court Analysis – Long Term (2023)

Noise monitoring was set-up at the rear of #30 Balannup Road with permission from the resident with the 15-minute data of all recorded noise plotted in *Figure 4-9*. It was noted by the resident that has been there for over 10 years that the dog barking noise is not an issue and is rarely heard. This location was chosen as it is in the direction of the proposed subdivision and the previous monitoring location has now been subdivided so a secure location could not be found.

Upon review of the audio files, the residents statement is generally supported. Even on a Sunday where road traffic noise is less than other days, whilst dog barking noise could occasionally be heard, it could not be quantified. Bird noise and frog noise were also influencing the noise levels. The best data to quantify dog barking noise occurred between 5.00am and 6.00am, where bird calling and road traffic were less and particularly between 5.45am and 6.00am as the worst-case 15-minute period, recording 54 dB L_{Amax} and 51 dB L_{A1}. Outside of this time, dog barking was infrequent.

Again, with limited difference between the L_{Amax} and L_{A1}, it is the L_{A1} that will determine compliance. It is also noted that no L_{A10} value was recorded for dog barking since barking occurred for less than 10% of the time. These recorded levels are approximately 5 dB higher than those from the 2021 short-term measurements and as such, the sound power level has been adjusted accordingly as per *Table 4-3*. Note outside of this 15-minute period, the next worst-case was 48 dB L_{Amax} and 45 dB L_{A1}, which more closely aligns with the 2021 measurements, meaning the use of the *Table 4-3* sound power level is considered conservative.

Table 4-3 Hatch Court 2023 Determined Sound Power Level, dB(A)

Description	Octave Band Centre Frequency (Hz)								Overall
	63	125	250	500	1k	2k	4k	8k	
2021 Hatch Court Dog Barking – L_{A1}	81	85	96	113	103	87	71	63	**114**

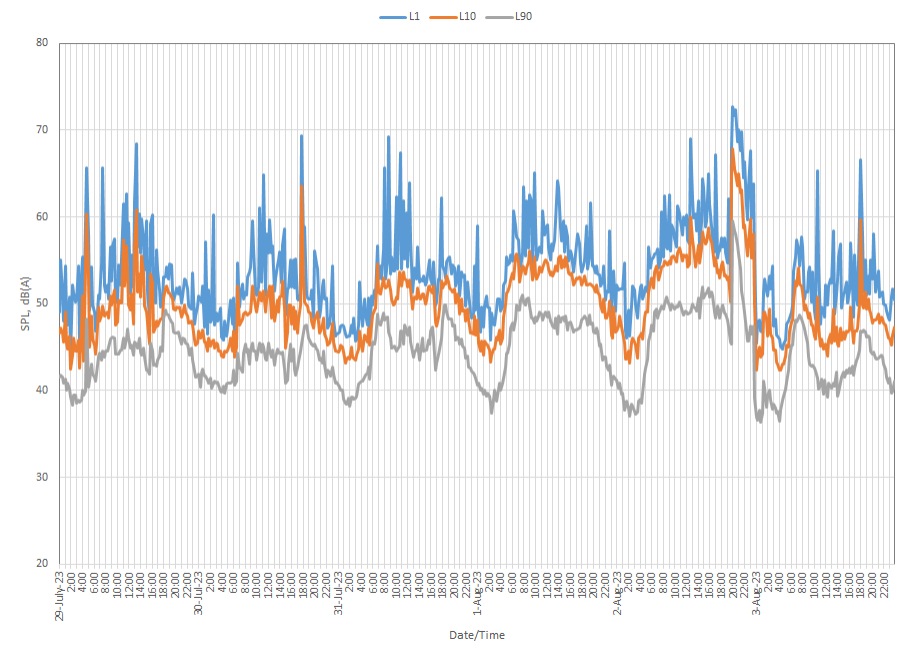


Figure 4-9 Long Term Monitoring at 30 Balinnup Road (2023)

4.2.3 Matison Street Analysis – Short Term (2021)

The audio files at this location were also reviewed. The position of the logger is around 70 metres from Ranford Road and is significantly influenced by road traffic noise. Bird noise is also significant at this location. From the audio files, it is apparent that dog barking noise is more continuous in this area. Whilst the dog barking noise is audible, it is generally not at a level that allows it to be accurately quantified. For instance, the background noise is generally around 45-47 dB(A) and does not change when barking occurs, despite the noise being audible. This indicates that barking noise is below the overall background noise level. Unlike Hatch Court, there were no distinct maximum noise events but rather just distant and much more persistent barking, most likely because of the number of kennels and that they are shielded by buildings to the logger location (and subject site).

As a clean signal could not be obtained from the measurements, the same spectra determined in *Section 4.2.1* has been used. It has then been reduced to an overall level of 101 dB(A) (refer *Table 3-4*), representing an L_{A10} level in this case since dog barking occurs more frequently. This results in a noise level of 45 dB L_{A10} at the Matison Street logger.

4.2.4 Matison Street Analysis – Long Term (2023)

The noise logger on this occasion was set-up further from Ranford Road, in an attempt to minimise road traffic noise, whilst still recording noise in the general direction of the proposed subdivision, with the 15-minute data of all recorded noise provided in *Figure 4-10*.

Reviewing the audio files, road traffic noise still dominates the noise levels in the area and by 6.00am, even on a Sunday, there was too much traffic noise to be able to quantify dog barking noise. The influence of road traffic noise is evident by the day/night trend shown on the logger results. For the Hatch Court logger, with dog barking being infrequent, the barking was extracted from the data set. For this area, the barking is far more consistent, such that data that is influenced by vehicles passing was extracted, with the focus being between 5.00am and 6.00am, as the only period where dog barking was persistent and road traffic was relatively intermittent.

Finding the worst-case 15-minute period, results in noise levels of 53 dB L_{Amax}, 50 dB L_{A1} and 45 dB L_{A10}. Again with relatively small differences between the three parameters, it will be the L_{A10} that determines compliance. The result of 45 dB L_{A10} aligns with that previously used from the 2021 analysis and is therefore unchanged.

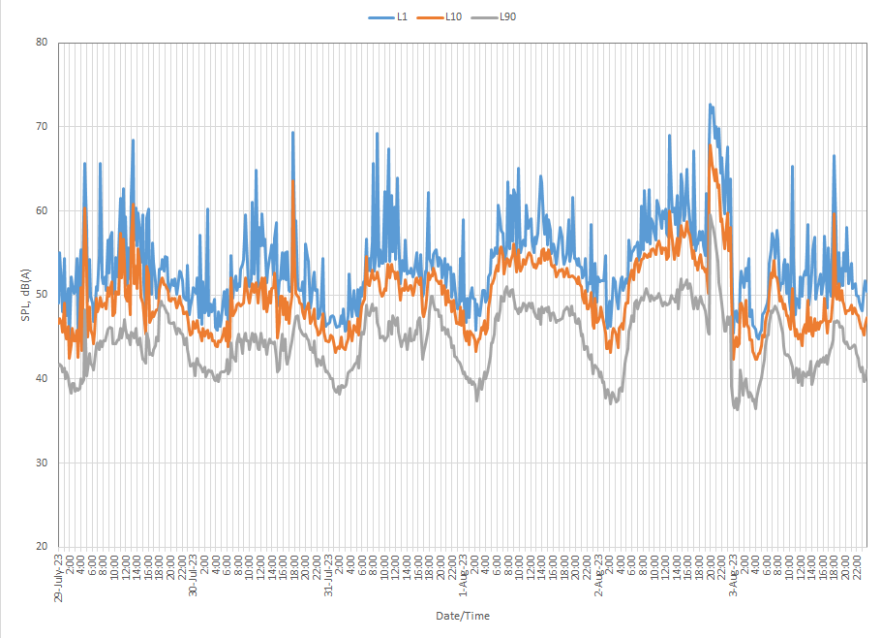


Figure 4-10 Long Term Monitoring at Matison Street (2023)

4.2.5 Hatch Court Noise Modelling

The results from the Hatch Court kennel area are presented as noise contours in *Figure 4-11* and *Figure 4-12*, being for the ground and upper floor levels respectively. Also shown on the contour plots are the lines defining the different areas of assigned noise level, depending on a residences proximity to Ranford Road (refer *Table 2-4*).

As discussed in *Section 4.2.1*, intrusive characteristics are not considered present at the proposed subdivision in accordance with the Regulations and as such, no penalties are considered applicable. This is based on the measurements, the background noise levels and the separation distance. However, the local government commented tonality and impulsiveness should be applied. In past projects (Heron Park and Piara Waters), tonality has been applied to L_{A10} and L_{A1} levels. Impulsiveness has been applied to L_{Amax} levels, however in this project L_{Amax} is less critical for compliance. As such, to be consistent with other approved subdivisions, predicted L_{A1} and L_{A10} noise levels are to be adjusted by 5 dB for tonality.

For those residences within 100 metres of Ranford Road, the most stringent assigned noise level is 51 dB L_{A1}. This reduces to 47 dB L_{A1} for those residences within 450 metres of Ranford Road (and greater than 100 metres). Where a residence is more than 450 metres from Ranford Road, the assigned noise level is 45 dB L_{A1}.

Noise control is to be in the form of notifications on title and architectural packages. For consistency, those used for road traffic have been adopted, although it is noted these are more effective for barking noise than road traffic as there is less low frequency noise as follows:

- Within 5 dB of the assigned level (thereby allowing for tonal penalty) – Package A;
- Up to 5 dB above the assigned level – Package B;
- More than 10 dB above the assigned level – Package C.

The above are noted in *Figure 4-15* and *Figure 4-16* after being combined with the City of Gosnells kennel zone impacts and were defined as:

- Southwest of the blue line the assigned level is 45 dB L_{A1}. Allowing for tonality, lots where noise contours are between 40 dB L_{A1} and 45 dB L_{A1} are to incorporate Package A, which would be all houses in this area.
- Between the blue line and the brown line, the assigned level is 47 dB L_{A1}. Allowing for tonality, lots where noise contours are between 42 dB L_{A1} and 47 dB L_{A1} are to incorporate Package A.
- Northeast of the brown line, the assigned level is 51 dB L_{A1}. Allowing for tonality, lots where noise contours are between 46 dB L_{A1} and 51 dB L_{A1} would need to incorporate Package A. From *Figure 4-11* and *Figure 4-12*, this does not occur in this area, although it is noted that such a package is applied in any case for road traffic.

4.2.6 Matison Street Noise Modelling

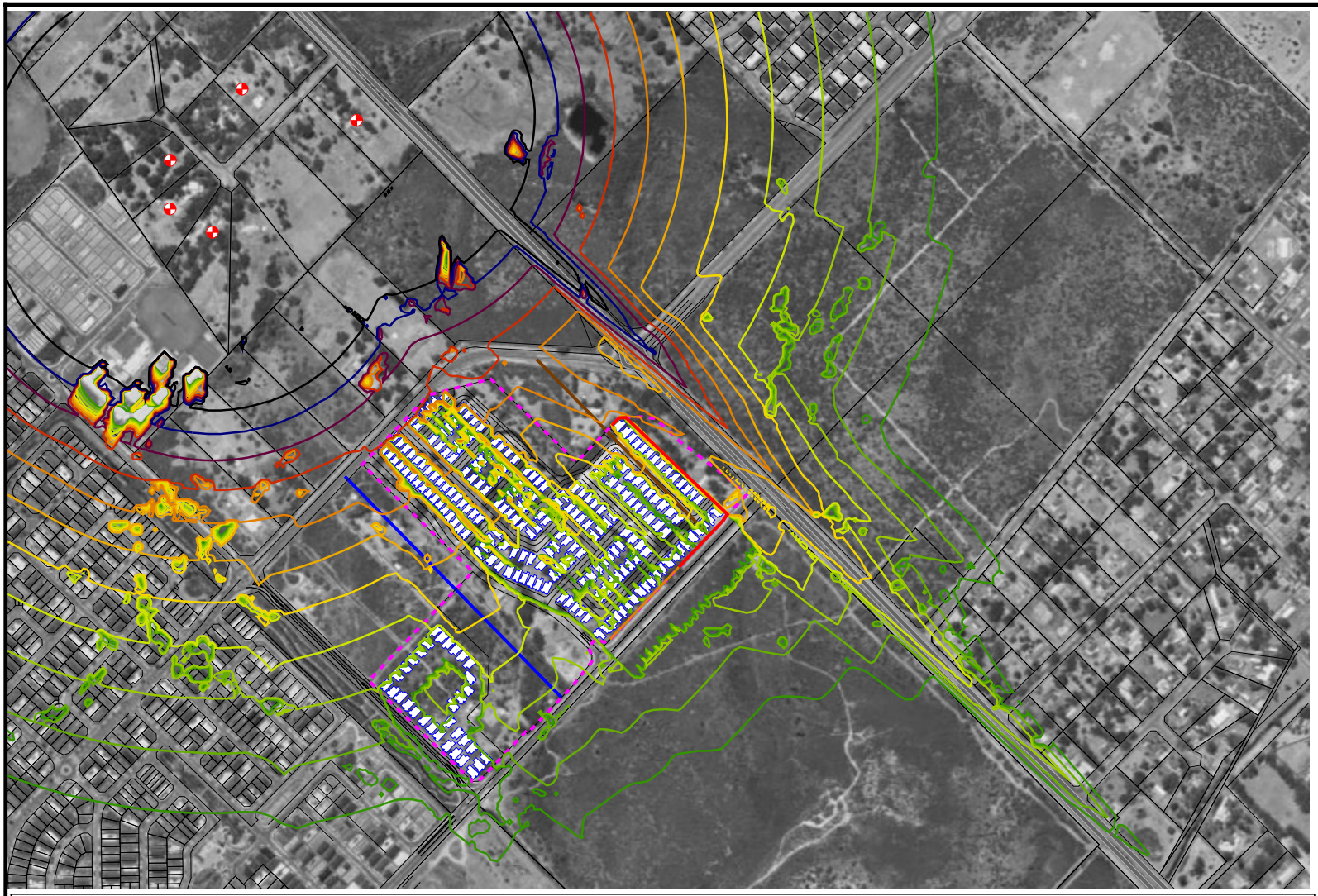
The noise modelling results from the kennel area in City of Gosnells, east of Matison Street are presented as noise contours in *Figure 4-13* and *Figure 4-14*, being for the ground and upper floor levels respectively. Again the contour plots include the lines defining the different areas of assigned noise level, depending on a residences proximity to Ranford Road (refer *Table 2-4*).

For those residences within 100 metres of Ranford Road, the most stringent assigned noise level is 41 dB L_{A10}. This reduces to 37 dB L_{A10} for those residences within 450 metres of Ranford Road (and greater than 100 metres). Where a residence is more than 450 metres from Ranford Road, the assigned noise level is 35 dB L_{A10}. As discussed in *Section 4.2.5*, the + 5 dB tonality adjustment is to be considered.

The above are noted in *Figure 4-15* and *Figure 4-16* after being combined with the Hatch Court kennel impacts and were defined as:

- Southwest of the blue line the assigned level is 35 dB L_{A10}. Allowing for tonality, lots where noise contours are between 30 dB L_{A10} and 35 dB L_{A10} are to incorporate Package A, which would not apply to any of these houses, although it is noted Package A would be implemented due to Hatch Court.
- Between the blue line and the brown line, the assigned level is 37 dB L_{A10}. Allowing for tonality, lots where noise contours are between 32 dB L_{A10} and 37 dB L_{A10} are to incorporate Package A.
- Northeast of the brown line, the assigned level is 41 dB L_{A10}. Allowing for tonality, lots where noise contours are between 36 dB L_{A10} and 41 dB L_{A10} would need to incorporate Package A, noting this is required for road traffic noise in any case.

Figure 4-11



Noise levels
L_{A1}, dB

= 40.0
= 41.0
= 42.0
= 43.0
= 44.0
= 45.0
= 46.0
= 47.0
= 48.0
= 49.0
= 50.0

Signs and symbols

- Ranford Road
- Indicative Building
- Std Fence
- Noise Wall
- Subject Site
- 100m to Ranford
- 450m to Ranford
- Active Kennel License

N

Length Scale 1:10000

0 50 100 200 300 400 m

Proposed Subdivision Harrisdale -
Hatch Court Dog Kennel Noise - L_{A1} to Ground Floor

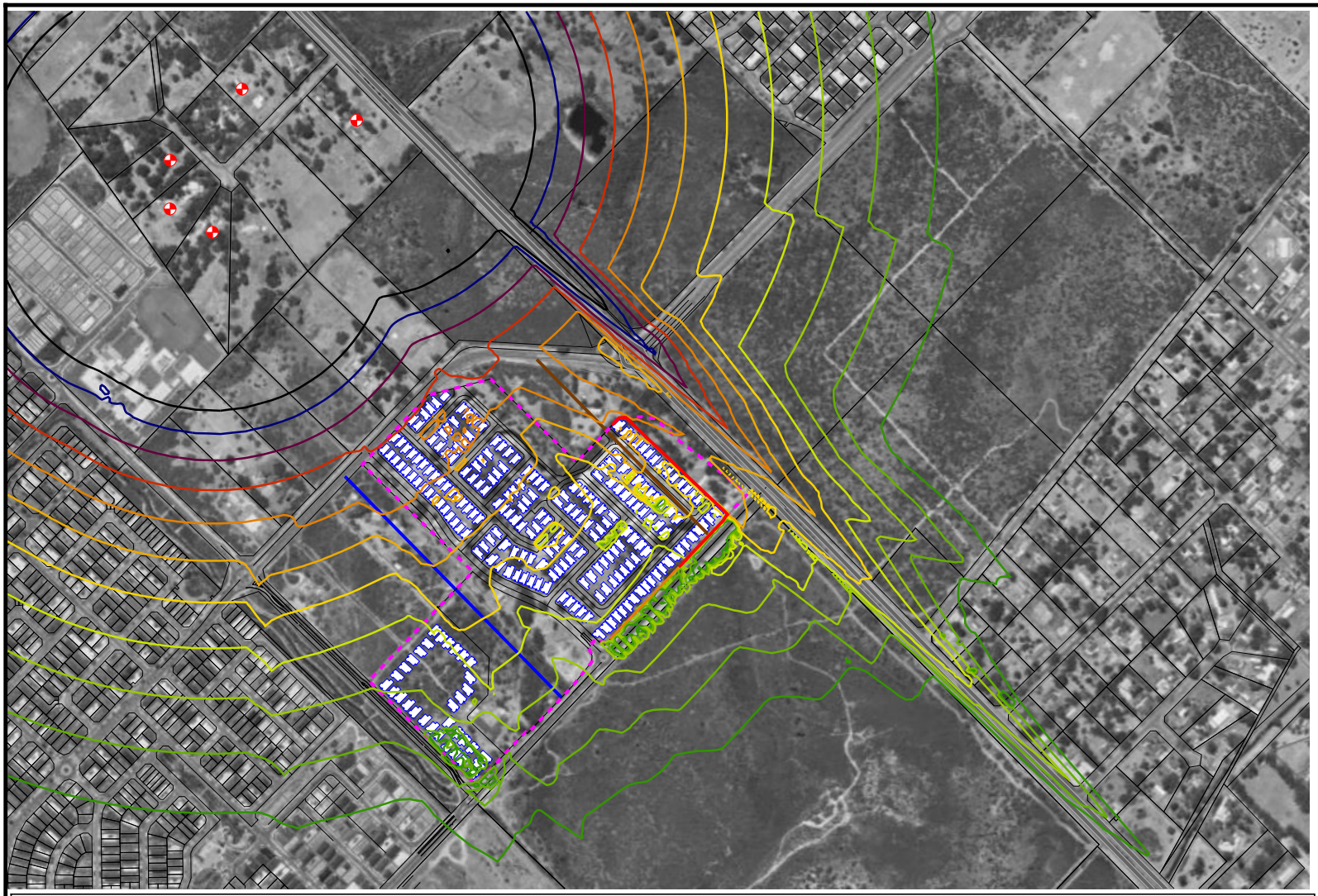
Includes Fence and Wall for Road Traffic Mitigation

SoundPLAN v8.2
CONCAWE Algorithms - 3m/s Winds and Temperature Inversion

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Figure 4-12



Noise levels
L_{A1}, dB

= 40.0
= 41.0
= 42.0
= 43.0
= 44.0
= 45.0
= 46.0
= 47.0
= 48.0
= 49.0
= 50.0

Signs and symbols

- Ranford Road
- Indicative Building
- Std Fence
- Noise Wall
- Subject Site
- 100m to Ranford
- 450m to Ranford
- Active Kennel License

N

Length Scale 1:10000

0 50 100 200 300 400 m

Proposed Subdivision Harrisdale -
Hatch Court Dog Kennel Noise - L_{A1} to Upper Floor

Includes Fence and Wall for Road Traffic Mitigation

SoundPLAN v8.2
CONCAWE Algorithms - 3m/s Winds and Temperature Inversion

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Figure 4-13



Noise levels
L_{A10}, dB

= 30.0
= 31.0
= 32.0
= 33.0
= 34.0
= 35.0
= 36.0
= 37.0
= 38.0
= 39.0
= 40.0

Signs and symbols

- Ranford Road
- Indicative Building
- Std Fence
- Noise Wall
- Subject Site
- 100m to Ranford
- 450m to Ranford
- Active Kennel License

N

Length Scale 1:10000

0 50 100 200 300 400 m

Proposed Subdivision Harrisdale -
Gosnells Dog Kennel Noise - L_{A10} to Ground Floor

Includes Fence and Wall for Road Traffic Mitigation

SoundPLAN v8.2
CONCAWE Algorithms - 3m/s Winds and Temperature Inversion

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Figure 4-14



Noise levels
L_{A10}, dB

= 30.0
= 31.0
= 32.0
= 33.0
= 34.0
= 35.0
= 36.0
= 37.0
= 38.0
= 39.0
= 40.0

Signs and symbols

- Ranford Road
- Indicative Building
- Std Fence
- Noise Wall
- Subject Site
- 100m to Ranford
- 450m to Ranford
- Active Kennel License

N

Length Scale 1:10000

0 50 100 200 300 400 m

Proposed Subdivision Harrisdale -
Gosnells Dog Kennel Noise - L_{A10} to Upper Floor

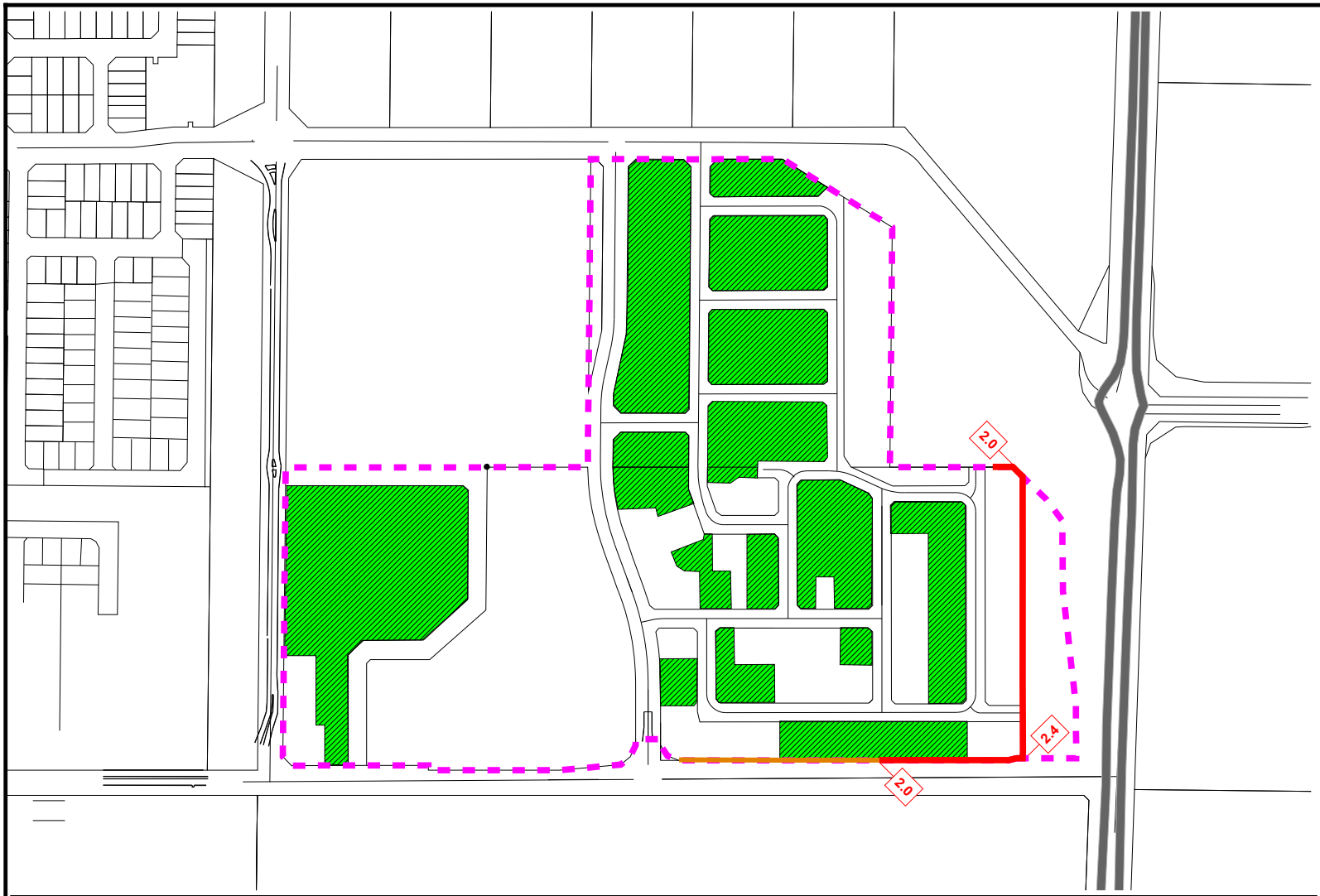
Includes Fence and Wall for Road Traffic Mitigation

SoundPLAN v8.2
CONCAWE Algorithms - 3m/s Winds and Temperature Inversion

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Figure 4-15



Signs and symbols
- Ranford Road
- Std Fence
- Noise Wall
- Subject Site
- Package A
- Package B
- Package C

Proposed Subdivision Harrisdale -
Kennel Mitigation Requirements - Ground Floor (With Wall)

Includes Fence and Wall for Road Traffic Mitigation (Read Left to Right Down to Up)

SoundPLAN v8.2
CONCAWE Algorithms

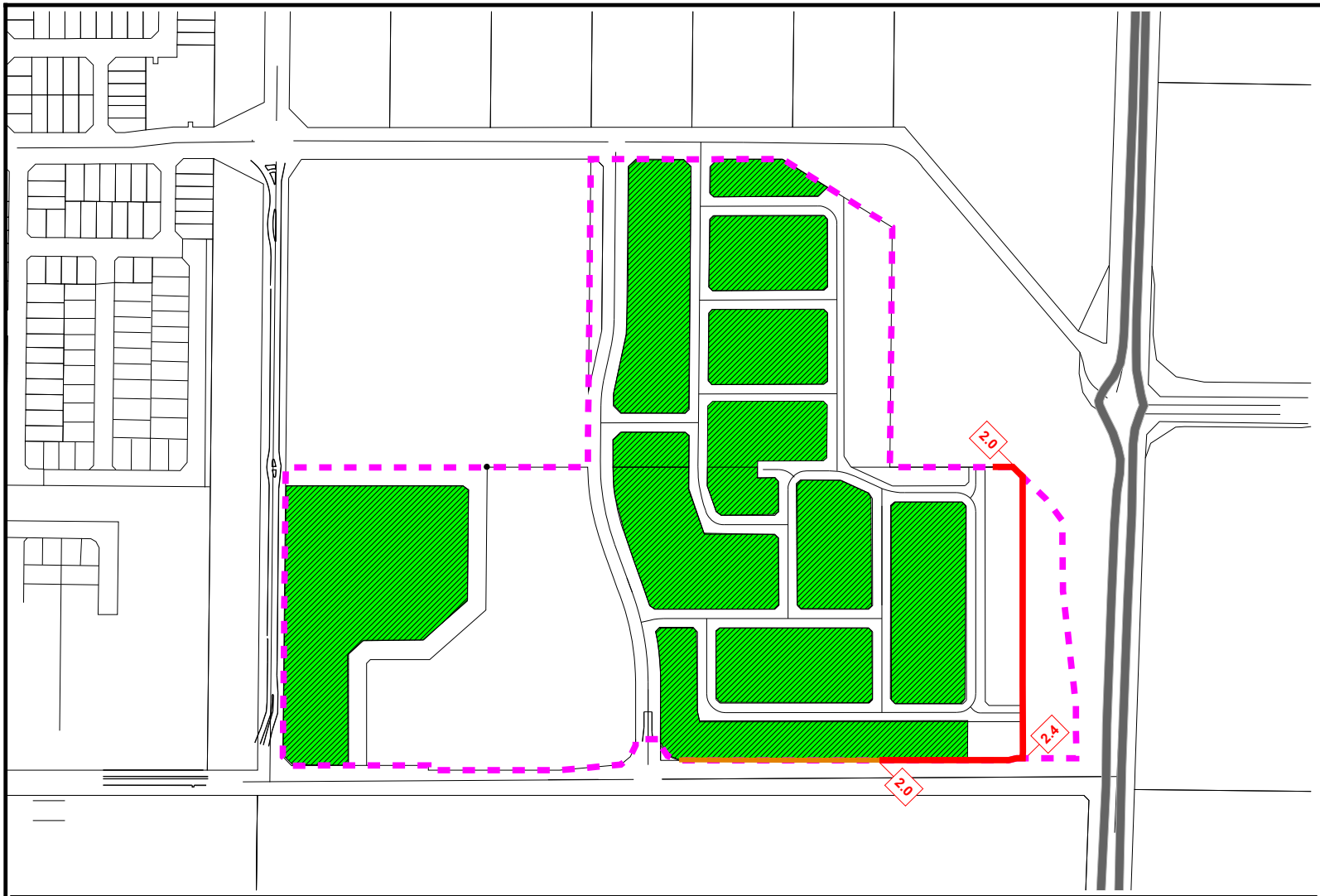
16 Aug 2023

Length Scale 1:5000

0 25 50 100 150 200 m

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(08) 9401 7770

Figure 4-16



Signs and symbols

- Ranford Road
- Std Fence
- Noise Wall
- Subject Site
- Package A
- Package B
- Package C

Proposed Subdivision Harrisdale -
Kennel Mitigation Requirements - Upper Floor (With Wall)

Includes Fence and Wall for Road Traffic Mitigation (Read Left to Right Down to Up)

SoundPLAN v8.2
CONCAWE Algorithms

16 Aug 2023

Length Scale 1:5000

0 25 50 100 150 200 m

Lloyd George Acoustics
PO Box 717
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(08) 9401 7770

5 CONCLUSION

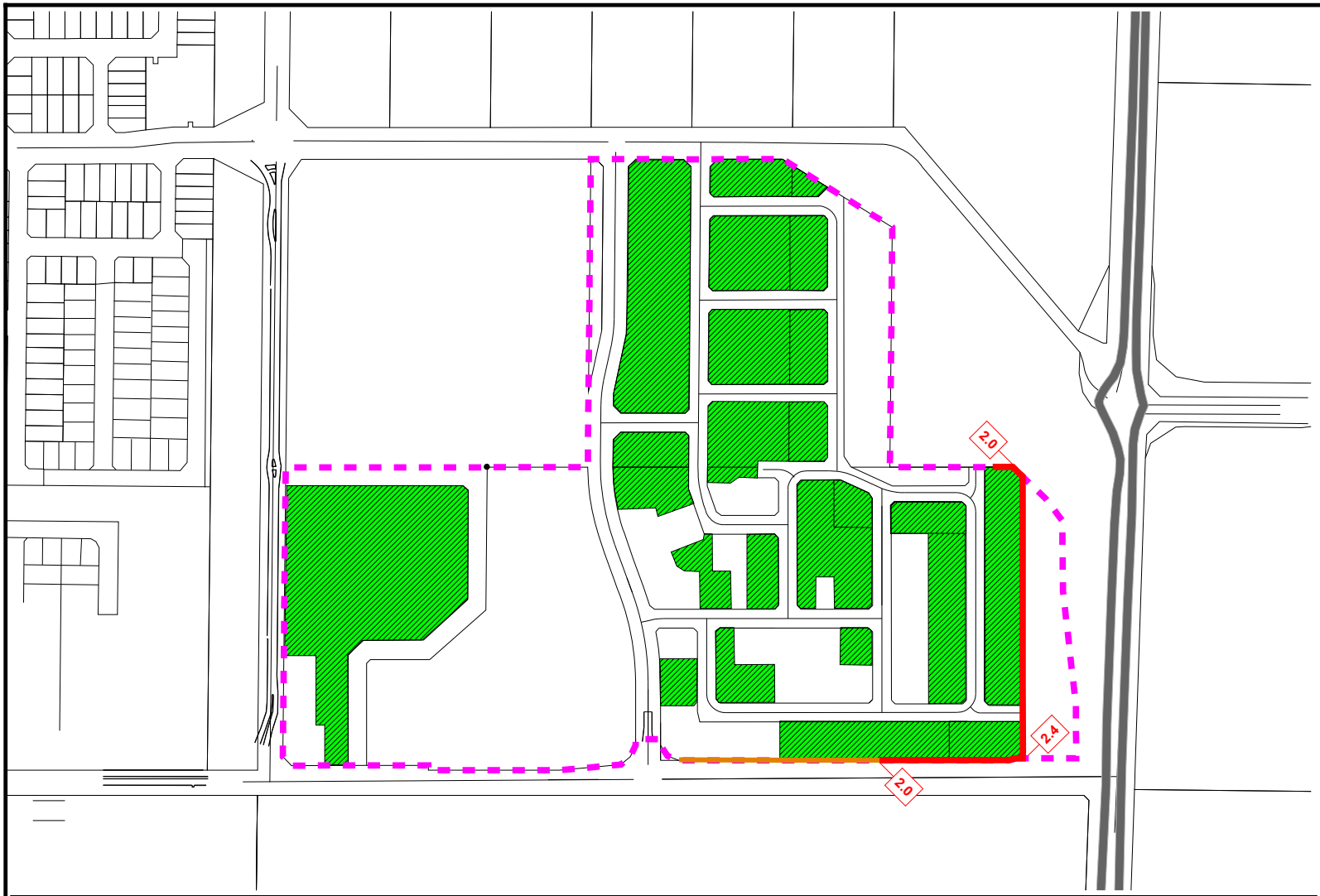
This report has been prepared to consider noise impacts from road traffic and dog kennels to the proposed subdivision, bound by Ranford Road, Balannup Road, Reilly Road and Skeet Road in Harrisdale. The outcomes of the study are:

- Construct a noise wall as shown in *Figure 5-1*. The noise wall is to be solid, free of gaps and of minimum surface mass 15 kg/m^2. The wall ranges in height from 2.0m to 2.4m (relative to finished lot level). A portion of standard fencing is also required along Skeet Road.
- Dwellings are to incorporate architectural packages (refer *Appendix A*) as shown on *Figure 5-1* and *Figure 5-2* for ground and upper floors respectively, noting these combine the requirements for both noise sources.

  Alternative constructions from the deemed to satisfy packages may be acceptable if supported by a report undertaken by a suitably qualified acoustical consultant (member firm of the Association of Australasian Acoustical Consultants (AAAC)), once the lots specific building plans are available.

- All lots affected by road traffic are to have notifications on lot titles as per SPP 5.4 requirements – refer *Appendix A*.
- All lots within the development are to have notifications on lot titles advising of the potential for dog barking noise.

Figure 5-1



Signs and symbols
- Ranford Road
- Std Fence
- Noise Wall
- Subject Site
- Package A
- Package B
- Package C

Proposed Subdivision Harrisdale -
Combined Mitigation Requirements - Ground Floor (With Wall)

Includes Fence and Wall for Road Traffic Mitigation (Read Left to Right Down to Up)

SoundPLAN v8.2

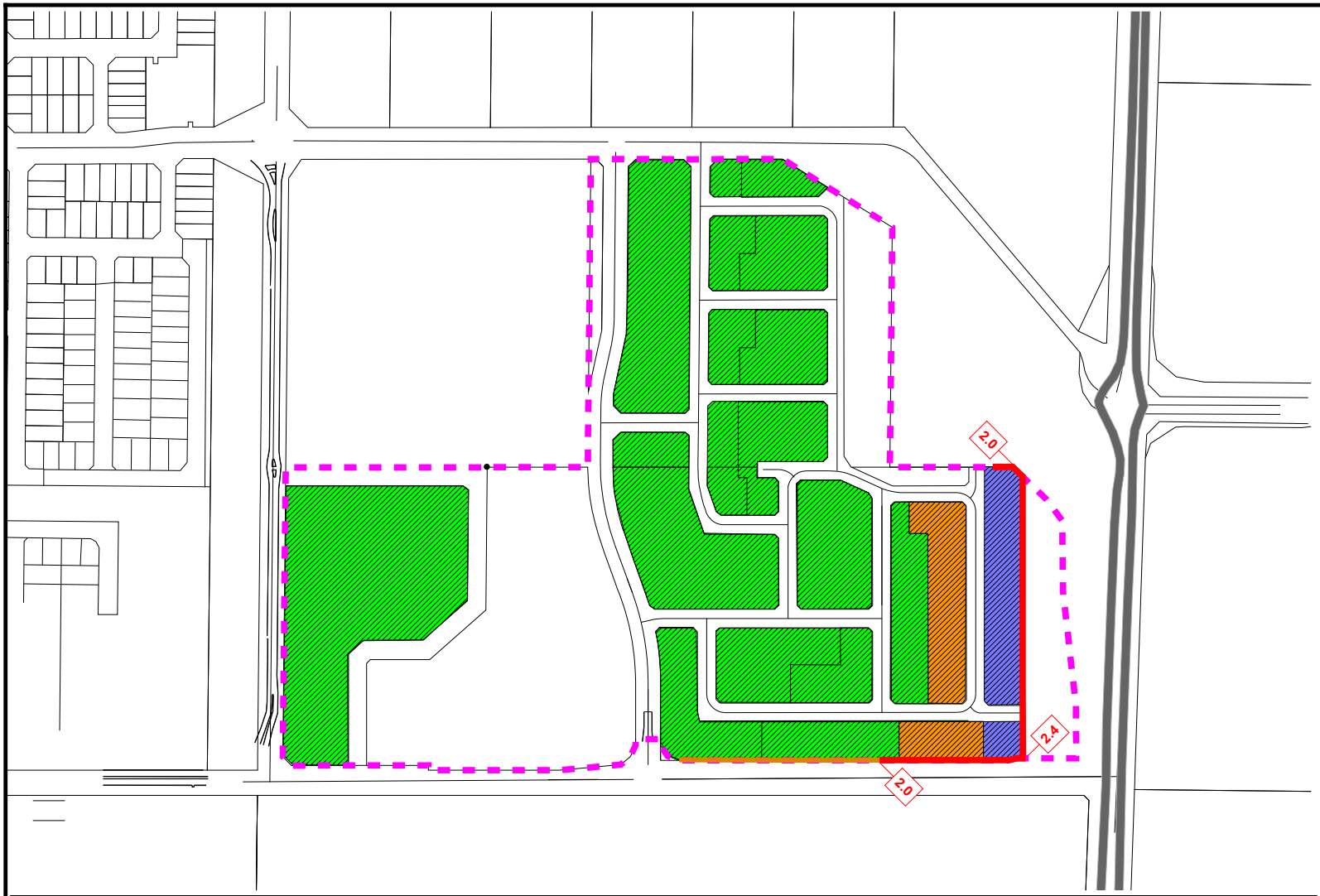
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Figure 5-2



Signs and symbols

- Ranford Road
- Std Fence
- Noise Wall
- Subject Site
- Package A
- Package B
- Package C

Proposed Subdivision Harrisdale -
Combined Mitigation Requirements - Upper Floor (With Wall)

Includes Fence and Wall for Road Traffic Mitigation (Read Left to Right Down to Up)

SoundPLAN v8.2

16 Aug 2023

Length Scale 1:5000

0 25 50 100 150 200 m

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Appendix A

Quiet House Packages

The packages and information provided on the following pages are taken from *Road and Rail Noise Guidelines* (September 2019).

Where outdoor and indoor noise levels received by a noise-sensitive land-use and/or development exceed the policy's noise target, implementation of quiet house requirements is an acceptable solution.

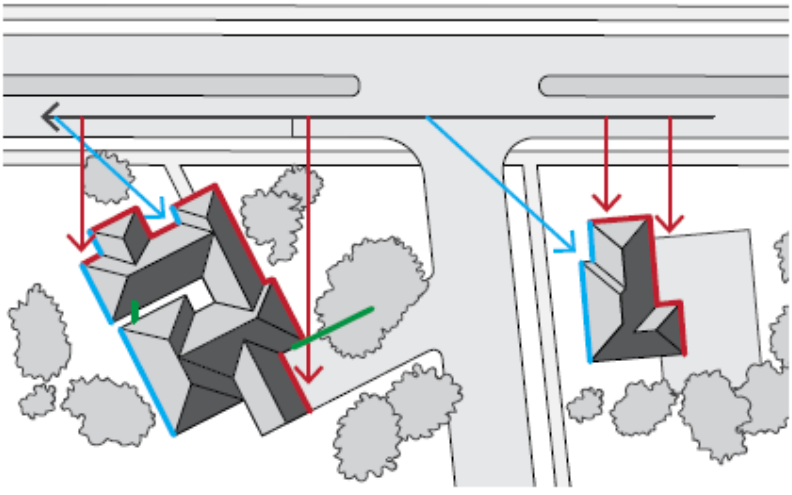
The quiet house packages are not the only solution to achieving acceptable internal transport noise levels. A suitably qualified acoustical engineer or consultant may also determine more tailored acoustic design requirements for buildings in a transport noise corridor by carrying out acoustic design in accordance with relevant industry standards. This includes the need to meet the relevant design targets specified in AS/NZS 2107:2016 for road traffic noise.

With regards to the packages, the following definitions are provided:

- **Facing** the transport corridor (red): Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular (at a 90 degree angle) to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).

- **Side-on** to transport corridor (blue): Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line, at any angle, can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).

- **Opposite** to transport corridor (green): Neither 'side on' nor 'facing', as defined above.



Quiet House Package A

Element	Orientation	Room	
		Bedroom	**Indoor Living and Work Areas**
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): ○ Sliding or double hung with minimum 10mm single or 6mm-12mm-10mm double insulated glazing; ○ Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$): ○ Sealed awning or casement windows with minimum 6mm glass.	• Up to 40% floor area ($R_w + C_{tr} \geq 25$): ○ Sliding or double hung with minimum 6mm single or 6mm-12mm-6mm double insulated glazing; • Up to 60% floor area ($R_w + C_{tr} \geq 28$); • Up to 80% floor area ($R_w + C_{tr} \geq 31$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	No specific requirements	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.	• Doors to achieve $R_w + C_{tr} \geq 25$: ○ 35mm Solid timber core hinged door and frame system certified to R_w 28 including seals; ○ Glazed sliding door with 10mm glass and weather seals.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less.	
	Opposite	No specific requirements	
External Walls	All	• $R_w + C_{tr} \geq 45$: ○ Two leaves of 90mm thick clay brick masonry with minimum 20mm cavity; or ○ Single leaf of 150mm brick masonry with 13mm cement render on each face; or ○ One row of 92mm studs at 600mm centres with: ▪ Resilient steel channels fixed to the outside of the studs; and ▪ 9.5mm hardboard or fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside; ▪ 75mm thick mineral wool insulation with a density of at least 11kgkg/m^3; and ▪ 2 x 16mm fire-rated plasterboard to inside.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: ○ Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard.	

Quiet House Package B

Element	Orientation	Room	
		Bedroom	**Indoor Living and Work Areas**
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): ○ Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): ○ Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): ○ Sliding or double hung with 6mm-12mm-10mm double insulated glazing; ○ Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$); • Up to 80% floor area ($R_w + C_{tr} \geq 34$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass.	• Doors to achieve $R_w + C_{tr} \geq 28$: ○ 40mm Solid timber core hinged door and frame system certified to R_w 32 including seals; ○ Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: ○ Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester (24kg/m³). Resilient ties used where required to connect leaves. ○ Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). ○ Single leaf of 220mm brick masonry with 13mm cement render on each face. ○ 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. ○ Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m³) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: ○ Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling with R3.0+ fibrous insulation.	

Quiet House Package C

Element	Orientation	Room	
		Bedroom	**Indoor Living and Work Areas**
External Windows	Facing	• Up to 20% floor area ($R_w + C_{tr} \geq 31$): ○ Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 40% floor area ($R_w + C_{tr} \geq 34$): ○ Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): ○ Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): ○ Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Not recommended.	• Doors to achieve $R_w + C_{tr} \geq 30$: ○ Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass; ○ 40mm Solid timber core side hinged door, frame and seal system certified to R_w 32 including seals. Any glass inserts to be minimum 6mm.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: ○ Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). Resilient ties used where required to connect leaves. ○ Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m³). ○ Single leaf of 220mm brick masonry with 13mm cement render on each face. ○ 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. ○ Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m³) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 40$: ○ Concrete or terracotta tile roof with sarking, or metal sheet roof with foil backed R2.0+ fibrous insulation between steel sheeting and roof battens; ○ R3.0+ insulation batts above ceiling; ○ 2 x 10mm plasterboard ceiling or 1 x 13mm sound-rated plasterboard affixed using steel furring channel to ceiling rafters.	

Mechanical Ventilation requirements

In implementing the acceptable treatment packages, the following mechanical ventilation / air-conditioning considerations are required:

- Acoustically rated openings and ductwork to provide a minimum sound reduction performance of R_w 40 dB into sensitive spaces;
- Evaporative systems require attenuated ceiling air vents to allow closed windows;
- Refrigerant based systems need to be designed to achieve National Construction Code fresh air ventilation requirements;
- Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable.

Notification

Notifications on title advise prospective purchasers of the potential for noise impacts from major transport corridors and help with managing expectations.

The Notification is to state as follows:

This lot is in the vicinity of a transport corridor and is affected, or may in the future be affected, by road and rail transport noise. Road and rail transport noise levels may rise or fall over time depending on the type and volume of traffic.

Appendix B

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)

The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

Sound Power Level (L_w)

Under normal conditions, a given sound source will radiate the same amount of energy, irrespective of its surroundings, being the sound power level. This is similar to a 1kW electric heater always radiating 1kW of heat. The sound power level of a noise source cannot be directly measured using a sound level meter but is calculated based on measured sound pressure levels at known distances. Noise modelling incorporates source sound power levels as part of the input data.

Sound Pressure Level (L_p)

The sound pressure level of a noise source is dependent upon its surroundings, being influenced by distance, ground absorption, topography, meteorological conditions etc and is what the human ear actually hears. Using the electric heater analogy above, the heat will vary depending upon where the heater is located, just as the sound pressure level will vary depending on the surroundings. Noise modelling predicts the sound pressure level from the sound power levels taking into account ground absorption, barrier effects, distance etc.

L_{ASlow}

This is the noise level in decibels, obtained using the A frequency weighting and the S (Slow) time weighting as specified in IEC 61672-1:2002. Unless assessing modulation, all measurements use the slow time weighting characteristic.

L_{AFast}

This is the noise level in decibels, obtained using the A frequency weighting and the F (Fast) time weighting as specified in IEC 61672-1:2002. This is used when assessing the presence of modulation only.

L_{APeak}

This is the greatest absolute instantaneous sound pressure in decibels using the A frequency weighting as specified in IEC 61672-1:2002.

L_{Amax}

An L_{Amax} level is the maximum A-weighted noise level during a particular measurement.

L_{A1}

An L_{A1} level is the A-weighted noise level which is exceeded for one percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{A10}

An L_{A10} level is the A-weighted noise level which is exceeded for 10 percent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{Aeq}
The equivalent steady state A-weighted sound level ("equal energy") in decibels which, in a specified time period, contains the same acoustic energy as the time-varying level during the same period. It is considered to represent the "average" noise level.

L_{A90}
An L_{A90} level is the A-weighted noise level which is exceeded for 90 percent of the measurement period and is considered to represent the "*background*" noise level.

One-Third-Octave Band
Means a band of frequencies spanning one-third of an octave and having a centre frequency between 25 Hz and 20 000 Hz inclusive.

L_{Amax} assigned level
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded at any time.

L_{A1} assigned level
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 1% of the representative assessment period.

L_{A10} assigned level
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 10% of the representative assessment period.

Tonal Noise
A tonal noise source can be described as a source that has a distinctive noise emission in one or more frequencies. An example would be whining or droning. The quantitative definition of tonality is:

the presence in the noise emission of tonal characteristics where the difference between -

(a) the A-weighted sound pressure level in any one-third octave band; and

(b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

is greater than 3 dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ Slow}$ levels.

This is relatively common in most noise sources.

Modulating Noise
A modulating source is regular, cyclic and audible and is present for at least 10% of the measurement period. The quantitative definition of modulation is:

a variation in the emission of noise that —

(a) is more than 3 dB $L_{A\ Fast}$ or is more than 3 dB $L_{A\ Fast}$ in any one-third octave band;

(b) is present for at least 10% of the representative.

Impulsive Noise
An impulsive noise source has a short-term banging, clunking or explosive sound. The quantitative definition of impulsiveness is:

a variation in the emission of a noise where the difference between $L_{A\ peak}$ and $L_{A\ Max\ slow}$ is more than 15 dB when determined for a single representative event;

Major Road
Is a road with an estimated average daily traffic count of more than 15,000 vehicles.

Secondary / Minor Road
Is a road with an estimated average daily traffic count of between 6,000 and 15,000 vehicles.

Influencing Factor (IF)

$$= \frac{1}{10}(\%\ \text{Type A}_{100} + \%\ \text{Type A}_{450}) + \frac{1}{20}(\%\ \text{Type B}_{100} + \%\ \text{Type B}_{450})$$

where:

$\%\ \text{Type A}_{100}$ = the percentage of industrial land within a100m radius of the premises receiving the noise

$\%\text{TypeA}_{450}$ = the percentage of industrial land within a 450m radius of the premises receiving the noise

$\%\ \text{Type B}_{100}$ = the percentage of commercial land within a100m radius of the premises receiving the noise

$\%\text{TypeB}_{450}$ = the percentage of commercial land within a 450m radius of the premises receiving the noise

+ Traffic Factor (maximum of 6 dB)
= 2 for each secondary road within 100m
= 2 for each major road within 450m
= 6 for each major road within 100m

Representative Assessment Period
Means a period of time not less than 15 minutes, and not exceeding four hours, determined by an inspector or authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission.

Background Noise
Background noise or residual noise is the noise level from sources other than the source of concern. When measuring environmental noise, residual sound is often a problem. One reason is that regulations often require that the noise from different types of sources be dealt with separately. This separation, e.g. of traffic noise from industrial noise, is often difficult to accomplish in practice. Another reason is that the measurements are normally carried out outdoors. Wind-induced noise, directly on the microphone and indirectly on trees, buildings, etc., may also affect the result. The character of these noise sources can make it difficult or even impossible to carry out any corrections.

Ambient Noise
Means the level of noise from all sources, including background noise from near and far and the source of interest.

Specific Noise
Relates to the component of the ambient noise that is of interest. This can be referred to as the noise of concern or the noise of interest.

$L_{A10,18hour}$
The $L_{A10,18\ hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00 am and midnight. The *CoRTN* algorithms were developed to calculate this parameter.

$L_{Aeq,24hour}$
The $L_{Aeq,24\ hour}$ level is the logarithmic average of the hourly L_{Aeq} levels for a full day (from midnight to midnight).

$L_{Aeq,8hour}$ / $L_{Aeq\ (Night)}$
The $L_{Aeq\ (Night)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 10.00 pm to 6.00 am on the same day.

$L_{Aeq,16hour}$ / $L_{Aeq\ (Day)}$
The $L_{Aeq\ (Day)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 6.00 am to 10.00 pm on the same day. This value is typically 1-3 dB less than the $L_{A10,18hour}$.

Noise-sensitive land use and/or development
Land-uses or development occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan park, camping ground, educational establishment, child care premises, hospital, nursing home, corrective institution or place of worship.

About the Term 'Reasonable'
An assessment of reasonableness should demonstrate that efforts have been made to resolve conflicts without comprising on the need to protect noise-sensitive land-use activities. For example, have reasonable efforts been made to design, relocate or vegetate a proposed noise barrier to address community concerns about the noise barrier height? Whether a noise mitigation measure is reasonable might include consideration of:

- The noise reduction benefit provided;
- The number of people protected;
- The relative cost vs benefit of mitigation;
- Road conditions (speed and road surface) significantly differ from noise forecast table assumptions;
- Existing and future noise levels, including changes in noise levels;
- Aesthetic amenity and visual impacts;
- Compatibility with other planning policies;
- Differences between metropolitan and regional situations and whether noise modelling requirements reflect the true nature of transport movements;
- Ability and cost for mobilisation and retrieval of noise monitoring equipment in regional areas;
- Differences between Greenfield and infill development;
- Differences between freight routes and public transport routes and urban corridors;
- The impact on the operational capacity of freight routes;
- The benefits arising from the proposed development;
- Existing or planned strategies to mitigate the noise at source.

About the Term 'Practicable'

'Practicable' considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. It is defined as "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge" (*Environmental Protection Act 1986*). These may include:

- Limitations of the different mitigation measures to reduce transport noise;
- Competing planning policies and strategies;
- Safety issues (such as impact on crash zones or restrictions on road vision);
- Topography and site constraints (such as space limitations);
- Engineering and drainage requirements;
- Access requirements (for driveways, pedestrian access and the like);
- Maintenance requirements;
- Bushfire resistance or BAL ratings;
- Suitability of the building for acoustic treatments.

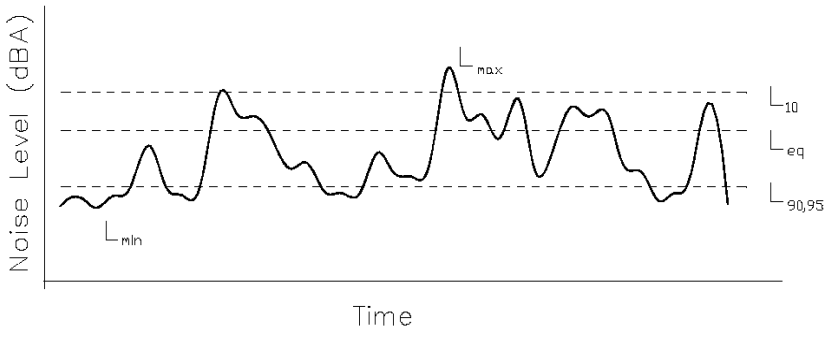
R_w

This is the weighted sound reduction index and is similar to the previously used STC (Sound Transmission Class) value. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

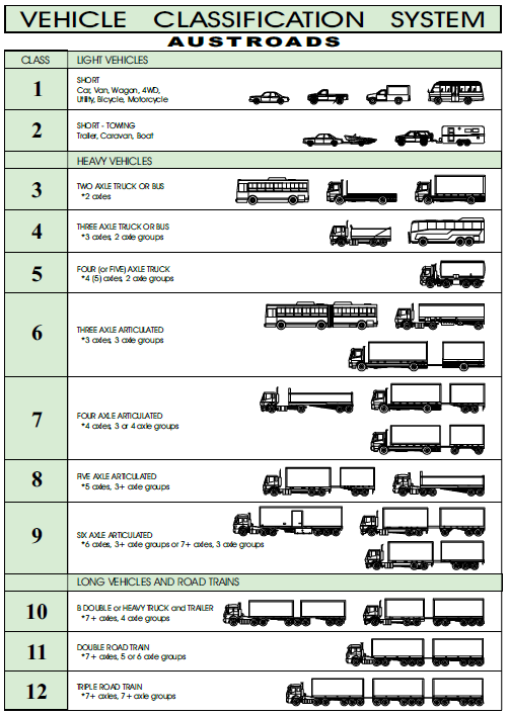
C_{tr}

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of –4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -14 dB.

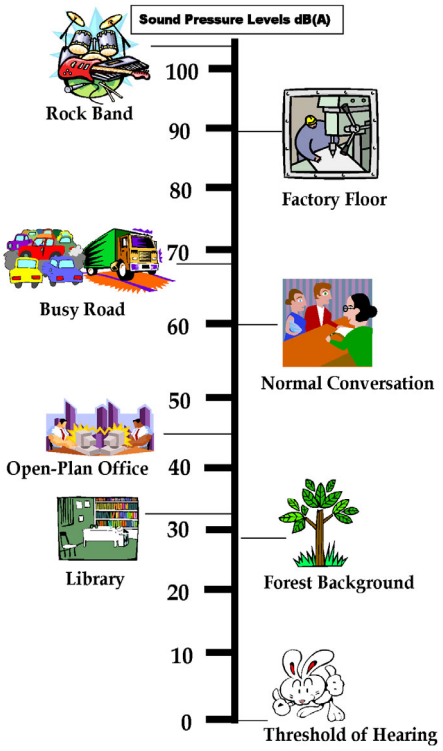
Chart of Noise Level Descriptors



Austroads Vehicle Class



Typical Noise Levels



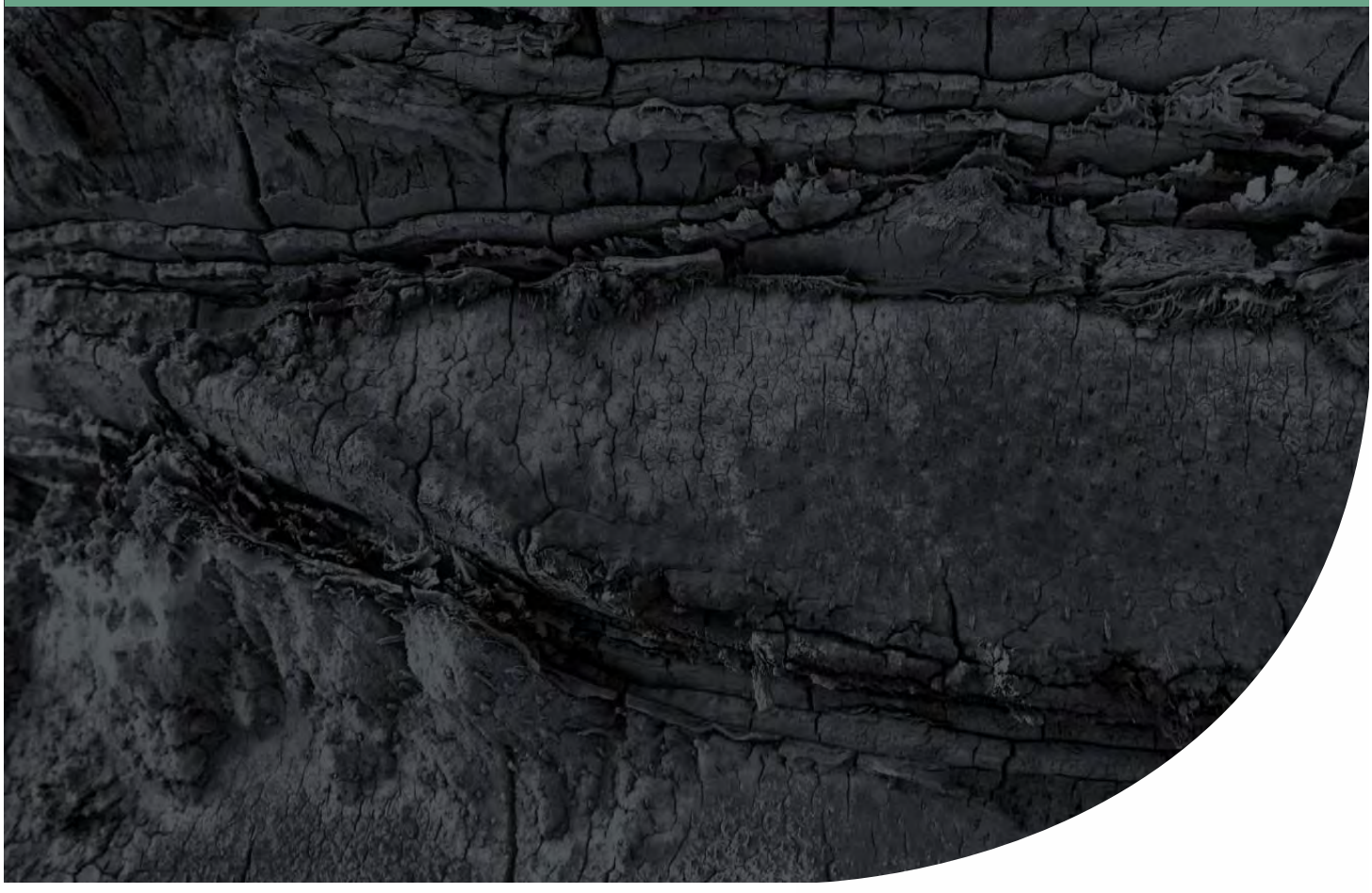
APPENDIX 6 – BUSHFIRE MANAGEMENT STRATEGY

Bushfire Management Plan

North Harrisdale Structure Plan

Project No: EP20-127(11)

Prepared for Yolk Property Group Pty Ltd
August 2023



Document Control

Doc name:	Bushfire Management Plan North Harrisdale Structure Plan				
Doc no.:	**EP20-127(11)—010B HPB**				
Version	**Date**	**Author**		**Reviewer**	
1	July 2021	Heidi Becker	HPB	Kirsten Knox	KK
		Dana Elphinstone	DAE		
	Report issued for client review.				
A	May 2022	Bianca Bertelli	BRB	Dana Elphinstone	DAE
	Updated in response to final structure plan layout				
B	August 2023	Daniel Bussell	DVB	Kirsten Knox	KK
				Anthony Rowe	AJR
	Updated to address Western Australian Planning Commission (WAPC) modification request and change to structure plan layout				

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This document has been prepared primarily to consider the layout of development and/or the appropriate building construction standards applicable to development, where relevant. The measures outlined are considered to be prudent minimum standards only based on the standards prescribed by the relevant authorities. The level of bushfire risk mitigation achieved will depend upon the actions of the landowner or occupiers of the land and is not the responsibility of the author. The relevant local government and fire authority (i.e. Department of Fire and Emergency Services or local bushfire brigade) should be approached for guidance on preparing for and responding to a bushfire.

Notwithstanding the precautions recommended in this document, it should always be remembered that bushfires burn under a wide range of conditions which can be unpredictable. An element of risk, no matter how small, will always remain. The objective of the Australian Standard AS 3959-2018 is to "prescribe particular construction details for buildings to reduce the risk of ignition from a bushfire while the front passes" (Standards Australia 2018). Building to the standards outlined in AS 3959 does not guarantee a building will survive a bushfire or that lives will not be lost.

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Executive Summary

Yolk Property Group Pty Ltd (the proponent) are progressing the North Harrisdale Structure Plan to develop Lots 601 to 603 Balannup Road and Lots 200 to 202 Skeet Road, Harrisdale (herein referred to as the 'site') for residential and commercial purposes. The site consists of an area of approximately 20.4 ha in size and is located within the City of Armadale. It is bounded by Ranford Road to the north-east, Skeet Road to the south-east, Reilly Road to the south-west and Balannup Road to the north-west.

The site is currently identified as a 'bushfire prone area' under the state-wide *Map of Bush Fire Prone Areas* prepared by the Office of Bushfire Risk Management (OBRM 2019). The identification of the site within an area declared as bushfire prone necessitates a further assessment of the determined bushfire risk affecting the site (in accordance with *Australian Standard 3959-2018 Construction of buildings in bushfire prone areas* (AS 3959)). The assessment is required to demonstrate satisfactory compliance of the proposal with the policy measures described in *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) (WAPC 2015) and its associated *Guidelines for Planning in Bushfire Prone Areas Version 1.4* (the Guidelines) (DPLH & WAPC 2021).

The purpose of SPP 3.7 and its policy intent is to implement effective risk-based land use planning and development to preserve life and reduce the impact of bushfire on property and infrastructure through effective risk-based land use planning. Importantly, it is a risk-based approach requiring a methodical approach to identify and evaluate the hazards and provide the treatments to ameliorate these hazards to an acceptable level. SPP3.7 requires that the determining authority consider the precautionary principle (clause 6.11 in SPP 3.7) and they must be satisfied that the potential for significant adverse impacts can be adequately reduced or managed.

This Bushfire Management Plan (BMP) examines the various responses to the identified bushfire risk (following development) that will make the ultimate use of the land suitable for its intended purpose and achieve compliance with the policy intent. The policy intent can be met by demonstrating compliance with the policy objectives, and policy measures informed by the bushfire protection criteria in the Guidelines and satisfaction of its four elements. As part of this, a bushfire attack level (BAL) assessment has been undertaken to determine the associated bushfire risk, the applicable BAL ratings (if any), and in turn the building siting and construction response that will achieve compliance with the bushfire protection criteria and satisfy the precautionary principle.

As part of assessing the long-term bushfire risk to the site, the vegetation within the site and 150 m of the site has been classified in accordance with AS 3959. The following bushfire hazards were identified in the post-development scenario:

- Forest (Class A) vegetation, largely associated with remnant vegetation within the wetland in the southern public open space (POS) and its associated buffer, as well as forest vegetation to the north east of the site which is considered a temporary hazard.
- Woodland (Class B) vegetation within landholdings north west and east of the site. Vegetation to the east is considered a temporary hazard.
- Scrub (Class D) vegetation associated with the wetland in the north-western and north-eastern POS (and associated buffers), as well as within landholdings to the north, east, south and west

outside the site. This vegetation largely is associated with remnant vegetation within Balannup Lake.

- Grassland (Class G) vegetation identified within the north and south-west portions of the site, largely associated with the portions of POS that are outside the wetland and wetland buffers. The City of Armadale have not committed to managing POS to achieve low threat, and therefore all areas of POS assume classified vegetation is present.

The outcomes of this BMP demonstrate that as development progresses, it will be possible for an acceptable solution to be adopted for each of the applicable bushfire protection criteria outlined in the Guidelines. Future detailed design at subdivision stage will be required to demonstrate how the acceptable solutions of the bushfire protection criteria will be achieved. This includes:

- **Location:** future habitable buildings can be located in an area that will, on completion, be subject to a low or moderate bushfire hazard.
- **Siting and Design:** The site accommodates a suitable asset protection zone (APZ) for all proposed development cells generally through the provision of a perimeter public road network, enabling the majority of lots to achieve BAL-29 or less. Portions of the site in the north-east will have areas subject to BAL-40 or BAL-FZ (predominantly within the commercial area) as result of temporary bushfire hazards that will be removed when development in the broader area is progressed. This can be managed as part of staging of development. In the central-southern portion of the site, surrounding the POS, BAL-40 (and a small area of BAL-FZ along the western boundary) extends into the development cells as a result of retained vegetation and/or assumption around future treatment (assumed to be 'forest'). Development will be separated from classified vegetation in the POS by a public road interface, and it would be possible to achieve BAL-29 with a 6 m front lot setback for lots to the west of the POS and a 1 m front lot setback for lots to the east. This can be considered when lot layout is addressed at future subdivision stages and through use of local development plans.
- **Vehicular Access:** the proposed structure plan provides for an interconnected road network within the site that will utilise existing and future connections to the existing public road network, including connections to Balannup Road to the north and Skeet Road to the south (and the future Reilly Road to the west), providing egress opportunities in multiple directions. Interim access measures (such as temporary turn around areas or emergency access ways) may be required at subdivision stage to facilitate sufficient access at all stages of subdivision development.
- **Water:** the development will be provided with a permanent and reticulated water supply to support onsite firefighting requirements.

The management/mitigation measures to be implemented through the proposed structure planning and development of the site, as discussed in this BMP, demonstrate that the acceptable solutions and/or intent of each element can be met. Staging of development will need to consider the impacts of temporary vegetation and the associated BAL ratings on setback requirements, to ensure BAL-29 or less is able to be achieved. Having regard to clause 6.11 of SPP 3.7, the precautionary principle has been satisfied. A BMP will be prepared to support subdivision of the site and will address the specifics of detailed design, including ensuring provision for separation to achieve BAL-29 or less and vehicle access.

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Appendices

Appendix A

Structure Plan

Appendix B

Landscape Report

List of Abbreviations

Table A1: Abbreviations – General terms

General terms	
AHD	Australian Height Datum
AS	Australian Standard
APZ	Asset Protection Zone
BAL	Bushfire Attack Level
BMP	Bushfire Management Plan
BPAD	Bushfire Planning and Design
CCW	Conservation category wetland
EEP	Emergency Evacuation Plan
ESL	Emergency Services Levy
FDI	Fire Danger Index
FZ	Flame Zone
POS	Public open space
REW	Resource enhancement wetland

Table A2: Abbreviations – Organisations

Organisations	
DBCA	Department of Biodiversity Conservation and Attractions
DoW	Department of Water (now known as Department of Water and Environment Regulation)
DFES	Department of Fire and Emergency Services
DPLH	Department of Planning, Lands and Heritage
OBRM	Office of Bushfire Risk Management
SES	State Emergency Services
WAPC	Western Australian Planning Commission

Table A3: Abbreviations – Legislation and policies

Legislation	
Guidelines	Guidelines for Planning in Bushfire Prone Areas version 1.4 (DPLH & WAPC 2021)
SPP 3.7	State Planning Policy 3.7 Planning in Bushfire Prone Areas (WAPC 2015)

Table A4: Abbreviations – Planning and building terms

Planning and building terms	
AS 3959	*Australian Standard 3959-2018 Construction of buildings in bushfire prone areas*
MRS	Metropolitan Region Scheme
TPS	Town Planning Scheme

1 Introduction

1.1 Background

Yolk Property Group Pty Ltd (the proponent) are progressing the North Harrisdale Structure Plan in order to develop Lots 601 to 603 Balannup Road and Lots 200 to 202 Skeet Road, Harrisdale (herein referred to as the 'site') for residential and commercial purposes, as shown in the attached structure plan provided in **Appendix A**. The site is shown in **Figure 1** and consists of an area of approximately 20.4 ha in size and is located within the City of Armadale. It is bounded by Ranford Road to the north-east, Skeet Road to the south-east, Reilly Road to the south-west and Balannup Road to the north-west.

The site is currently identified as a 'bushfire prone area' under the state-wide *Map of Bush Fire Prone Areas* prepared by the Office of Bushfire Risk Management (OBRM 2019) and is shown in **Plate 1** below. The identification of an area within a declared bushfire prone area necessitates a further assessment of the bushfire risk and suitability of the proposed development to be undertaken in accordance with *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) (WAPC 2015) and the *Guidelines for Planning in Bushfire Prone Areas Version 1.4* (the Guidelines) (DPLH & WAPC 2021).

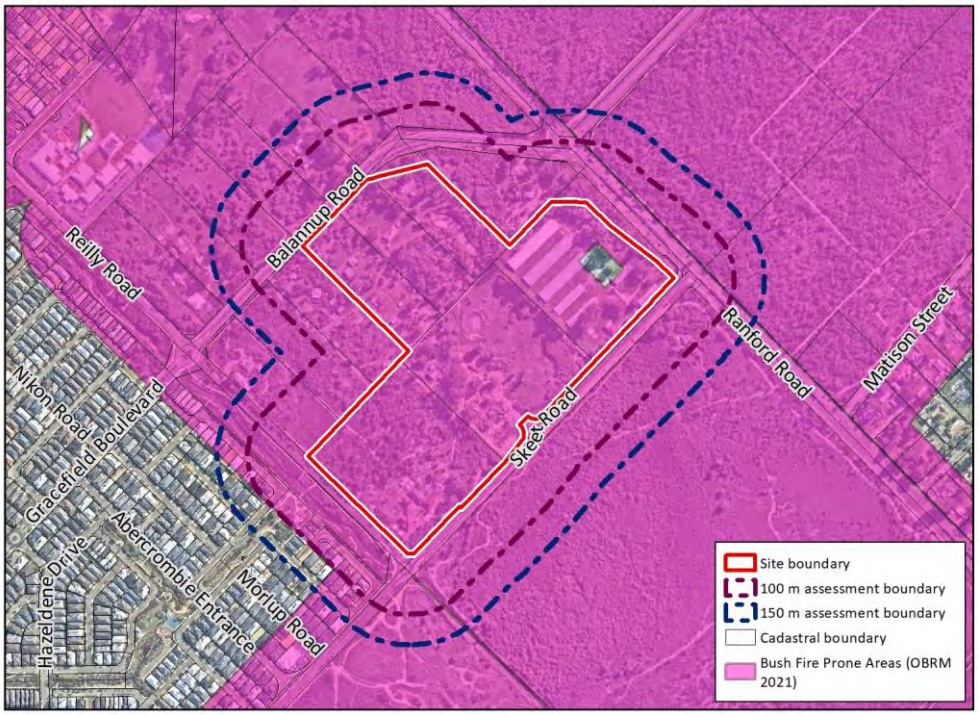


Plate 1: Areas within and surrounding the site identified as 'bushfire prone areas' (as indicated in purple) under the state-wide Map of Bush Fire Prone Areas (OBRM 2021).

1.2 Aim of this report

The aim of this BMP is to assess bushfire hazards within the site and nearby areas and ensure that the threat posed by any identified hazards can be appropriately mitigated and managed and demonstrate satisfaction of clause 6.11 of SPP 3.7 the precautionary principle. It has been prepared to support the proposed structure plan for the site and addresses the requirements of SPP 3.7 (WAPC 2015), the Guidelines (DPLH & WAPC 2021) and *Australian Standard 3959-2018 Construction of buildings in bushfire prone areas* (AS 3959) (Standards Australia 2018). The document provides an assessment of the general bushfire management strategies to be considered as part of the future residential development within the site and includes:

- Overview of the proposed development (see **Section 1.4**).
- An assessment of the existing classified vegetation in the vicinity of the site (within 150 m) and consideration of bushfire hazards that will exist in the post-development scenario (**Section 3**).
- Commentary on how future development can achieve the bushfire protection criteria outlined within the Guidelines (**Section 5**).
- An outline of the roles and responsibilities associated with implementing this BMP (see **Section 6**).

1.3 Statutory policy and framework

The following key legislation, policies and guidelines are relevant to the preparation of a bushfire management plan:

- *Fire and Emergency Services Act 1998*
- *Bush Fires Act 1954*
- *Planning and Development Act 2005* and associated regulations
- *Building Act 2011* and associated regulations
- *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (WAPC 2015)
- *Guidelines for Planning in Bushfire Prone Areas*, Version 1.4 (DPLH & WAPC 2021)
- *Australian Standard AS 3959 – 2018 Construction of buildings in bushfire prone areas* (Standards Australia 2018).

A Bushfire Management Plan was previously prepared by Emerge Associates (2020) to support the Metropolitan Region Scheme (MRS) amendment of the site. The scheme amendment was to lift the 'Urban Deferred' zone in order to facilitate future residential subdivision and development of the site. As part of the lifting of the 'Urban Deferred' zone, the concurrent rezoning of the affected land under the provisions of the City of Armadale's Town Planning Scheme No. 4 to 'Development' zone was also proposed. The outcomes of the previous assessment, in particular assumptions about the future treatment of public open space have been considered as part of this assessment.

1.4 Description of the proposed development

A structure plan has been prepared for the site and is provided in **Appendix A**. The proposed structure plan for the site will facilitate the future subdivision and development of the site to support residential and commercial land uses, and will include:

- Development cells proposed for residential purposes, with an average lot area of 350-380 m^2.
- An area proposed for commercial purposes in the north-eastern portion of the site.
- Three areas of public open space (POS) aligned with supporting retention of a conservation category wetland (CCW) and two resource enhancement wetlands (REW) and their associated buffers.
- A small portion of an easement for Western Power powerlines, extending through the western portion of the site.
- An interconnected public road network.

The entire site is currently zoned 'Urban' under the Metropolitan Region Scheme (MRS) (as shown in **Plate 2**) and 'general rural' under the City of Armadale's Town Planning Scheme (TPS) No.4 (and is in the process of being rezoned to align with the MRS).

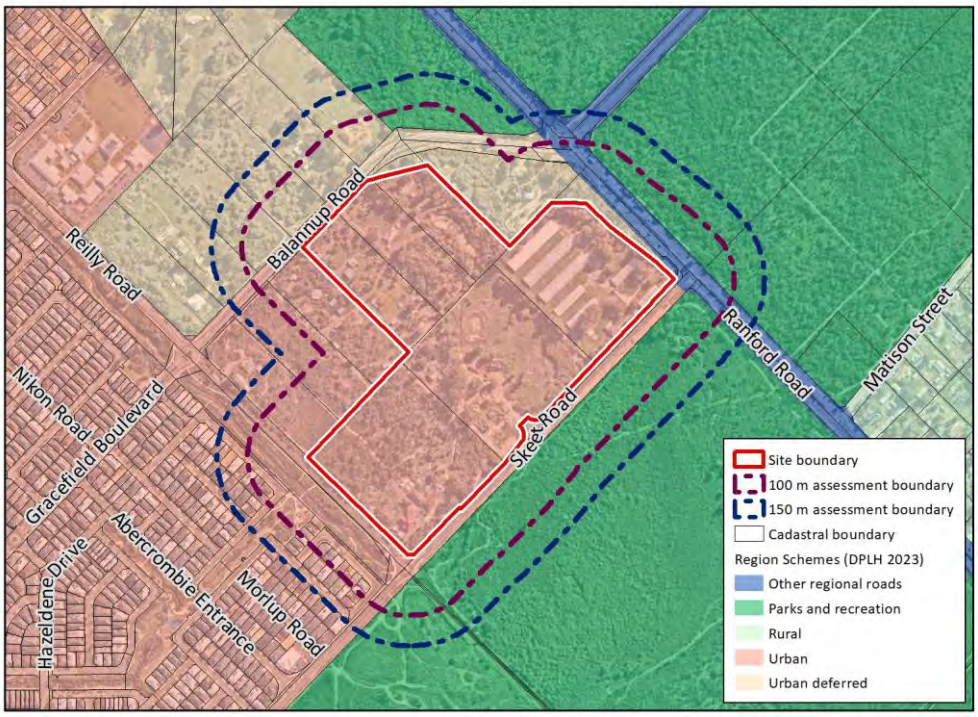


Plate 2: Metropolitan Region Scheme zones and reserves within and surrounding the site.

1.5 Description of land characteristics

Topography of the site is relatively flat with elevation ranging from 21 m Australian height datum (m AHD) to 23 m AHD across the site (DoW 2008). It is noted that there are several elevated areas with an elevation up to 24 m AHD just outside the site boundary, perpendicular to Skeet Road on the western boundary and along Ranford Road to the east as shown on **Figure 1.**

Much of the site has been subject to considerable historical disturbance and comprises cleared land and planted non-native vegetation, particularly in the eastern portion. The western half of the site tends to comprise more intact native vegetation. The eastern portion is slightly lower lying then the western portion and some areas showed evidence of periods of inundation.

The general locality surrounding the site is characterised by residential land uses associated with the suburb of Harrisdale. The land uses surrounding the site include:

- Bush Forever Site No. 413 (Balannup Lake and adjacent bushland, Southern River/Forrestdale), reserved 'Parks and Recreation' under the MRS, and Ranford Road to the north.
- Bush Forever Site No. 342 (Anstey/Keane Dampland and adjacent bushland, Forrestdale) located to the south and east.
- Large rural residential lots to the immediate west, with existing residential development zoned 'Urban' under the MRS further to the west.
- Large rural residential lots and Balannup Road to the north-west.

2 Environmental Considerations

In accordance with the *Bushfire Management Plan – BAL Contour* template prepared by Department of Planning, Lands and Heritage (DPLH) (2018), this BMP has considered whether there are any environmental values that may require specific consideration through either protection, retention or revegetation. To support this, a review of publicly available databases, as well as site specific information (where available) has been undertaken, with particular reference to the Shared Location Information Platform (SLIP) databases.

A number of site-specific environmental investigations and surveys were undertaken to support the proposed development of the site, these investigations include:

- *Basic Fauna and Targeted Black Cockatoo Assessment – Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale (Emerge Associates 2021a)*
- *Environmental Assessment and Management Strategy – North Harrisdale Structure Plan (Emerge Associates 2022)*
- *Spring Flora and Vegetation Assessment – Lots 600 – 606 Balannup Road and 200 – 202 Skeet Road, Harrisdale (Emerge Associates 2021b)*

A review of historical aerial images available from 1953 onwards shows the site supported undisturbed remnant native vegetation until 1965, after which an easement was constructed transecting Lots 604-606. Between 1974 and 1987, the majority of Lots 200 to 202 and Lots 600 and 601 were cleared and a large body of water was constructed within the center of the site. A number of buildings were constructed circa 1978, including the chicken farm within Lot 202. Since 2008, most of the site has been subject to limited clearing, and areas of regrowth of native vegetation are visible, particularly in Lots 200, 600 and 604-606.

A review of the site-specific environmental investigations and the publicly available datasets identified a number of environmental values within or nearby to the site and have been summarised in **Table 1**.

Table 1: Summary of potential environmental considerations that may be associated with the site (based on a search of the SLIP databases)

Key environmental feature (information in brackets refers to data source)	Yes / no / potentially occurring	If yes / potentially, describe the value that may be impacted
Conservation category wetlands and buffer (Geomorphic wetlands, Swan Coastal Plain (DBCA-019))	Yes	A review of the *Geomorphic Wetlands of the Swan Coastal Plain* dataset (DBCA 2022a) indicated that the majority of the site is mapped as a multiple use wetland (MUW) (unique feature identifier (UFI) #16168). Two resource enhancement wetlands (REW) (UFI #16165 and UFI #15946) interface with the northern portion of the site, while a conservation category wetland (CCW) (UFI #14880) is located in the south-western portion of the site. CCW's are considered priority wetland areas that support a high level of ecological attributes and function, whilst REW's are considered to support a lower level of ecological attributes and functions. A 50 m buffer is proposed to be provided to the CCWs and will be accommodated with POS, while a 30 m wide buffer to the REW adjacent to the north-eastern boundary of the site will be provided. The buffer for the REW will extend into the site and be accommodated within POS or road reserve. It is assumed that the associated wetlands will be retained.
RAMSAR wetlands (DBCA-010)	No	Not applicable. No RAMSAR sites are located within or nearby to the site.
Waterways (DWER-031)	No	Not applicable. No waterways are present within the site.
Threatened and priority flora (Emerge Associates 2021c	Yes	No threatened flora species were recorded within the site; however, three priority flora species were recorded: *Acacia lasiocarpa* var. *bracteolata* long peduncle variant (G.J. Keighery 5026) (P1), *Jacksonia gracillima* (P3) and *Verticordia lindleyi* subsp. *lindleyi* (P4). The majority of the priority flora species identified within the site will be retained and protected within POS.
Threatened and priority fauna (Emerge Associates 2021a).	Yes	The site supports vegetation which has the potential to provide habitat for threatened fauna, including black cockatoos. The native vegetation in the site, particularly that in the southern portion, is contiguous with extensive areas of intact native vegetation outside of the site and would contribute to ecological linkages.
Threatened ecological communities (TEC)	Yes	One TEC listed as endangered under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) ('banksia woodlands of the Swan Coastal Plain TEC') has been identified within the site. Correspondingly, the description, area, and condition thresholds of this TEC also apply to a state-listed priority ecological community (PEC) ('banksia woodlands of the Swan Coastal Plain PEC'). Approximately 7.64 ha of this TEC/PEC occurs within the site, within Lot 603and Lot 200 (Emerge Associates 2021b). Portions of the banksia woodlands of the Swan Coastal Plain TEC are proposed to be retained in POS.
DBCA controlled lands or waters (DBCA-011)	No	Not applicable. No DBCA controlled lands or water exist within or in close proximity to the site.
Clearing regulations – Environmentally Sensitive Areas (DWER-046)	Yes	One environmentally sensitive area (ESA) is present over the entirety of the site. The mapped ESA within the site is likely related to the presence of the CCW and TEC and nearby Bush Forever sites.
Aboriginal heritage places (DPLH-001)	No	Not applicable. No Aboriginal heritage places are identified within or adjacent to the site.
Heritage Council WA – State Register (DPLH-006)	No	Not applicable. No state-listed heritage places are identified within or adjacent to the site.

2.1 Native vegetation – modification and clearing

The vegetation associated with the REWs and CCWs will be retained within three separate POS areas. In addition, a large area of remnant vegetation within the south-western portion of the site will also be retained within POS. The location of the POS areas is shown within the structure plan provided in **Appendix A**.

The remainder of vegetation within the site will most likely be removed as part of the proposed development or where possible retained within road reserves (but modified to low threat). The entire site is mapped as an ESA and is likely to be associated with the CCW and Banksia Woodland TEC identified within the site and in the broader area.

Clearing of native vegetation needs to be undertaken in accordance with a clearing permit or valid exemption pursuant to the *Environmental Protection Act 1986*. Clearing undertaken in accordance with addressing conditions associated with a subdivision approval, pursuant to the *Planning and Development Act 2005*, are exempt from requiring a clearing permit pursuant to Schedule 6 of the *Environmental Protection Act 1986* (where approved by a responsible authority).

2.2 Revegetation and landscape plans

A Landscape Report has been prepared by Emerge Associates (refer to **Appendix B**) to detail the landscaping treatments across the structure plan area. The Landscape Report identifies the areas of public open space (POS) proposed for the structure plan. The POS areas integrate the various wetlands and wetland buffers, based on a recent review of the vegetation condition and extents of the wetlands, as well as areas of retained banksia woodlands of the Swan Coastal Plain TEC. The wetland areas will be surrounded by retained vegetation, bio retention areas and flood storage areas. Where native vegetation is to be retained and/or rehabilitated, this vegetation has been classified in **Section 3** below.

Road reserves and the portions of POS areas not containing retained or rehabilitated vegetation (i.e. within wetlands and their buffer areas, or areas of retained TEC) are proposed to be landscaped as part of future development. These areas will be designed to achieve low threat vegetation in accordance with Section 2.2.3.2(f) of AS 3959. . Future verges and areas of turf and low shrub planting will be maintained and irrigated (where required). The management of the POS and road reserves will be the responsibility of the proponent initially prior to handover to the City of Armadale (where agreed). For the purposes of this BMP, and following feedback from the City of Armadale, all POS areas are assumed to contain classified vegetation and be a bushfire hazard.

Where low threat vegetation is agreed to, ongoing management is expected to align with the typical maintenance requirements for POS and road reserves, and is likely to include activities such as:

- Regular mowing/slashing of grass/turf to less than 100 mm in height (where present).
- Irrigation of grass and garden beds (where required).
- Regular removal of weeds and built up dead material (such as fallen branches, leaf litter etc.).
- Low pruning of trees (branches below 2 m in height removed where appropriate).
- Application/replacement of ground/surface covers such as mulch or non-flammable materials as required.

3 Bushfire Assessment Results

Bushfire risk for the site has been appropriately considered in the specific context of the Guidelines (DPLH & WAPC 2021) (using AS 3959) out to 150 m from the development site, but for determining the likely bushfire impacts upon a building, a distance of 100 m is used. The objective of AS 3959 is to reduce the risk of ignition and loss of a building to bushfire. It provides a consistent method for determining a radiant heat level (radiant heat flux) as a primary consideration of bushfire attack on a building or object. It also prescribes simple national construction responses that can resist the determined radiant heat level at a given distance from the fire and are based on six Bushfire Attack Level (BAL) ratings: BAL-LOW, BAL-12.5, BAL-19, BAL-29, BAL-40 and BAL-FZ.

The building construction requirements outlined within AS 3959 only apply to new Class 1, 2, 3 and associated 10a buildings. Any construction requirements detailed within AS 3959 that may be indicated as part of the BAL assessment will only apply to the new habitable buildings to be constructed as part of the proposed development of the site and that are designated bushfire prone within the state-wide *Map of Bush Fire Prone Areas* (as updated).

Two separate methods (Method 1 and Method 2) are outlined in AS 3959 for determining the impact of bushfire on dwellings. Method 1 (used in this BMP), outlined in Section 2 and Appendix A of AS 3959, provides a basic assessment of radiant heat flux levels at various distances from classified vegetation (up to 100 m). This method assumes standard fuel loads for classified vegetation as outlined in AS 3959 and considers the effective slope beneath vegetation. This method can be used to determine appropriate setbacks to dwellings to achieve different levels of radiant heat exposure (i.e. BAL-12.5 to BAL-FZ).

3.1 Bushfire attack level (BAL) assessment

In accordance with Appendix Five of the Guidelines, a method 1 BAL assessment has been undertaken to support the structure plan for the site, in order to determine the BAL ratings potentially applicable to the habitable buildings based on the vegetation classification and effective slope. The BAL ratings are illustrated across the site in the BAL contour plan (discussed further below in **Section 3.1.2**).

3.1.1 Assessment inputs

Assessing bushfire hazards takes into account the classes of vegetation within the site and surrounding area for a minimum of 100 m, in accordance with AS 3959. The assignment of vegetation classifications is based on an assessment of vegetation structure, which includes consideration of the various fuel layers of different vegetation types. For example, fuel layers in a typical forest environment can be broken down into five segments as illustrated in **Plate 3** below. These defined fuel layers are considered when determining the classification of vegetation and associated bushfire hazard levels.



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

Not all vegetation is a classified bushfire risk. Vegetation and ground surfaces that are exempt from classification as a potential hazard is identified as a low threat under Section 2.2.3.2 of AS 3959. Low threat vegetation includes the following:

a) *Any vegetation that is more than 100 m from the site.*
b) *Single areas of vegetation less than 1 ha in area and not within 100 m of other areas of vegetation being classified.*
c) *Multiple areas of vegetation less than 0.25 ha in area and not within 20 m of the site, or each other, or of other areas of vegetation being classified.*
d) *Strips of vegetation less than 20 m in width (measured perpendicular to the elevation exposed to the strip of vegetation) regardless of length and not within 20 m of the site or each other, or other areas of vegetation being classified.*
e) *Non-vegetated areas, that is, areas permanently cleared of vegetation, including waterways, exposed beaches, roads, footpaths, buildings and rocky outcrops.*
f) *Vegetation regarded as a low threat due to factors such as flammability, moisture content or fuel load. This includes grassland managed in a minimal fuel condition, mangroves and other saline wetlands, maintained lawns, golf courses (such as playing areas and fairways), maintained public reserves and parklands, sporting fields, vineyards, orchards, banana plantations, market gardens (and other non-curing crops), cultivated gardens, commercial nurseries, nature strips and windbreaks.*

An assessment of existing vegetation and effective slope within the site and surrounding 150 m was undertaken on the 21st of January 2021, following the method in accordance with AS 3959 and the Guidelines. It has also been considered as part of subsequent site visits, the most recent being August 2022. A description of the pre-development vegetation classifications and supporting photographs are provided in **Table 2**.

*Table 2: Pre-development AS 3959 vegetation classification (refer to **Figure 2**)*

Photo ID:	1	**Plot:**	1
Vegetation Classification or Exclusion Clause			
Class A - Forest			
Description / Justification for Classification			
Areas of forest vegetation have been identified within the southern portion of the site. The vegetation has a multi-tiered fuel structure and is associated with an overstorey of Eucalyptus trees up to at least 15 m in height and foliage cover greater than 30%. The understorey consists of mixed small trees, shrubs, grass and herbs. This vegetation is associated with the CCW proposed to be retained.			



Photo ID:	2	**Plot:**	2
Vegetation Classification or Exclusion Clause			
Class A - Forest			
Description / Justification for Classification			
Areas of forest vegetation have been identified within the northern portion of the site. The vegetation has a multi-tiered fuel structure and is associated with an overstorey of Eucalyptus trees approximately 10-20 m in height and foliage cover greater than 30%. The understorey consists of mixed small trees, shrubs, grass and a ground cover of accumulated leaf litter and debris. This vegetation is to be removed/modified as part of future development.			



Photo ID:	3	**Plot:**	2
Vegetation Classification or Exclusion Clause			
Class A - Forest			
Description / Justification for Classification			
Areas of forest vegetation have been identified within the northern portion of the site. The vegetation has a multi-tiered fuel structure and is associated with an overstorey of Eucalyptus trees approximately 10-20 m in height and foliage cover greater than 30%. The understorey consists of mixed small trees, shrubs, grass and a ground cover of accumulated leaf litter and debris. This vegetation is to be removed/modified as part of future development.			



*Table 2: Pre-development AS 3959 vegetation classification (refer **to Figure 2**) (continued)*

Photo ID:	4	**Plot:**	3
Vegetation Classification or Exclusion Clause			
Class A – Forest			
Description / Justification for Classification			
Areas of forest vegetation have been identified within and external to the east of the site. The vegetation has a multi-tiered fuel structure and is associated with an overstorey of Eucalyptus trees approximately 10 m in height and foliage cover greater than 30%. The understorey consists of mixed small trees, shrubs, grass and a ground cover of accumulated leaf litter and debris. This vegetation is likely to be removed/modified as part of future development but timing is uncertain, so is identified as a temporary hazard.			
Photo ID:	5	**Plot:**	4
Vegetation Classification or Exclusion Clause			
Class A - Forest			
Description / Justification for Classification			
Areas of forest vegetation have been identified external to the north of the site (background of photo). Whilst some management may occur, this does not appear to be consistent. The vegetation contains a multi-tiered fuel structure associated with the overstorey of Eucalyptus trees approximately 10 m-15 m in height over small trees, grasses, and debris. Foliage cover is greater than 30%, and increases further into the plot.			
Photo ID:	6	**Plot:**	4
Vegetation Classification or Exclusion Clause			
Class A - Forest			
Description / Justification for Classification			
Areas of forest vegetation have been identified external to the northeast of the site, associated with Bush Forever site 413 Balannup Lake and adjacent bushland. The vegetation has a multi-tiered fuel structure and is associated with an overstorey of Eucalyptus trees up to 20 m in height and foliage cover greater than 30%. The understorey consists of mixed small trees, shrubs, grass and a ground cover of accumulated leaf litter and debris.			

*Table 2: Pre-development AS 3959 vegetation classification (refer to **Figure 2**)*

Photo ID:	7	**Plot:**	5
Vegetation Classification or Exclusion Clause			
Class B - Woodland			
Description / Justification for Classification			
Woodland vegetation has been identified within and external to the eastern portion of the site. The vegetation is characterised by an overstorey of predominantly planted Eucalyptus trees up to a height of approximately 20 m. Separation in tree canopy (and trunks) was apparent over the area (and represented a foliage cover of less than 30%. This vegetation is likely to be removed/modified as part of future development, but timing is uncertain, so is identified as a temporary hazard.			
Photo ID:	8	**Plot:**	5
Vegetation Classification or Exclusion Clause			
Class B - Woodland			
Description / Justification for Classification			
Woodland vegetation has been identified within and external to the eastern portion of the site. The vegetation is characterised by an overstorey of predominantly planted Eucalyptus trees up to a height of approximately 20 m. Separation in tree canopy (and trunks) was apparent over the area and represented a foliage cover of less than 30%. This vegetation is likely to be removed/modified as part of future development, but timing is uncertain, so is identified as a temporary hazard.			

*Table 2: Pre-development AS 3959 vegetation classification (refer **to Figure 2**) (continued)*

Photo ID:	9	**Plot:**	6
Vegetation Classification or Exclusion Clause			
Class B - Woodland			
Description / Justification for Classification			
Woodland vegetation has been identified external to the northwest of the site. The vegetation is characterised by an overstorey of Eucalyptus trees up to a height of approximately 15 m over grasses. Separation in tree canopy (and tree trunk) was apparent over the area with a foliage cover of less than 30%.			



Photo ID:	10	**Plot:**	6
Vegetation Classification or Exclusion Clause			
Class B - Woodland			
Description / Justification for Classification			
Woodland vegetation has been identified external to the northwest of the site. The vegetation is characterised by an overstorey of Eucalyptus trees up to a height of approximately 15 m over grasses. Separation in tree canopy (and tree trunk) was apparent over the area with a foliage cover of less than 30%.			



Photo ID:	11	**Plot:**	7
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation has been identified external to the northwest of the site. The area consists of predominantly of *Melaleuca spp*, scattered *Kunzea glabrecens* and grasses averaging approximately 2-3 m in height. Occasional *Banksia spp* up to 4 m in height are scattered throughout the area.			



*Table 2: Pre-development AS 3959 vegetation classification (refer to **Figure 2**)*

Photo ID:	12	**Plot:**	7
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation has been identified external to the west of the site. The area consists of predominantly of *Melaleuca spp*, scattered *Kunzea glabrecens* and grasses averaging approximately 2-3 m in height. Occasional *Banksia spp* up to 4 m in height are scattered throughout the area.			
Photo ID:	13	**Plot:**	7
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation has been identified external to the west of the site. The area consists of predominantly of *Melaleuca spp*, scattered *Kunzea glabrecens* and grasses averaging approximately 2-3 m in height. Occasional *Banksia spp* up to 4 m in height are scattered throughout the area.			
Photo ID:	14	**Plot:**	8
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation associated with a low lying drainage feature has been identified to the west and north-west of the site. This vegetation is associated with POS/drainage areas in adjacent residential development. Vegetation consists of predominantly *Melaleuca spp* and *Kunzea spp* up to 2-4 m in height. Areas of revegetated native sedges and small shrubs are also present within the drain. Some management is evident (use of mulch, weed control), however is assumed to be a bushfire hazard.			

*Table 2: Pre-development AS 3959 vegetation classification (refer to **Figure 2**)*

Photo ID:	15	**Plot:**	9
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation has been identified within the southeastern portion of the site, consisting of *Banksia spp* approximately 4 m in height over weeds and grasses. This vegetation is to be removed/modified as part of future development.			



Photo ID:	16	**Plot:**	10
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation associated with a low lying wetland features have been identified external to the south of the site and Skeet Road. Vegetation consists of predominantly *Melaleuca spp* approximately 2-4 m in height. This vegetation is associated with Bush Forever site 342 Anstey/Keane Dampland and adjacent bushland, and is proposed to remain in the long-term.			

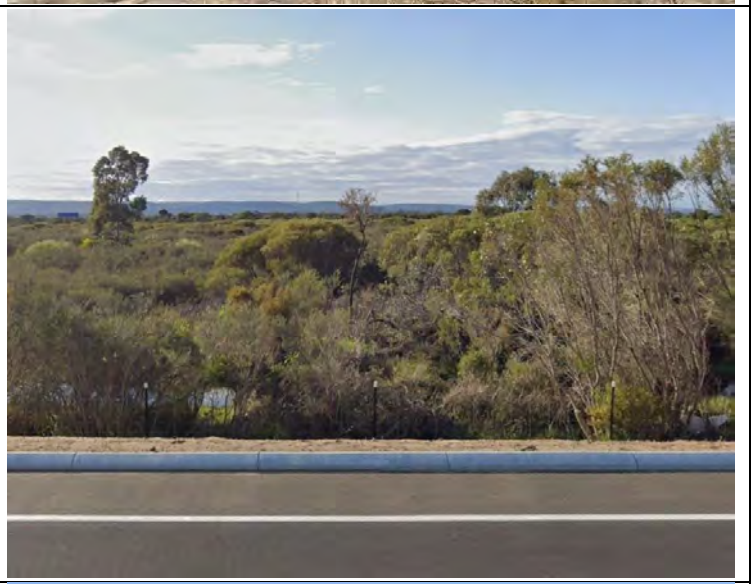


Photo ID:	17	**Plot:**	10
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation associated with low lying wetland features have been identified external to the south of the site and Skeet Road. Vegetation consists of predominantly *Melaleuca spp* approximately 2-4 m in height. This vegetation is associated with Bush Forever site 342 Anstey/Keane Dampland and adjacent bushland, and is proposed to remain in the long-term.			



*Table 2: Pre-development AS 3959 vegetation classification (refer **to Figure 2**) (continued)*

Photo ID:	18	**Plot:**	10
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation associated with low lying wetland features have been identified within the southern portion of the site. Vegetation consists of predominantly *Melaleuca spp* approximately 2-4 m in height. This is associated with the CCW feature and is proposed to remain in the long-term, however has been assumed to achieve 'forest' in the long term (aligning with adjacent vegetation that is also being retained).			
Photo ID:	19	**Plot:**	12
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation associated with low lying wetland features have been identified to the north of the site. Vegetation consists of predominantly *Melaleuca spp* approximately 2-4 m in height. This vegetation is predominantly associated with a REW feature, and is proposed to remain in the long-term.			
Photo ID:	21	**Plot:**	11
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation has been identified external to the east of the site, consisting of *Melaleuca spp* and *Banksia spp* approximately 2-4 m in height. This vegetation is associated with Bush Forever site 413 Balannup Lake and adjacent bushland, and is proposed to remain in the long-term.			

*Table 2: Pre-development AS 3959 vegetation classification (refer **to Figure 2**) (continued)*

Photo ID:	20	**Plot:**	12
Vegetation Classification or Exclusion Clause			
Class D - Scrub			
Description / Justification for Classification			
Scrub vegetation has been identified external to the north-west of the site, consisting of predominantly *Melaleuca spp* approximately 2-4 m in height over non-native grasses and weeds.			



Photo ID:	23	**Plot:**	13
Vegetation Classification or Exclusion Clause			
Class G – Grassland			
Description / Justification for Classification			
Areas of grassland vegetation has been identified within the north-west portion of the site and are associated with areas that have historically been cleared to support agricultural/rural-residential land uses. These areas are characterised by non-native grass species, which while appear to be subject to some management, are currently unmanaged, growing to a height of between 15 cm – 1 m. This vegetation is to be removed/modified as part of future development.			



Photo ID:	24	**Plot:**	13
Vegetation Classification or Exclusion Clause			
Class G – Grassland			
Description / Justification for Classification			
Areas of grassland vegetation has been identified throughout portions of the site and are associated with areas that have historically been cleared to support agricultural/rural-residential land uses. These areas are characterised by non-native grass species, which are currently unmanaged, growing to a height of between 15 cm – 1 m. This vegetation is to be removed/modified as part of future development.			



*Table 2: Pre-development AS 3959 vegetation classification (refer to **Figure 2**)*

Photo ID:	22	**Plot:**	14
Vegetation Classification or Exclusion Clause			
Class G – Grassland			
Description / Justification for Classification			
Areas of grassland vegetation has been identified external to the south of the site and are associated with areas that have historically been cleared to support agricultural/rural-residential land uses. These areas are characterised by non-native grass species, which are currently unmanaged, growing to a height of between 15 cm – 1 m.			



Photo ID:	25	**Plot:**	15
Vegetation Classification or Exclusion Clause			
Exclusion 2.2.3.2(e)			
Description / Justification for Classification			
The photo shows the intersection of Skeet Road and Ranford Road consisting of paved surface and areas of mineral earth and roads have been excluded in accordance with Clause 2.2.3.2(e) of AS 3959. These areas may contain portions of managed vegetation however predominantly comprise non-vegetated areas.			



Photo ID:	26	**Plot:**	15
Vegetation Classification or Exclusion Clause			
Exclusion 2.2.3.2(e)			
Description / Justification for Classification			
Areas surrounding the site to the west are associated with residential development currently under construction consisting of roads, built structures (dwellings) and bare mineral earth and therefore has been excluded in accordance with Clause 2.2.3.2(e) of AS 3959. These areas may contain managed vegetation (gardens), however for ease of reference have been identified as non-vegetated areas			



*Table 2: Pre-development AS 3959 vegetation classification (refer to **Figure 2**)*

Photo ID:	27	**Plot:**	16
Vegetation Classification or Exclusion Clause			
Exclusion 2.2.3.2(f)			
Description / Justification for Classification			
Areas surrounding the site to the north/north-west associated with private landholdings contain managed lawns and gardens maintained to a low threat condition and have been excluded in accordance with Clause 2.2.3.2(f) of AS 3959.			
Photo ID:	28	**Plot:**	16
Vegetation Classification or Exclusion Clause			
Exclusion 2.2.3.2(f)			
Description / Justification for Classification			
Portions of the site are under management containing well-managed grass/garden areas (in mid-ground) as part of existing operating businesses and have been excluded in accordance with Clause 2.2.3.2 (f) of AS 3959. It is noted these areas also contain non-vegetated areas however primarily consist of managed vegetation. This vegetation is to be removed/modified as part of future development			

3.1.1.1 Post development assumptions

The BAL assessment for the site has been undertaken in accordance with Method 1 of AS 3959 to determine the maximum heat flux to which future dwellings within the site are likely to be exposed.

- The vegetation classification and effective slope applicable to vegetation within or nearby to the site in the post-development scenario have been summarised in **Table 3**. Overall, the assumed BAL assessment criteria includes: **Designated FDI**: 80
- **Flame temperature**: 1090 K
- **Vegetation classification**: forest (Class A), woodland (Class B), scrub (Class D) and grassland (Class G) vegetation as identified within the post-development scenario, as outlined in **Figure 4** and summarised in **Table 3**
- **Effective slope beneath classified vegetation**: flat/upslope (see **Figure 5**)
- **Setback distances**: as per Table 2.5 in AS 3959 with the relevant distances used to inform the BAL contour plan summarised in **Table 4**, with the BAL contour provided in **Figure 6**.

In addition to the above, the following key assumptions have informed this assessment:

- Retained vegetation will keep its current predominant structure (including wetlands and wetland buffers and areas of the banksia woodlands of the Swan Coastal Plain TEC) and have been classified accordingly. Where revegetation is assumed, this has been included as part of the indicated classification (and generally aligns with the predominant vegetation of the wetland).
- POS areas as per the request of the City of Armadale, have been assumed to be a bushfire hazard. It is possible that the areas outside retained environmental values will be subject to future management and considered low threat.
- Areas of low threat vegetation outside of the site (and not under the proponent's control) will continue to be managed and/or considered to achieve low threat (in accordance with Section 2.2.3.2 of AS 3959) based on the existing maintenance regimes, and/or as per the City of Armadale's fire control notice.
- Classified vegetation that has been identified outside of the proponent's landholdings has been assumed to remain in its current state (unless stated otherwise), and will, therefore, remain a bushfire hazard to development within the site.
- Vegetation located between the site boundary and Ranford Road is expected to be removed and developed in the future. As the timing of this is not known, the vegetation has been classified based on its current state but identified as a temporary hazard. The BALs are based on the existing vegetation structure in this area.

Table 3: Summary of the assumed post-development vegetation classification and associated effective slope within the site and 150 m in accordance with Table 2.5 (AS3959)

Pre-development (Figure 2)		Post-development vegetation classification (Figure 4)	Effective slope
Plot no.	Vegetation classification		
Plot 1	Class A – Forest	Class A – Forest (Plot 1): areas associated with the CCW and areas of TEC within POS.	Flat/upslope
Plot 2	Class A – Forest	Exclusion 2.2.3.2 (e) (Plot 15): will be modified for future roads and lot areas.	Not applicable
Plot 3	Class A – Forest	Class A – Forest (Plot 3): however is a temporary hazard.	Flat/upslope
Plot 4	Class A – Forest	Class A – Forest (Plot 4)	Flat/upslope
Plot 5	Class B – Woodland	Class B – Woodland (Plot 5): however is a temporary hazard	Flat/upslope
Plot 6	Class B – Woodland	Class B – Woodland (Plot 6)	Flat/upslope
Plot 7	Class D – Scrub	Class D – Scrub (Plot 7): where outside the site Exclusion 2.2.3.2 (e) (Plot 15): will be modified within the site for future roads and lot areas.	Flat/upslope (Plot 7) Not applicable (Plot 15
Plot 8	Class D – Scrub	Class D – Scrub (Plot 8)	Flat/upslope
Plot 9	Class D – Scrub	Exclusion 2.2.3.2 (e) (Plot 15): will be modified for future roads and lot areas.	Not applicable
Plot 10	Class D – Scrub	Class D – Scrub (Plot 10): associated with Bush Forever site 342	Flat/upslope
Plot 11	Class D – Scrub	Class D – Scrub (Plot 11): associated with Bush Forever site 413	Flat/upslope
Plot 12	Class D – Scrub	Class D – Scrub (Plot 12): associated with Bush Forever site 413. Class D – Scrub (Plot 17): Areas associated the portion of the REW buffer that extends into the site. It will be revegetated with native shrub species (known to support heights less than 6 m) where within POS.	Flat/upslope (Plot 12) Flat/upslope (Plot 17)
Plot 13	Class G – Grassland	Class D – Scrub (Plot 17): Areas associated with the portion of the REW buffer that extends into the site (to the west) will be revegetated with native shrub species (known to support heights less than 6 m) where within POS.. Exclusion 2.2.3.2 (e) (Plot 15): will be modified within the site for future roads and lot areas	Flat/upslope (Plot 17) Not applicable (Plot 15)
Plot 14	Class G – Grassland	Class G – Grassland (Plot 14).	Flat/upslope
Plot 15	Exclusion 2.2.3.2 (e)	Exclusion 2.2.3.2 (e) (Plot 15): will remain under existing management regimes, associated with roads, bare ground and residential development. Class G – Grassland (Plot 18): Associated with areas of POS outside wetland buffers and retained vegetation, which is assumed to be unmanaged for the purposes of this BMP.	Not applicable (Plot 15) Flat/upslope (Plot 18)

Table 3: Summary of the assumed post-development vegetation classification and associated effective slope within the site and 150 m in accordance with Table 2.5 (AS3959) (continued)

Pre-development (Figure 2)		Post-development vegetation classification (Figure 4)	Effective slope
Plot no.	Vegetation classification		
Plot 16	Exclusion 2.2.3.2 (f)	Class D – Scrub (Plot 17): Areas associated with the portion of the REW buffer that extends into the site (to the north) will be revegetated with native shrub species (known to support heights less than 6 m) where within POS.. Exclusion 2.2.3.2 (e) (Plot 15) – will be modified within the site for future roads and lot areas. Exclusion 2.2.3.2 (f) (Plot 16) – applicable to existing managed areas external to the site.	Flat/upslope (Plot 17) Not applicable (Plot 15) Not applicable (Plot 16)

3.1.2 Assessment outputs

Based on the outcomes of the BAL assessment (see **Figure 6**), the majority of the site is likely to be subject to a BAL rating of BAL-29 or less, with the bulk subject to BAL-12.5 or less. Portions of the site in the north-east will have areas subject to BAL-40 or BAL-FZ (predominantly within the commercial area) as result of temporary bushfire hazards that will be removed when development in the broader area is progressed. This can be managed as part of staging of development.

In the central-southern portion of the site, surrounding the POS, BAL-40 (and a small area of BAL-FZ along the western boundary) extends into the development cells as a result of retained vegetation and/or assumption around future treatment (assumed to be 'forest'). Development will be separated from classified vegetation in the POS by a public road interface, and it would be possible to achieve BAL-29 with a 6 m front lot setback for lots to the west of the POS and a 1 m front lot setback for lots to the east. This can be considered when lot layout is addressed at future subdivision stages and through use of local development plans

Table 4 provides a summary of the setback distances necessary from classified vegetation to achieve the indicated BAL ratings, with the BAL Contour Plan (provided in **Figure 6**) being a visual representation of these distances. The setback distances are based on the post-development classified vegetation (**Figure 4**), effective slope (**Figure 5**) and are taken from Table 2.5 of AS 3959.

Table 4: Setback distances based on post-development vegetation classification and effective slope and Table 2.5 of AS 3959, as determined by the method 1 BAL assessment

Post development plot number (see Figure 4)	Vegetation classification (see Figure 4)	Effective slope (see Figure 5)	Distance to vegetation (from Table 2.5 of AS 3959)	BAL rating (see Figure 6)
Plot 1, Plot 3, and Plot 4	Forest (Class A)	Flat/upslope	< 16 m	BAL-FZ
			16 - < 21 m	BAL-40
			21 - < 31 m	BAL-29
			31 - < 42 m	BAL-19
			42 - < 100 m	BAL-12.5
			> 100 m	BAL-LOW
Plot5 and Plot 6	Woodland (Class B)	Flat/upslope	< 10 m	BAL-FZ
			10 - < 14 m	BAL-40
			14 - < 20 m	BAL-29
			20 - < 29 m	BAL-19
			29 - < 100 m	BAL-12.5
			> 100 m	BAL-LOW
Plot 7, Plot 8, Plot 11, Plot 12, and Plot 17	Scrub (Class D)	Flat/upslope	< 10 m	BAL-FZ
			10 - < 13 m	BAL-40
			13 - < 19 m	BAL-29
			19 - < 27 m	BAL-19
			27 - < 100 m	BAL-12.5
			> 100 m	BAL-LOW
Plot 13, Plot 14, and Plot 18	Grassland (Class G)	Flat/upslope	< 6 m	BAL-FZ
			6 - < 8 m	BAL-40
			8 - < 12 m	BAL-29
			12 - < 17 m	BAL-19
			17 - < 50 m	BAL-12.5
			> 50 m	BAL-LOW

4 Identification of Bushfire Hazard Issues

From a bushfire hazard management perspective, the key issues that are likely to require management and/or consideration as part of future development within the site include:

- Provision of appropriate separation distances from permanent bushfire hazards within the site (i.e. classified vegetation associated with the POS areas, wetland and buffers) and surrounding the site to ensure a BAL rating of BAL-29 or less can be achieved at future habitable buildings. This includes the consideration of the long-term classification of vegetation based on potential revegetation and/or development.
- Provision of appropriate vehicular access to ensure that when development within the site is fully constructed, egress to at least two different destinations will be available to future residents and emergency personnel. This may include the use of temporary emergency access ways or turning heads as part of internal staging of subdivision, until the full road network associated with the structure plan is constructed.
- Provision of appropriate water supply and associated infrastructure (e.g. reticulated water and associated hydrant network).

These issues are considered further in **Section 5.**

5 Assessment Against the Bushfire Protection Criteria

This BMP provides an outline of the mitigation strategies that will ensure that as development progresses within the site, an acceptable solution and/or performance-based system of control can be adopted for each of the bushfire protection criteria detailed within Appendix Four of the Guidelines (DPLH & WAPC 2021). The bushfire protection criteria identified in the Guidelines and addressed as part of this BMP are:

- Element 1: Location of the development
- Element 2: Siting and design of the development
- Element 3: Vehicular access
- Element 4: Water supply.

For future development, the intent of the bushfire protection criteria can be satisfied through an acceptable solution. A summary of how this can be achieved and an associated compliance statement for each has been provided in **Table 5**.

Table 5: Summary of bushfire protection criteria and compliance statement

Bushfire protection criteria	Intent	Method of compliance		Proposed bushfire management strategies	Compliance statement
		Acceptable solution	Performance principle		
Element 1: Location	To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.	A1.1 Development location		The BAL contour plan indicates that the majority of the site will be able to achieve a BAL rating of BAL-29 or less. Based on the retained wetland values, associated buffers and proposed revegetation, minor portions of the site are likely to be subject to a BAL rating exceeding BAL-29. As part of future subdivision and detailed design, development can be designed to ensure habitable buildings achieve BAL-29 or less through the use of in-lot setbacks or the location of public roads. Temporary bushfire hazards will be a consideration for staged development and need to be factored in as part of proposed subdivision. Further planning at the subdivision application and/or development application stage will inform the proposed lot layout for the site, with an updated BMP (and associated BAL assessment) to be prepared to ensure that future habitable buildings are able to achieve a BAL rating of BAL-29 or less.	The proposed structure plan provides developable land[1] that will, on completion be subject to BAL-29 or below compliant with A1.1.
		Yes.	N/A		
Element 2: Siting and design of development	To ensure that the siting and design of development minimises the level of bushfire impact.	A2.1 Asset Protection Zone		Asset protection zones (APZ) around buildings are an important bushfire protection measure influencing the safety of people and property. The APZ is a low fuel area immediately surrounding a building and can include non-flammable features such as irrigated landscapes, gardens, driveways, public roads and managed public open space. The bushfire hazards in the post-development scenario that are relevant to the site are shown in **Figure 4**. These include retained forest and scrub vegetation within the site, associated with the wetland features, and their buffers, as well as POS areas. External bushfire hazards are predominantly associated with areas of forest and scrub vegetation to the north, east, south and west of the site. (continued below)	Continued below
		Yes	N/A		

[1] *Position Statement: Planning in bushfire prone areas - Demonstrating Elements 1: Location and Element 2: Siting and design* Department of Planning, Lands and Heritage (DPLH) 2019, *Position Statement: Planning in bushfire prone areas - Demonstrating Element 1: Location and Element 2: Siting and design*, Western Australian Planning Commission. has outlined that 'developable land' is "*land that can accommodate a habitable dwelling and would not generally include areas of BAL-40 and/or BAL-FZ, areas within the local government setback and areas subject to environmental constraints"*.

Table 5: Summary of bushfire protection criteria and compliance statement (continued)

Bushfire protection criteria	Intent	Method of compliance		Proposed bushfire management strategies	Compliance statement
		Acceptable solution	Performance principle		
Element 2: Siting and design	To ensure that the siting and design of development minimises the level of bushfire impact.	A2.1 Asset Protection Zone (Continued from above)		(Continued from above) The BAL assessment completed for the site indicates that a BAL rating of BAL-29 or less can be achieved at the majority of residential cells supporting future habitable buildings based on the indicated spatial layout for the development, as shown in **Figure 6**, with the majority of the future development areas likely to be subject to a BAL rating of BAL-12.5 or less. Separation from bushfire hazards can be accommodated through the public road network and/or in-lot setbacks. The BAL assessment has also identified a number of development cells (including the local centre) that will be subject to areas exceeding BAL-29 as a result of retained vegetation within POS or adjacent temporary hazards. Future residential lots located within the development cells adjacent to the immediate west and east of the southern POS, associated with wetland, wetland buffers and retained vegetation are located partially within BAL-40 (with a minor portion of the western cell, less than 1 m, in BAL0FZ) . For the development cell to the east, the area is separated by a proposed 20 m wide road reserve, and therefore only a 1 m in-lot setback is likely to be required for future habitable buildings to achieve BAL-29. For the development cell to the west of the POS, it is separated from the area of bushfire hazard by a proposed 15 m-wide road reserve, and an approximate 6 m-wide front lot setback would enable future habitable buildings to achieve BAL-29. Based on the R-codes of the development cells, future lots, would typically require a minimum front lot setback of 4-6 m. Portions of the site in the north-east (near Ranford Road) will have areas subject to BAL-40 or BAL-FZ (predominantly within the local centre area) as result of temporary bushfire hazards that will be removed when development in the broader area is progressed. This can be managed as part of staging of development. The acceptable solution can be satisfied for all existing and future habitable buildings. Where proposed to be constructed and within a designated bushfire prone area, new Class 1, 2, 3 and associated 10a buildings, in an area subject to a BAL rating of BAL-12.5 or higher will need to satisfy higher construction standards in accordance with AS 3959.	Based on the outlined management measures, future development would be able to comply with and meet the intent of Element 2: Siting and design. Subject to satisfying required setbacks through subdivision design and considering temporary bushfire hazards, future habitable buildings can achieve a BAL rating of BAL-29 or less, compliant with A2.1

Table 5: Summary of bushfire protection criteria and compliance statement (continued)

<table>
<tr><th rowspan="2">Bushfire protection criteria</th><th rowspan="2">Intent</th><th colspan="2">Method of compliance</th><th rowspan="2">Proposed bushfire management strategies</th><th rowspan="2">Compliance statement</th></tr>
<tr><th>Acceptable solution</th><th>Performance principle</th></tr>
<tr><td rowspan="4">Element 3: Vehicular access</td><td rowspan="4">To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event</td><td colspan="2">A3.1 Public road</td><td rowspan="2">Existing roads surrounding the site, in addition to the proposed new public roads within the site, can and will comply with the minimum standards outlined in Appendix Four of the Guidelines (DPLH & WAPC 2021) and includes a minimum 6 m-wide trafficable surface. An excerpt of the requirements (from Table 6 of the Guidelines) has been provided below.

Excerpt of Table 6 from The Guidelines (DPLH & WAPC 2021)
<table><tr><th>TECHNICAL REQUIREMENTS</th><th>1
Public roads</th><th>2
Emergency access way[1]</th><th>3
Fire service access route[1]</th><th>4
Battle-axe and private driveways[2]</th></tr><tr><td>Minimum trafficable surface (metres)</td><td>In accordance with A3.1</td><td>6</td><td>6</td><td>4</td></tr><tr><td>Minimum horizontal clearance (metres)</td><td>N/A</td><td>6</td><td>6</td><td>6</td></tr><tr><td>Minimum vertical clearance (metres)</td><td colspan="4">4.5</td></tr><tr><td>Minimum weight capacity (tonnes)</td><td colspan="4">15</td></tr><tr><td>Maximum grade unsealed road[3]</td><td rowspan="4">As outlined in the IPWEA Subdivision Guidelines</td><td colspan="3">1:10 (10%)</td></tr><tr><td>Maximum grade sealed road[3]</td><td colspan="3">1:7 (14.3%)</td></tr><tr><td>Maximum average grade sealed road</td><td colspan="3">1:10 (10%)</td></tr><tr><td>Minimum inner radius of road curves (metres)</td><td colspan="3">8.5</td></tr></table></td><td rowspan="2">Based on the outlined management measures, future development would be able to comply with and meet the intent of Element 3: Vehicular access.

In particular, access to at least two different destinations can be facilitated through the future development of the site.</td></tr>
<tr><td>Yes</td><td>N/A</td></tr>
<tr><td colspan="2">A3.2a Multiple access routes</td><td rowspan="2">The public road access within the structure plan has provided egress in two different directions to at least two different suitable destinations with an all-weather surface (two-way access). The proposed structure plan provides for an interconnected road network within the site that will utilise the existing and future connections to the existing public road network. This includes connections to Balannup Road to the north, Skeet Road to the south, and Reilly Road to the immediate west (under construction), providing egress opportunities to the north, east, south and west. Interim access measures may be required at subdivision stage to facilitate sufficient access at all stages of subdivision development where through roads remain under development.</td></tr>
<tr><td>Yes</td><td>N/A</td></tr>
</table>

Table 5: Summary of bushfire protection criteria and compliance statement (continued)

Bushfire protection criteria	Intent	Method of compliance		Proposed bushfire management strategies	Compliance statement
		Acceptable solution	Performance principle		
Element 3: Vehicular access	To ensure that the vehicular access serving a subdivision/ development is available and safe during a bushfire event	A3.2b Emergency access way		No permanent emergency access ways will be required given the structure plan provides for egress to at least two different destinations. It is possible that as part of staged development, emergency access ways may be required to ensure future development has access to at least two different destinations, until the full public road network is constructed. This should be considered as part of each stage of development. Where required, these should be implemented in accordance with the requirements of the Guidelines, unless agreed otherwise with the City of Armadale.	Continued from above
		N/A	N/A		
		A3.3 Through roads		Three permanent no-through roads are proposed as part of the structure plan layout (see in **Figure 7**) however two of the no-through roads are less than 30 m in length. Being less than 30 m in length means fire appliances can safely operate from the road junction without having to travel down the no-through roads and turn around (similar to the considerations for private driveways less than 70 m in length, where no additional access considerations are required), or if a fire appliance does need to travel down the no-through road it could easily navigate reversing this section of road. The third no-through road in the south-east of the site is approximately 35 m in length and provides lot access for several lots. It is noted that the road terminates with the local centre and in the long-term is not expected to function as a no-through road but rather an entrance to these areas. Until the progression of the local centre proceeds the road can be provided with a temporary turning head as per Appendix Four of the Guidelines. As part of the staging of development additional temporary no-through roads may be required. These no-through roads will be provided with turn-around areas that are able to comply with Appendix Four of the Guidelines. Indicative turning head locations have been shown in **Figure 7** to demonstrate the ability to meet the no through road technical requirements.	
		Yes	N/A		
		A3.4a Perimeter roads		A perimeter road is a public road where 10 or more lots are being proposed (including as part of a staged subdivision) with the aim of separating areas of vegetation classified under AS 3959, from the proposed lot(s). All future development cells and the local centre either have frontage to an existing public road or will be provided with a public road interface.	
		Yes	N/A		

Table 5: Summary of bushfire protection criteria and compliance statement (continued)

Bushfire protection criteria	Intent	Method of compliance		Proposed bushfire management strategies	Compliance statement
		Acceptable solution	Performance principle		
Element 3: Vehicular access Continued from above	Continued from above To ensure that the vehicular access serving a subdivision/ development is available and safe during a bushfire event.	A3.4b Fire service access route		Not required. All development is separated from areas of bushfire hazards by public roads.	Continued from above
		N/A	N/A		
		A3.5 Battle-axe access legs		Not applicable. The structure plan has not yet been designed to the lot level. Battle-axe lots should be avoided unless site constraints dictate these are necessary.	
		N/A	N/A		
		A3.6 Private driveways		Not applicable. No private driveways longer than 70 m are proposed and/or are likely based on the type and density of the proposed development. It is possible the local centre may have a driveway longer than 70 m, if this is the case, the requirements of the Guidelines will need to be considered but would be addressed at development application stage of the process.	
		N/A	N/A		
Element 4: Water	To ensure water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.	A4.1 Identification of future water supply		Bushfire events in this area are responded to by a network of metropolitan career Fire and Rescue Service stations and the State Emergency Services (SES) as required. Fire response services require ready access to and adequate water supply during bushfire emergencies. The site will connect with the reticulated water supply network.	Based on the outlined management measures, future development would be able to comply with and meet the intent of Element 4: Water given it will connect with the reticulated water supply network.
		Yes	N/A		
		A4.2 Provision of water for firefighting purposes		Fire hydrants installed by the developer will meet the specifications of Water Corporation (Design Standard DS 63) and the Department of Fire and Emergency Services (DFES). Fire hydrants on land zoned for residential purposes are generally required to be sited at or within 200 m of dwellings (Class 1a). Commercial development (local centre) will be subject to onsite hydrant requirements as specified by the National Construction Code.	
		Yes	N/A		

5.1 Additional management strategies

5.1.1 Future approval considerations

The BAL assessment within this document is considered to be a conservative assessment of potential bushfire risk posed to future residential and commercial development within the site based on the assumptions outlined in **Section 3**.

The measures to be implemented through this structure plan and associated future subdivision process have been outlined as part of this BMP and can be used to support future planning and development approval processes. A revised BMP is likely to be required to support any future subdivision applications, particularly if the development layout is different to that outlined within this document and will need to respond to the subdivision design (and/or stage of development).

5.1.2 Landscape management

5.1.2.1 Within the site

Within POS areas

In accordance with the request of the City of Armadale, proposed as part of development within the site have been identified as classified vegetation and a bushfire hazard (forest, scrub or grassland depending upon the pre-development scenario and expected use/purpose). The existing CCW and REW wetland areas will be retained, and the associated wetland buffers are assumed to be revegetated to the same vegetation classification as the wetland. This is shown in **Figure 4**. No ongoing management has been assumed in the POS areas for bushfire purposes, although it is noted from an amenity, public use and community expectation perspective management is likely to occur.

The design and construction of POS areas is generally a condition of subdivision approval, and the detailed design will be determined in collaboration with the City of Armadale as part of the standard development process (and based on typical maintenance requirements for urban/residential areas). A Landscape Report has been prepared and is provided in **Appendix B** showing intended uses/approach.

Within public road reserves

The proposed road reserves will be designed and maintained to achieve a low threat in accordance with Section 2.2.3.2 (e) and (f) of AS 3959 and will be the responsibility of the proponent initially until handover to the City of Armadale.

Future lots

All lots will be managed to a low threat standard by the proponent initially, and once sold, will be managed by the applicable landowners in accordance with the City of Armadale fire control notice (as published).

5.1.2.2 Surrounding the site

Where indicated as a low threat in **Figure 4**, it is assumed that the landholdings surrounding the site will be managed by the applicable landowners in accordance with the City of Armadale's fire break notice (as published) and/or in accordance with existing maintenance regimes. It is noted that the site does not rely on management within these areas given the road interface between lots and areas of classified or excluded vegetation.

Where indicated as classified vegetation in **Figure 4**, the landholdings surrounding the site have been assumed to remain a bushfire hazard in the long-term.

The forest and woodland vegetation along Ranford Road adjoining the site boundary is expected to be removed and developed in the future. However, the timing of this is not known and the current vegetation classifications have been applied to provide a conservative approach to the BAL ratings for the structure plan area and support future design/staging as part of the subdivision process.

5.1.3 City of Armadale Fire Break Notice

The City of Armadale releases a fire break notice annually (or as required) to provide a framework for bushfire management within the City. The City of Armadale is able to enforce this order in accordance with Section 33(1) of the *Bush Fires Act 1954* and landowners will need to ensure compliance with the fire break notice, as published, or any directions provided by the City of Armadale.

Following development for residential purposes, it is likely that landholdings will be required to have all long grass, weeds, etc., slashed, mowed or trimmed down by other means to a height no greater than 5 cm across the entire property. The firebreak notice (as updated) should be referred to for further detail.

5.1.4 Vulnerable or high-risk land uses

No vulnerable or high-risk land uses, as defined under SPP 3.7, are proposed within the site as part of the future development of the site. The requirements of policy measure 6.6 within SPP 3.7 are not applicable at this stage.

If any high-risk or vulnerable land uses are proposed in the future, the requirements of policy measure 6.6 of SPP 3.7 will need to be addressed, including the assessment of bushfire risk and/or the preparation of an emergency evacuation plan (for vulnerable land uses) or risk management plan (for high-risk land uses).

Currently, it is possible for all future lots to be located in an area with appropriate vehicle access to support emergency evacuation and for BAL-29 or less to be achieved at habitable buildings, enabling the requirements of SPP 3.7 to be satisfied.

5.1.5 Public education and preparedness

Community bushfire safety is a shared responsibility between individuals, the community, government and fire agencies. DFES has an extensive Community Bushfire Education Program including a range of publications, a website and Bushfire Ready Groups. The DFES website (https://www.dfes.wa.gov.au/bushfire/prepare/) provides a range of materials to help the community prepare for and survive the bushfire season.

The City of Armadale provides bushfire safety advice to residents available from their website https://www.armadale.wa.gov.au/firebreaks-and-burning-permits. Professional, qualified consultants also offer bushfire safety advice and relevant services to residents and businesses in high-risk areas in addition that that provided in this BMP.

In the case of a bushfire in the area, advice would be provided to residents and businesses by DFES, the Department of Biodiversity Conservation and Attractions (DBCA) and/or the City of Armadale on any specific recommendations with regard to responding to the bushfire, including evacuation if required. It is highly recommended that residents make themselves aware of their responsibilities with regard to preparing for and responding to a potential bushfire that may impact upon them, their property and their visitors at the time, regardless of the BAL rating the building is subject to.

6 Responsibilities for Implementation and Management of Bushfire Measures

Table 6 outlines the future responsibilities of the proponent (developer) and the City of Armadale associated with implementing this BMP. These responsibilities will need to be considered as part of the subsequent development and implementation process.

Table 6: Responsibilities for the implementation of this BMP

Management action	Timing
Developer	
Provide a copy of this BMP to the relevant decision makers to support approval of the proposed structure plan.	To support the structure plan approval process.
If required, prepare a new/revised BMP in accordance with SPP 3.7, the Guidelines and AS 3959 to support future subdivision applications, based on the proposed subdivision layout and in consideration of existing bushfire hazards or those that will be present following development. This will need to consider staging of development, and how temporary vehicle access and/or BAL ratings setbacks will be managed. If the assumptions regarding the treatment of the POS and public road reserves change as part of future detailed design stages, a revised BMP will be required.	To support each future subdivision application.
Where required, and based on the outcomes this BMP or subsequent BMP/s, make spatial provision within the subdivision layout/design to accommodate: • A suitable road network that provides access to at least two different destinations. The trafficable surface of the public roads should meet the minimum requirements of Appendix Four in the Guidelines (or as agreed with the City of Armadale). The proposed structure plan currently supports this requirement. • The proposed no through roads should meet the minimum requirements of Appendix Four in the Guidelines (or as agreed with the City of Armadale), including provision of a suitable turning head. • If any temporary no through roads or emergency access ways are required (based on staging of development), ensure these meet the requirements outlined in Appendix Four of the Guidelines (if applying an acceptable solution), or as agreed with the City of Armadale. • Ensure future habitable buildings are able to be located so that BAL-29 or less can be achieved. Separation distances should be in accordance with the minimum distances outlined in **Table 4** of this BMP for the corresponding vegetation plot/classification, or as determined in subsequent BMPs/BAL assessments. This may include the provision of public roads and/or managed public open space between built form and bushfire hazards, or by ensuring lots are an adequate depth or width to accommodate in-lot setbacks to ensure BAL-29 is not exceeded at future built form.	To support each future subdivision application.
Comply with the City of Armadale fire break notice/s as published and/or in accordance with directions given by the local government.	Ongoing.

7 Applicant Declaration

7.1 Accreditation

This BMP has been prepared by Emerge Associates who have been providing bushfire risk management advice for more than ten years, undertaking detailed bushfire assessments (and associated approvals) to support the land use development industry.

Anthony Rowe is a Fire Protection Association of Australia (FPAA) Level 3 Bushfire Planning and Design (BPAD) accredited practitioner (BPAD No. 36690) in accordance with clause 6.12 of the Guidelines.

7.2 Declaration

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

Signature:



Name: Anthony Rowe

Company: Emerge Associates/Envision Bushfire Protection

Date: 29 August 2023

BPAD Accreditation: Level 3 BPAD no. 36690

8 References

8.1 General references

Department of Water (DoW) 2008, LiDAR Elevation Dataset, Swan Coastal Plain, Perth.

Department of Planning, Lands and Heritage (DPLH) 2019, Position Statement: Planning in bushfire prone areas - Demonstrating Element 1: Location and Element 2: Siting and design, Western Australian Planning Commission.

Department of Planning, Lands and Heritage, and Western Australian Planning Commission, (DPLH & WAPC) 2021, Guidelines for Planning in Bushfire Prone Areas Version 1.4, Perth, Western Australia.

Emerge Associates 2020, Bushfire Management Plan -Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale, EP20-127(11)--010 HPB.

Emerge Associates 2021a, Basic Fauna and Targeted Black Cockatoo Assessment - Lots 600-606 Balannup Road and 200-202 Skeet Road, Harrisdale EP20-127(03)--006 SCM, Version 1.

Emerge Associates 2021b, Spring Flora and Vegetation Assessment - Lots 600 - 606 Balannup Road and 200 - 202 Skeet Road, Harrisdale, EP20-127(02)--003, 1.

Standards Australia 2018, AS 3959:2018 Construction of buildings in bushfire-prone areas, Sydney.

Western Australian Planning Commission (WAPC) 2015, State Planning Policy 3.7 Planning in Bushfire Prone Areas, Perth.

8.2 Online references

Landgate 2019, Locate V5, viewed March 2021, <https://maps.slip.wa.gov.au/landgate/locate/>

Office of Bushfire Risk Management (OBRM) 2021, Map of Bush Fire Prone Areas, viewed March 2022, https://maps.slip.wa.gov.au/landgate/bushfireprone/

Figures

Figure 1: Site Location and Topographic Contours

Figure 2: Existing Site Conditions – AS 3959 Vegetation Classifications

Figure 3: Existing Site Conditions – Bushfire Hazard Rating

Figure 4: Post Development Conditions – AS 3959 Vegetation Classifications

Figure 5: Post Development Conditions – Effective Slope

Figure 6: Bushfire Attack Level Contours

Figure 7: Vehicle Access Plan



Figure 1: Site Location and Topographic Contours

Project: Bushfire Management Plan
North Harrisdale Structure Plan

Client: Yolk Property Group Pty Ltd

Plan Number:
EP20-127(11)--F107

Drawn:	WJC
Date:	28/08/2023
Checked:	DVB
Approved:	KK
Date:	29/08/2023

N

0 100 200 300
Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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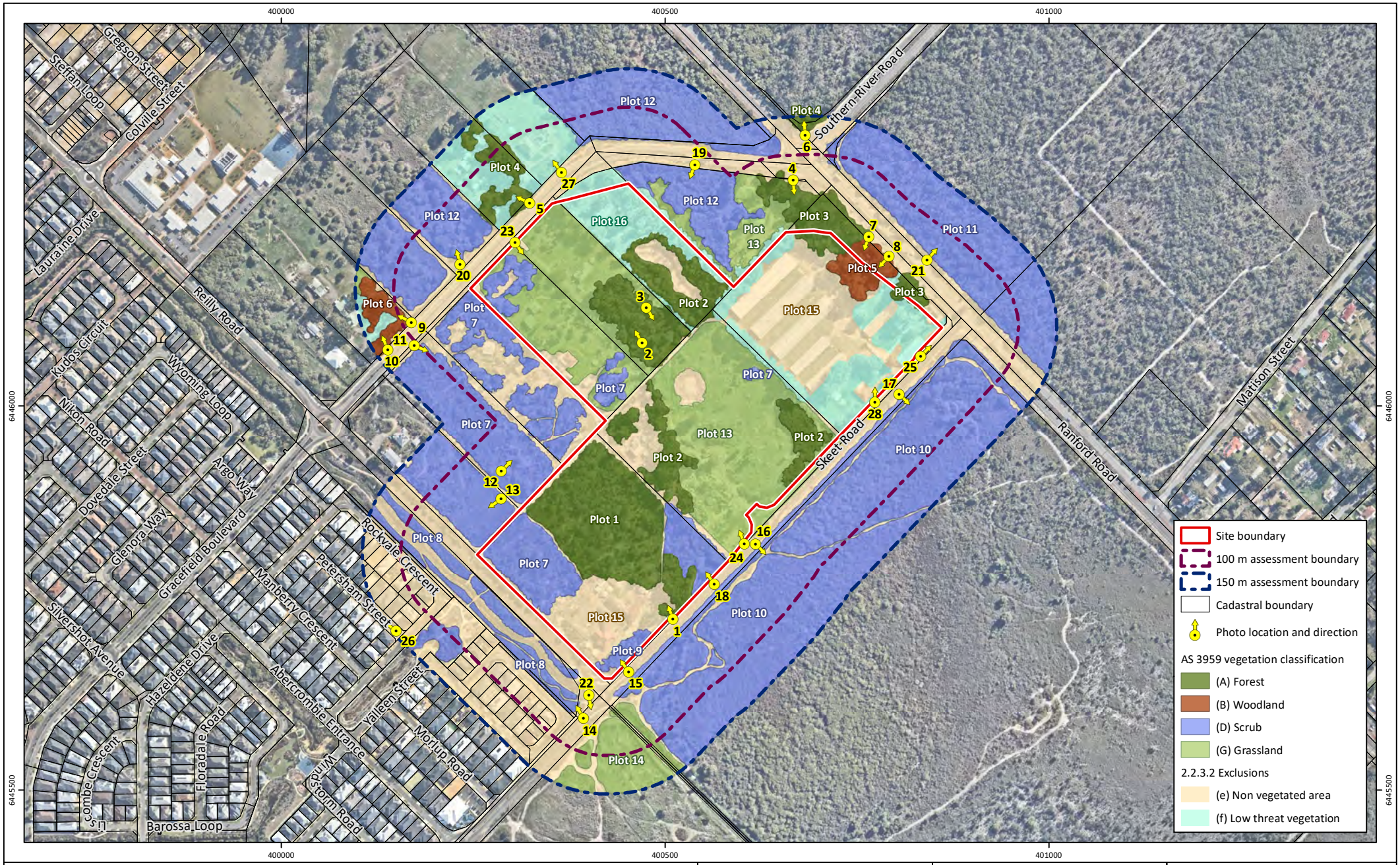


Figure 2: **Existing Site Conditions - AS 3959 Vegetation Classifications**

Project:	Bushfire Management Plan North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(11)--F108

Drawn:	WJC
Date:	28/08/2023
Checked:	DVB
Approved:	KK
Date:	29/08/2023

N

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Metres

Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

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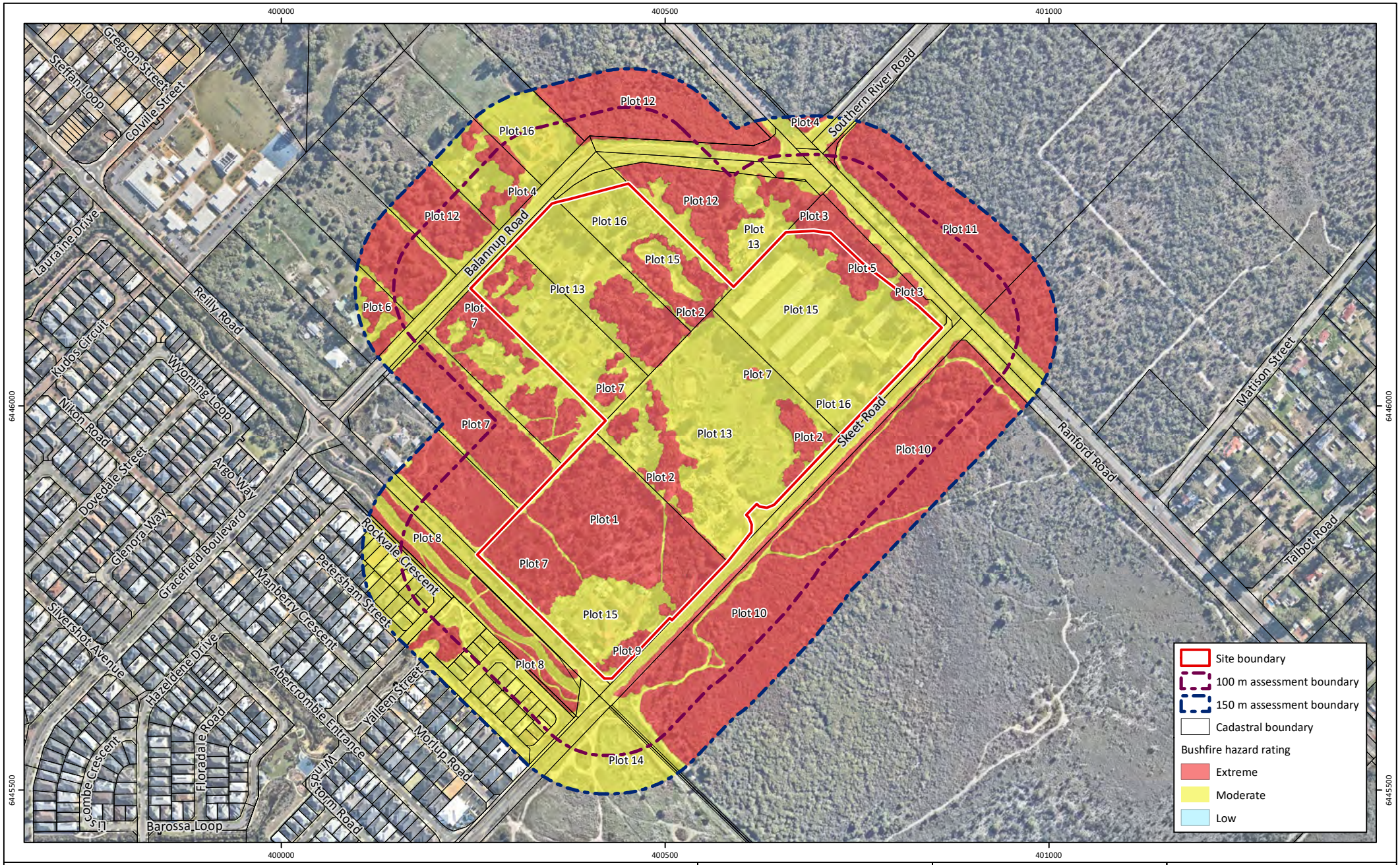


Figure 3: Existing Site Conditions - Bushfire Hazard Rating

Project:	Bushfire Management Plan North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(11)--F109

Drawn:	WJC
Date:	28/08/2023
Checked:	DVB
Approved:	KK
Date:	29/08/2023

N

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Metres

Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

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Figure 4: Post Development Conditions - AS 3959 Vegetation Classifications

Project:	Bushfire Management Plan North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(11)--F110

Drawn:	WJC
Date:	28/08/2023
Checked:	DVB
Approved:	KK
Date:	29/08/2023

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Metres

Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

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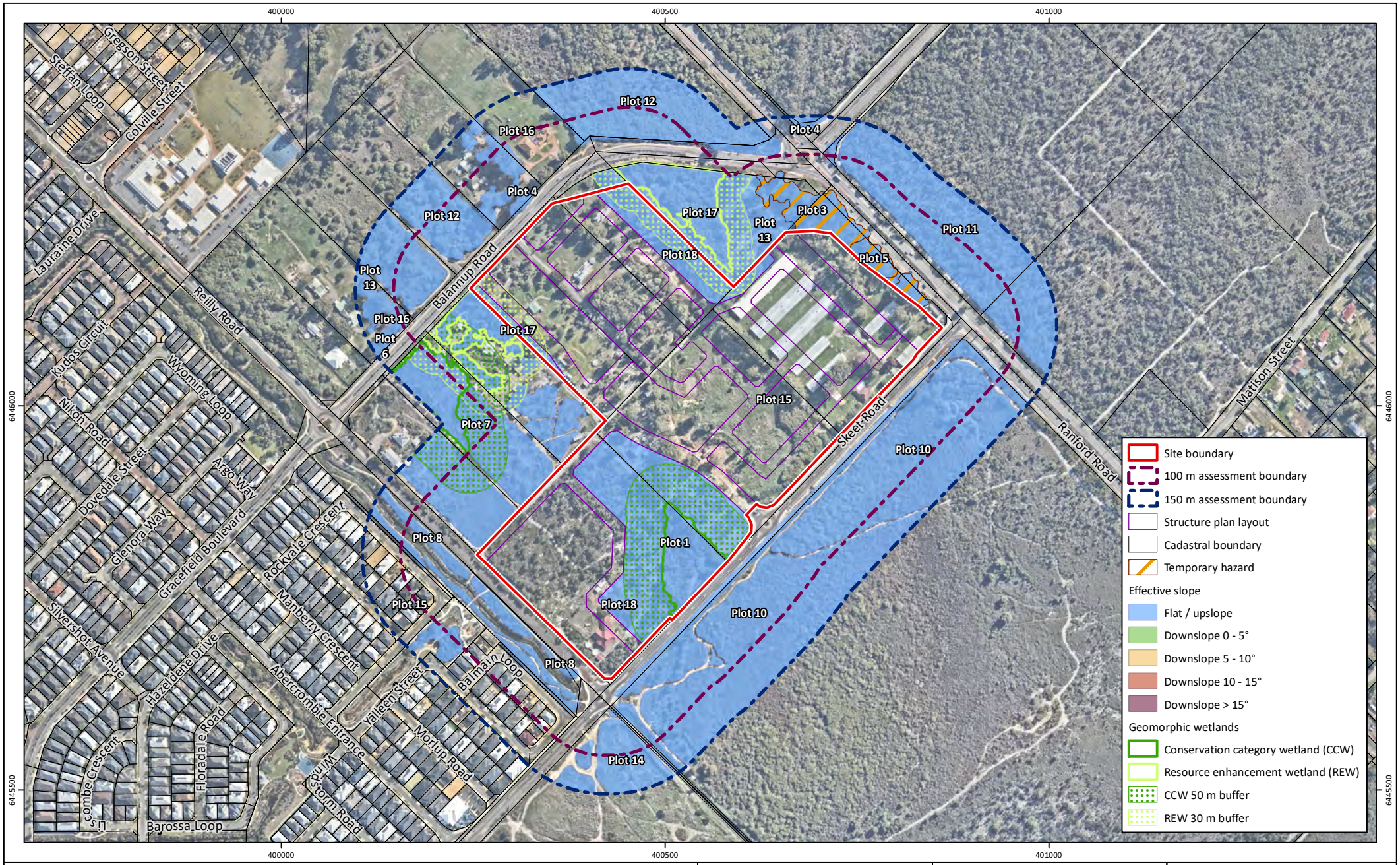


Figure 5: Post Development Conditions - Effective Slope

Project:	Bushfire Management Plan North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(11)--F111

Drawn:	WJC
Date:	28/08/2023
Checked:	DVB
Approved:	KK
Date:	29/08/2023

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Metres

Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

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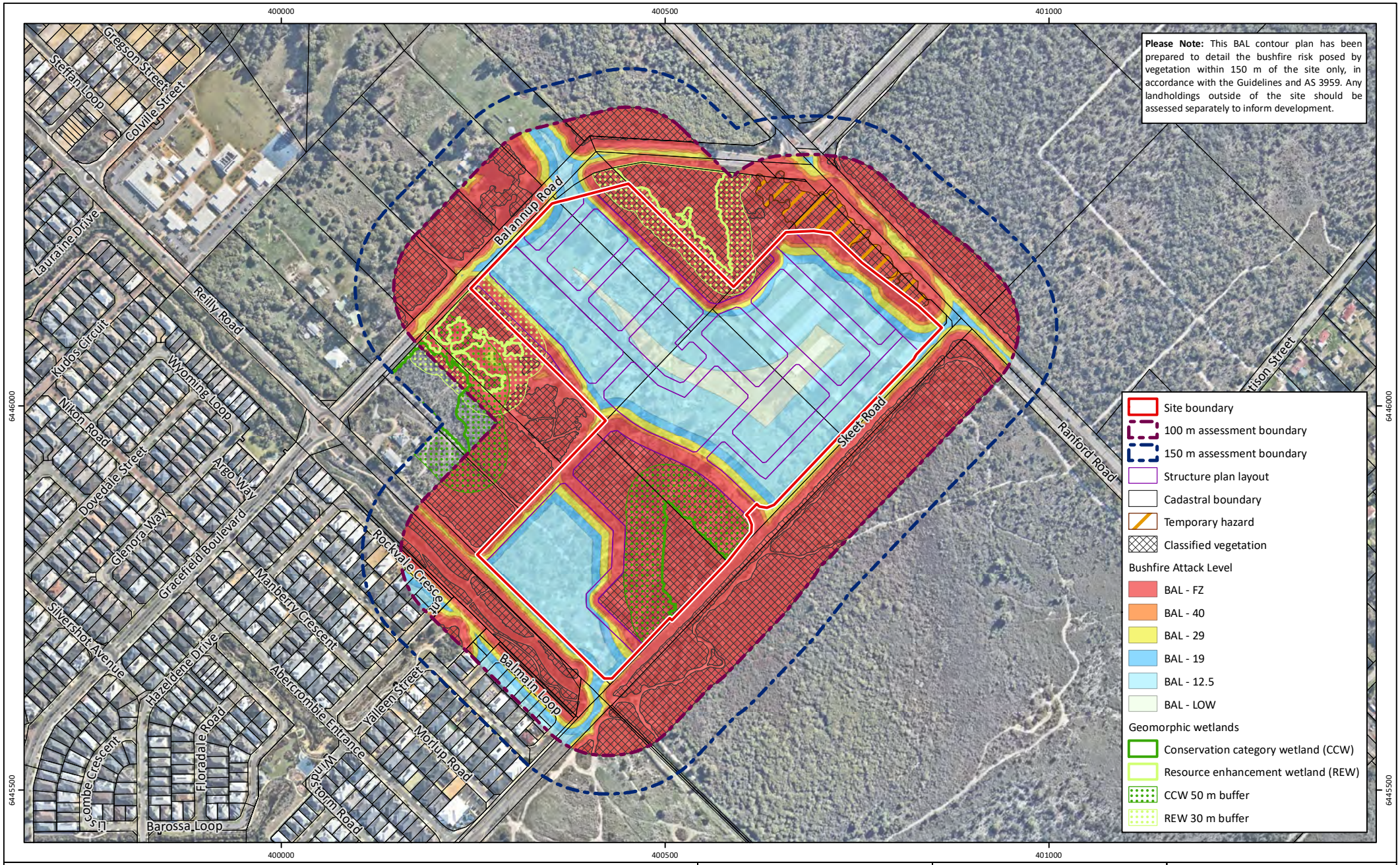


Figure 6: Bushfire Attack Level Contours

Project:	Bushfire Management Plan North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(11)--F112

Drawn:	WJC
Date:	28/08/2023
Checked:	DVB
Approved:	KK
Date:	29/08/2023

N

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Metres

Scale: 1:6,500@A4

GDA 1994 MGA Zone 50

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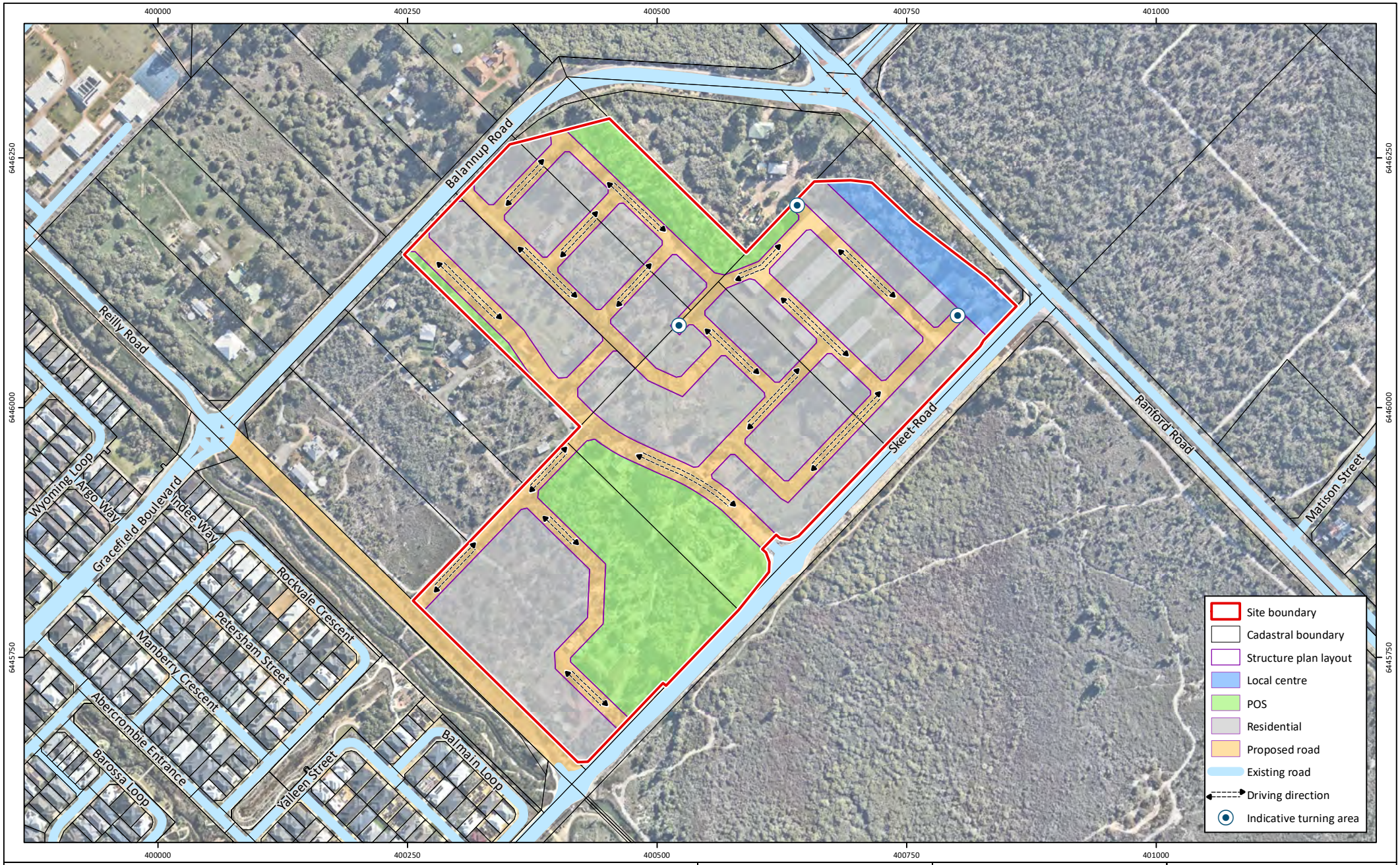


Figure 7: Vehicle Access Plan

Project:	Bushfire Management Plan North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(11)--F113

Drawn:	WJC
Date:	28/08/2023
Checked:	DVB
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Date:	29/08/2023

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Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

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Appendix A

Structure Plan

BALANNUP ROAD

REILLY ROAD

SOUTHERN RIVER RD

RANFORD ROAD

SKEET ROAD

606

605

604

603

602

601

600

POS

POS

POS

200

201

202

98

171

1771

Legend

- Subject Site
- Parent Lot
- CCW
- 50m Buffer to CCW
- REW
- 30m Buffer to REW
- Easement (30m Width)
- Residential R25
- Residential R30
- Public Open Space (POS)
- Local Centre
- Access Streets
- Neighbourhood Connector

22001001B

0m 50 100 200m

HARRISDALE NORTH STRUCTURE PLAN

Harrisdale. Armadale, WA

Project YOLHA 22001001B | Scale 1:2500 @ A3 | Date: June 2023

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Appendix B

Landscape Report

NORTH HARRISDALE STRUCTURE PLAN

LANDSCAPE REPORT

AUGUST 2023

emerge ASSOCIATES



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1.0 SITE CONTEXT

Lots 600 - 606 Balannup Road and Lots 200 - 202 Skeet Road, Harrisdale (referred to herein as ‘the site’) are located approximately 20 kilometres (km) south of the Perth Central Business District within the City of Armadale.

The site is approximately 29.29 hectares (ha) in size and is bound by Ranford Road to the north east, Skeet Road to the south east, Balannup Road to the north west and vacant land associated with the easement for the future continuation of Reilly Road to the south west.

The local structure plan (LSP) allows for the creation of residential lots, three areas of public open space (POS) with integration of various wetlands and wetland buffers (based on recent review of condition and extents), a commercial area, and an existing Western Power easement (which cuts through the south-western corner of the site).

The LSP provides for a well connected open space network which will provide the local community with safe parklands, supporting various open space functions whilst facilitating significant environmental outcomes through the retention and protection of existing conservation category wetlands (CCW). The landscape master plan for the proposal includes retention of existing vegetation and the revegetation of buffers for the CCW as well as the resource enhancement wetland (REW) to the north of the site.





























2.0 LANDSCAPE MASTER PLAN

LEGEND

- SUBJECT SITE
- EASEMENT (30M WIDTH)
- CCW BOUNDARY
- REW BOUNDARY
- 30M BUFFER TO REW
- 50M BUFFER TO CCW
- CCW TO BE RETAINED
- VEGETATION RETENTION AND REVEGETATION
- BIO RETENTION AREA (BRA)
- FLOOD STORAGE AREA (FSA)
- MANAGED LOW LANDSCAPE
- BENCH SEATING
- SHELTER / BBQ FACILITIES
- PROPOSED STREET TREES
- RESIDENTIAL
- COMMERCIAL
- WALKING TRAIL



3.0 LANDSCAPE STRATEGY

The Landscape Strategy is intended to be an overall guide to the proposed functions, amenities and landscape treatment within North Harrisdale LSP.

The parklands will be charcterised with native planting reflecting the historical flora of the area.

The public open scape (POS) areas have been located to retain and protect the CCW and REW areas as well as integrate a variety of local amenity and storm water management functions.



4.0 LANDSCAPE STRATEGY POS CENTRAL

This POS is located centrally within the proposed development providing a concentrated suite of amenity and POS function accessible to the wider community. It incorporates the CCW to the south adjacent Skeet Road.

- Informal active recreation uses on open grassed areas
- Gathering nodes with picnic and shelter facilities
- Opportunity for informal walking trails through controlled access points through the POS. Location and alignment of trails to avoid disturbance of areas of significant vegetation.
- Stormwater retention and conveyance through a vegetated and stabilized swale
- Retention and protection of CCW and revegetation of associated buffer
- Retention of existing Banksia Woodland areas
- Opportunity for nature play nodes to existing areas of clearing
- Path network which links into the greater development
- Manicured landscape areas fully irrigated outside buffer and retained vegetation areas
- All areas outside of wetland, vegetated wetland buffer area and bioretention areas to be “low threat vegetation” in accordance with AS3959:2018.



LOCATION PLAN









5.0 LANDSCAPE STRATEGY POS WEST

This POS is located within the western corner of the proposed LSP along the central entry road off Balannup Road . It includes the REW buffer to the west of the site.

- Vegetation retention and revegetation of associated buffer to REW
- Opportunity for informal walking trails through controlled access points through the POS. Location and alignment of trails to avoid disturbace of areas of significant vegetation
- Path network which links into the greater development Retention of existing significant trees and vegetation where possible
- Opportunity for education of the site and its environmental assets through signage or other means along walking trails
- Majority of this POS will be classified vegetation and therefore a bushfire hazard in accordance with AS3959:2018



LOCATION PLAN





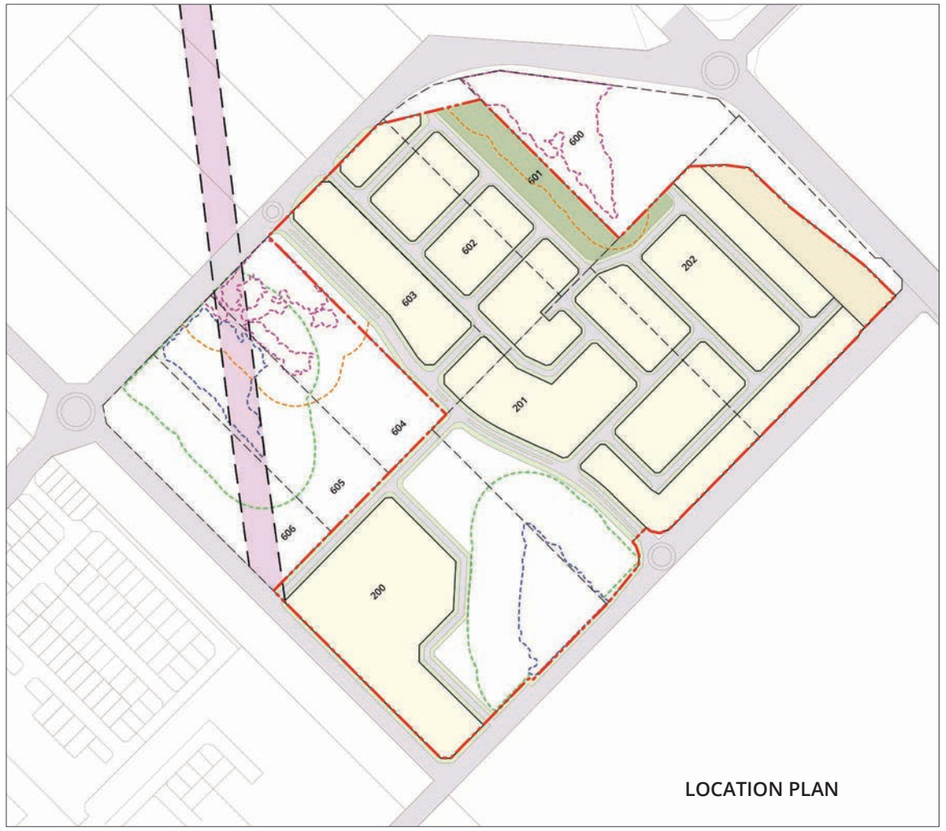




6.0 LANDSCAPE STRATEGY POS EAST

This POS is located in the north east corner of the site. It provides for a revegetated buffer to the REW to the north of the site. It is linear in shape and will provide a north-south greenspace connection through the development.

- Gathering nodes with seating along footpath network
- Stormwater retention and conveyance through a vegetated and stabilised swale
- Vegetation retention and revegetation of associated buffer to REW
- Retention of existing significant trees and vegetation where possible
- Path network which links into the greater development
- Manicured landscape areas fully irrigated outside buffer areas
- All areas outside of the wetland, vegetated wetland buffer and bio retention areas to be “ loe threat vegetation” in accordance with AS3959:2018



LOCATION PLAN







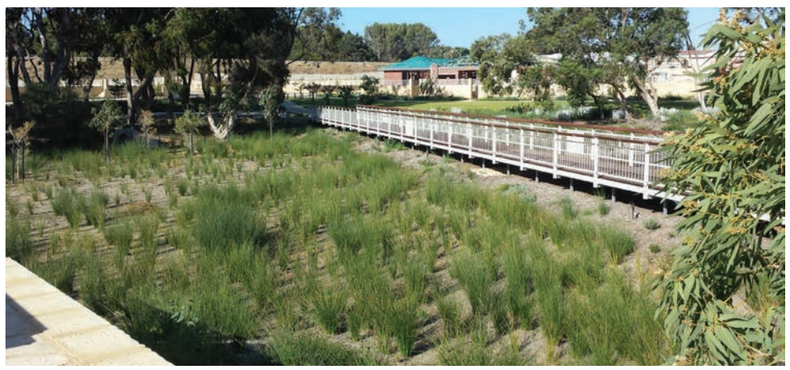


7.0 STORM WATER MANAGEMENT STRATEGY

All stormwater from the development will be directed into bio-retention treatment areas constructed along the edges of the POS. These will be sized to treat the flows from the small rainfall event in accordance with the principles of water sensitive urban design. Storm events in excess of these will be directed into flood storage areas typically located within CCW and REW buffer areas. Flood storage areas will be revegetated with native species. Bio-retention areas will be located outside of CCW buffer areas.





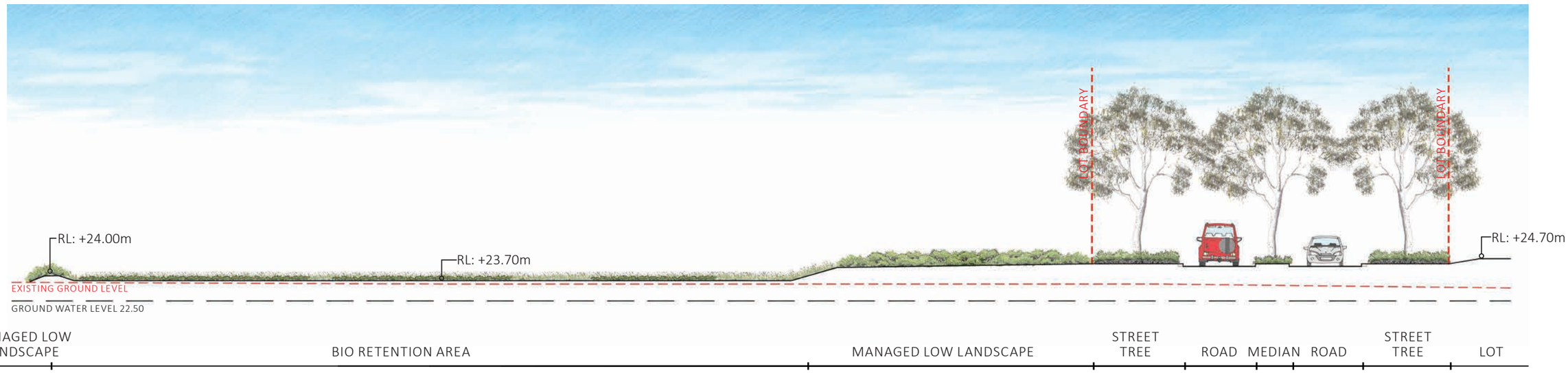




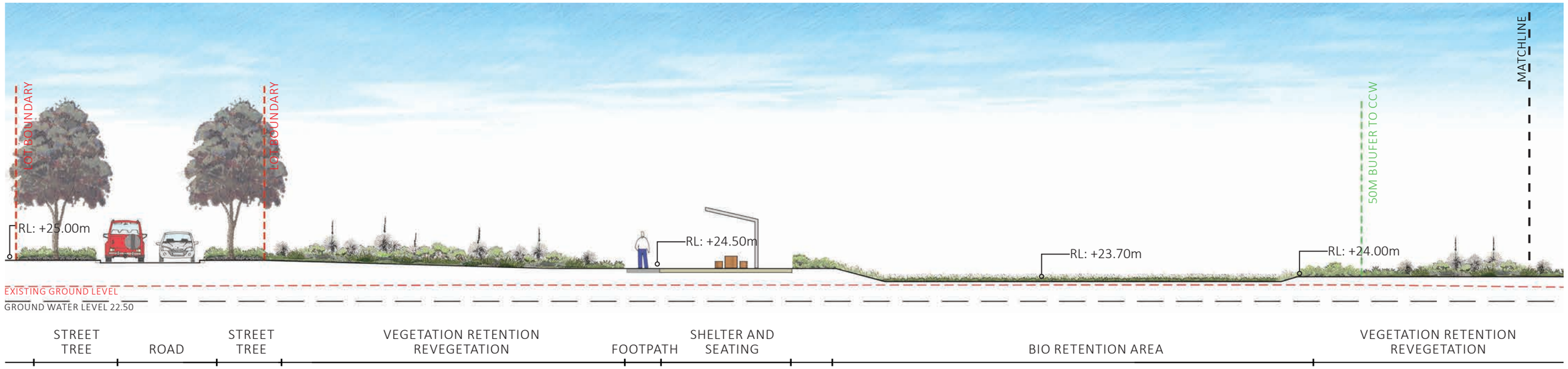
8.0 DRAINAGE CROSS SECTIONS



SECTION A-A

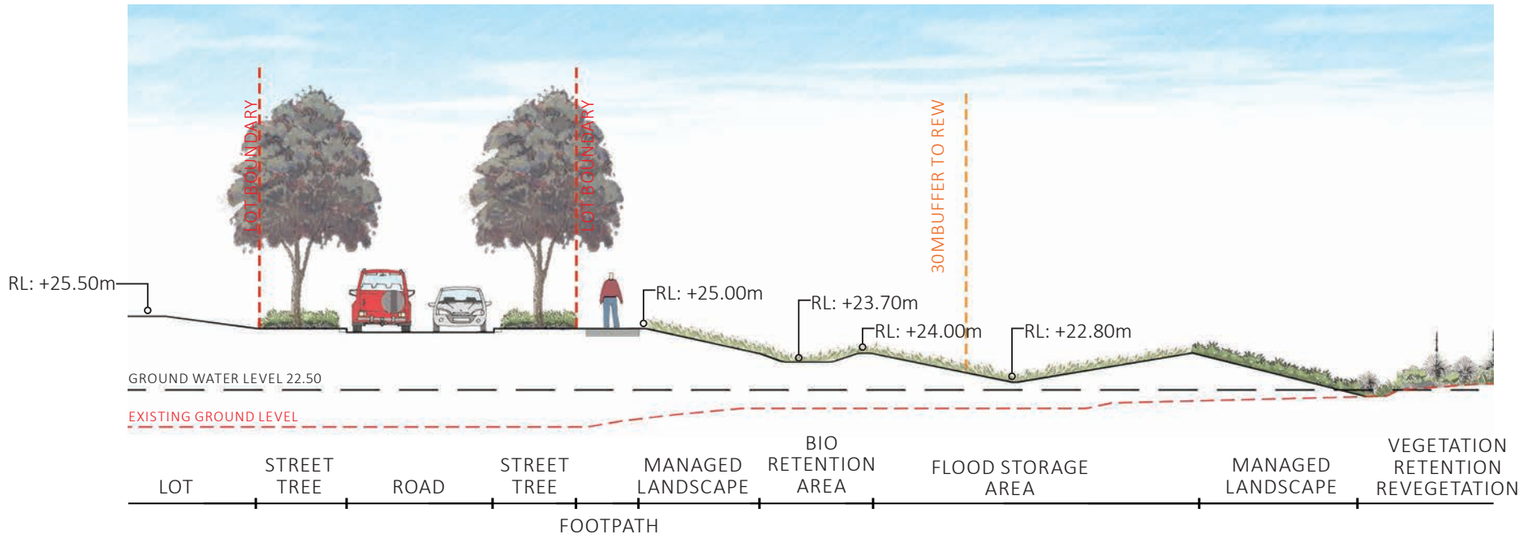


SECTION B-B





SECTION C-C



SECTION D-D

9.0 STREESTSCAPE PLAN

The streetscape planting strategy design will be translated through different palettes of street trees providing legibility through the development.

Tree species selected are waterwise, fast growing, reliable and readily available whilst providing shade and amenity to each street. The proposed species below offer consistencies in appearance with differences in size and scale. Larger, taller trees are shown around POS areas and along north-south roads as the major connector roads through the development. Smaller trees are shown on east-west roads as minor local roads.





CORYMBIA FICIFOLIA







CORYMBIA MACULATA





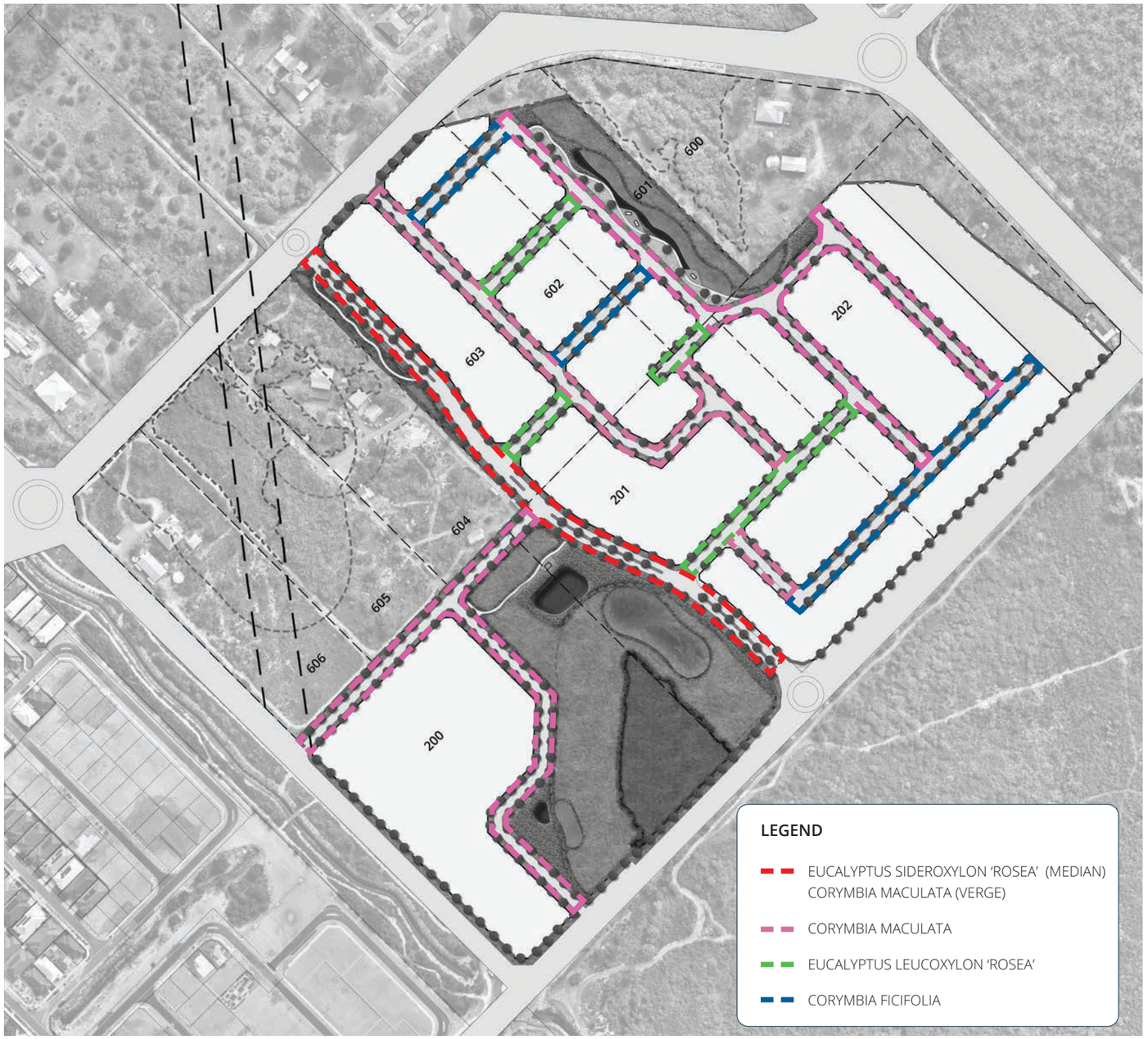


EUCALYPTUS SIDEROXYLON





EUCALYPTUS LEUCOXYLON ‘ROSEA’



10.0 IRRIGATION STRATEGY

The planting design of all streetscape and public open space areas will consist of predominantly native species. Planting design is proposed to include a water sensitive design approach and will also seek to reduce irrigation rates over the long term to planting areas to promote a longer term water saving strategy for the development.

Hydrozoning will also provide a supplementary design principle whereby groups of plants with similar irrigation demand needs will be grouped together. This will facilitate irrigation efficiencies that can be made across the scheme.

Areas within the stormwater swales, bio retention basins and revegetation areas are proposed to be in the main non-irrigated. Swales and basins will be planted with native sedges and rushes to facilitate the stormwater treatment requirements for the site. The water table in these areas will be close to the surface particularly in winter months possibly limiting the need for irrigation within swale. Revegetation areas will be planted with endemic native species.





11.0 MAINTENANCE STRATEGY

In all cases, a maintenance regime will be in place inclusive of general maintenance minimisation through design practices and will aim to use sustainable maintenance practices. This includes, but is not limited to, defined edges and borders, minimal and preferably alternate approaches to pesticides, controlled and minimized fertilizer use.

Maintenance will be undertaken via general access to all public accessible areas. Light maintenance vehicles can access all public areas and can adjoin all private areas within the development. This will occur initially via the road system and then by careful access over landscaped grass areas and select areas of the pedestrian path system. Use of removable bollards will limit and control unauthorize access to link areas between roads.

Maintenance will be managed by the development for the first 2 years minimum. The 2 year maintenance timeframe may be extended in certain locations at the developer's discretion in liaison with the City.

The routine and general maintenance of areas outside of the wetland, revegetation, vegetation retention areas, and bioretention areas would be sufficient to satisfy the requirements to be considered "low treat vegetation" in accordance with AS3959:2018. Specially these areas would be irrigated to avoid seasonal die off, and any overgrown and for dead vegetative material would be routinely removed including weeds.







APPENDIX 7 – CONCEPT SUBDIVISION PLAN

BALANNUP ROAD

REILLY ROAD

SOUTHERN RIVER RD

SKEET ROAD

RANFORD ROAD

606

605

604

603

602

601

600

200

201

202

98

171

1771

POS

20m Road Reserve

15m Road Reserve

15(13) m Road Reserve

13m Nib

Legend

- Subject Site
- Parent Lot
- CCW
- 50m Buffer to CCW
- REW
- 30m Buffer to REW
- Easement (30m Width)
- Residential R25
- Residential R30
- Public Open Space (POS)
- Local Centre
- Access Streets
- Neighbourhood Connector

22001001B

0m 50 100 200m

HARRISDALE NORTH STRUCTURE PLAN

Harrisdale. Armadale, WA

Project YOLHA 22001001B | Scale 1:2500 @ A3 | Date: June 2023

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APPENDIX 8 – LANDSCAPE MASTERPLAN

NORTH HARRISDALE STRUCTURE PLAN

LANDSCAPE REPORT

AUGUST 2023

emerge ASSOCIATES



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3.0 LANDSCAPE STRATEGY 6

4.0 LANDSCAPE STRATEGY POS CENTRAL 7

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1.0 SITE CONTEXT

Lots 600 - 606 Balannup Road and Lots 200 - 202 Skeet Road, Harrisdale (referred to herein as ‘the site’) are located approximately 20 kilometres (km) south of the Perth Central Business District within the City of Armadale.

The site is approximately 29.29 hectares (ha) in size and is bound by Ranford Road to the north east, Skeet Road to the south east, Balannup Road to the north west and vacant land associated with the easement for the future continuation of Reilly Road to the south west.

The local structure plan (LSP) allows for the creation of residential lots, three areas of public open space (POS) with integration of various wetlands and wetland buffers (based on recent review of condition and extents), a commercial area, and an existing Western Power easement (which cuts through the south-western corner of the site).

The LSP provides for a well connected open space network which will provide the local community with safe parklands, supporting various open space functions whilst facilitating significant environmental outcomes through the retention and protection of existing conservation category wetlands (CCW). The landscape master plan for the proposal includes retention of existing vegetation and the revegetation of buffers for the CCW as well as the resource enhancement wetland (REW) to the north of the site.





























2.0 LANDSCAPE MASTER PLAN

LEGEND

- SUBJECT SITE
- EASEMENT (30M WIDTH)
- CCW BOUNDARY
- REW BOUNDARY
- 30M BUFFER TO REW
- 50M BUFFER TO CCW
- CCW TO BE RETAINED
- VEGETATION RETENTION AND REVEGETATION
- BIO RETENTION AREA (BRA)
- FLOOD STORAGE AREA (FSA)
- MANAGED LOW LANDSCAPE
- BENCH SEATING
- SHELTER / BBQ FACILITIES
- PROPOSED STREET TREES
- RESIDENTIAL
- COMMERCIAL
- WALKING TRAIL



3.0 LANDSCAPE STRATEGY

The Landscape Strategy is intended to be an overall guide to the proposed functions, amenities and landscape treatment within North Harrisdale LSP.

The parklands will be charcterised with native planting reflecting the historical flora of the area.

The public open scape (POS) areas have been located to retain and protect the CCW and REW areas as well as integrate a variety of local amenity and storm water management functions.



4.0 LANDSCAPE STRATEGY POS CENTRAL

This POS is located centrally within the proposed development providing a concentrated suite of amenity and POS function accessible to the wider community. It incorporates the CCW to the south adjacent Skeet Road.

- Informal active recreation uses on open grassed areas
- Gathering nodes with picnic and shelter facilities
- Opportunity for informal walking trails through controlled access points through the POS. Location and alignment of trails to avoid disturbance of areas of significant vegetation.
- Stormwater retention and conveyance through a vegetated and stabilized swale
- Retention and protection of CCW and revegetation of associated buffer
- Retention of existing Banksia Woodland areas
- Opportunity for nature play nodes to existing areas of clearing
- Path network which links into the greater development
- Manicured landscape areas fully irrigated outside buffer and retained vegetation areas
- All areas outside of wetland, vegetated wetland buffer area and bioretention areas to be “low threat vegetation” in accordance with AS3959:2018.



LOCATION PLAN









5.0 LANDSCAPE STRATEGY POS WEST

This POS is located within the western corner of the proposed LSP along the central entry road off Balannup Road . It includes the REW buffer to the west of the site.

- Vegetation retention and revegetation of associated buffer to REW
- Opportunity for informal walking trails through controlled access points through the POS. Location and alignment of trails to avoid disturbace of areas of significant vegetation
- Path network which links into the greater development Retention of existing significant trees and vegetation where possible
- Opportunity for education of the site and its environmental assets through signage or other means along walking trails
- Majority of this POS will be classified vegetation and therefore a bushfire hazard in accordance with AS3959:2018



LOCATION PLAN





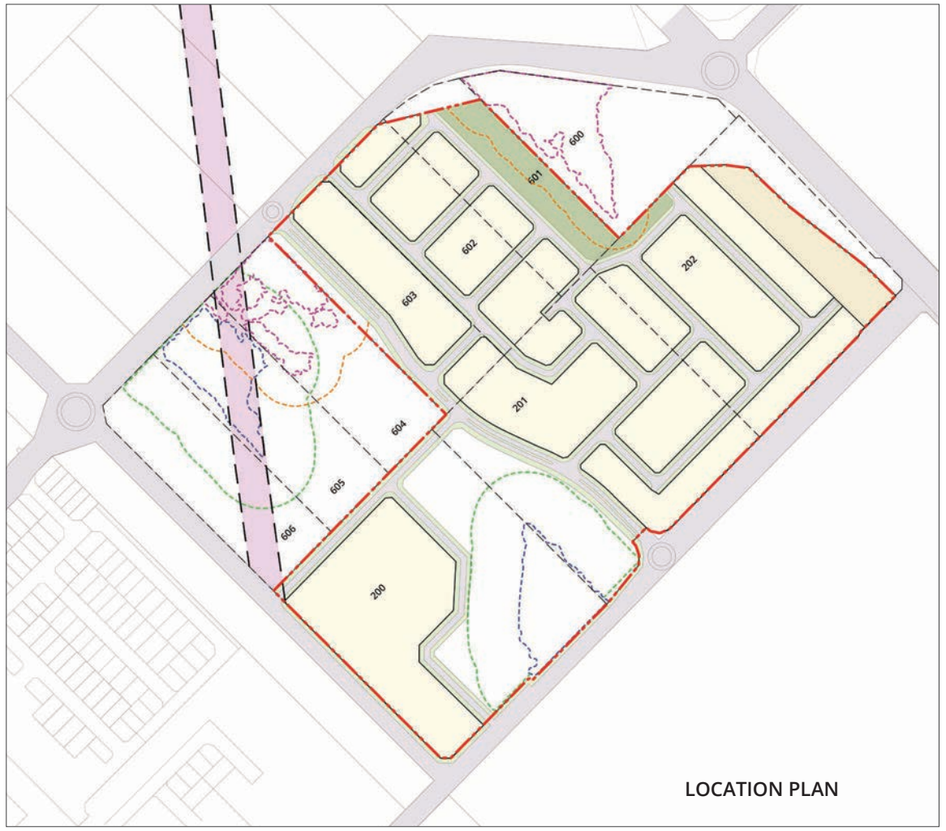




6.0 LANDSCAPE STRATEGY POS EAST

This POS is located in the north east corner of the site. It provides for a revegetated buffer to the REW to the north of the site. It is linear in shape and will provide a north-south greenspace connection through the development.

- Gathering nodes with seating along footpath network
- Stormwater retention and conveyance through a vegetated and stabilised swale
- Vegetation retention and revegetation of associated buffer to REW
- Retention of existing significant trees and vegetation where possible
- Path network which links into the greater development
- Manicured landscape areas fully irrigated outside buffer areas
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LOCATION PLAN







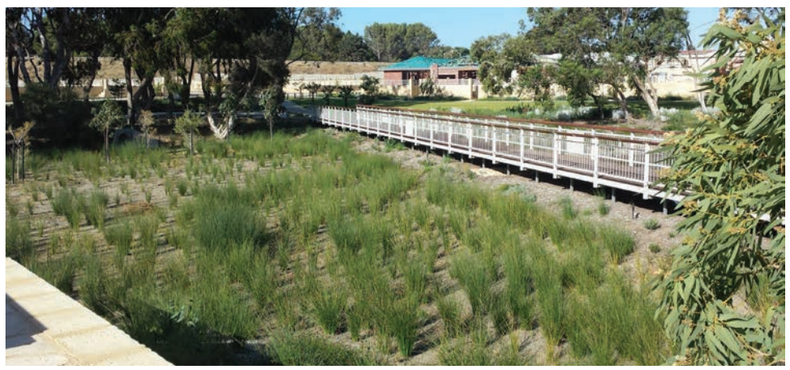


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All stormwater from the development will be directed into bio-retention treatment areas constructed along the edges of the POS. These will be sized to treat the flows from the small rainfall event in accordance with the principles of water sensitive urban design. Storm events in excess of these will be directed into flood storage areas typically located within CCW and REW buffer areas. Flood storage areas will be revegetated with native species. Bio-retention areas will be located outside of CCW buffer areas.





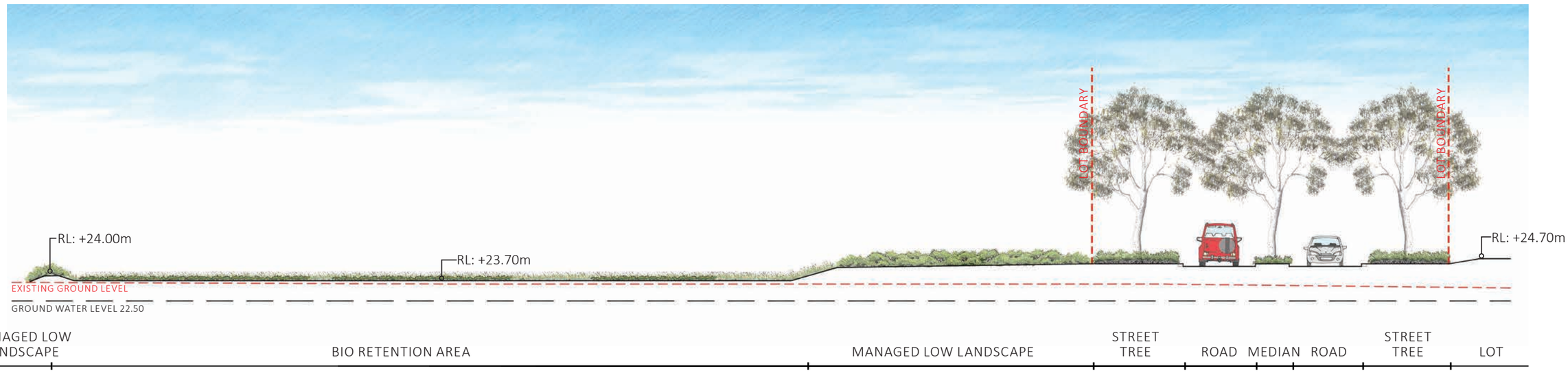




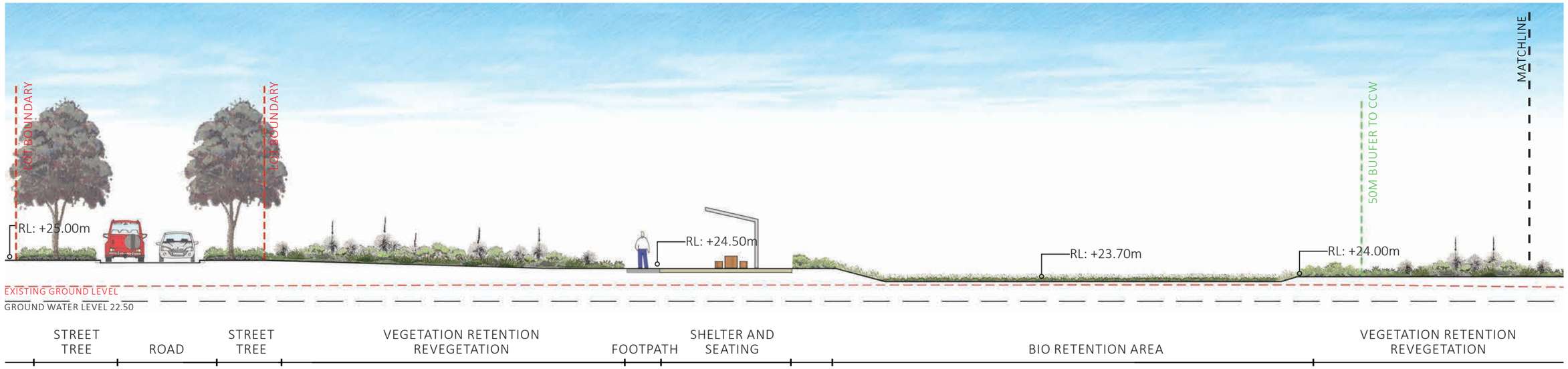
8.0 DRAINAGE CROSS SECTIONS



SECTION A-A

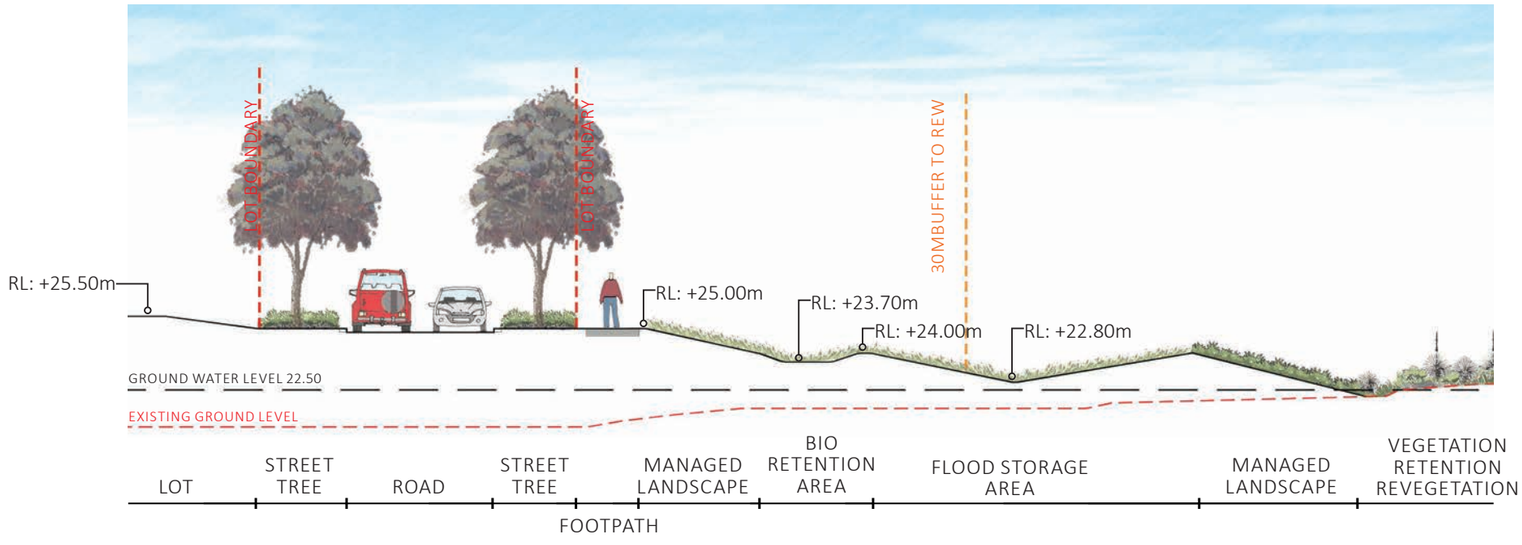


SECTION B-B





SECTION C-C



SECTION D-D

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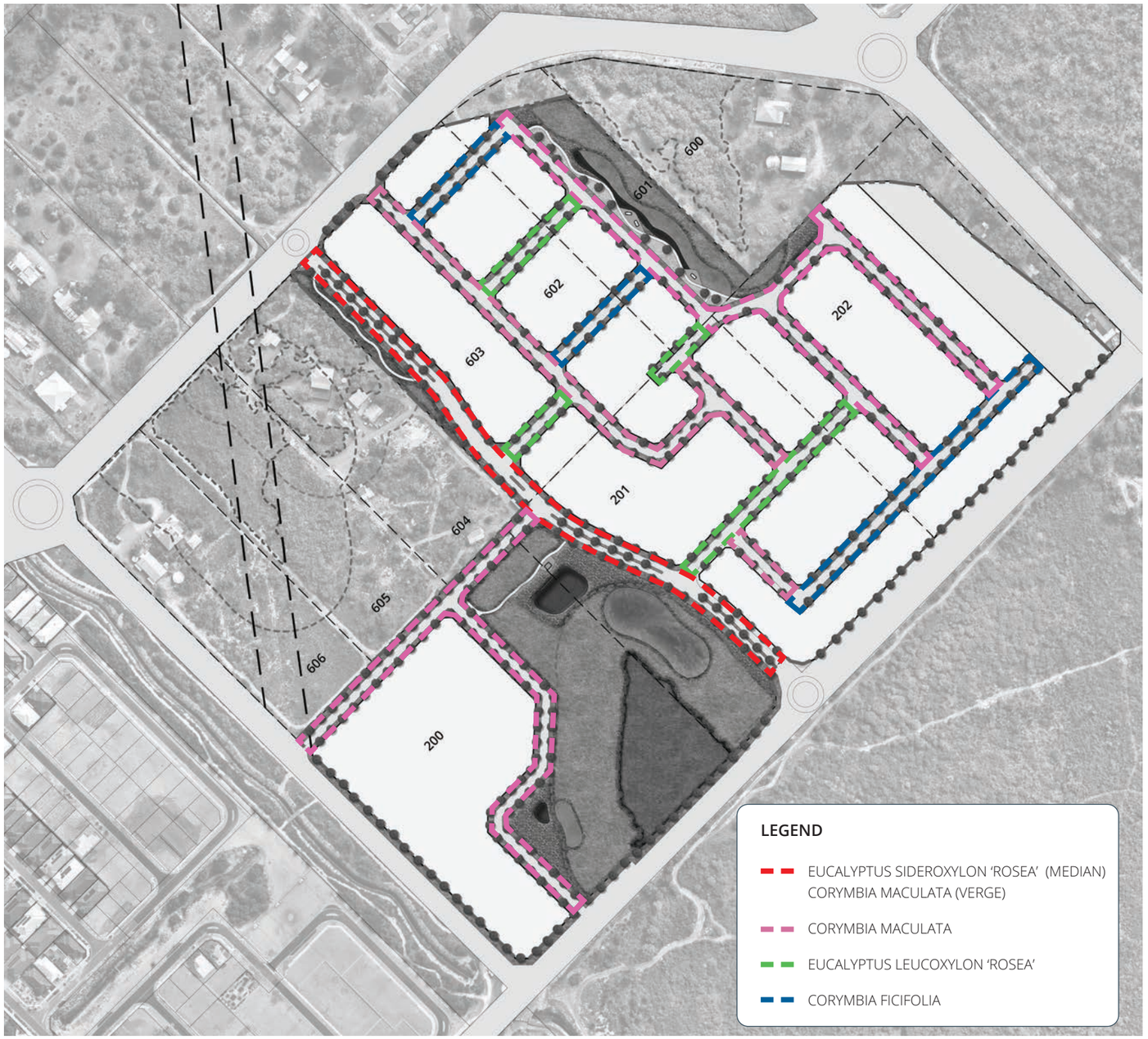


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In all cases, a maintenance regime will be in place inclusive of general maintenance minimisation through design practices and will aim to use sustainable maintenance practices. This includes, but is not limited to, defined edges and borders, minimal and preferably alternate approaches to pesticides, controlled and minimized fertilizer use.

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APPENDIX 9 – LOCAL WATER MANAGEMENT STRATEGY

Local Water Management Strategy

North Harrisdale Local Structure Plan

Project No: EP20-127(09)

Prepared for Yolk Property Group
August 2023



Document Control

Doc name:	Local Water Management Strategy North Harrisdale Local Structure Plan				
Doc no.:	**EP20-127(09)—007B TEM**				
Version	**Date**	**Author**		**Reviewer**	
1	July 2021	Tess McAllister	TEM	David Coremans	DPC
	Issued to project team				
A	May 2022	Johanna Boonzaaier	JB	David Coremans	DPC
	Updated to reflect amended structure plan				
B	August 2023	Johanna Boonzaaier	JB	David Coremans	DPC
	For council submission				

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Executive Summary

Hex Design and Planning (Hex) on behalf of the landowners (collectively referred to as 'the proponent') of Lots 601-603 Balannup Road and Lots 200-202 Skeet Road, Harrisdale (herein referred to as 'the site') intend to progress residential development of the site.

The site is approximately 26.3 hectares (ha) in size and is bound by Ranford Road to the north-east, Skeet Road to the south-east, Reilly Road to the south-west and Balannup Road to the north-west. The site is located within the City of Armadale (herein referred to as 'the City'), approximately 20 km south-east of the Perth central business district.

The local structure plan (LSP) allows for the creation of residential lots, three large areas of public open space (POS) integrated with various wetlands and wetland buffer areas (based on recent review of condition and extents), a commercial area, and an existing Western Power easement (which cuts through the south-western corner of the site).

This local water management strategy (LWMS) details the water management approach to support the development of the site. The LWMS is intended to satisfy the requirements of *Better Urban Water Management* (WAPC 2008), and to address the expectations of the Department of Water and Environmental Management (DWER) and the City.

In summary, environmental investigations undertaken during the LWMS works indicate that:

- Historical land uses cross the site comprised of an informal salvage yard, a poultry farm and rural residential dwellings.
- Topography of the site ranges from 21 m Australian height datum (mAHD) to 23 mAHD.
- The western portion of the site is underlain with sand, whereas the eastern is underlain with peaty sand and peat-rich sand.
- Geotechnical investigations found ground conditions to be a mixture of sand, sandy clay and clayey sand, with sandy clay.
- Permeability testing of the sand found infiltration to generally be >10 m/day.
- The north/north east portion of the site has a 'high to moderate' risk of ASS occurring within 3 m of the natural soil surface. The remainder of the site is classified as 'moderate to low' risk of ASS occurring within 3 m of the natural soil surface.
- The entire site is classified as an environmentally sensitive area.
- The entire site is classified as a sewage sensitive area under the Government Sewerage Policy.
- One mapped CCW occurs within a small area along the eastern boundary. A further wetland located along the western boundary is consistent with a CCW. The remainder of the site is mapped as a MUW. A REW exists directly north of the site within Lot 600.
- A perennial lake is present within Lot 201 and two earth dams are present within Lots 601 and 602. It is noted that the perennial lake is smaller than indicated by regional datasets.
- The Balannup major drain runs along Reilly Road and continues along an unsealed road that runs adjacent to the south-western boundary of the site (i.e. not within the site).

- Catchment and topographical analysis indicate that there are no defined surface runoff channels/drains/streamlines within the site that would convey water from the site. Any runoff leaving the site would only be likely to occur in response to infrequent rainfall events and via overland flow.
- Results from the pre-development surface runoff modelling indicate that runoff from infrequent rainfall events would traverse south and exit the site near the corner of Skeet Road and Reilly Road into the Balannup Drain at a rate of 0.5 m^3/s in the 10% annual exceedance probability (AEP) event and 0.9 m^3/s in the 1% AEP event. It is noted that the recent construction of Skeet Road may limit the ability for this to occur.
- Regional groundwater contours indicate that groundwater flows in an easterly direction across the site, ranging in elevation from approximately 22.2 m AHD, to 22.5 m AHD.
- Calibrated maximum groundwater levels (MGL) contours based on monitoring within the site were calculated to be 22.25 mAHD to 22.68 mAHD (i.e. 0.65 mBGL to 1 mBGL) and flow in an north-easterly direction.
- Groundwater quality results from 2014-2015 found significantly elevated total nitrogen levels across all bores. In particular, bore MW04 recorded concentrations between 1.4 mg/L – 89 mg/L (average 27.7 mg/L).

Water supply and conservation

The overall approach to water supply is to utilise scheme water and implement water conservation measures (e.g. rainwater tanks, water efficient fixtures, use of water sensitive urban design (WSUD) measures, and planting of water wise species) to reduce water requirements. Non-potable water for irrigation purposes will be supplied by groundwater.

Stormwater quality

The stormwater management strategy for the site aims to maintain the pre development hydrology. Most runoff will be treated and retained within the site. Lots facing Reilly Road will discharge to Reilly Road and ultimately to the Balannup drain. The small rainfall event will be captured and treated as close to source as possible and outside of wetland buffer areas to ensure runoff is treated before infiltrating to groundwater.

All lots will retain and treat the small rainfall event (i.e. first 15 mm) within the lot via previous garden areas/soakwells. Runoff from the road reserve will be conveyed downstream to a vegetated bioretention area (BRA) where treatment will be via vegetation and the underlying soil profile which will absorb nutrients prior to reaching groundwater.

Flood mitigation

Runoff above the small event, up to the major event (i.e. 1% AEP rainfall) which does not fall on the front of lot (75% of the lot) will be retained within the lot via soakwells and permeable surfaces.

In rainfall events greater than the small event and up to the major event, runoff from the front of lot (i.e. 25% of the lot) will overflow to the adjacent road reserve which will be conveyed downstream to the BRA. Once treated (via the BRA), runoff will overflow to an adjacent flood storage area (FSA) for retention of the major runoff event for most lots within the site. Lots facing Reilly Road will discharge

to Reilly Road and ultimately to the Balannup drain. Retaining runoff within FSAs will assist in recharging the superficial aquifer.

Groundwater management

Groundwater management will include the use of imported fill to maintain sufficient clearance to groundwater in lower areas of the site. Subsoil drains will be used in some areas of the site to control the rise of groundwater post-development. These will be set at or above MGL and therefore will not be used to lower groundwater. Groundwater quality will be managed through the appropriate treatment of surface runoff and sub-soil drains prior to infiltration to groundwater, and management of landscape management practices (i.e. minimising fertiliser use).

The design criteria and the manner in which the detailed designs achieve compliance with the design criteria are provided in **Table E** 1.

Table E 1: Water management criteria and compliance

Management Element	Criteria Number	Criteria Description	Manner in which compliance has been achieved	Responsibility for implementation	When implemented
Water Conservation	WC1	Consumption target of 100 kL/person/year with no more than 40-60 kL/person/year of scheme water.	Installation of water efficient fittings and appliances within residential lots.	Lot owner	Building approval
			Adoption of waterwise gardening practices by lot owners.	Lot owner	Landscape design and implementation
			Lot owners will be encouraged to install rainwater tanks for in-house and ex-house non-potable uses.	Proponent	At point of sale
	WC2	Maintain a maximum irrigation rate of 7,500 kL/ha/yr in POS areas.	Landscape design that follows waterwise gardening practices.	Proponent	Following POS construction
			The LSP contains approximately 1.14 ha of recreational POS which will require 8,550 kL/year (at a rate of 7,500 kL/ha/year). This will be supplied with the existing groundwater allocation of 13,850 kL.	Proponent	Landscape design and implementation
Stormwater Management	SW1	Retain and treat the first 15 mm of rainfall as close to source as possible.	The commercial area will retain runoff up to the 1% AEP event.	Lot owner /The City	Building approval
			Lots will retain and treat the first 15 mm of rainfall within soakwells/pervious garden areas.	Proponent	Detailed drainage design and implementation
			Runoff from the road reserve will be retained and treated within vegetated BRAs. Treatment will be via vegetation and the underlying soil profile which will absorb nutrients prior to reaching groundwater.	Proponent	Detailed drainage design and implementation
	SW2	Detain flows up to the 1% AEP event so that pre development discharge from site is not exceeded	The commercial area will retain runoff up to the 1% AEP event onsite.	Lot owner /The City	Building approval
			Back of lots (75% of the lot) will retain runoff up to the 1% AEP event within soakwells/pervious garden areas.	Lot owner /The City	Building approval
			Runoff from the front of lots facing Reilly Road (25% of the lot) will be discharged to Reilly Road. Runoff from road reserves and front of lot (25% of the lot) for all other lots will be conveyed to a nearby BRA then FSA, which will retain up to the 1% AEP event.	Proponent	Detailed drainage design and implementation

Table E1: Water management criteria and compliance (continued)

Management Element	Criteria Number	Criteria Description	Manner in which compliance has been achieved	Responsibility for implementation	When implemented
Stormwater Management	SW3	Finished floor levels must have a minimum of 500 mm clearance above the 1% AEP flood levels in flood retention structures.	Conceptual earthwork levels demonstrate that lots have sufficient clearance (> 500 mm) to major event top water levels within FSAs.	Proponent	Detailed drainage design and implementation
	SW4	Inverts of flood retention structures must be at least 300 mm above the MGL.	Groundwater levels beneath the site are generally greater than 0.5 m BGL. Hence the design of BRAs/FSAs will ensure that at least 300 m of clearance is maintained post-development.	Proponent	Detailed drainage design and implementation
	SW5	Design infiltration areas to avoid creating mosquito habitat.	BRAs/FSAs will ensure there is sufficient clearance to MGL and/or will be constructed in permeable sand to ensure they dry out between rainfall events and do not become a mosquito risk.	Proponent	Detailed drainage design and implementation
	SW6	Utilise best management practices to reduce the risk of nutrient loading to stormwater and the underlying aquifer.	Minimising fertiliser use to establish and maintain vegetation.	Maintenance contractor/Lot owner	Landscape implementation
			The use of drought tolerant turf and vegetation species.	Proponent/Lot owner	Landscape design and implementation
			Contractor management of dust and sediment	Proponent	During construction
			Street sweeping	Proponent/the City	Post construction
			Maintenance of POS, BRAs and FSAs	Maintenance contractor	Two years following construction
			Education of residents.	Proponent	Point of sale

Table E1: Water management criteria and compliance (continued)

Management Element	Criteria Number	Criteria Description	Manner in which compliance has been achieved	Responsibility for implementation	When implemented
Groundwater	GW1	Use subsoil drains to control rise of groundwater where finished lot levels are <1.5m above the MGL.	A subsoil network is proposed across the southern portion of the site, and will be placed at or above the existing MGL.	Proponent	Detailed drainage design and implementation
	GW2	Where used, subsoil drains to be set at or above the MGL.	A subsoil network is proposed across the southern portion of the site, and will be placed at or above the existing MGL	Proponent	Detailed drainage design and implementation
	GW3	Ensure all subsoil drainage has a free draining outfall.	All sub-soil drains will have a clearance of 150 mm from the discharge point (BRA1/BRA2), thereby providing a free-flowing outlet.	Proponent	Detailed drainage design and implementation
	GW4	Groundwater captured by subsoil drains must be treated to mitigate movement of legacy nutrients	All sub-soil drains will discharge to a BRA (BRA1/BRA2) for treatment.	Proponent	Detailed drainage design and implementation
	GW5	Utilise best management practices to reduce the risk of nutrient loading to groundwater.	Direct small event runoff to the vegetated BRAs. Treatment is provided through interaction with vegetation and adsorption of nutrients to soil particles through infiltration	Proponent	Detailed drainage design and implementation
			Minimise fertiliser use in POS and road verges	Proponent	Landscape design and implementation
			Use roll-on, drought tolerant turf species	Proponent	Landscape design and implementation
			Treatment of discharges from subsoil drains within BRAs.	Proponent	Detailed drainage and landscape design and implementation
			Education of residents on use of WWG and fertiliser use	Proponent	At point of sale
	GW6	Use WSUD approaches to recharge the superficial aquifer	Runoff will be directed to the FSAs (sized for the 1% AEP event) to locally retain and infiltrate runoff on-site.	Proponent	Detailed drainage design and implementation

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
ANZECC	Australian and New Zealand Environment and Conservation Council
BOM	Bureau of Meteorology
DoW	Department of Water
DWER	Department of Water and Environmental Regulation
DPLH	Department of Planning, Lands and Heritage
WAPC	Western Australian Planning Commission

Table A2: Abbreviations – General terms

General terms	
AEP	Annual exceedance probability
AHD	Australian height datum
ARI	Average recurrence interval
ASS	Acid sulfate soil
BF	Bush forever
CCW	Conservation category wetland
CoA	City of Armadale
ESA	Environmentally sensitive area
LWMS	Local water management strategy
MGL	Maximum groundwater level
MOU	Memorandum of Understanding
MRS	Metropolitan regional scheme
MUW	Multiple use wetland
POS	Public open space
LSP	Local structure plan
TWL	Top water level
UWMP	Urban water management plan
UFI	Unique feature identifier

Table A4: Abbreviations – units of measurement

Units of measurement	
cm	Centimetre
ha	Hectare
m	Metre
m^2	square metre
m AHD	m in relation to the Australian height datum
mm	Millimetre

Terminology Tables

Table A3: AEP – ARI equivalence

Rainfall event	Annual exceedance probability (AEP)	Average recurrence interval (ARI)
Small	-	1
Minor	20 %	5
	10 %	10
Major	1 %	100

1 Introduction

1.1 Background

Hex Design and Planning (Hex) on behalf of the landowners ('the proponents,' which include Yolk Property Group Pty Ltd) are progressing with a residential development across part Lot 601 Balannup Road, Lots 602-603 Balannup Road, Lots 200 and 201 Skeet Road, and part Lot 202 Skeet Road, Harrisdale (herein referred to as 'the site').

The site is approximately 20.4 ha in size and is bound by Ranford Road to the north-east, Skeet Road to the south-east, Reilly Road to the south-west and Balannup Road to the north-west (see **Figure 1**). The site is located within the City of Armadale (herein referred to as 'the City'), approximately 20 km south-east of the Perth central business district.

The north Harrisdale local structure plan (LSP) allows for the creation of residential lots, three large areas of public open space (POS) integrated with various wetlands and wetland buffer areas (based on recent review of condition and extents), a commercial area, and an existing Western Power easement (which cuts through the south-western corner of the site). The proposed development is discussed further in **Section 2** and the LSP is provided in **Appendix A.**

1.2 Planning context

A Metropolitan Regional Scheme (MRS) amendment request has been submitted to lift the 'Urban Deferred' zone (which applies across the entire site) to facilitate future residential subdivision and development. As part of the lifting of the 'Urban Deferred' zone, the concurrent rezoning of the site under the provisions of the City's Town Planning Scheme No. 4 (TPS 4) to 'Development' zone is also sought.

1.3 Purpose

It is important that the manner in which water will be managed is clearly documented early in the planning process, and this should be in a manner which avoids flooding and protects the environment. This approach provides the framework for actions and measures to achieve the desired outcomes during development.

This local water management strategy (LWMS) details the water management approach to support the development of the site, and is intended to satisfy the requirements of *Better Urban Water Management* (WAPC 2008), and to address the expectations of the Department of Water and Environmental Management (DWER) and the City.

1.4 Policy framework

There are a number of Local and State Government policies of relevance to the development. These policies include:

- *State Water Strategy (Government of WA 2003)*
- *State Planning Policy 2.9 Water Resources* (WAPC 2006a)
- *State Planning Policy 2.10 Swan Canning River System* (WAPC 2006b)
- *Statement of Planning Policy No. 3: Urban Growth and Settlement* (WAPC 2006c)
- *State Water Plan (Government of WA 2007)*
- *Liveable Neighbourhoods Edition 4* (WAPC 2007)
- *Planning Bulletin No. 64: Acid Sulfate Soils* (WAPC 2009)
- *Southern River Integrated Land and Water Management Strategy* (DoW 2009b)
- *Water Wise Perth-Two Year Action Plan* (Government of WA 2019).

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding the water discharge characteristics that developments should aim to achieve. These are key inputs that relate either directly or indirectly to the development of the site and include:

- *Australian Runoff Quality* (Engineers Australia 2006)
- *Stormwater Management Manual for Western Australia* (DoW 2007b)
- *Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *Better Urban Water Management (BUWM)* (WAPC 2008)
- *Local Biodiversity Strategy* (CoA 2009)
- *wan Canning Water Quality Improvement Plan* (SRT 2009)
- *Landscape Guidelines for Public Open Space* (CoA 2013)
- *Subdivision and Development Guidelines* (CoA 2014) *Stormwater Management Handbook* (CoA 2015)
- *Decision Process for Stormwater Management in Western Australia (DWER 2017)*
- *Drainage for Liveability Fact Sheet* (Water Corporation 2017)
- *Corporate Policy Statement No. 50 - Planning for Dewatering Affecting the Swan Canning Development Control Area* (DPaW 2017)
- *A National Water Quality Management Strategy* (Australian Government 2018)
- *Australian Rainfall and Runoff* (Ball J *et al.* 2019).

1.5 Previous studies

1.5.1 Urban Water Management Strategy (JDA 2002)

In 2001, the Western Australian Planning Commission (WAPC), in conjunction with the cities of Armadale and Gosnells prepared and adopted the Southern River/Forrestdale/Brookdale/Wungong District Structure Plan (DSP). The DSP provide a broad framework for land use, conservation and development of land within the locality.

The *Southern River/Forrestdale/Brookdale/Wungong Urban Water Management Strategy* (UWMS) (JDA 2002) was prepared to support the DSP. The UWMS was developed to assist in integrating land use planning with total water cycle management. The level of detail provided is considered to be similar to that of a district water management strategy. The water management criteria proposed are provided in **Table 1**.

Table 1: Design criteria for water management, adapted from the UWMS (JDA 2002)

Management element	Design criteria
Water conservation	• Achieve a potable water consumption target of less than 100 kL/person/year.
Water quantity management	• Achieve nutrient load reduction in the average annual load of stormwater runoff and groundwater pollutants estimated to be discharged from the development Onsite retention of the small rainfall event. o Bioretention structures/systems are to be sized at 2% of connected constructed impervious areas. • Non-structural measures to reduce applied nutrient loads. • As compared to a development that does not actively manage groundwater quality, the following should be achieved: o At least 60 per cent reduction of total phosphorous concentrations o At least 45 per cent reduction of total nitrogen concentrations.
Surface water	• Minimise changes to hydrology to prevent impacts on receiving environments. • All developments shall retain all flows, generated by constructed impervious surfaces, up to and including the 1% annual exceedance probability (AEP) event. • Manage surface water flows from major events to protect infrastructure and assets. • Apply the principles of water sensitive urban design.
Groundwater	• Manage groundwater levels to protect infrastructure and assets. • Maintain groundwater regimes for the protection of groundwater-dependent ecosystems. • Manage the shallow aquifer to protect the value of groundwater resources.
Protection of environmental assets	• Manage groundwater to protect infrastructure and assets, ecosystems and water resources. • Minimise changes to hydrology to prevent impacts on watercourses and wetlands • Manage and restore watercourses and wetlands

1.5.2 Southern River Integrated Land and Water Management Strategy (DoW 2009)

As part of the UWMS approval, a Memorandum of Understanding (MOU) was entered into by the key government agencies responsible for implementation of the UWMS. The MOU required a total water cycle plan to be prepared to cover key elements of water conservation, excess water management during storm events, water quality, monitoring and reporting. The Department of Water (now DWER) subsequently released the *Southern River Integrated Land and Water Management Strategy* (DoW 2009b) in order to satisfy this requirement.

The Strategy sets out management requirements for water management at the regional, local and lot scale as well as monitoring, auditing and reporting requirements to support an adaptive management approach. These requirements are consistent with the approach proposed throughout this LWMS.

1.5.3 Forrestdale Main Drain Arterial Drainage Strategy (DoW 2009a)

The *Forrestdale Main Drain Arterial Drainage Strategy* (FMDADS) (DoW 2009a) provides guidance with regards to water management issues to help development proceed within the Forrestdale Main Drain (FMD) catchment area. The FMD catchment has a surface water drainage catchment area of 5,400 ha. The FMDADS provides indicative post-development catchment areas, discharge locations for these catchments and flood storage required in each in order to ensure that the capacity of waterways is not exceeded.

All water management strategies, local structure plans, local planning scheme amendments and subdivision plans prepared for areas of proposed new development should demonstrate compliance with the strategies, objectives and design criteria detailed in the FMDADS.

1.5.4 District Water Management Strategy (JDA 2014)

A DWMS was prepared by JDA (2014) to facilitate the re-zoning of Lots 172, 515 and 516 Skeet Road from 'Rural' to 'Urban Deferred' under the MRS, and was approved in 2014. The DWMS provided the framework for water management criteria and includes the key principles and design criteria outlined in **Table 2.**

Table 2: Design criteria for water management, adapted from the DMWS (JDA 2014)

Management element	Design criteria
Water conservation	The State Water Plan target for water use of 100 kL/person/year with no more than 40-60 kL/person/year of scheme water.
Water Quantity Management	For ecological protection, 1 year average recurrence interval (ARI) volume and peak flow rates maintained at pre-development conditions.
	Flood Management – manage up to the 100 year ARI event peak flows and flood levels described in the FMDADS.
	Infrastructure Protection.
	Measured pollutant outputs from development not to exceed pre-development baseline conditions or agreed targets.
	Structural and non-structural stormwater water quality treatment to be implemented.
	Bio-retention areas to be sized as 2% of the interconnected impervious areas.
Environmental Asset Protection	Protection of environmental assets such as water resources, ecological corridors and biodiversity taking into account recommended targets from catchment management plans.
Disease Vector and Nuisance Insect Management	Reduce health risks from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated in a time period not exceeding 96 hours. Permanent water bodies are discouraged, but where accepted must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice from the DoW and Department of Health.

1.6 LWMS objectives

This LWMS has been developed in consideration of the objectives and principles detailed in DWMS (described in **Section 1.5.4**) and *Better Urban Water Management* (BUWM) (WAPC 2008). It is intended to support the development within the site and is based on the following major objectives:

- Provide a broad level stormwater management framework to support future urban development.
- Treat and detain/retain all stormwater runoff from within the development.
- Retain and protect wetlands identified as being in appropriate condition to warrant conservation.
- Develop a water conservation strategy for the site that will ensure the efficient use of all water resources.
- Incorporate appropriate best management practices (BMPs) into the development that address the environmental and water management issues identified.
- Ensure that sufficient land area is set aside in the LSP to manage stormwater runoff.
- Reduce pollutant loads discharged from the development into surface water and groundwater systems, as compared to a traditional connected drainage system.
- Minimise ongoing operation and maintenance costs for the land owners and the City.
- Gain support from DWER and the City for the proposed method to manage stormwater within the site.

Detailed objectives for water management within the site are further discussed in **Section 4**.

2 Proposed Development

The LSP will allow for the creation of the following land uses:

- Residential lots (generally around 380 m^2)
- Commercial land fronting Ranford Road
- Public open space (POS) (approximately 10 ha)
- Recreational facility
- Retirement facility
- Integration with and retention of various wetlands, including buffer areas (discussed further in **Section 3.8.1**).
- Western Power easement
- Internal road network.

The stormwater management approach proposes to include the following water sensitive urban design (WSUD) measures (discussed further in **Section 6**):

- Lot scale infiltration (soakwells)
- Bio-retention areas (BRAs) located within POS
- Flood storage basins (FSAs) located within wetland buffer areas
- Waterwise landscaping.

The LSP is provided in **Appendix A.** The conceptual civil and landscape designs are provided in **Appendix B** and **Appendix C**, respectively.

3 Existing Environment

3.1 Sources of information

The following sources of information were used to provide a broad regional environmental context to the site:

- *Weather and Climate Statistics* (BoM 2021)
- *LIDAR elevation dataset, Swan Coastal Plain* (DWER 2021a)
- *Geological survey of Western Australia* (Gozzard 1986)
- *Perth Groundwater Map* (DWER 2021a)
- *Acid sulfate soils (ASS) risk mapping* (DWER 2021b)
- *Geomorphic wetlands of the Swan Coastal Plain database* (DBCA 2021)
- *Water Register* (DWER 2021c)
- *Water Information Reporting* (DWER 2021d)
- *Landgate Aerial Photography* (WALIA 2021)
- *National Water Quality Management Strategy (NWQMS)* (Australian Government 2018)
- *District Water Management Strategy* (JDA 2014)
- *Due Diligence Environmental and Geotechnical Study - Proposed Road Widening Balannup Road and Skeet Road Harrisdale* (Galt Environmental 2018).
- *Groundwater monitoring data* (360 Environmental 2015).

3.2 Historical land uses

Review of historical aerial imagery (WALIA 2021) shows the eastern portion of the site as a large wetland feature, from 1953 to 1965. Circa 1974, clearing is observed and a man-made earth dam is present across Lots 201 and 202. This dam is partially filled in post 2000 and still presently remains a portion of its original construction. Lots 600 and 601 are observed as frequently inundated up until early 2000s where a constructed lake is observed within Lot 601 that is still present.

Historical land uses across the site comprised of an informal salvage yard, a poultry farm and rural residential dwellings. The poultry farm was constructed between 1987 to 1989.

3.3 Climate

The site experiences a dry Mediterranean climate of hot dry summers and moderately wet, mild winters. Long term climatic averages indicate that the site is located in an area of moderate to high rainfall, receiving an average of 816 mm annually (BoM 2021) with the majority of rainfall received between May and August. Mean maximum temperatures range from 19.1^{o}C in July to 34.9^{o}C in February, while mean minimum temperatures range from 16.5^{o}C in July to 29.3^{o}C in February (BoM 2021).

3.4 Geotechnical conditions

3.4.1 Topography

Elevation across the site is relatively flat, ranging from 23 metres Australian height datum (mAHD) down to 21 mAHD at a localised low point around an earth dam located centrally within the site (described in **Section 3.8.2**). Reilly Road, which runs along the south-western boundary has an elevation of 24 mAHD. Topographic contours across the site are shown in **Figure 2.**

3.4.2 Regional geology

Environmental geology for the site has been mapped by the *Geological Survey of Western Australia* (Gozzard 1986). The site consists of:

- S10 – Sand - as S8 (Sand) over sandy clay to clayey sand of the Guildford Formation, of eolian origin.
- Sp1 – Peaty sand - grey to black, fine to medium-grained, moderately sorted quartz sand, slightly peaty, of lacustrine origin.
- Sp2 – Peat-rich sand - fine to medium-grained quartz sand with much brown to black organic material, grades to peat, of lacustrine origin.

Regional geology across the site is shown in **Figure 3**.

3.4.3 Local geology and soils

Two geotechnical investigations have been conducted beneath the site. Galt Environmental (2018) undertook an investigation in relation to the proposed widening of Skeet and Balannup Roads, and a further investigation was undertaken by Galt Geotechnics (2021) to support the Structure Plan and detailed design. Soils encountered during the surveys were predominately fine to medium grained sand overlying clayey sand/sandy clay, and are generally consistent with the regional mapping.

Test pits are shown in **Figure 3**. The geotechnical logs are provided in **Appendix D**.

In summary, the geotechnical investigation found:

- Most test pits exhibited a layer of topsoil in the top 300 mm, some with peaty sand.
- Some test pits exhibited varying depths (0.5m - >2.5m) of fill/rubble/disturbed soil.
- Beneath the topsoil in majority of test pits was a layer of sand (fine to coarse grained, sub-angular to sub-rounded, grey-brown, trace non-plastic fines, trace rootlets) up to test pit termination depths (2.5 mBGL).
- Some test pits (TPB06- TPB08, TPB10, TPB11, TPB13, TPB15, TPB17 and TPS03) found underlying clayey sand/sandy clay (fine to medium grained sand, sub-angular to sub-rounded, brown, medium to high plasticity fines) intruding from 0.3 mBGL, although generally >1.5 mBGL.
- Test pits TP33 and TP35 were inferred to have coffee rock generally around 2 mBGL. Test pits TP01, TP03, were noted as ‘potential coffee rock’ due to test pit refusal.

3.4.3.1 Infiltration testing

Galt Environmental (2018) conducted three infiltration tests at one location on Lot 513 (see **Figure 3**) at 0.88 m BGL. The testing location consisted of sand and permeability was recorded between 10.2 – 11.5 m/day (Galt Environmental 2018).

Galt Geotechnics (2021) conducted an additional six infiltration tests within Lots 200-202 and 601-603. All tests were conducted on sand and most recorded a hydraulic conductivity >15 m/day, with the exception of IFT03 (within Lot 601), which recorded an average of 2.5 m/day (and was within fine grained fill material, not natural soils). A design infiltration rate of 5 m/day which includes clogging and compaction was recommended in relation to the sizing of drainage features (Galt Geotechnics 2021).

3.4.4 Acid sulfate soil

Regional acid sulfate soil (ASS) risk mapping identifies the north/north east portion of the site (associated with the soil units Sp1 and Sp2 (Peaty sand)) as having a 'high to moderate' risk of ASS occurring within 3 m of the natural soil surface (DWER 2021). The remainder of the site is classified as 'moderate to low' risk of ASS occurring within 3 m of the natural soil surface. Regional ASS mapping is shown in **Figure 4.**

The extent of ASS which is encountered and potentially disturbed, and any management requirements, will be largely dependent upon the future extent of excavation below the natural soil surface and any potential dewatering activities associated with development of the site, which will be outlined during detailed design. It is noted that the existing conceptual sewer design relies on connection to existing sewer at the intersection of Balannup Road and Reilly Road. This results in sewer levels above natural surface levels in those areas shown as high to moderate risk, which will assist in mitigating the extent of ASS risk during construction. The existing conceptual sewer design including levels are contained in **Appendix B**.

3.5 Contamination

A review of the DWER *Contaminated Sites Database* (DWER 2021) indicates that no registered contamination sites are located with the site. The database however does indicate that Lot 600 Balannup Road (located directly adjacent to the north of Lot 601) is identified as 'contaminated - restricted use' pursuant to the *Contaminated Sites Act 2003* (CS Act) due to the presence of asbestos containing material (ACM) in the soil (see **Figure 4**).

Known historical land uses within the site comprised an informal salvage yard, a poultry farm, uncontrolled filling, materials storage. It is expected that the potentially contaminating activities will be addressed through relevant subdivision conditions and managed under the provisions of the *Contaminated Sites Act 2003*.

3.6 Environmentally sensitive areas

An environmentally sensitive area (ESA) is present over the entire site, likely associated with multiple intersecting geomorphic wetlands (detailed in **Section 3.8.1**).

3.7 Sewage sensitive areas

The entirety of the site is classified as a sewage sensitive area by the *Government Sewerage Policy* (DPLH 2019), as shown in **Figure 5**. The policy defines sewage sensitive areas geographically based on proximity to a variety of environmental assets and sensitivity to on-site sewage disposal. The two classifications of relevance to the site define a sewage sensitive area as:

- Estuary catchments on the Swan and Scott Coastal Plains.
- Within 1 km of a significant wetland.

Whilst identified as a sewage sensitive area, the entire site is proposed to be serviced by existing sewer located at the boundary of the site.

3.8 Surface water

3.8.1 Wetlands

Review of the *Geomorphic Wetlands of the Swan Coastal Plain* (DBCA 2020a) dataset indicates that the entire site supports mapped geomorphic wetlands. One conservation category wetland (CCW) (UFI 14880) occurs within a small area in the south-eastern portion of the site, a multiple use wetland (MUW) (UFI 13347) is present within the western half of the site, and an additional MUW (UFI 14404) is present over the eastern half of the site. A REW (UFI 15946) also exists within Lot 600 (directly towards the north) and a MUW (UFI 14879) occurs within lot 605 (west of the site).

The locations of the mapped geomorphic wetlands within and in proximity to the site are shown in **Figure 6.**

Following advice from the Department of Biodiversity, Conservation and Attractions (DBCA), Emerge Associates (Emerge) conducted a *Wetland assessment* Emerge Associates (2021) across the site to delineate the on-ground wetland values of the site that may not be correctly mapped in the *Geomorphic Wetlands of the Swan Coastal Plain* dataset.

The findings of the assessment indicated that one additional wetland with CCW characteristics is located within lot 605 (north west). The REW towards the north (not within the site) is proposed to remain relatively consistent with the mapped dataset. The two wetlands which are consistent with a CCWs and the location and boundary of these is shown in **Figure 6.**

The proposed CCWs within the site, as well as the REW adjacent to the northern boundary will likely require 50 m and 30 m respective buffers to ensure their protection in a manner which addresses DBCA expectations. The proposed/assessed wetland and appropriate buffers have been retained and incorporated within the LSP.

3.8.2 Existing hydrological features

The DWER *Hydrography Linear* (DWER 2020) dataset indicates a perennial lake (UFI 416684) is present within Lot 201 and two earth dams are present within Lots 601 and 602 (UFI 416511 and UFI 416512).

These three features are located within a larger area that is mapped as an 'area subject to inundation' that extends over most of the eastern portion of the site (see **Figure 6**). The Balannup Lake is also located directly north of the site (see **Figure 6**).

The Balannup drain (UFI 417215) runs along Reilly Road and continues along an unsealed road which runs adjacent to the south-western boundary of the site (i.e. not within the site). Runoff within Balannup drain is eventually conveyed south towards the FMD and ultimately the Southern River, approximately 6 km upstream of its confluence with the Canning River (DoW 2009a).

The site does not have any significant existing surface channels or culverts conveying runoff from the site. Due to the gentle topography and moderate-high infiltration capacity of in-situ soils (described in **Section 3.4.1** and **Section 3.4.3**, respectively), surface runoff from majority of the site is expected to infiltrate at source, with large events traversing south directly into Balannup Drain. In areas of high groundwater, runoff is expected to pool prior to inundation.

3.8.2.1 Pre-development modelling

Emerge have prepared a dynamic 1D pre-development surface runoff model to characterise the existing environment (using the software XPSWMM). Loss values, roughness and runoff coefficients were based on the assumptions used for the FMDADS (DoW 2009a). The modelling assumptions report provided in **Appendix E** presents the detailed methods and assumptions used to develop the model.

Results from the pre-development catchment analysis and XPSWMM model indicate the runoff which exceeds local infiltration capacity (i.e. in extreme runoff events) would generally traverse south and exit the site at the corner of Skeet and Reilly road into the Balannup Drain at a rate of 0.5 m^3/s in the 10% annual exceedance probability (AEP) event and 0.9 m^3/s in the 1% AEP event. It is expected that if this were to occur flow would occur as shallow sheet flow. It is also noted that Skeet Road has recently been upgraded, which would likely remove the ability for the site to discharge as per the above.

3.9 Groundwater

3.9.1 Groundwater resources

The *Water Register* (DWER 2021c) indicates aquifers beneath the site comprise of the following:

- Superficial Swan (unconfined)
- Leederville (confined)
- Yarragadee North (confined).

At the time of preparing this report (March 2021), all aquifers are recorded as fully allocated.

3.9.2 Regional groundwater

A review of the regional groundwater contours shown in the *Perth Groundwater Map* (DWER 2021) indicates that groundwater flows in an easterly direction across the site, from approximately 22.5 m AHD, down to 22.2 m AHD (i.e. within 0 m to 2 m below the natural surface.

3.9.3 Local groundwater

Groundwater level monitoring was undertaken by 360 Environmental (2015) at five bores within the site and three bores within proximity (towards the north-west) (see **Figure 2**). Monitoring was conducted monthly from August 2014 to December 2015 resulting in the capture of two annual groundwater peak levels.

Bores within the site (MW01-MW05) were installed into at least 2.5 m of sand (see soil lithology logs provided in **Appendix F**), hence measured maximum groundwater levels (MGLs) are inferred to be a representation of the superficial aquifer. Measured MGL within the site was recorded to be between 22.1 mAHD to 22.53 mAHD (i.e. 0.65 to 1.01 mBGL).

Emerge has also commenced groundwater level monitoring in June 2021 across existing bores within the site to provide a recent representation of levels and to capture the 2021 MGL. During the June monitoring round, bores MW01 and MW04 were recorded as dry and Bore MB02 was not assessed as it has been destroyed during the widening of Skeet Road.

Results to date are summarised in **Table 3** and the full monitoring dataset is provided in **Appendix F**.

Table 3: Maximum measured groundwater levels in and around the site (2014-2015, 2021)

		MW01	MW02	MW03	MW04	MW05	MW06	MW07	MW08
Monitoring 2014-2015	Maximum groundwater level (mAHD)	22.1	22.46	22.51	22.2	22.53	22.89	22.59	22.16
	Maximum groundwater level (mBGL)	0.74	0.73	0.87	0.65	1.01	0.19	0.72	1.08
Monitoring 2021	Maximum groundwater level (mAHD)	22.04	Destroyed	22.26	22.09	22.16	Not sampled	Not sampled	Not sampled
	Maximum groundwater level (mBGL)	0.79		1.12	0.77	1.39	Not sampled	Not sampled	Not sampled

The WIR database (DWER 2021d) indicates that two DWER monitoring locations (one groundwater bore and one surface water monitoring location, ref: 616110444, 6162558, respectively) have monthly level data available and are located within proximity to the site (see **Figure 2**). Bore 616110444 was installed into the superficial aquifer. Emerge inspected the surface monitoring location 6162558 in June 2021 which suggests that the location has the potential to represent groundwater levels where these rise above the existing ground level.

The data from both monitoring locations is therefore considered to provide an indication of the recent and relevant groundwater levels beneath the site. The highest groundwater elevation at bore 616110444 occurred in 2018 at 25.3 mAHD, which varied by 0.15 m to the MGL recorded in 2014-2015 at 25.15 mAHD (DWER 2021d). The recorded levels at surface location 6162558 similarly experienced a high in 2018 at 22.1 mAHD, which varied by 0.08 m to the MGL recorded in 2014-2015. A correction of 0.15 m was therefore to applied to the 2014-2015 levels measured at the site to calibrate the site data to a long term record.

Based on the above, the calibrated MGL levels within the site were calculated to be 22.25 mAHD to 22.68 mAHD (i.e. 0.65 m BGL to 1 m BGL) and contours displaying these levels are shown in **Figure 2**. It is noted that the measured and calibrate maximum levels at the site are consistent with the regional historical maximum groundwater levels which show a 22.5mAHD contour through the centre of the site.

3.9.4 Groundwater quality

Groundwater quality sampling was undertaken by 360 Environmental (2015) on a quarterly basis from August 2014 to December 2015. Emerge also undertook one round of groundwater quality monitoring in June 2021. Results are shown in **Table 4**.

Groundwater quality results were found to have significantly elevated total nitrogen (TN) concentrations across all bores, in comparison to the *National Water Quality Management Strategy* (NWQMS) (Australian Government 2018) guideline values for lowland rivers. In particular, MB04 (which is within the site) recorded TN levels between 1.4 mg/L – 89 mg/L (average 27.7 mg/L). Total phosphorous (TP) concentrations were predominately recorded as <0.5 mg/L, it is noted that the raw data does not note the limit of reporting and therefore results could be significantly lower than 5 mg/L. Monitoring in 2021 shows similar elevated levels of TN and TP, namely MW03 with TN concentrations of 5.1 mg/L and TP concentrations at 0.08 mg/L.

Table 4: Groundwater quality results (2014-2015, 2021)

	Date	pH -	EC µS/cm	DO	TN mg/L	Ammonia mg/L	KNT mg/L	TP mg/L	Phosphate mg/L
NWQMS (Australian government 2018)		6.5 - 8			1.2			0.065	
MW01	2014-2015	*5.98*	*6120*	*1.76*	*5.41*	*4.55*	*5.41*	*<5*	*0.17*
	June 2021	Dry							
MW02	2014-2015	*7.06*	*1361*	*2.17*	*2.63*	*1*	*1.88*	*<0.5*	*0131*
	June 2021	Destroyed							
MW03	2014-2015	*6.77*	*789*	*2.55*	*3.4*	*0.59*	*3.44*	*<0.5*	*0.09*
	June 2021	6.04	995	0.16	5.1	1.15	5.1	0.08	/
MW04	2014-2015	*6.96*	*1792*	*2.38*	*27.73*	*0.18*	*4.76*	*<0.5*	*0.66*
	June 2021	Dry							

Note: Results in italics are averages

3.10 Summary of existing environment

In summary, environmental investigations undertaken during the LWMS works indicate that:

- Historical land uses across the site comprised of an informal salvage yard, a poultry farm and rural residential dwellings.
- Topography of the site ranges from 21 mAHD to 23 mAHD.
- The western portion of the site is underlain with sand, whereas the eastern is underlain with peaty sand and peat-rich sand.
- Geotechnical investigations found ground conditions to be a mixture of sand, sandy clay and clayey sand, with sandy clay.
- Permeability testing of the sand found infiltration to generally be >10 m/day.
- The north/north east portion of the site has a 'high to moderate' risk of ASS occurring within 3 m of the natural soil surface. The remainder of the site is classified as 'moderate to low' risk of ASS occurring within 3 m of the natural soil surface.
- The entire site is classified as an ESA.
- The entire site is classified as a sewage sensitive area under the Government Sewerage Policy.
- One mapped CCW occurs within a small area along the eastern boundary. A further wetland located along the western boundary is consistent with a CCW. The remainder of the site is mapped as a MUW. A REW exists directly north of the site within Lot 600.
- A perennial lake is present within Lot 201 and two earth dams are present within Lots 601 and 602. It is noted that the perennial lake is smaller than indicated by regional datasets.
- The Balannup major drain runs along Reilly Road and continues along an unsealed road that runs adjacent to the south-western boundary of the site (i.e. not within the site).
- Catchment and topographical analysis indicate that there are no defined surface runoff channels/drains/streamlines within the site that would convey water from the site. Any runoff leaving the site would only be likely to occur in response to infrequent rainfall events and via overland flow.
- Results from the pre-development surface runoff modelling indicate that runoff from infrequent rainfall events would traverse south and exit the site near the corner of Skeet and Reilly Road into the Balannup Drain at a rate of 0.5 m^3/s in the 10% AEP event and 0.9 m^3/s in the 1% AEP event. It is noted that the recent construction of Skeet Road may limit the ability for this to occur.
- Regional groundwater contours indicate that groundwater flows in an easterly direction across the site, at elevations from approximately 22.5 m AHD, to 22.2 m AHD.
- Calibrated MGL contours within the site based on measured groundwater were calculated to be 22.25 mAHD to 22.68 mAHD (i.e. 0.65 mBGL to 1 mBGL) and flow in an north-easterly direction.
- Groundwater quality results from 2014-2015 found significantly elevated TN levels across all bores. In particular, bore MW04 recorded concentrations between 1.4 mg/L – 89 mg/L (average 27.7 mg/L).

4 Design Criteria and Objectives

This section outlines the objectives and design criteria that this LWMS and future water management plans must achieve. The design criteria have been adopted from criteria proposed in previous studies and water management plans (see **Section 1.5**), although has been updated to reflect site-specific environmental attributes outlined in **Section 3** and current best practice. The water management strategy includes water conservation, surface water management and groundwater management.

4.1 Integrated water cycle management

The *State Water Strategy* (Government of WA 2003) and *BUWM* (WAPC 2008) endorses integrated water cycle management and application of WSUD principles to provide improvements in the management of surface water, and to increase the efficient use of other existing water supplies. The key principles of integrated water cycle management include:

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

Integrated water cycle management addresses not only physical and environmental aspects of water resource use and planning, but also integrates other social and economic concerns. Water management design objectives should therefore seek to deliver best practice outcomes in terms of:

- Potable water consumption
- Surface water management
- Groundwater management.

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving environments. The existing environmental context of the site has been discussed in **Section 3**. Guidance regarding environmental values and criteria is provided by a number of National and State policies and guidelines, as well as previous studies relevant to the site. These were detailed in **Section 1.4** and **Section 1.5,** respectively.

4.2 Water conservation

This DWMS proposes the following water conservation criteria:

Criteria WC1 Consumption target of 100 kL/person/year with no more than 40 – 60 kL/person/year of scheme water.

Criteria WC2 Maintain a maximum irrigation rate of 7,500 kL/ha/yr in POS areas.

The manner in which the above objectives will be achieved is further detailed in **Section 5**.

4.3 Surface water management

This LWMS proposes the following surface water design criteria:

Criteria SW1 Retain and treat the first 15 mm of rainfall as close to the source as possible.

Criteria SW2 Detain flows up to the 1% AEP event so that pre development discharge from site is not exceeded

Criteria SW3 Finished floor levels must have a minimum of 500 mm clearance above the 1% AEP flood levels in flood retention structures.

Criteria SW4 Inverts of flood retention structures must be at least 300 mm above the MGL.

Criteria SW5 Design infiltration areas to avoid creating mosquito habitat.

Criteria SW6 Utilise best management practices to reduce the risk of nutrient loading to stormwater and the underlying aquifer.

The manner in which these objectives will be achieved is further detailed in **Section 6**.

4.4 Groundwater management

This LWMS proposes the following groundwater management criteria:

Criteria GW1 Use subsoil drains to control rise of groundwater where finished lot levels are <1.5m above the MGL.

Criteria GW2 Where used, subsoil drains to be set at or above the MGL.

Criteria GW3 Ensure all subsoil drainage has a free draining outfall.

Criteria GW4 Groundwater captured by subsoil drains must be treated to mitigate movement of legacy nutrients.

Criteria GW5 Utilise best management practices to reduce the risk of nutrient loading to groundwater.

Criteria GW6 Use WSUD approaches to recharge the superficial aquifer.

The manner in which these objectives will be achieved is further detailed in **Section 8**.

5 Water Source Allocation, Infrastructure, Fit-for-Purpose and Water Use

5.1 Fit-for-purpose water use

Conservation of water through fit-for-purpose use and best management practices is encouraged so that scheme water is not wasted. Fit-for-purpose principles have been utilised in the water conservation strategy for the site and will help to achieve **Criteria WC1** and **WC2**.

5.1.1 Scheme water

The development operates within the Water Corporation's Integrated Water Supply System (IWSS) and therefore lots will be supplied by scheme water for potable and non-potable uses. The conceptual potable water servicing plan is contained in **Appendix B (r**efer to drawing 20-2-20/902).

5.1.2 Groundwater

The site is located above a multi-layered system comprising of the Superficial Swan, Leederville and Yarragadee aquifers.

At the time of preparing this report, all aquifers are fully allocated.

A groundwater licence is currently held across Lot 202 for 13, 850 kL/annum (GWL205680). This allocation will be transferred to the proponent upon formal sale of the property, and will be utilised for up to 1.84 ha of permanent irrigation requirements across the development (discussed further in **Section 5.4.2**).

5.1.3 Rainwater tanks

Collection of runoff from roof surfaces can be undertaken, with this water stored within rainwater tanks (RWTs) for later use. Stored rainwater may be used for some lot scale irrigation requirements however this will likely need to be supplemented with scheme water during the lower rainfall months. During the higher rainfall months, the majority of the stored rainwater can potentially be used to supplement internal building non-potable uses. The water efficiency strategy for this LWMS recommends that rainwater is used in washing machines, toilets and hot water systems.

RWTs will not be mandated for the site however they will be promoted by the proponent at point of sale by providing educational literature regarding the benefits of their use. The stormwater management strategy does not rely on the use of RWTs, and they are therefore only considered to be a water conservation measure. It is assumed for the purposes of the water usage analysis (detailed in this LWMS) that, where installed, RWTs will have at least 3 kL of storage capacity and will be plumbed for internal supply to toilets, washing machine and domestic hot water systems. The water usage analysis assumes an uptake rate of 9%, informed by the Australian Bureau of Statistics (ABS) studies (ABS 2013b).

Examples of educational material are provided in **Appendix G**. The above measures will assist in achieving **Criteria WC1**.

5.2 Water conservation measures

The development will utilise water wise garden (WWG) principles for lot scale gardens and estate landscaping, and water efficient fixtures and appliances (WEFA) to ensure that the development minimises the use of water. These measures are further discussed in the following Sections.

5.2.1 Water efficient fixtures and appliances

Significant reductions in in-house water uses can be achieved with the use of WEFA. Water use rates consistent with water saving devices have been used in the lot scale water usage analysis discussed in **Section 5.4**.

The water conservation strategy proposes that all dwellings use WEFA. Water efficient fittings will be implemented by the lot owner during building construction, while uptake of water efficient appliances will be encouraged by the proponent through provision of educational materials at point of sale. Examples of educational material are provided in **Appendix G**.

The above measures will assist in achieving **Criteria WC1**.

5.2.2 Water wise gardens

Reductions in water use for irrigation by employing water efficiency measures can significantly reduce the total water usage. The following water efficiency measures will be used/promoted in landscaped areas:

- Where required, soil shall be improved with soil conditioner certified to Australian Standard AS4454 to a minimum depth of 150 mm where turf is to be planted and a minimum depth of 300 mm for garden beds.
- Garden beds to be mulched to 75 mm with a product certified to Australian Standard AS4454.
- Implementation of hydrozoning design practices, which will group plant species with similar / same irrigation requirements.
- Irrigation systems will have emitters which disperse coarse droplets to minimise losses to evaporation.
- Irrigation will not be utilised during winter months.
- Xeriscaped gardens (garden beds are landscaped using ‘waterwise plants’) will be adopted where possible.
- Community awareness of water conservation will be promoted at the point of sale and during the development sales lifespan.

WWG principles will be utilised within POS and road reserves at an average irrigation rate of 7,500 kL/ha/year. Uptake of WWG practices for lot landscaping will be encouraged by the proponent at the point of sale of lots through the provision of educational material (see examples provided in **Appendix G**). The concept landscaping masterplan is provided in **Appendix C**.

The above measures will assist in achieving **Criteria WC1**, **WC2**, **SW7** and **GW4**.

5.3 Wastewater management

The development will be connected to the Water Corporation deep sewer network at the corner of Balannup Road and Reilly Road. The concept wastewater servicing plan is provided in **Appendix B** (refer drawing 20-2-20/901).

5.4 Water use analysis

5.4.1 Lot scale water use analysis

A water balance analysis for the site was undertaken as part of investigations supporting the LWMS. The analysis considers realistic uptakes of non-mandatory water conservation measures including WEFA, RWTs and WWG, using data taken from the Australian Bureau of Statistics (ABS) (ABS 2013a, b). The results of the water balance indicate that on average, if households in the development adopt the proposed water conservation measures at typical uptake rates, they will use 42 kL/year/person. On this basis **Criteria WC1** has been satisfied.

5.4.2 Estate scale water use analysis

As discussed in **Section 5.1.2**, groundwater will be utilised as a source of permanent irrigation with up to 13,850 kL/annum of allocation available. This will facilitate the irrigation of up to 1.85 ha of POS at a rate of 7,500 kL/ha/annum, or a greater area at a reduced rate.

The LSP contains 2.89 ha of POS, however 1.75 ha of this is considered remnant vegetation which will not require ongoing irrigation. The LSP therefore contains 1.14 ha of recreational POS areas and the allocation of 13,850 kL/year will be sufficient for the ongoing irrigation requirements of these areas. Any irrigation of road reserves or wetland buffer areas will be of a temporary nature i.e. for establishment purposes, and can come from a portion of the permanent irrigation licence or scheme water. The irrigation measures will be outlined further when landscaping is known in the successive urban water management plan (UWMP).

The above measures will assist in achieving **Criteria WC2**.

5.5 Water conservation criteria compliance summary

A summary of the proposed water conservation design criteria and how these are addressed within the site is provided in **Table 5** below.

Table 5: Water conservation compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
	Consumption target for water of 100 kL/person/year, including not more than 60 kL/person/year of scheme water	Use of WEFA by lot owners
		Adoption of WWG practices by lot owners
		Education regarding water conservation provided to lot purchasers
	POS areas will be limited to an average water use of 7,500 kL/ha/year	Landscape design that follows WWG practices
		The LSP contains approximately 1.14 ha of recreational POS which will require 8,550 kL/year (at a rate of 7,500 kL/ha/year). This will be supplied with the existing groundwater allocation of 13,850 kL.

6 Stormwater Management Strategy

The stormwater management strategy for the site aims to maintain the pre development hydrology. Most runoff will be treated and retained within the site. The exception is the lots facing Reilly Road, which will discharge to Reilly Road and ultimately to the Balannup drain. The small rainfall event (i.e. the first 15 mm) will be captured and treated as close to source as possible and outside of wetland buffer areas to ensure runoff is treated before entering the CCWs and before infiltrating to groundwater. All remaining runoff up to the major (i.e. 1% AEP event) (except for lots facing Reilly Road) will be retained and infiltrated on-site within the wetland buffer areas which will assist in recharging the superficial aquifer. The stormwater management features have been designed to maintain the wetland function, values and hydrology as discussed in **Section 6.4.1**.

WSUD measures that will be utilised to manage stormwater runoff from the site, include:

- Soakwells within lots
- BRAs
- FSAs.

Conceptual civil designs for the site are attached in **Appendix B** and demonstrate compliance to the surface and groundwater design criteria.

Detailed hydrological modelling using XPStorm has been completed to determine the required size of stormwater management infrastructure and the assumptions/methodology for this is detailed in the *Modelling Assumptions Report* provided in **Appendix E**. The modelling results are discussed in the following sections.

6.1 Lot drainage

All lots will retain and treat the small rainfall event (i.e. first 15 mm) within the lot via previous garden areas/soakwells. The potential exception to this is a small number of lots facing the central POS which may have lot connection pits to discharge the small event to the downstream BRA (discussed in **Section 6.3.2**)

Runoff above the small event, and up to the major 1% AEP rainfall which does not fall to the front of lot (75% of the lot) will be retained within the lot via soakwells/surface infiltration within permeable areas. Lot retention will be achievable due to 1.7 m and 3.5 m of permeable fill that will be used across the site to achieve the required finished floor levels (see drawing 20-2-20/900 in **Appendix B**). In addition, garden areas in lots will have high infiltration rates as it is likely that sand-based landscape mix or mulch will be used.

In rainfall events greater than the small event, the front of lot (i.e. the remaining 25% of the lot) will overflow to the adjacent road reserve to be managed within the development drainage (detailed in **Section 6.3**). represents impervious driveways/paved areas which are likely to discharge to the road network.

The above measures will assist in achieving **Criteria SW1** and **SW2**.

6.2 Commercial zone

The commercial zone will retain runoff up to the major (1% AEP) event within lot. While the design of this area is yet to be undertaken, this could be achieved by a number of approaches including soakwells, subsurface storage, above ground storage in carpark areas, rainwater storage tanks etc. Onsite retention will be possible and practical given the significant amount of fill required to be imported at this portion of the site. Drainage designs for the commercial area will be the responsibility of the commercial centre developer and will need to be reviewed and approved by the City as part of the building approvals process.

The lot retention measures detailed above will assist in achieving **Criteria SW1** and **SW2**.

6.3 Development drainage

6.3.1 Pit and pipe network

A system of pits and pipes are proposed for the site and will be sized to cater for the minor (20% AEP event). Gross pollutant traps (GPTs) can be used prior to discharge to BRAs and if used these will provide an additional level of treatment. The conceptual pipe network layout is shown in the civil designs provided in **Appendix B**.

6.3.2 Bio-retention areas

Three BRAs will be located within the development to provide treatment of the first 15 mm of rainfall from an adjacent road catchment as close to source as practicable. The runoff catchments are relatively small, and the BRAs are therefore close to the source of runoff generation. BRAs will be located within POS areas, and once at capacity the BRAs will overflow to the adjacent FSAs (described in **Section 6.3.3**). BRAs will be separate from FSAs and will not be located within the wetland buffers. BRAs will be 300 mm deep with 1:3 side slopes.

BRAs will be planted with native vegetation to encourage biological nutrient uptake, consistent with the *Vegetation guidelines for stormwater biofilters in the south-west of Western Australia* (Monash University 2014). BRAs will be underlain with soil media that has a high phosphorous index (PRI) (>PRI 10) or equivalent to increase nutrient removal from runoff during infiltration. It is also acceptable to utilise existing soils where these can be demonstrated to provide an appropriate nutrient removal function.

The size and spatial requirements for BRAs are shown in **Table 6** and illustrated in **Figure 7**. Inundation resulting from the small rainfall event is shown in **Figure 8**. BRAs will assist in achieving **Criteria SW1**, **SW2**, **SW6** and **GW6**.

6.3.3 Flood storage area

Surface runoff from the site that is not retained higher in the catchment (i.e. within lot or within a BRA) will be conveyed to a FSA located within the wetland buffer areas. The FSA will be utilised to retain and infiltrate major event (1% AEP) runoff. FSAs will be 1.2 m deep and will have 1:6 side slopes.

The design of FSAs and adjacent lot levels will be such that the finished floor levels of adjacent lots will be at least 500 mm above the maximum top water level (TWL) to ensure protection from flooding during extreme rainfall events. The preliminary earthworks strategy which demonstrates that this is achieved is provided in **Appendix B,** and this demonstrates that **Criteria SW4** will be achieved.

The FSAs will be designed to dry out within 96 hours following rainfall events, therefore will not create mosquito breeding risk. This will be achieved by constructing the basins within permeable fill and with inverts above the MGL.

The sizes and spatial requirements for the FSAs are shown in **Table 7** and illustrated in **Figure 7**. Inundation resulting from the minor and major rainfall event is shown in **Figure 9** and **Figure 10**, respectively. FSAs will assist in achieving **Criteria SW2** and **GW6**.

6.4 Stormwater management design

The development drainage system has been designed to achieve the objectives and criteria stated in **Section 4.3**. Surface runoff modelling undertaken using XPStorm has been used to inform the design of stormwater infrastructure with modelling assumptions and methodology provided in **Appendix F**.

6.4.1 Treatment of stormwater

Surface runoff up to and including runoff from the 1% AEP storm event will be treated and retained on site, with the exception of lots facing Reilly Road which will discharge to Reilly Road and ultimately to the Balannup drain. Reilly Road will be constructed by the developer such that storm water is directed to the Balannup Drain. Discharge to Reilly Road will not exceed pre-development and allowable discharge and will therefore not impact on the capacity of the FMD.

As discussed in **Section 6.1**, lots will retain the small rainfall event within the lot (via soakwells or alternative measures) where local soils permit. BRAs will be vegetated with native nutrient removal species appropriate for wetland buffers to provide water quality treatment by removing fine sediments, trace metals, nutrients, bacteria and organics. BRAs will be underlain by soil media that has a high phosphorous index (PRI) (>PRI 10) an is suitable for water quality treatment where existing soils cannot provide an appropriate nutrient removal function time (see **Section 6.3.2**). BRAs are not designed to be permanently wet. Instead, stormwater will infiltrate into the underlying soil medium. If required, subsoil drains will be utilised the BRAs to ensure they can dry out in adequate time.

Surface runoff up to and including the 1% AEP storm event that is not retained higher in the catchment (i.e. within lot or within BRAs) will be conveyed to FSAs located within the wetland buffer areas (see **Section 6.3.3**). The FSA will be within permeable soils and have inverts above the MGL to effectively retain and infiltrate the major event (1% AEP) runoff.

Since there will be no discharge from the site into wetlands for storm events up to the 1% AEP storm event and will be infiltrated locally as currently occurs, stormwater management is not expected to have an impact on the functions, values or hydrology of the wetlands.

6.4.2 Small rainfall event

Runoff from the road reserve will be conveyed to the downstream BRA for water quality treatment and retention of the small rainfall event. The size and spatial requirements of water quality treatment assets are presented in **Table 6**, and inundation resulting from the small event is shown in **Figure 8**.

Table 6: Small event (first 15 mm) treatment requirements

Catchments	Treatment	Depth (m)	TWL surface area (m^2)	Volume (m^3)
Ct-01	BRA 1	0.3	105	25
Ct-02	BRA 2	0.3	1,025	290
Ct-03	BRA3	0.3	280	75

6.4.3 Flood retention

Runoff from all events greater than the small event will be managed within FSAs. The proposed locations of these features are shown in **Figure 7**, and inundation resulting from the minor (20% AEP) and major (1% AEP) events are illustrated in **Figure 9** and **Figure 10**, respectively. The storage requirements which will assist in achieving **Criteria SW2** and **GW5** are provided in **Table 7**.

Table 7: Stormwater storage requirements for the minor (20% AEP) and major (1% AEP) event

Catchment	Storage name	Minor event storage (20%AEP)			Major event flood storage							
		Depth (m)	TWL surface area (m^2)	Volume (m^3)	MGL (mAHD)	Min. Invert level (mAHD)	TWL (mAHD)	Adjacent lot level (mAHD)	Depth (m)	TWL surface area (m^2)	Volume (m^3)	Emptying time (hrs)
Ct-01	FSA 1	0.64	132	41	~22.5	22.8	24	24.7	1.20	330	165	14
Ct-02	FSA 2	0.36	1451	465	~22.5	22.8	24	24.7	1.20	2325	2035	12
Ct-03	FSA 3	0.50	347	123	~22.5	22.8	24	25.6	1.20	735	495	12

6.4.4 Stormwater peak flow rates

Runoff from the front of lot (25% of the lot) will be discharged to Reilly Road, for lots facing Reilly Road (Ct-05 and Ct-06).

The total post development discharge for the 20% AEP and the 1% AEP is less than the pre development discharge for the 20% AEP and 1% AEP (0.4 m^3/s and 0.9 m^3/s respectively). On this basis **Criteria SW2** is achieved.

Table 8: Post development discharges

Catchment	Post development peak discharge (m^3/s)	
	20% AEP event	1% AEP event
Ct-05	0.01	0.03

6.5 Non-structural stormwater management measures

A number of non-structural measures will be implemented across the site to help reduce nutrient loads within stormwater runoff.

These measures include:

- Minimising fertiliser use to establish and maintain vegetation within BRAs, FSAs, POS and road verges.
- Use of drought tolerant turf species that require minimal water and nutrients.
- Street sweeping.
- Maintenance of BRAs, FSAs and the pipe network to remove sediments and other pollutants.
- Education of residents regarding fertiliser use and nutrient absorbing vegetation species within lots. Examples of educational materials are provided in **Appendix G**.

The above measures will assist in achieving **Criteria SW6** and **GW5**.

6.6 Stormwater design criteria compliance

A summary of the proposed stormwater management design criteria and how these are addressed within the development is provided in **Table 9** below.

Table 9: Stormwater management compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
SW1	Retain and treat the first 15 mm of rainfall as close to source as possible.	The commercial area will retain runoff up to the 1% AEP event.
		Lots will retain and treat the first 15 mm of rainfall within soakwells/pervious garden areas.
		Runoff from the road reserve will be retained and treated within vegetated BRAs. Treatment will be via vegetation and the underlying soil profile which will absorb nutrients prior to reaching groundwater.
SW2	Detain flows up to the 1% AEP event so that pre development discharge from site is not exceeded.	The commercial area will retain runoff up to the 1% AEP event onsite.
		Back of lots (75% of the lot) will retain runoff up to the 1% AEP event within soakwells/pervious garden areas.
		Runoff from the front of lots facing Reilly Road (25% of the lot) will be discharged to Reilly Road. For all other areas within the site, runoff from road reserve and front of lot (25% of the lot) will be conveyed to a nearby BRA/FSA which will retain up to the 1% AEP event.

Table 9: Stormwater management compliance summary (continued)

Criteria number	Criteria description	Manner in which compliance will be achieved
SW3	Finished floor levels must have a minimum of 500 mm clearance above the 1% AEP flood levels in FSAs.	Conceptual earthwork levels demonstrate that lots have sufficient clearance (> 500 mm) to major event TWLs.
SW4	Inverts of retention structures must be at least 300 mm above the MGL.	Groundwater levels beneath the site are generally greater than 0.5 m BGL. Hence the design of BRAs/FSA will ensure that at least 300 m of clearance is maintained post-development.
SW5	Design infiltration areas to avoid creating mosquito habitat.	BRAs/FSA will ensure there is sufficient clearance to MGL and/or will be filled with permeable sand to ensure they dry out and do not become a mosquito risk.
SW6	Utilise best management practices to reduce the risk of nutrient loading to stormwater.	Utilise WWG practices in POS and BRAs
		Minimising fertiliser use to establish and maintain vegetation
		Maintenance of POS and drainage areas (BRAs, FSAs) and the pipe network
		Street sweeping.
		Education of residents on use of WWG and fertilisers.

7 Groundwater Management

The principles behind groundwater management are to recharge the superficial aquifer necessary for nearby wetlands, and maintain or improve the existing groundwater quality by ensuring legacy nutrients are not transported.

7.1 Groundwater level management

As discussed in **Section 3.9.3**, groundwater across the site is approximately 22.68 mAHD to 22.25 mAHD (i.e. 0.65 mBGL to 1 mBGL), hence consideration of groundwater levels is required when setting drainage infrastructure elevation and finished lot levels.

7.1.1 Sand fill specifications

The final earthwork levels across the site will result in an import of up to 3 m of permeable sand fill. This is driven by the elevation of the available sewer connection. The highest levels of fill will be at the eastern end of the site adjacent to the commercial centre (see concept earthworks provided in **Appendix B**).

7.1.2 Subsoil drains

Where the finished lot levels will be <1.5m from the MGL, groundwater rise beneath the southern lots and road reserve will be controlled through the installation of subsoil drains beneath the road reserve.

Subsoil drain inverts are not proposed to lower the existing superficial aquifer as they will be set at or above MGL. This is possible as most of the site will be filled as described above. Subsoil drains beneath road reserves are therefore intended to provide an up-front contingency should groundwater rise post-development.

For the majority of the site, the invert of subsoil drains will be set at or above pre-development MGL. Clearance from the invert of subsoil drains and the pre-development MGL (or low permeability layer) will vary across the site and generally increases from the subsoil drain outlet upstream. The minimum clearance between the invert of subsoil drains and the MGL is 1.5 m. The conceptual subsoil drainage plan is provided in **Appendix B**.

Subsoil drains beneath road reserves will discharge to BRAs (either BRA1 or BRA2) and will therefore receive treatment from the vegetation and soil media proposed in these areas. Subsoil discharges will have a minimum 150 mm clearance from the downstream invert to ensure that they remain free draining.

7.2 Groundwater quality management

The main objective for the management of the groundwater quality is to maintain or improve the existing groundwater quality. This will be achieved by the change in land use from uncontrolled rural land uses and a poultry farm to contemporary urban development using WSUD approaches.

Once developed, further improvement can be achieved by treating surface runoff prior to infiltration via the application of appropriate stormwater management assets, thereby reducing the total nutrient load into the groundwater that originates from the development. The retention and infiltration of surface runoff will also assist in recharging the superficial aquifer.

The nutrient load to groundwater from landscaping practices within the development itself will be minimised by:

- The use of slow-release fertiliser.
- The use of native species and xeriscaping (which in turn reduces the need for fertilisers).
- Minimising turf areas.
- Educating lot purchasers in relation to fertiliser use and WWG. Examples of educational material are provided in **Appendix G**.

Groundwater that originates from the development is surface water runoff that has infiltrated into the soil profile. Therefore, improving groundwater quality can also be achieved by the treatment of surface water runoff prior to infiltrating to groundwater.

As discussed in **Section 6**, surface water runoff will be treated by retaining water in soakwells, BRAs and FSAs, where runoff will infiltrate into the underlying soil profile. Removal of nutrients will also occur through vegetative uptake from runoff retained in the BRAs.

The above measures will assist in achieving **Criteria GW4** and **GW5**.

7.3 Groundwater design criteria compliance

A summary of the proposed groundwater quantity design criteria and how these are addressed within the development area is provided in **Table 10**.

Table 10: Groundwater management compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
GW1	Use subsoil drains to control rise of groundwater where finished lot levels are <1.5m above the MGL.	A subsoil network is proposed across the southern portion of the site, and will be placed at or above the existing MGL (see **Appendix B**)
GW2	Where used, subsoil drains to be set at or above the MGL	A subsoil network is proposed across the southern portion of the site, and will be placed at or above the existing MGL (see **Appendix B**)
GW3	Ensure all subsoil drainage has a free draining outfall.	All sub-soil drains will have a clearance of 150 mm from the discharge point (BRA1/BRA2), thereby providing a free-flowing outlet.
GW4	Groundwater captured by subsoil drains must be treated to mitigate movement of legacy nutrients	All sub-soil drains will discharge to a BRA (BRA1/BRA2) for treatment.

Table 10: Groundwater management compliance summary (continued)

Criteria number	Criteria description	Manner in which compliance will be achieved
GW5	Utilise best management practices to reduce the risk of nutrient loading to groundwater.	Direct small event runoff to the vegetated BRAs. Treatment is provided through interaction with vegetation and adsorption of nutrients to soil particles through infiltration
		Minimise fertiliser use in POS and road verges
		Use roll-on, drought tolerant turf species
		Education of residents on use of WWG and fertiliser use
GW6	Use WSUD approaches to recharge the superficial aquifer.	Runoff will be directed to the FSAs (sized for the 1% AEP event) to locally retain and infiltrate runoff on-site.

8 Subdivision and Urban Water Management Plans

The requirement to undertake preparation of more detailed water management plans to support subdivision is generally imposed as a condition of subdivision. The development of any future UWMP should follow the guidance provided in *Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions* (DoW 2008).

While strategies have been provided within this LWMS that address planning for water management within the site, it is a logical progression that future subdivision designs and the supportive UWMP will clarify details not provided within the LWMS. The main areas that will require further clarification within the future UWMP include:

- Implementation of water conservation strategies
- Imported fill strategy
- Modelling and configuration of the drainage structures
- Subsoil drain network specification and design
- Non-structural water quality improvement measures
- Construction period management strategy
- Management and maintenance requirements
- Wetland management actions and design considerations.

These are further detailed in the following sections.

8.1 Implementation of water conservation strategies

A number of potential measures to conserve water have been presented within this LWMS (see **Section 5**). These water conservation strategies will be incorporated into the design and the ongoing maintenance of all POS areas. Landscape design measures that will be incorporated into the water conservation strategy will be further detailed within the future UWMP produced for the development.

It is expected that where any irrigation is proposed, the future UWMP will demonstrate that an adequate water source has been obtained to meet irrigation requirements, or that an appropriate contingency plan has been established.

The use of groundwater as an irrigation source is currently being arranged by the proponent. Any groundwater licences obtained for use in irrigation of landscaping, along with the location of bores will be confirmed in the future UWMP.

The manner in which the developer intends to promote water conservation measures discussed in this LWMS to future lot owners will also be discussed within the future UWMP.

8.2 Imported fill strategy

While an initial earthworks strategy has been developed, the fill approach and specifications will need to be refined at subdivision stage. Should the permeability specifications change these will be documented in the UWMP and the assumptions for surface runoff modelling will be updated as required.

8.3 Modelling and configuration of drainage structures

The design of the drainage system to date has been undertaken at an appropriate level for local structure planning and surface runoff modelling of the stormwater drainage system will be reviewed once detailed drainage design has commenced.

It is acknowledged that the drainage strategies documented in this LWMS are based upon broad-scale assumptions. These assumptions are considered adequate for development of treatment and drainage structures and are of an appropriate level of detail. However, if the site layout is refined then verification of proposed subdivision drainage designs will be undertaken by modelling the catchments serviced by the drainage network. Such modelling will allow verification that the development undertaken within the structure planning area is consistent with this LWMS. It is anticipated that this will occur during the subdivision design process and detailed within the future UWMP.

The exact location and shape of stormwater management assets structures will therefore need to be specified and presented within the future UWMP.

8.4 Subsoil drain network specifications and design

As discussed in **Section 0**, sand fill and subsoil drainage will be required to ensure sufficient clearances are achieved between finished lot levels and the phreatic crest for some parts of the site. The current fill strategy and lot elevations provide most lots across the structure planning area with in excess of 1.5 m of permeable sand fill. If the fill depth over the impervious layer/MGL were to be reduced, groundwater modelling may be required to calculate the post-development phreatic surface rise between subsoil drains.

The future UWMP will provide detailed earthwork and subsoil drainage drawings to demonstrate that the required clearances are achieved.

8.5 Non-structural water quality improvement measures

Guidance for the development and implementation of non-structural water quality improvement measures is provided within the *Stormwater Management Manual for Western Australia* (DoW 2007a). Some measures will be more appropriately implemented at a local government level, such as street sweeping, however many can be implemented relatively easily within the design and maintenance of the subdivision.

It is expected that the future UWMP will provide reference to measures such as public education (through measures such as signage that may be implemented to raise awareness).

8.6 Construction period management strategy

It is anticipated that the construction stage will require some management of various aspects (e.g. dust, surface runoff, noise, traffic etc.). The management measures undertaken for construction management will be addressed either in the future UWMP or a separate Construction Management Plan (CMP).

8.7 Management and maintenance requirements

The management measures to be implemented to address surface water quality, such as the use of BRAs and FSAs will require ongoing maintenance. It is therefore expected that future UWMPs will provide detailed management and maintenance plans that will set out maintenance actions (e.g. gross pollutant removal), timing (e.g. how often it will occur), locations (e.g. exactly where it will occur) and responsibilities (e.g. who will be responsible for carrying out the actions). Given that approval from the City and DWER will be sought for the proposed measures, it is anticipated that consultation with these agencies will be undertaken and referral to guiding policies and documents will be made.

8.8 Wetland management actions and design considerations

Given the prominence of wetland areas within the site, it is expected that the management requirements and design considerations for the wetland areas will need to be appropriately documented and accepted by DBCA. Any relevant aspects from the proposed approach to wetlands will need to be considered during design of the FSAs where they are located within wetland buffers. This may include consideration of side slopes, vegetative planting and access for maintenance.

These management and design considerations (i.e. those relevant to water management) will be included in the future UWMP.

A midge and mosquito management plan may also need to be prepared and implemented across the site to manage stormwater assets. This management plan will include the actions, timing, frequency and responsibility of measures to manage midges and mosquitos.

8.9 Impact on surface and groundwater of adjacent lots

The stormwater management strategy of the site does not rely on lots 604, 605 and 606 Balannup Road to be developed. These lots are predominantly self-contained, and if any surface discharge were to occur, these lots have a slight grade to the north, towards Balannup Road and therefore no changes to the pre-development surface water runoff is expected as a result of developing the lots included in the structure planning area.

The approach to managing groundwater uses subsoil drains which will discharge to bio-retention areas for treatment and infiltration. These will be set based on the discharge invert and will be above

pre-development groundwater levels. Subsoil drain flow directions are proposed to follow surface runoff catchments. The use of subsoil drains will control the potential rise of groundwater in the post-development environment so that there will be no changes to the adjacent groundwater levels.

Imported fill is also required to ensure that lots have sufficient clearance above groundwater.

Runoff from the road link perpendicular to Reilly Road will be directed to BRA2 and subsoil drains beneath the road will mitigate potential control groundwater rise. Therefore, groundwater can be adequately mitigated and managed without impacting adjacent lots which are not developed.

9 Monitoring

9.1 Pre-development monitoring

Pre-development groundwater monitoring was completed in 2014-2015 (see **Section 3.9**) across five bores. The collective data to date is considered sufficient to inform the conceptual civil design and water management approach, however additional monitoring (both levels and quality) is currently underway (commenced in June 2021) to provide an update which includes recent data. Any additional monitoring data undertaken prior to the future UWMP and detailed civil design process will be used to refine/inform (if necessary) the civil and landscape designs.

9.2 Post-development monitoring

9.2.1 Condition monitoring

The overall condition of the development will be monitored on a bi-annual basis from completion of the civil and landscaping works. A visual assessment will be undertaken to monitor the overall condition of the development, with the aim to ascertain that the maintenance activities (which will be detailed in the UWMP as described in **Section 8**) are achieving the overall management objectives for the development. The parameters that will be monitored include:

- Gross pollutants
- Terrestrial weeds
- Irrigation
- Vegetation density
- Paths, benches, walkways and other infrastructure.

The management and maintenance objectives will be detailed within the future UWMP along with details of the corresponding monitoring program.

9.2.2 Water monitoring

Monitoring of groundwater quality concentrations is proposed to occur at two of the pre-development bore locations (see **Figure 2**) if these locations can be retained. One upstream bore and one downstream bore should be utilised. Where they cannot be retained, they will be reinstalled as close as practicable, preferrable towards the north-west and south-eastern portions of the site. Monitoring will be conducted quarterly for a period of two years from practical completion of open space areas.

9.2.3 Wetland monitoring

It is possible, given the presence of two CCWs and an REW, that ongoing monitoring and maintenance of the wetland areas may be required. Where required, this would be documented an a wetland management. This monitoring would likely cover different aspects to the future UWMP monitoring, and will more appropriately be dealt with under a wetland/natural area management context/framework.

9.3 Guideline values

Guideline values are presented in **Table 11** and have been established in consideration of the *NWQMS* (Australian Government 2018) however reflect the high legacy nutrient concentrations from bores within the site (MW01-MW05). It is not anticipated that the legacy nutrients will be mobilised beyond the site, and therefore it is expected that the guideline values will need to be revised following initial measurement post-development. Guideline values will also need to be reconsidered when additional groundwater quality monitoring is completed in 2021, and should be outlined in the successive UWMP.

Table 11: Water quality monitoring trigger values

Analyte	Short-term groundwater quality guideline values	Long-term groundwater quality guideline values
TN as N (mg/L)	8.8	1.2
TP as P (mg/L)	1.2	0.65

9.4 Reporting

A post-development monitoring report will be prepared on conclusion of the two-year monitoring period, and will be provided to the City and DWER. Interim results (spreadsheet) can be provided to either the City or DWER on request during the monitoring program.

10 Implementation

The LWMS is a key supportive document for the LSP. The development of the LWMS has been undertaken with the intention of providing a structure within which subsequent development can occur consistent with an integrated water cycle management approach. It is also intended to provide overall guidance to the general stormwater management principles for the area and to guide the development of the future UWMP.

10.1 Roles and Responsibility

The LWMS provides a framework that the proponent can utilise to assist in establishing stormwater management methods that have been based upon the existing environment, are consistent with relevant State and Local Government policies and have been endorsed by the City. The responsibility for working within the framework established within the LWMS rests with the subdivider, although it is anticipated that the future UWMP will be developed in consultation with the City and DWER and in consideration of other relevant policies and documents.

10.2 Funding

The cost of implementing the management strategies outlined in this LWMS will be borne solely by the proponent, with the exception of lot scale subsurface structures, which will be borne by the lot purchaser (including the commercial lot).

10.3 Review

It is not anticipated that this LWMS will be reviewed, unless additional land parcels/lots are added to the development area prior to subdivision, or the development undergoes significant change post-lodgement of the LWMS. If additional areas are required to be covered by the LWMS it is most likely that an addendum to cover these areas could be prepared. If the development is substantially modified, surface runoff modelling undertaken for this LWMS will need to be reviewed and the criteria proposed revised to ensure that all are still appropriate.

The following stage of development is subdivision, and it is likely that a condition of subdivision approval will be to prepare a UWMP. **Section 8** discusses water management aspects that should be reviewed/revised at UWMP stage.

The next stage of development following the UWMP is single lot or multiple dwelling developments. It is recognised that certain elements of the LWMS and the UWMP will not be implemented until this late stage, and that there is little or no statutory control that can be applied to ensure the implementation of any remaining measures. While the remaining measures are unlikely to be enforced at this stage their implementation could be encouraged by the City through policy (or modification of these where necessary), building licence or awareness programs (such as the Water Corporation Waterwise program).

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11.1 General references

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Figures

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Figure 1: Site Locality

Project:	Local Water Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(09)--F40a

Drawn:	GAR
Date:	18/08/2023
Checked:	JB
Approved:	DPC
Date:	18/08/2023

N

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Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

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Figure 2: Topographic Contours and Groundwater Levels

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Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(09)--F41a

Drawn:	WJC
Date:	18/08/2023
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Date:	18/08/2023

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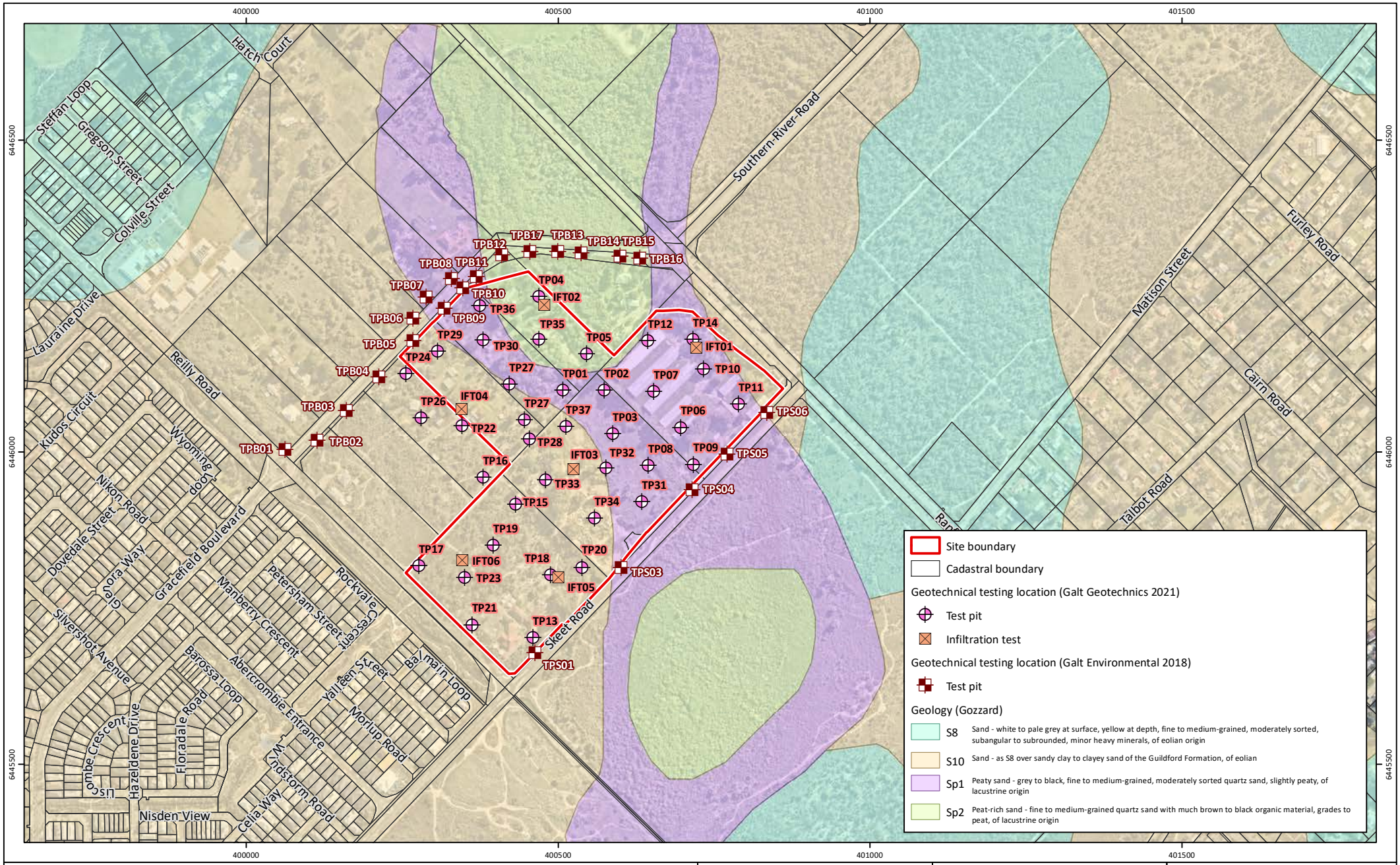


Figure 3: Environmental Geology

Project:	Local Water Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(09)--F42a

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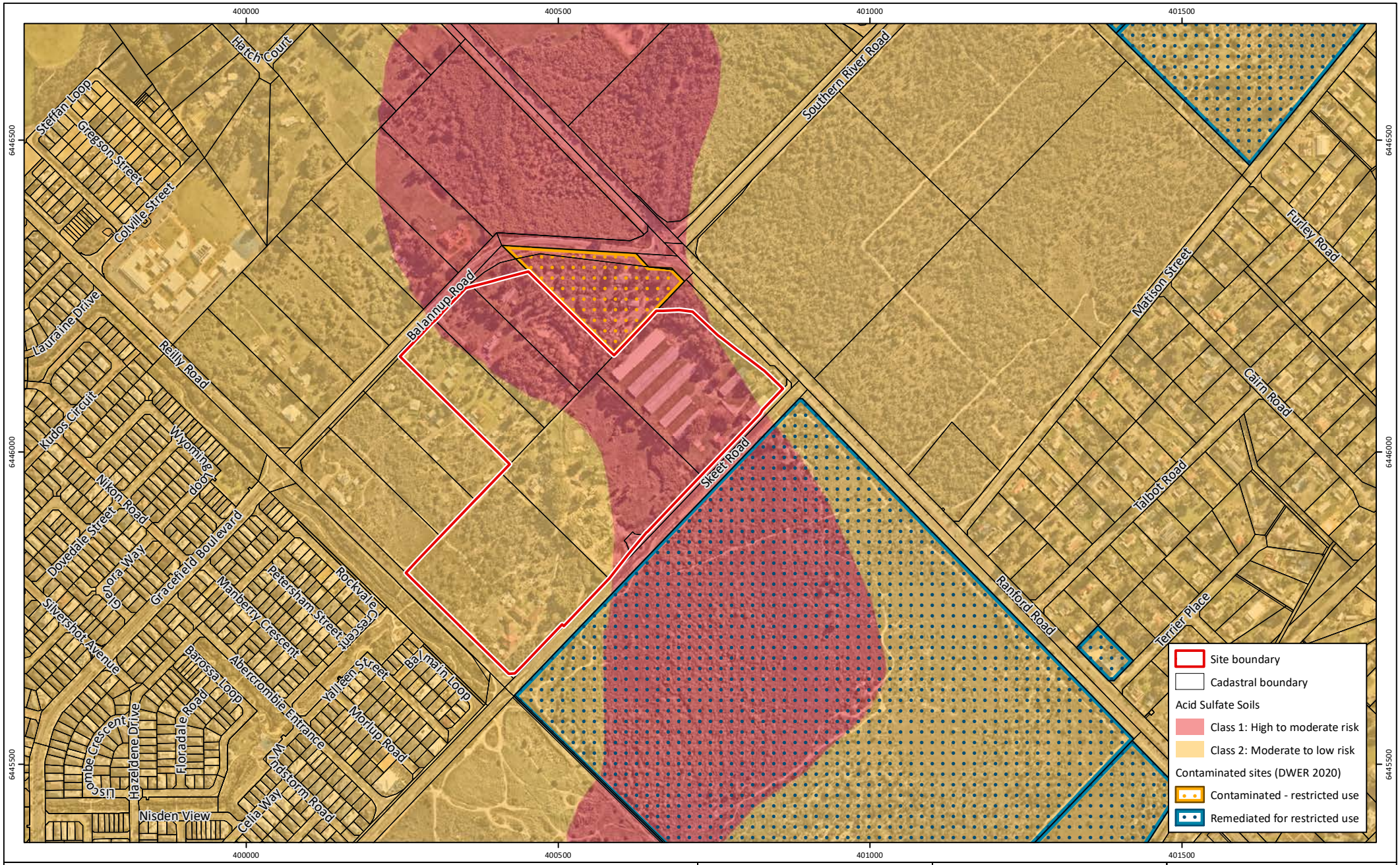


Figure 4: Acid Sulfate Soil Risk Mapping and Contaminated Sites

Project:	Local Water Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(09)--F43a

Drawn:	GAR
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Metres

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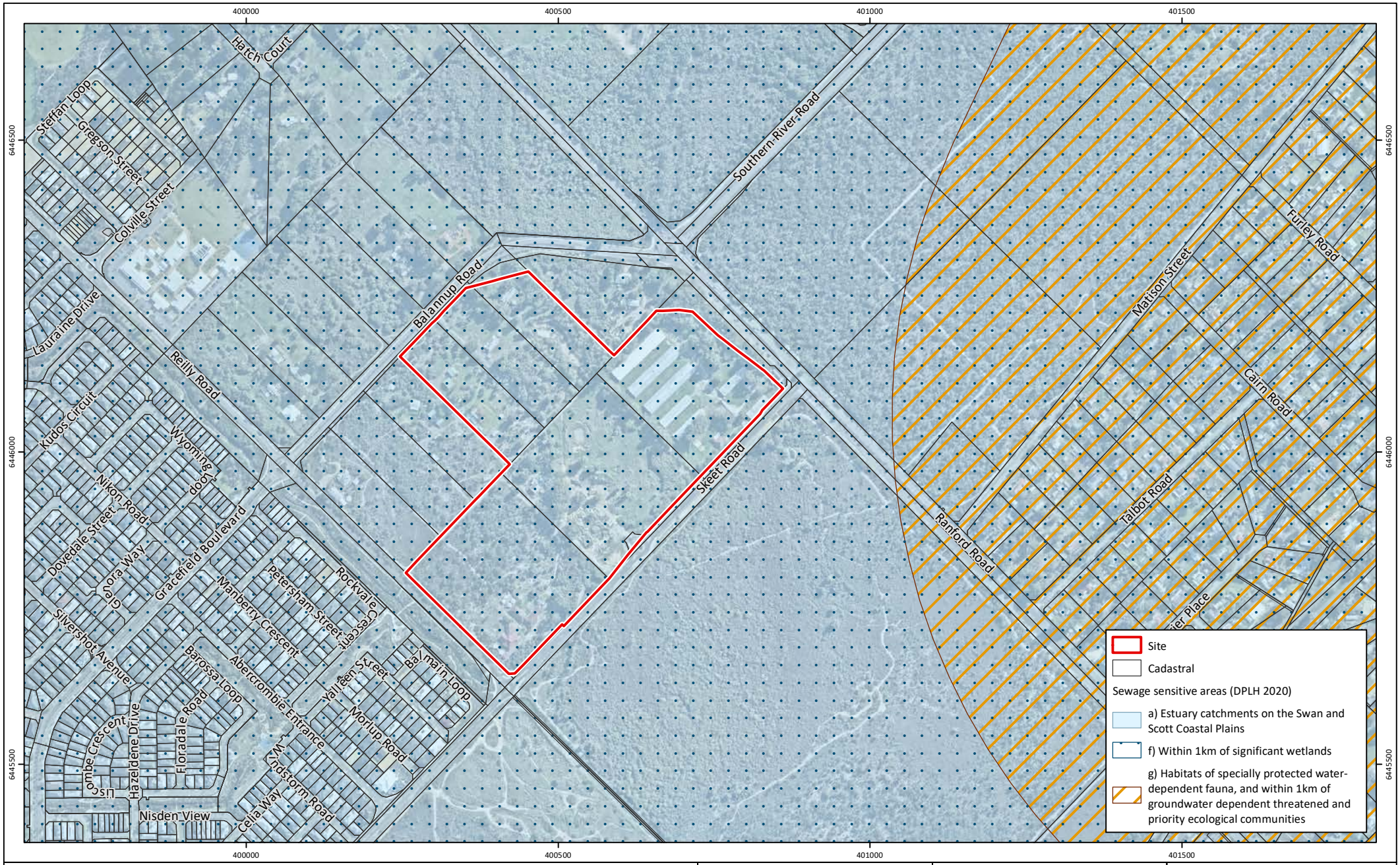


Figure 5: Sewage Senstive Areas

Project:	Local Water Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(09)--F44a

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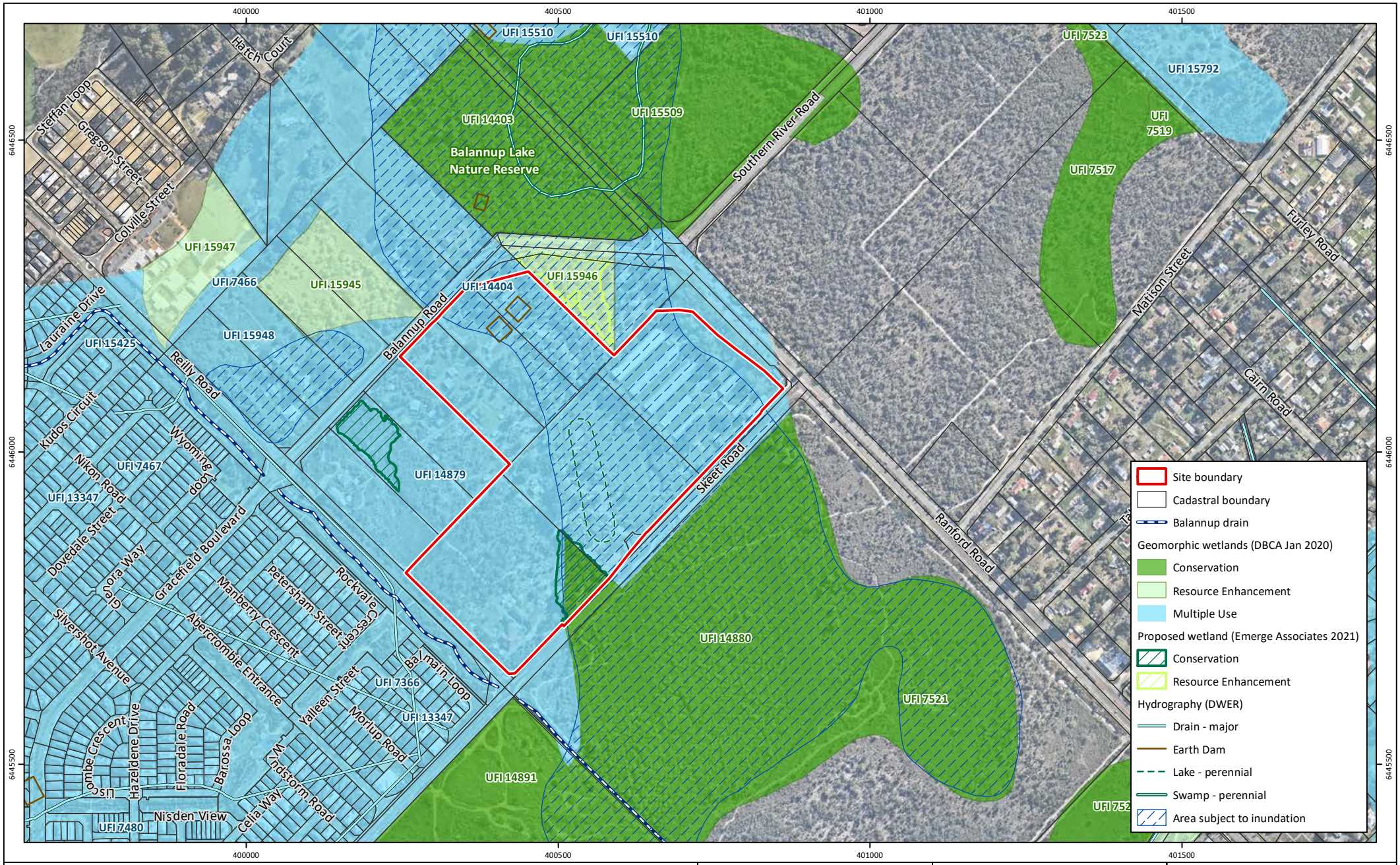


Figure 6: Geomorphic Wetlands and Existing Hydrological Features

Project:	Local Water Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(09)--F45a

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Figure 7: Stormwater Management Plan

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Plan Number:
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Figure 8: Small Event Inundation

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Plan Number:
EP20-127(09)--F47b

Drawn:	GAR
Date:	18/08/2023
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Date:	18/08/2023

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Metres

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Figure 9: Minor (20% AEP) Event Inundation

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Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(09)--F48b

Drawn:	GAR
Date:	18/08/2023
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Metres

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Figure 10: Major (1% AEP) Event Inundation

Project:	Local Water Management Strategy North Harrisdale Structure Plan
Client:	Yolk Property Group Pty Ltd

Plan Number:
EP20-127(09)--F65b

Drawn:	GAR
Date:	18/08/2023
Checked:	JB
Approved:	DPC
Date:	18/08/2023

N

0 100 200
Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used
©Landgate (2023). Nearmap Imagery date: 30/04/2023

Appendix A

Structure Plan

Prepared by Hex Design and Planning (2023)

BALANNUP ROAD

REILLY ROAD

SOUTHERN RIVER RD

RANFORD ROAD

SKEET ROAD

606

605

604

603

602

601

600

POS

POS

POS

200

201

202

98

171

1771

Legend

- Subject Site
- Parent Lot
- CCW
- 50m Buffer to CCW
- REW
- 30m Buffer to REW
- Easement (30m Width)
- Residential R25
- Residential R30
- Public Open Space (POS)
- Local Centre
- Access Streets
- Neighbourhood Connector

22001001B

0m 50 100 200m

HARRISDALE NORTH STRUCTURE PLAN

Harrisdale. Armadale, WA

Project YOLHA 22001001B | Scale 1:2500 @ A3 | Date: June 2023

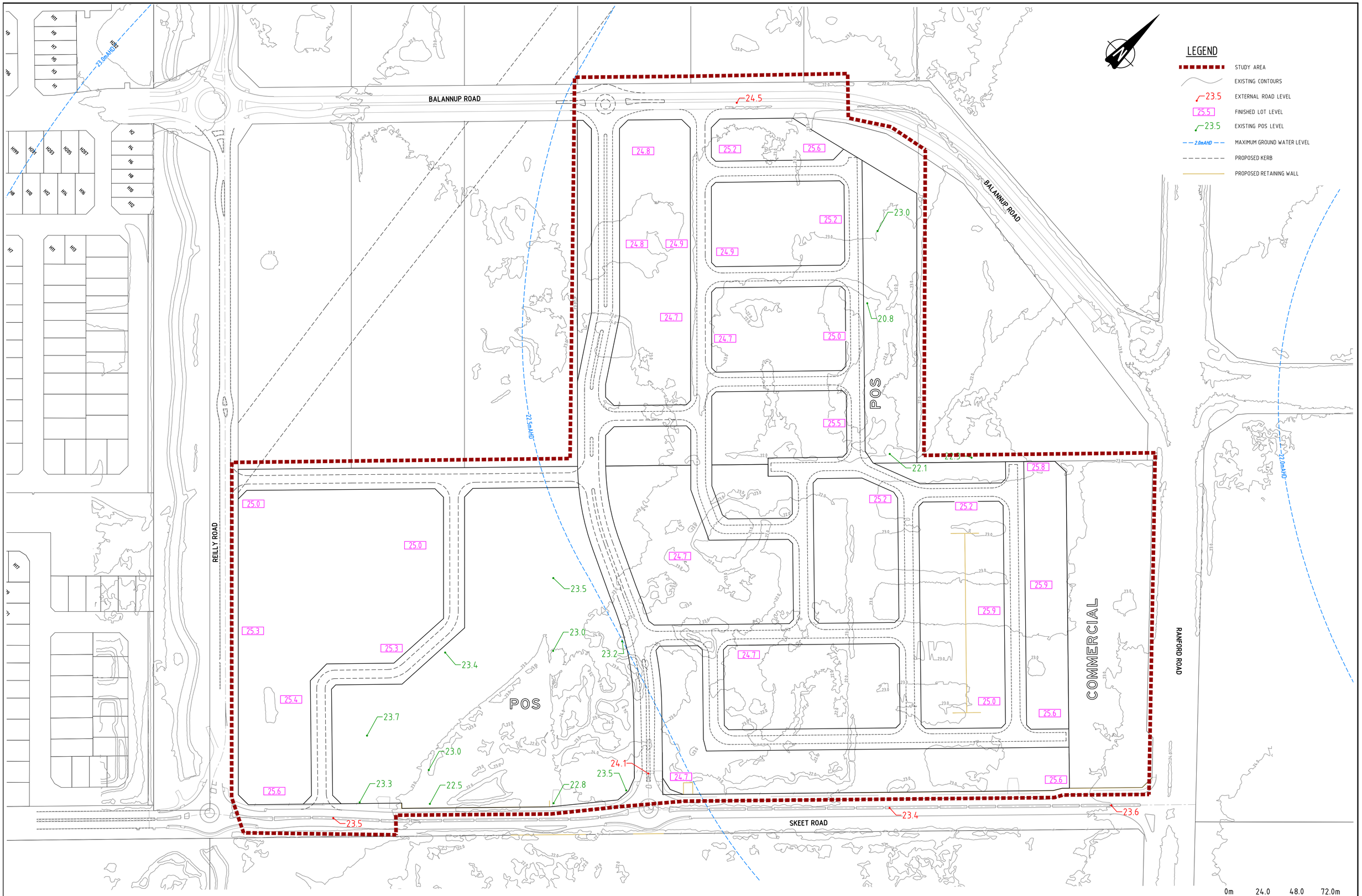
Hex Design and Planning
ABN 34 627 142 299
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E sheldon@hexdesignplanning.com.au

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Appendix B

Concept civil designs

Prepared by Porters Engineering (2023)



PROJECT:

HARRISDALE NORTH STRUCTURE PLAN

No.	DATE	REVISION	BY
F	1-8-2023	LAYOUT UPDATED AS PER STRUCTURE PLAN DATED 11-6-2022	MEG
E	12-5-2022	PROPOSED CADASTRAL BOUNDARIES ALTERED, LEVELS ADJUSTED, KERBS ADJUSTED TO SUIT	MEG
D	3-8-2021	MAXIMUM GROUND WATER LEVELS ADDED	MEG
C	29-6-2021	PROPOSED CADASTRAL BOUNDARIES ALTERED, WALLS ADJUSTED, KERBS ADJUSTED	MEG
B	14-6-2021	LOGO ADDED, TITLE BLOCK UPDATED, LEVELS UPDATED	MEG
A	24-5-2021	ISSUED FOR CONCEPT	MEG

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ONLY PLANS WITH NUMERICAL REVISION (REV 'F' OR HIGHER) AND SIGNED AS APPROVED SHALL BE USED FOR CONSTRUCTION

Porter Consulting Engineers

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TUSMO Pty Ltd ACN 070 097 568 as trustee for the Consulting Engineering Unit Trust trading as Porter Consulting Engineers ABN 78 636 396 385

CLIENT: YOLK PROPERTY GROUP

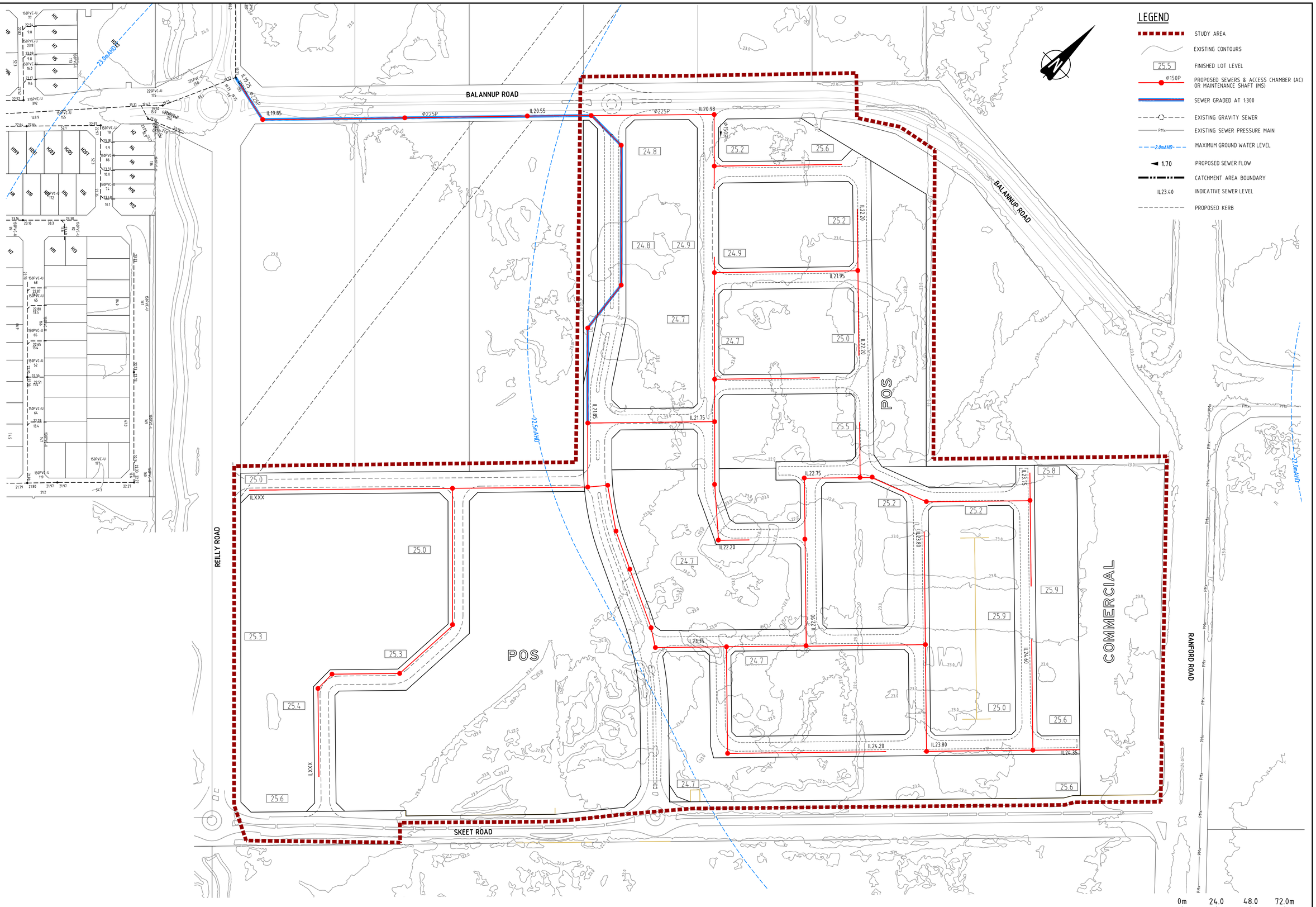
DRAWING: **CONCEPT EARTHWORKS PLAN**

STATUS: **CONCEPT**

SCALE	1:1200
DATE	MAY 2021
DESIGN	SCH
DRAWN	MEG
CHECK	
APP'D	

DRAWING No. **20-2-20/900** REV No. **F** ORIGINAL DRAWING SIZE **A1**

FILE NAME: S:\ACTIVE PROJECTS\20-02-020\ACAD\20220-900.dwg



PROJECT:

HARRISDALE NORTH STRUCTURE PLAN

No.	DATE	REVISION	BY
G	1-8-2023	LAYOUT UPDATED AS PER STRUCTURE PLAN DATED 11-6-2022	MEG
F	12-5-2022	PROPOSED CADASTRAL UPDATED AND SEWER MOVED TO SUIT	MEG
E	2021-08-13	SEWER LAYOUT AND LEVELS ADJUSTED	MEG
D	3-8-2021	MAXIMUM GROUND WATER LEVELS ADDED	MEG
C	29-6-2021	PROPOSED BOUNDARIES ADJUSTED, SEWER ADJUSTED, KERBS ADJUSTED	MEG
B	14-6-2021	LOGO ADDED, TITLE BLOCK UPDATED, SEWER LEVELS UPDATED	MEG
A	24-5-2021	ISSUED FOR CONCEPT	MEG

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CLIENT: YOLK PROPERTY GROUP

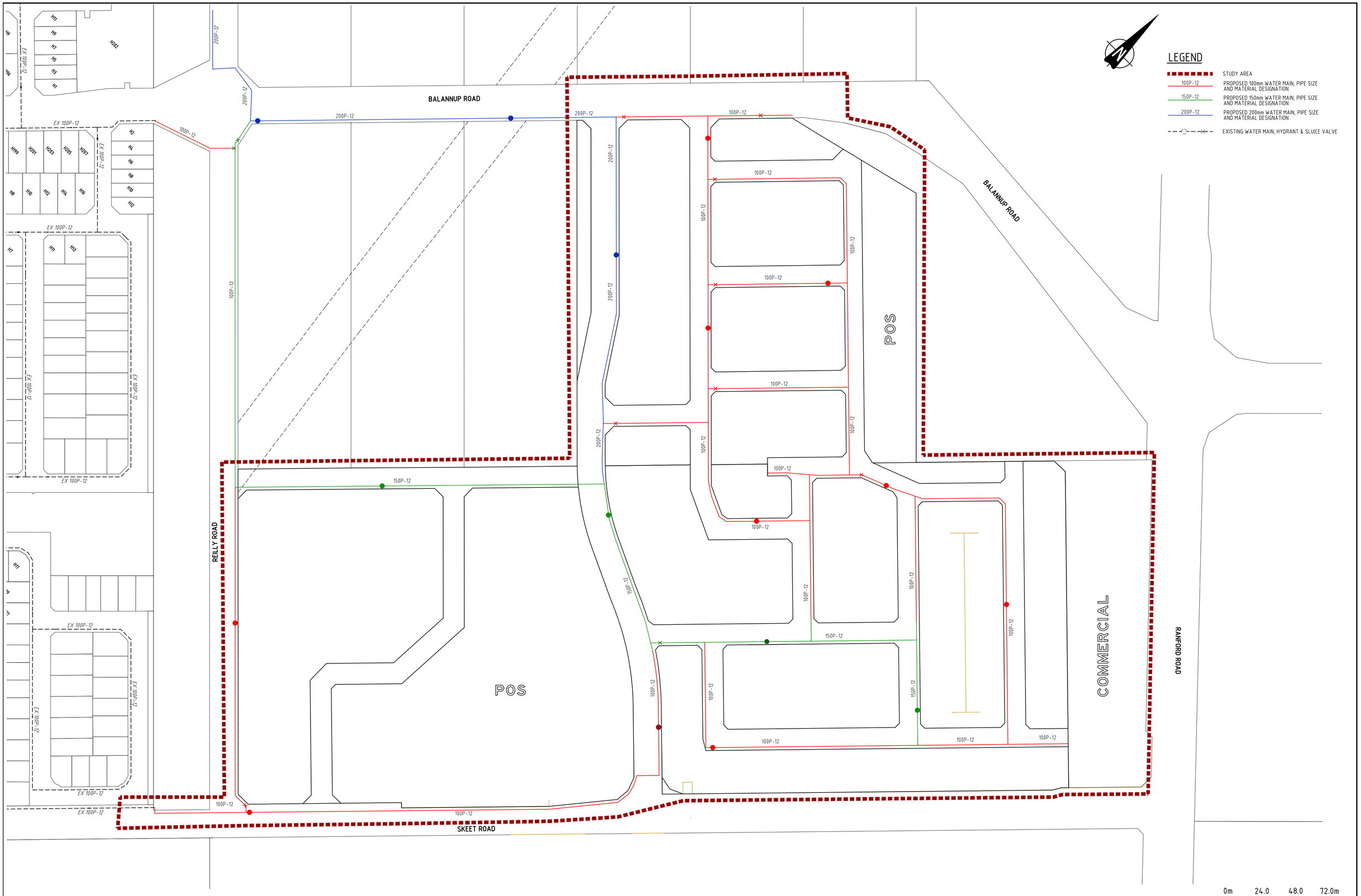
DRAWING: **CONCEPT WASTEWATER SERVICING PLAN**

STATUS: **CONCEPT**

SCALE	1:1200
DATE	MAY 2021
DESIGN	SCH
DRAWN	MEG
CHECK	
APP'D	

DRAWING No. **20-2-20/901** REV No. **G** ORIGINAL DRAWING SIZE **A1**

FILE NAME S:\ACTIVE PROJECTS\20-02-020\ACAD\20220-901.dwg



PROJECT:

HARRISDALE NORTH STRUCTURE PLAN

No.	DATE	REVISION	BY
E	1-8-2023	LAYOUT UPDATED AS PER STRUCTURE PLAN DATED 11-6-2022	MEG
D	12-5-2022	PROPOSED CADASTRAL UPDATED AND WATER ADJUSTED TO SUIT	MEG
C	29-6-2021	PROPOSED BOUNDARIES ALTERED, WATER ADJUSTED	MEG
B	14-6-2021	LOGO ADDED, TITLE BLOCK UPDATED	MEG
A	24-5-2021	ISSUED FOR CONCEPT	MEG

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CLIENT: YOLK PROPERTY GROUP

DRAWING: **CONCEPT WATER SERVICING PLAN**

STATUS: **CONCEPT**

SCALE	1:1200
DATE	MAY 2021
DESIGN	SCH
DRAWN	MEG
CHECK	
APP'D	

DRAWING No. **20-2-20/902** REV No. **E** ORIGINAL DRAWING SIZE **A1**

FILE NAME: S:\ACTIVE PROJECTS\20-02-020\ACAD\20220-902.dwg

LEGEND

- STUDY AREA
- EXISTING CONTOURS
- 25.5 — FINISHED LOT LEVEL
- PROPOSED KERB
- CONCRETE FOOTPATH
- 23.5 — EXTERNAL ROAD LEVEL
- CONCEPTUAL DRAINAGE
- SD — CONCEPTUAL SUBSOIL DRAINAGE
- CONCEPTUAL DRAINAGE PIT
- Dx — EXISTING DRAINAGE
- SDx — EXISTING SUBSOIL DRAINAGE
- ~2.0mAHD — MAXIMUM GROUND WATER LEVEL
- 6.70 — PROPOSED ROAD LEVELS
- PROPOSED DRAINAGE FLOW
- CATCHMENT BOUNDARY
- ENVIRONMENTAL BUFFER

BALANNUP ROAD
REILLY ROAD
SKEET ROAD
RANFORD ROAD
POS
POS
COMMERCIAL
~23.0mAHD
~22.5mAHD
~22.0mAHD
EXISTING IL20.99m
EXISTING IL21.00m
EXISTING SUBSOIL IL21.83
EXISTING SUBSOIL IL22.47
EXISTING SUBSOIL IL22.83

0m 24.0 48.0 72.0m
1:1200

PROJECT:

HARRISDALE NORTH STRUCTURE PLAN

No.	DATE	REVISION	BY
F	1-8-2023	LAYOUT UPDATED AS PER STRUCTURE PLAN DATED 11-6-2022	MEG
E	12-5-2022	PROSED CADASTRAL UPDATED, DRAINAGE ADJUSTED TO SUIT	MEG
D	3-8-2021	MAXIMUM GROUND WATER LEVELS ADDED	MEG
C	29-6-2021	PROPOSED BOUNDARIES ALTERED, ROADS, DRAINAGE AND PATHS ADJUSTED TO SUIT	MEG
B	14-6-2021	LOGO ADDED, TITLE BLOCK UPDATED	MEG
A	24-5-2021	ISSUED FOR CONCEPT	MEG

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CLIENT: YOLK PROPERTY GROUP

DRAWING: **CONCEPT ROAD AND DRAINAGE LAYOUT PLAN**

STATUS: **CONCEPT**

SCALE	1:1200
DATE	MAY 2021
DESIGN	SCH
DRAWN	MEG
CHECK	
APP'D	

DRAWING No. **20-2-20/903** | REV No. **F** | ORIGINAL DRAWING SIZE **A1**

FILE NAME: S:\ACTIVE PROJECTS\20-02-020\ACAD\20220-903.dwg

Appendix C

Landscape report

Prepared by Emerge Associates (2023)

NORTH HARRISDALE STRUCTURE PLAN

LANDSCAPE REPORT

AUGUST 2023

emerge ASSOCIATES



CONTENTS

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9.0 STREESTSCAPE PLAN 13

10.0 IRRIGATION STRATEGY 14

11.0 MAINTENANCE STRATEGY 15

1.0 SITE CONTEXT

Lots 600 - 606 Balannup Road and Lots 200 - 202 Skeet Road, Harrisdale (referred to herein as ‘the site’) are located approximately 20 kilometres (km) south of the Perth Central Business District within the City of Armadale.

The site is approximately 29.29 hectares (ha) in size and is bound by Ranford Road to the north east, Skeet Road to the south east, Balannup Road to the north west and vacant land associated with the easement for the future continuation of Reilly Road to the south west.

The local structure plan (LSP) allows for the creation of residential lots, three areas of public open space (POS) with integration of various wetlands and wetland buffers (based on recent review of condition and extents), a commercial area, and an existing Western Power easement (which cuts through the south-western corner of the site).

The LSP provides for a well connected open space network which will provide the local community with safe parklands, supporting various open space functions whilst facilitating significant environmental outcomes through the retention and protection of existing conservation category wetlands (CCW). The landscape master plan for the proposal includes retention of existing vegetation and the revegetation of buffers for the CCW as well as the resource enhancement wetland (REW) to the north of the site.





























2.0 LANDSCAPE MASTER PLAN

LEGEND

- SUBJECT SITE
- EASEMENT (30M WIDTH)
- CCW BOUNDARY
- REW BOUNDARY
- 30M BUFFER TO REW
- 50M BUFFER TO CCW
- CCW TO BE RETAINED
- VEGETATION RETENTION AND REVEGETATION
- BIO RETENTION AREA (BRA)
- FLOOD STORAGE AREA (FSA)
- MANAGED LOW LANDSCAPE
- BENCH SEATING
- SHELTER / BBQ FACILITIES
- PROPOSED STREET TREES
- RESIDENTIAL
- COMMERCIAL
- WALKING TRAIL



3.0 LANDSCAPE STRATEGY

The Landscape Strategy is intended to be an overall guide to the proposed functions, amenities and landscape treatment within North Harrisdale LSP.

The parklands will be charcterised with native planting reflecting the historical flora of the area.

The public open scape (POS) areas have been located to retain and protect the CCW and REW areas as well as integrate a variety of local amenity and storm water management functions.



4.0 LANDSCAPE STRATEGY POS CENTRAL

This POS is located centrally within the proposed development providing a concentrated suite of amenity and POS function accessible to the wider community. It incorporates the CCW to the south adjacent Skeet Road.

- Informal active recreation uses on open grassed areas
- Gathering nodes with picnic and shelter facilities
- Opportunity for informal walking trails through controlled access points through the POS. Location and alignment of trails to avoid disturbance of areas of significant vegetation.
- Stormwater retention and conveyance through a vegetated and stabilized swale
- Retention and protection of CCW and revegetation of associated buffer
- Retention of existing Banksia Woodland areas
- Opportunity for nature play nodes to existing areas of clearing
- Path network which links into the greater development
- Manicured landscape areas fully irrigated outside buffer and retained vegetation areas
- All areas outside of wetland, vegetated wetland buffer area and bioretention areas to be “low threat vegetation” in accordance with AS3959:2018.



LOCATION PLAN









5.0 LANDSCAPE STRATEGY POS WEST

This POS is located within the western corner of the proposed LSP along the central entry road off Balannup Road . It includes the REW buffer to the west of the site.

- Vegetation retention and revegetation of associated buffer to REW
- Opportunity for informal walking trails through controlled access points through the POS. Location and alignment of trails to avoid disturbace of areas of significant vegetation
- Path network which links into the greater development Retention of existing significant trees and vegetation where possible
- Opportunity for education of the site and its environmental assets through signage or other means along walking trails
- Majority of this POS will be classified vegetation and therefore a bushfire hazard in accordance with AS3959:2018



LOCATION PLAN





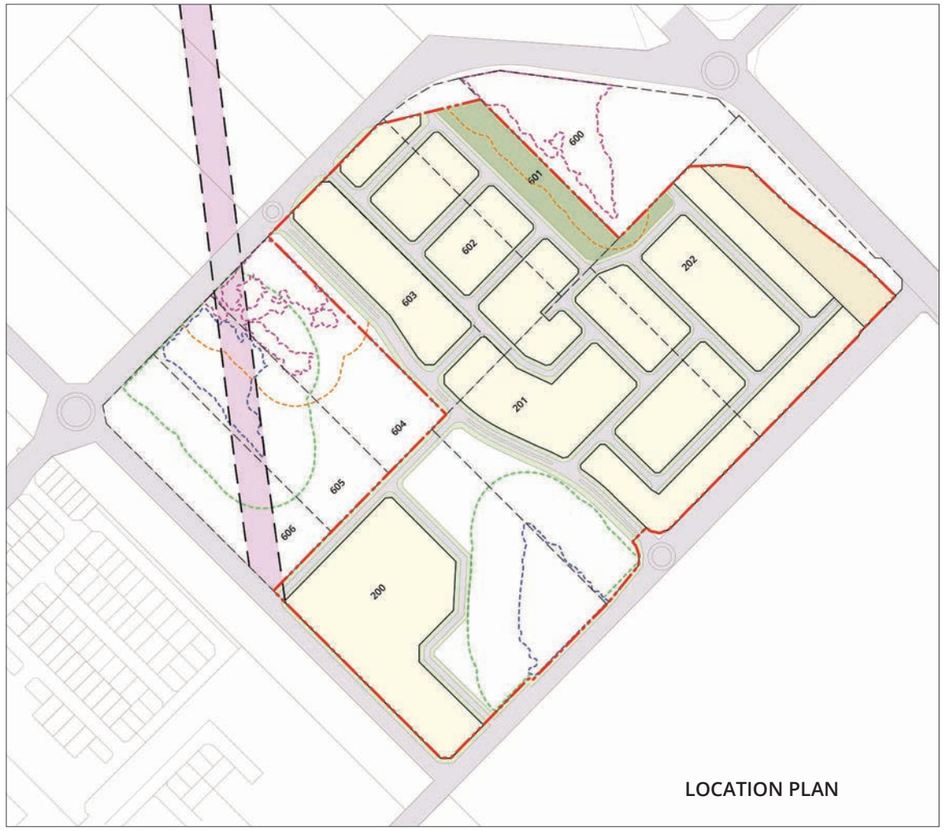




6.0 LANDSCAPE STRATEGY POS EAST

This POS is located in the north east corner of the site. It provides for a revegetated buffer to the REW to the north of the site. It is linear in shape and will provide a north-south greenspace connection through the development.

- Gathering nodes with seating along footpath network
- Stormwater retention and conveyance through a vegetated and stabilised swale
- Vegetation retention and revegetation of associated buffer to REW
- Retention of existing significant trees and vegetation where possible
- Path network which links into the greater development
- Manicured landscape areas fully irrigated outside buffer areas
- All areas outside of the wetland, vegetated wetland buffer and bio retention areas to be “ loe threat vegetation” in accordance with AS3959:2018



LOCATION PLAN







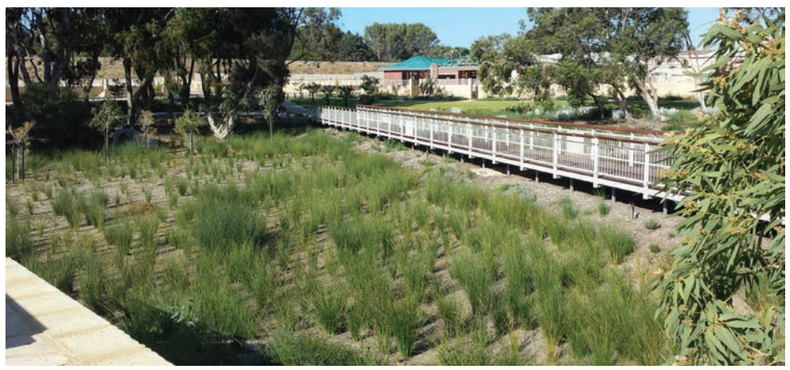


7.0 STORM WATER MANAGEMENT STRATEGY

All stormwater from the development will be directed into bio-retention treatment areas constructed along the edges of the POS. These will be sized to treat the flows from the small rainfall event in accordance with the principles of water sensitive urban design. Storm events in excess of these will be directed into flood storage areas typically located within CCW and REW buffer areas. Flood storage areas will be revegetated with native species. Bio-retention areas will be located outside of CCW buffer areas.





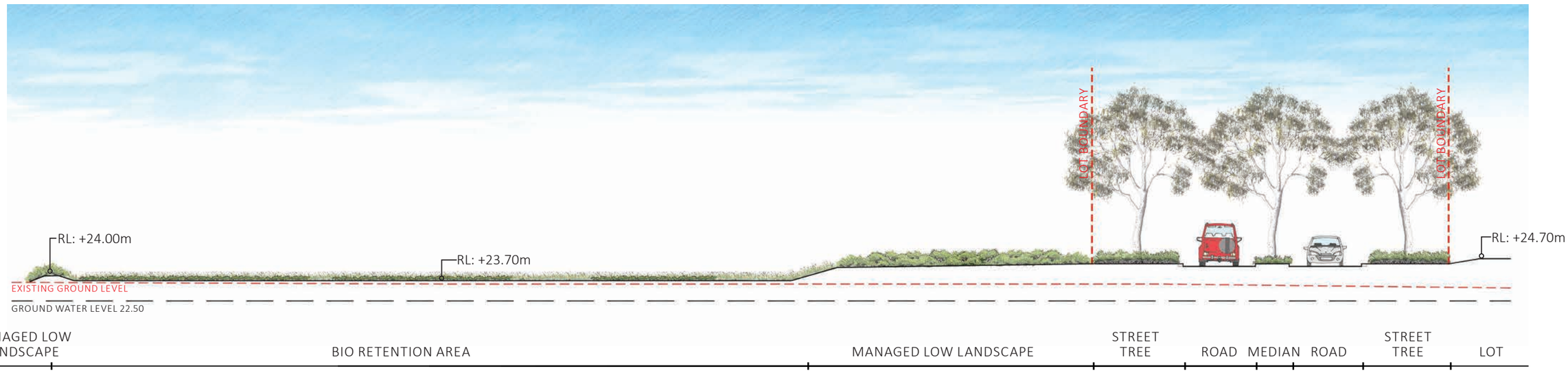




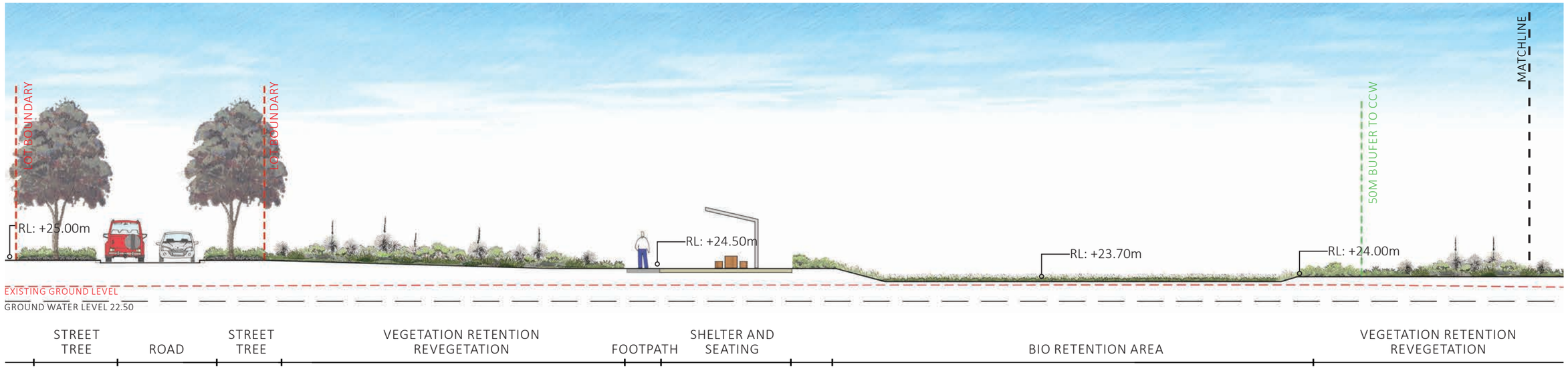
8.0 DRAINAGE CROSS SECTIONS



SECTION A-A

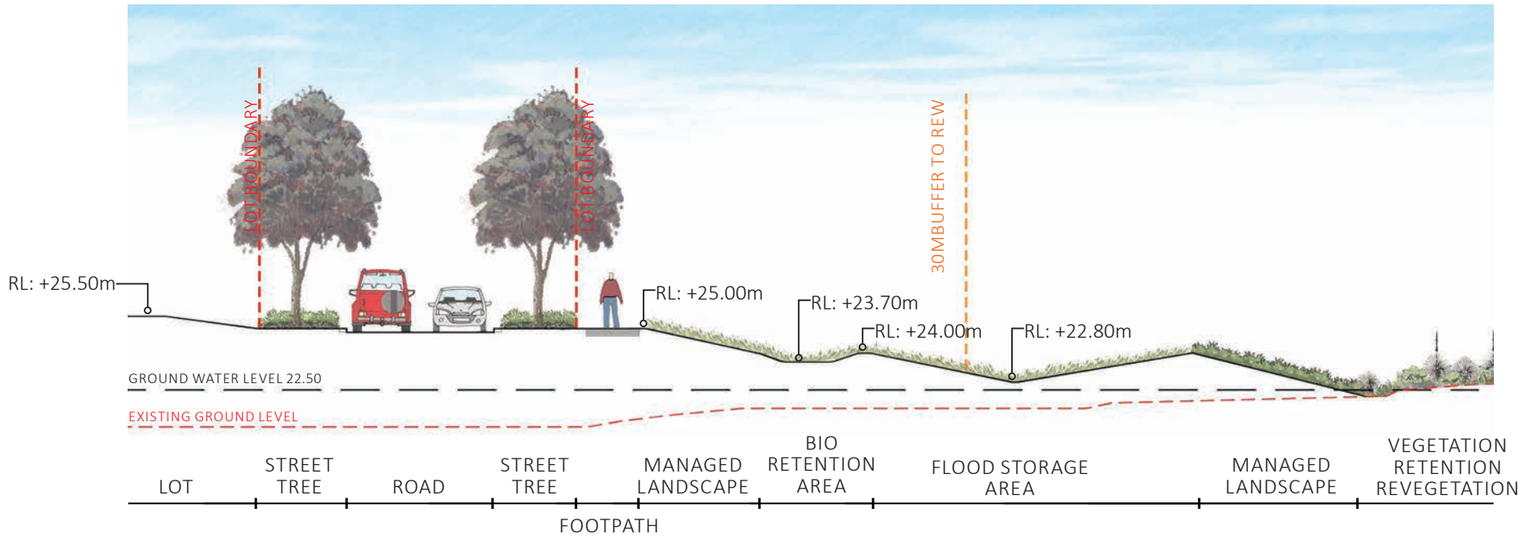


SECTION B-B





SECTION C-C



SECTION D-D

9.0 STREESTSCAPE PLAN

The streetscape planting strategy design will be translated through different palettes of street trees providing legibility through the development.

Tree species selected are waterwise, fast growing, reliable and readily available whilst providing shade and amenity to each street. The proposed species below offer consistencies in appearance with differences in size and scale. Larger, taller trees are shown around POS areas and along north-south roads as the major connector roads through the development. Smaller trees are shown on east-west roads as minor local roads.





CORYMBIA FICIFOLIA







CORYMBIA MACULATA





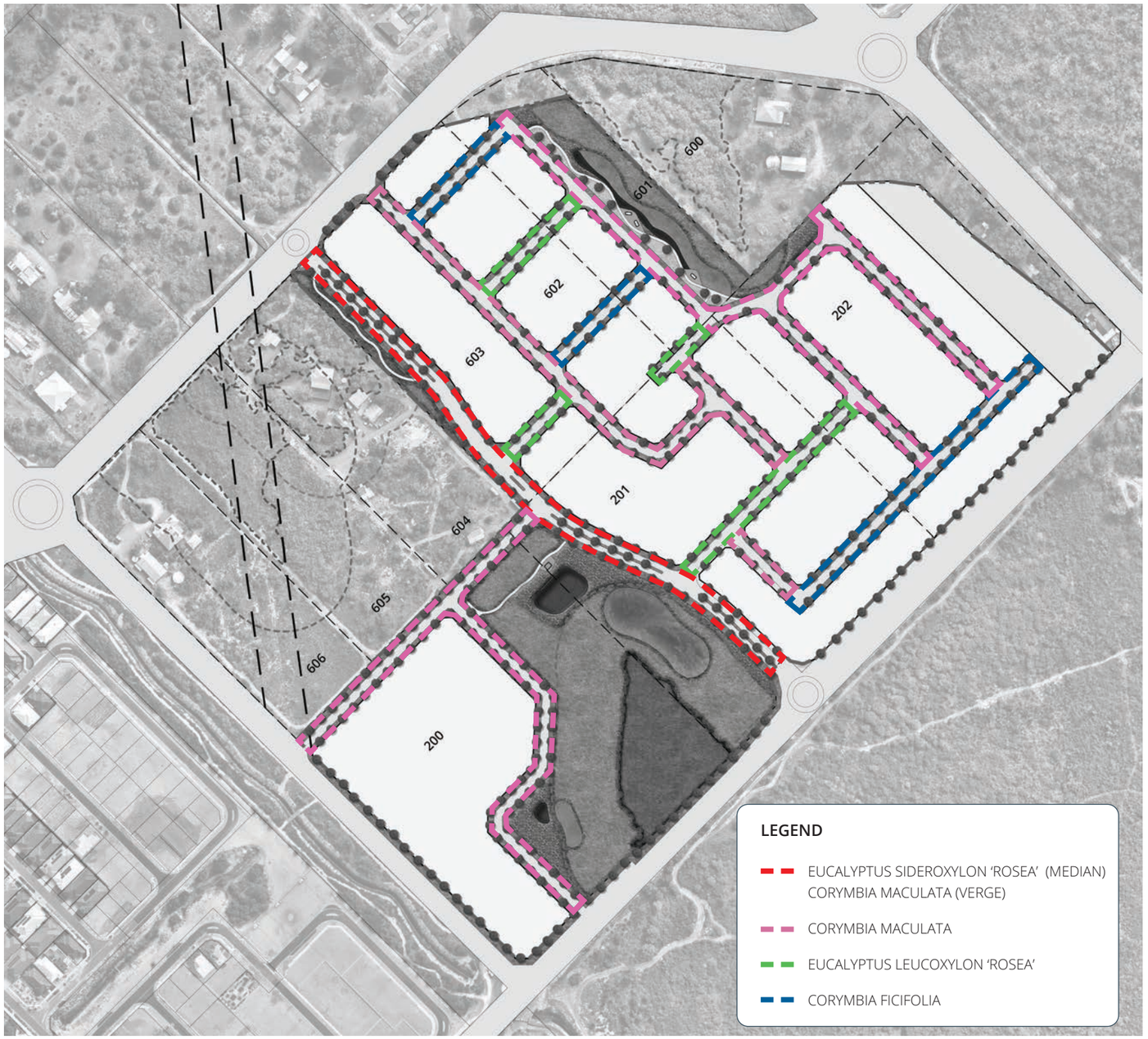


EUCALYPTUS SIDEROXYLON





EUCALYPTUS LEUCOXYLON ‘ROSEA’



10.0 IRRIGATION STRATEGY

The planting design of all streetscape and public open space areas will consist of predominantly native species. Planting design is proposed to include a water sensitive design approach and will also seek to reduce irrigation rates over the long term to planting areas to promote a longer term water saving strategy for the development.

Hydrozoning will also provide a supplementary design principle whereby groups of plants with similar irrigation demand needs will be grouped together. This will facilitate irrigation efficiencies that can be made across the scheme.

Areas within the stormwater swales, bio retention basins and revegetation areas are proposed to be in the main non-irrigated. Swales and basins will be planted with native sedges and rushes to facilitate the stormwater treatment requirements for the site. The water table in these areas will be close to the surface particularly in winter months possibly limiting the need for irrigation within swale. Revegetation areas will be planted with endemic native species.





11.0 MAINTENANCE STRATEGY

In all cases, a maintenance regime will be in place inclusive of general maintenance minimisation through design practices and will aim to use sustainable maintenance practices. This includes, but is not limited to, defined edges and borders, minimal and preferably alternate approaches to pesticides, controlled and minimized fertilizer use.

Maintenance will be undertaken via general access to all public accessible areas. Light maintenance vehicles can access all public areas and can adjoin all private areas within the development. This will occur initially via the road system and then by careful access over landscaped grass areas and select areas of the pedestrian path system. Use of removable bollards will limit and control unauthorize access to link areas between roads.

Maintenance will be managed by the development for the first 2 years minimum. The 2 year maintenance timeframe may be extended in certain locations at the developer's discretion in liaison with the City.

The routine and general maintenance of areas outside of the wetland, revegetation, vegetation retention areas, and bioretention areas would be sufficient to satisfy the requirements to be considered "low treat vegetation" in accordance with AS3959:2018. Specially these areas would be irrigated to avoid seasonal die off, and any overgrown and for dead vegetative material would be routinely removed including weeds.







Appendix D

Geotechnical logs

Prepared by Galt (2020)

TEST PIT: TP01

Job Number:	J2101147	**Easting:**	400796 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446091 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
600-606 (No 7-67) Balannup Road, Harrisdale				**Width:** 0.45 m	**Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, dark brown/black, trace fines, trace roots, trace fine roots, trace organics			Grass on surface (lawn) Glass observed in fill
								SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, pale brown, trace gravel (5-10%), trace fines			
			0.5					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace organics		L - MD	Peaty Sand topsoil
					B(TP01-01)				SAND, fine to medium grained, sub-angular to sub-rounded, grey-brown becoming pale brown with depth, trace fines	D - M	D - VD	
			1.5		B(TP01-02)			SP	Black, trace organics			Inferred 'Coffee rock' (easy to excavate)
									Dark grey, no organics			
			2.0							W		
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 2.3 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J2101147.GPJ <<DrawingFile>> 19/07/2021 16:15 10.02.00.04 Datgel DGD, CPT, Photo, Monitoring Tools [Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP02

Job Number:	J2101147	**Easting:**	400738 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446148 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, brown, trace fines, trace roots, trace fine roots, trace organics	D	MD - D	Grass on surface. Nearby trees (large)
			0.5						UNCONTROLLED FILL: MIXTURE of SAND (60%), CONSTRUCTION RUBBLE (30%) and Sandy GRAVEL (LIMESTONE) (10%): SAND, fine to medium grained, sub-angular to sub-rounded, grey, trace fines; CONSTRUCTION RUBBLE (30%): concrete, brick, timber, wire, fabric , large concrete boulders			
			1.0		B(TP02-01)							
			1.5					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, pale brown		D	Roots to 1.5 m
		▼	2.0							W		
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 2.3 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP03

Job Number:	J2101147	**Easting:**	400717 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446198 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, black, with roots, trace fines, trace fine roots, trace organics	D - M	L	Grass on surface. Large trees nearby. Blue metal, limestone, clay brick gravel sized fragments
								SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, grey-brown, trace fines, trace gravel (5%)			
			0.5					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace organics			Natural topsoil
									SAND, fine to medium grained, sub-angular to sub-rounded, pale grey-brown, trace fines		MD	Roots to 1.2 m
			1.0						Dark brown/black			Possible Coffee Rock
			1.5					SP			D	
			2.0							W		
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 1.9 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP04

Job Number:	J2101147	**Easting:**	400645 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446195 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, pale brown and brown, trace gravel (5%), trace fines, trace roots, trace fine roots, trace organics			Grass on surface Roots observed in fill layer. PVC pipe, plastic bags and bricks observed.
			0.5		B(TP04-01)				FILL: SAND, fine to medium grained, sub-angular to sub-rounded, brown, with some non-plastic, organic fines, trace construction rubble		L - MD	
			1.0					SP		D - M		Concrete unreinforced
			1.5								MD - D	
			2.0		B(TP04-02)			SP	SAND, fine to medium grained, sub-angular to sub-rounded, pale grey/white, trace fines	W		Brick observed
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 1.9 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP05

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Job Number:	J2101147	**Easting:**	400655 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446110 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, brown, trace fines, trace roots, trace fine roots, trace organics		L	Grass on surface
			0.5		B(TP05-01)			SP	FILL: SAND (80%), fine to medium grained, sub-angular to sub-rounded, brown, black and yellow layers, with some non-plastic, organic fines, trace organics; CONSTRUCTION RUBBLE (20%): bricks, timber, steel bar, black fabric lining, possible asbestos, clay roof tiles		D	
			1.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace fine roots, trace organics	D - M		
			1.5					SP	SAND, fine to medium grained, sub-angular to sub-rounded, pale grey, trace fines			
			2.0							W		
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 2 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP06

Sheet 1 OF 1

Job Number:	J2101147	**Easting:**	400699 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446051 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, brown, trace fines, trace roots, trace fine roots, trace organics			Grass on surface
			0.5					SP	FILL: SAND (80-90%), fine to medium grained, sub-angular to sub-rounded, brown, trace fines; CONSTRUCTION RUBBLE (10-20%): bricks, timber, steel wire, possible asbestos, contains material		L	
			1.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace organics	D - M		Peaty SAND
								SP	SAND, fine to medium grained, sub-angular to sub-rounded, pale grey/white becoming pale brown/brown with depth, trace fines		MD - D	
			1.5									
			2.0							W		
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 2.3 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP07

Job Number:	J2101147	**Easting:**	400721 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445990 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots 600-606 (No 7-67) Balannup Road, Harrisdale			**Bucket:**	Toothed	**Checked By:**	ORW
				Width:	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace roots, trace fine roots, trace organics			Grass on surface
			0.5		B(TP07-01)			SP	FILL: SAND (80-90%), fine to medium grained, sub-angular to sub-rounded, yellow-brown, trace fines, trace fine roots; CONSTRUCTION RUBBLE (10-20%): PVC pipes, bricks, timber, black and white plastic, steel, steel wire, boulders		L	
			1.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace organics			
								SP	SAND, fine to medium grained, sub-angular to sub-rounded, pale grey becoming pale brown with depth, trace fines	D - M		
			1.5		B(TP07-02)						MD - D	
			2.0		B(TP07-03)			SC	Clayey SAND: fine to medium grained, sub-angular to sub-rounded, grey-green, low plasticity fines (10-15%)			
			2.5							W		
			3.0						Hole terminated at 2.60 m Target depth Groundwater encountered at approximately 2.5 m			

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP08

Sheet 1 OF 1

Job Number:	J2101147	**Easting:**	400651 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445988 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP08-01)			SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, dark brown/black, trace fines, trace roots, trace fine roots, trace organics	D - M	MD - D	Dense grass on surface. Medium sized trees nearby. Roots observed to approximately 0.5 m.
			0.5					SP	SAND, fine to medium grained, sub-angular to sub-rounded, pale brown, trace fines			
			1.0								VD	
			1.5		B(TP08-02)			SC	Clayey SAND: fine to medium grained, sub-angular to sub-rounded, grey-brown, non-plastic fines becoming low plasticity with depth	W		Odour towards bottom of test pit
			2.0						Hole terminated at 2.00 m Soil collapse Groundwater encountered at 1.3 m			
			2.5									
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP09

Job Number:	J2101147	**Easting:**	400584 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446033 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots 600-606 (No 7-67) Balannup Road, Harrisdale			**Bucket:**	Toothed	**Checked By:**	ORW
				Width:	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	▼	0.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, dark grey/black, trace fines, trace roots, trace fine roots, trace organics			Dense grass on surface. Fine roots to approximately 1.0 m.
									SAND, fine to medium grained, sub-angular to sub-rounded, grey, trace fines, fines content increasing with depth	D - M	L - MD	
			0.5									
			1.0									
			1.5					SP			D - VD	
			2.0		B(TP09-01)					W		Sulfurous smell
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 1.3 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP10

Sheet 1 OF 1

Job Number:	J2101147	**Easting:**	400573 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446107 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots 600-606 (No 7-67) Balannup Road, Harrisdale			**Bucket:**	Toothed	**Checked By:**	ORW
				Width:	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, dark grey, trace fines, trace roots, trace fine roots, trace organics	D - M	L	Dense grass on surface
									FILL: Clayey GRAVEL, fine to medium grained, sub-angular to sub-rounded, orange-brown, low to medium plasticity fines (10-20%), with fine to medium grained, sub-angular to sub-rounded sand (10-20%), trace roots, trace fine roots			
			0.5					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, pale brown, trace fines, construction rubble including PVC pipe, sign post, concrete footing, glass bottle, black plastic fabric lining, steel wire			
			1.0									
			1.5					SP	SAND, fine to medium grained, sub-angular to sub-rounded, grey to dark grey, trace fines, trace fine roots to 1.6 m depth		MD - D	
			2.0					SC	Clayey SAND: fine to medium grained, sub-angular to sub-rounded, brown-grey, low to medium plasticity fines			
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP11

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Job Number:	J2101147	**Easting:**	400541 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446168 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP11-01)			SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, black, with organics, trace fines, trace roots, trace fine roots			Peaty SAND. Layer is on an angle, 0.5 m to South, 0.2 to North (Southern River Road)
			0.5		B(TP11-02)			SP	SAND, fine to medium grained, sub-angular to sub-rounded, grey to brown becoming grey with depth, trace non-plastic fines	D - M	L	
			1.0									
		▼	1.5					SP	SAND: fine to medium grained, sub-angular to sub-rounded, dark grey, with low plasticity fines (5-12%)	W	MD - D	Sulfurous smell
			2.0		B(TP11-03)							
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 1.5 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP12

Job Number:	J2101147	**Easting:**	400461 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446264 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots 600-606 (No 7-67) Balannup Road, Harrisdale			**Bucket:**	Toothed	**Checked By:**	ORW
				Width:	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace roots, trace fine roots, trace organics	M	D	Grass on surface, nearby large trees
			0.5		B(TP12-01)			SP	FILL: Gravelly SAND (65-70%), fine to medium grained, sub-angular to sub-rounded, brown and yellow, fine to coarse grained, sub-angular to sub-rounded gravel (20-30%), trace cobbles (5%), trace boulders (5%); CONSTRUCTION RUBBLE (30-35%): bricks, metal, plastic straps, concrete, rocks, timber, clay roof tiles and pots, cobble and boulder size rocks			
			1.0									
			1.5									
			2.0		B(TP12-03)			SP	SAND: fine to medium grained, sub-angular to sub-rounded, brown/dark brown, with low plasticity fines (5-10%), trace peaty fines			Peaty SAND
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP13

Job Number:	J2101147	**Easting:**	400364 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446249 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots 600-606 (No 7-67) Balannup Road, Harrisdale			**Bucket:**	Toothed	**Checked By:**	ORW
				Width:	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, dark brown, trace fines, trace roots, trace fine roots, trace organics			Low dense grass
			0.5					SP	FILL: SAND (70-80%), fine to medium grained, sub-angular to sub-rounded, brown and yellow, trace fines; CONSTRUCTION RUBBLE (20-30%): brick, concrete, steel, plastic, steel wire/mesh, limestone		L - MD	
			1.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace roots, trace organics	D - M		
			1.5					SP	SAND: fine to medium grained, sub-angular to sub-rounded, pale grey, trace fines			
			2.0									
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP14

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Job Number:	J2101147	**Easting:**	400463 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446197 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace roots, trace fine roots, trace organics	D - M	L - MD	Grass on surface. Nearby lake.
								SP	FILL: SAND (70-80%), fine to medium grained, sub-angular to sub-rounded, dark brown, trace fines; CONSTRUCTION RUBBLE (20-30%): bricks, timber and plastic, possible asbestos, containing material			
	E-H		0.5					SP	SAND, fine to medium grained, sub-angular to sub-rounded, brown, trace fines, organics			
			1.0									
			1.5						Hole terminated at 1.20 m Refusal on solid hard ground, possible 'Coffee Rock' Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP15

Job Number:	J2101147	**Easting:**	400504 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446110 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP15-01)			SM	TOPSOIL: Silty SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace roots, trace fine roots, trace organics			Construction rubble to north-east (bricks, pipes, plastic lining, etc). Low vegetation (surrounding trees)
								SP	SAND, fine to medium grained, sub-angular to sub-rounded, pale brown, with some non-plastic fines	D - M	L	
			0.5									
			1.0		B(TP15-02)						MD - D	
		▼							Brown, odour, with some organic fines	W		Rotten egg smell
			1.5						Hole terminated at 1.50 m Soil collapse Groundwater encountered at 1.2 m		VD	
			2.0									
			2.5									
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP16

Job Number:	J2101147	**Easting:**	400511 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446055 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, dark grey and brown, trace fines, trace roots, trace fine roots, trace organics		L	Dense grass on surface. Close to man-made pond to south. Bricks and yellow plastics
			0.5						FILL: SAND, fine to medium grained, sub-angular to sub-rounded, layers of yellow, brown and grey, trace fines, trace fine roots		VD	
			1.0					SP	Black, trace organics	D - M	L - MD	
			1.5		B(TP16-01)				Grey			
			2.0		B(TP16-02)			SC	Clayey SAND: fine to medium grained, sub-angular to sub-rounded, dark brown to black, low to medium plasticity fines (20%)			
			2.5									
			3.0						Hole terminated at 2.60 m Target depth Groundwater not encountered			

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP17

Sheet 1 OF 1

Job Number:	J2101147	**Easting:**	400575 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445983 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots 600-606 (No 7-67) Balannup Road, Harrisdale			**Bucket:**	Toothed	**Checked By:**	ORW
				Width:	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, grey and dark grey, trace fines, trace roots, trace fine roots, trace organics	D	MD - D	Dense grass on surface. Near access track.
			0.5					SP	SAND: fine to medium grained, sub-angular to sub-rounded, grey, trace fines			Fine roots to 1.3 m
			1.0									
			1.5					SC	Clayey SAND: fine to medium grained, sub-angular to sub-rounded, dark brown mottled pale brown and green, low to medium plasticity fines (20-30%)	D - M		
			2.0									
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			Rotten egg smell
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP18

Job Number:	J2101147	**Easting:**	400633 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445926 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace roots, trace fine roots, trace organics			
								SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, orange-brown becoming dark grey with depth, trace fines, trace roots, trace fine roots, trace gravel (<5%)		MD - D	
			0.5					SP	SAND: fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace peaty fines		VD	
			1.0					SP	SAND: fine to medium grained, sub-angular to sub-rounded, grey, trace fines	D - M		
			1.5						Becoming pale brown with depth			
			2.0					SC	Clayey SAND: fine to medium grained, sub-angular to sub-rounded, green-grey, low plasticity fines (10-15%)			Slight smell
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP19

Job Number:	J2101147	**Easting:**	400557 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445901 m	**Machine:**	JCB 3CX	**Logged:**	JS
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND/Peaty SAND, fine to medium grained, sub-angular to sub-rounded, brown, with non-plastic fines, up to 5% organics, fine to coarse grained, sub-rounded gravel (10-20%), trace sub-angular cobbles	D - M	L - VD	Surface fill. Gravel store. Tree stumps. Isolated builders waste of bricks and concrete (no steel).
			0.5		B(TP19-01)							
			1.0					SP	SAND: fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace organics			Lateritic gravel. Large cemented boulders up to 0.5 m diameter. Brick fragments, concrete kerb and danger tape.
									Sandy GRAVEL: fine to coarse grained, sub-angular to sub-rounded, orange-brown, fine to medium grained, sub-angular to sub-rounded sand, with clay (5-10%), trace boulders			
			1.5		B(TP19-02)			GP	Becoming pale brown with depth			
	E-F		2.0		B(TP19-03)			SC	Clayey SAND: fine to medium grained, sub-angular to sub-rounded, black, low plasticity fines (10-20%), trace organics	W		
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 1.7 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP20

Job Number:	J2101147	**Easting:**	400490 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445958 m	**Machine:**	JCB 3CX	**Logged:**	JS
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0						FILL: Clayey GRAVEL: fine to medium grained, sub-angular to sub-rounded, orange-brown, low to medium plasticity fines (10-20%), with fine to medium grained, sub-angular to sub-rounded sand (10-20%)	D - M	MD - VD	Potentially fill
			0.5		B(TP20-01)				FILL: MIXTURE of SAND (50%) and Clayey SAND (50%): SAND, fine to medium grained, sub-angular to sub-rounded, dark grey; Clayey SAND: fine to medium grained, sub-angular to sub-rounded, dark grey, low to medium plasticity fines, trace organics, with some gravel			
			1.0									
								SP	SAND: fine to medium grained, sub-angular to sub-rounded, grey becoming pale grey with depth			
			1.5									
			2.0		B(TP20-02)			CI	Sandy CLAY: medium plasticity, pale brown, fine to medium grained, sub-angular to sub-rounded sand			Foul smell
			2.5									
									Hole terminated at 2.60 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP21

Job Number:	J2101147	**Easting:**	400452 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446025 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP21-01)			SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace roots, trace fine roots, trace organics	D	L	Low vegetation on surface. Roots observed to full depth. Surrounding trees.
									SAND, fine to medium grained, sub-angular to sub-rounded, grey, trace fines			
			0.5									
			1.0					SP			MD - D	
			1.5						Pale brown			
			2.0		B(TP21-02)					D - M		
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP22

Sheet 1 OF 1

Job Number:	J2101147	**Easting:**	400420 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446118 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, brown, trace fines, trace roots, trace fine roots, trace organics			Dense grass on surface. Trees nearby.
			0.5					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, grey-brown, trace fines		L	
								SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, dark grey, trace fines, trace roots, trace fine roots, trace organics			
			1.0						SAND, fine to medium grained, sub-angular to sub-rounded, pale grey to white, trace fines, trace roots, trace fine roots to 1.2 m	D - M		
			1.5					SP				
			2.0							W		Slight odour
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 2.2 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP23

Job Number:	J2101147	**Easting:**	400370 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446192 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots 600-606 (No 7-67) Balannup Road, Harrisdale			**Bucket:**	Toothed	**Checked By:**	ORW
				Width:	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	FILL: SAND, fine to medium grained, sub-angular to sub-rounded, brown, trace fines, trace roots, trace fine roots, trace organics	M	MD - D	Medium dense grass on surface.
					B(TP23-01)			SP	FILL: SAND (70-80%), fine to medium grained, sub-angular to sub-rounded, brown becoming yellow at depth, trace fines; CONSTRUCTION RUBBLE (20-30%): bricks, metal, timber, clay tiles, plastic straps, plastics, wire, concrete			
			0.5									
			1.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace roots, trace fine roots, trace organics			
			1.5						SAND, fine to medium grained, sub-angular to sub-rounded, pale grey becoming pale brown with depth, trace fines			
			2.0		B(TP23-02)			SP				
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			Clayey SAND at full depth (2.5 m)
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP24

Job Number:	J2101147	**Easting:**	400297 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446170 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace roots, trace fine roots, trace organics			Low vegetation on surface. Surrounding trees. Roots to approximately 1.5 m.
									SAND, fine to medium grained, sub-angular to sub-rounded, pale brown to brown, trace fines			
			0.5		B(TP24-01)			SP			L - MD	
			1.0							M	VD	
			1.5		B(TP24-02)			SP	SAND: fine to medium grained, sub-angular to sub-rounded, pale brown, with low plasticity clay fines (5-10%)			
			2.0		B(TP24-03)			SM	Silty SAND: fine to medium grained, sub-angular to sub-rounded, green, non- plastic fines (10-20%)			
			2.5							W		
									Hole terminated at 2.50 m Target depth Groundwater encountered at 2.4 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP28

Job Number:	J2101147	**Easting:**	400441 m	**Contractor:**	ANH Contracting	**Date:**	30/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6446062 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
600-606 (No 7-67) Balannup Road, Harrisdale				**Width:** 0.45 m	**Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	▼	0.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, black, trace fines, trace roots, trace fine roots, trace organics			Low vegetation on surface. Nearby mid-size trees.
									SAND, fine to medium grained, sub-angular to sub-rounded, grey, with roots to 1.5 m, trace fines		L	
			1.0							D		
									Pale brown to white			
			1.5					SP			MD - D	
		▼	2.0							W		
			2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at approximately 2.0 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP30

Sheet 1 OF 1

Job Number:	J2101147	**Easting:**	400427 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445922 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots 600-606 (No 7-67) Balannup Road, Harrisdale			**Bucket:**	Toothed	**Checked By:**	ORW
				Width:	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, grey-brown, trace fines, trace roots, trace fine roots, trace organics	D - M	L - MD	Low to moderate vegetation on surface. Roots to 1.0 m.
								SP	SAND, fine to medium grained, sub-angular to sub-rounded, pale grey becoming white with depth, trace fines			
			0.5									
			1.0									
			1.5									
			2.0									
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			Soil collapse.
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP31

Job Number:	J2101147	**Easting:**	400541 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445819 m	**Machine:**	JCB 3CX	**Logged:**	JS
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, dark brown, trace fines, trace roots, trace fine roots, trace organics	D - M	L	Dense vegetation
			0.5					SP	SAND, fine to medium grained, sub-angular to sub-rounded, dark grey and brown, trace fines, trace organics, trace roots		MD - D	
			1.0									
			1.5					SC	Clayey SAND: fine to medium grained, sub-angular to sub-rounded, dark brown, low to medium plasticity fines, trace organics			
			2.0									
			2.5						Hole terminated at 2.40 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP32

Sheet 1 OF 1

Job Number:	J2101147	**Easting:**	400486 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445805 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots 600-606 (No 7-67) Balannup Road, Harrisdale			**Bucket:**	Toothed	**Checked By:**	ORW
				Width:	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, dark grey and brown, with roots, trace fines, low organics			Moderate vegetation. Roots to 1.2 m.
									SAND, fine to medium grained, sub-angular to sub-rounded, pale grey to white, trace fines, trace organics	D - M	L	
			0.5									
			1.0								MD - D	
			1.5					SP				
			2.0		B(TP32-01)							
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			Sidewall collapse.
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP33

Sheet 1 OF 1

Job Number:	J2101147	**Easting:**	400392 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445851 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, grey and dark grey, with roots (5-10%), trace fines, trace fine roots, trace organics	D - M	L	Low to moderate vegetation. Roots to 0.5 m.
			0.5						SAND, fine to medium grained, sub-angular to sub-rounded, pale grey to white, trace fines			
			1.0		B(TP33-01)			SP			L - MD	
			1.5									
	E-F		2.0						Dark brown to black, trace organics			
			2.5						Hole terminated at 2.30 m Refusal - soil collapse possible "Coffee Rock" Groundwater not encountered			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP34

Sheet 1 OF 1

Job Number:	J2101147	**Easting:**	400272 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445816 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP34-01)			SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, dark grey, trace fines, trace roots, trace fine roots, trace organics	D - M	L	Trace fine roots to approximately 1.0 m
								SP	SAND, fine to medium grained, sub-angular to sub-rounded, grey becoming pale brown with depth, trace fines		MD - D	
			0.5									
			1.0									
			1.5									
			2.0									
			2.5						Hole terminated at 2.30 m Refusal - soil collapse Groundwater not encountered			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP35

Job Number:	J2101147	**Easting:**	400343 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445805 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, dark grey, with roots (5-10%), trace fines, trace fine roots, trace organics			Moderate vegetation on surface. Roots to 1.0 m.
			0.5						SAND, fine to medium grained, sub-angular to sub-rounded, grey to pale grey-white, trace fines	D - M	L	
			1.0					SP				
			1.5								MD	
	H		2.0		B(TP35-01)				Dark brown to black, some cementation, ("Coffee Rock")			
									Hole terminated at 2.00 m Refusal on hard ground (Coffee Rock?) Groundwater not encountered			
			2.5									
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP36

Sheet 1 OF 1

Job Number:	J2101147	**Easting:**	400355 m	**Contractor:**	ANH Contracting	**Date:**	29/06/2021
Client:	Porter Consulting Engineers	**Northing:**	6445722 m	**Machine:**	JCB 3CX	**Logged:**	PF
Project:	Proposed Development	**Datum:**	MGA94 Zone 50	**Operator:**	Neil	**Checked Date:**	16/07/2021
Location:	Lots 200-202 (No 10-56(Skeet Road and Lots			**Bucket:**	Toothed	**Checked By:**	ORW
	600-606 (No 7-67) Balannup Road, Harrisdale			**Width:**	0.45 m **Length:** 3 m		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	▼	0.0					SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, dark grey, trace fines, trace roots, trace fine roots, trace organics	D - M	L	
									SAND, fine to medium grained, sub-angular to sub-rounded, pale grey/white, trace fines to 1.0 m depth			
			0.5		B(TP36-01)			SP			MD	
			1.0									
			1.5		B(TP36-02)				Clayey SAND: fine to medium grained, sub-angular to sub-rounded, black with brown and green mottling, appears as medium to high plasticity, trace organics			
	E-F		2.0					SC		W		
			2.5						Hole terminated at 2.40 m Refusal - soil collapse Groundwater encountered at 1.5 m			
			3.0									

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB01

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	15/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0		ASS-			SP	TOPSOIL: SAND: fine to coarse grained, sub-angular to sub-rounded, dark grey, trace non-plastic fines, with some organics in top 300 mm, with some rootlets			TPB01/0.00	0.00 : Surface grasses, no asbestos noted
			0.5		ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey-brown, trace non-plastic fines, trace rootlets	D		TPB01/0.50	
			1.0		ASS-					W		TPB01/1.00	
			1.5		ASS-				Hole terminated at 1.50 m Collapse due to shallow groundwater Groundwater encountered at 0.9 m			TPB01/1.50	
			2.0										
			2.5										
			3.0										
			3.5										

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB02

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	15/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0		ASS-			SP	TOPSOIL: SAND: fine to coarse grained, sub-angular to sub-rounded, dark grey, trace non-plastic fines, with some organics in top 300 mm, with some rootlets	D		TPB02/0.00	0.00 : Surface vegetation
			0.5		ASS-				SAND: fine to coarse grained, sub-angular to sub-rounded, grey-brown, trace non-plastic fines, trace rootlets	M		TPB02/0.50	
	E		1.0		ASS-			SP				TPB02/1.00	
					ASS-					W			
			1.5		ASS-				Hole terminated at 1.50 m Collapse due to shallow groundwater Groundwater encountered at 1 m			TPB02/1.50	
			2.0										
			2.5										
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB03

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Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	15/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0		ASS-			SP	TOPSOIL: SAND: fine to coarse grained, sub-angular to sub-rounded, dark grey, trace non-plastic fines, with some organics in top 300 mm, with some rootlets	D		TPB03/0.00	
			0.5		ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey-brown, trace non-plastic fines, trace rootlets	M		TPB03/0.50	
			1.0		ASS-							TPB03/1.00	
			1.5		ASS-				Dark brown, very weakly to weakly cemented			TPB03/1.50	
			2.0		ASS-				Hole terminated at 1.50 m Collapse due to shallow groundwater Groundwater encountered at 0.8 m				
			2.5										
			3.0										
			3.5										

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB04

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Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	15/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0		ASS-			SP	TOPSOIL: SAND: fine to coarse grained, sub-angular to sub-rounded, dark grey, trace non-plastic fines, with some organics in top 300 mm, with some rootlets	D		TPB04/0.00	
			0.5		ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey-brown, trace non-plastic fines, trace rootlets	M		TPB04/0.50	
			1.0		ASS-							TPB04/1.00	
			1.5		ASS-				Brown-dark brown, very weakly to weakly cemented			TPB04/1.50	
			2.0		ASS-				Hole terminated at 1.50 m Collapse due to shallow groundwater Groundwater encountered at 0.9 m				
			2.5										
			3.0										
			3.5										

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB05

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Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	15/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0		ASS-			SP	TOPSOIL: SAND: fine to coarse grained, sub-angular to sub-rounded, dark grey, trace non-plastic fines, with some organics in top 300 mm, with some rootlets	D		TPB05/0.00	0.00 : Surface grasses
			0.5		ASS-				SAND: fine to coarse grained, sub-angular to sub-rounded, grey-brown, trace non-plastic fines, trace rootlets	M		TPB05/0.50	
					ASS-			SP	Becoming brown				
			1.0		ASS-							TPB05/1.00	
					ASS-					W			
					ASS-				With some low plasticity clayey nodules, brown mottled dark brown and green, trace silt			TPB05/1.50	
			1.5		ASS-				Hole terminated at 1.50 m Collapse due to shallow groundwater Groundwater encountered at 0.9 m				
			2.0										
			2.5										
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB06

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Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	15/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0		ASS-			SP	TOPSOIL: SAND: fine to coarse grained, sub-angular to sub-rounded, dark grey, trace non-plastic fines, with some organics in top 300 mm, with some rootlets	D		TPB06/0.00	0.00 : Surface grasses
			0.5		ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey-brown, trace non-plastic fines, trace rootlets	M - W		TPB06/0.50	
	E-F		1.0		ASS-			SC	Clayey SAND / Sandy CLAY: fine to medium grained sand, sub-angular to sub-rounded, brown, medium to high plasticity fines Pale brown mottled green	M		TPB06/1.00	
			1.5		ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, pale brown mottled brown and yellow, with some low to medium plasticity fines, very weakly to moderately cemented in parts			TPB06/1.50	
			2.0		ASS-				Hole terminated at 2.00 m Target depth Groundwater not encountered			TPB06/2.00	
			2.5										
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB07

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Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	15/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0		ASS-			SP	FILL: SAND: fine to medium grained, sub-angular to sub-rounded, brown, trace non-plastic fines, trace gravel, rootlets in top 200 mm	D		TPB07/0.00	0.00 : Surface grasses
			0.5		ASS-					M		TPB07/0.50	
					ASS-			CI-CH	Organic Sandy CLAY: dark grey-black, medium to high plasticity fines, with some organics	M - W			
					ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey-pale brown, trace non-plastic fines	W		TPB07/1.00	
			1.0		ASS-				Brown, very weakly to weakly cemented				
					ASS-							TPB07/1.50	
			1.5		ASS-			SC	Clayey SAND: fine to medium grained, sub-angular to sub-rounded, pale brown, mottled brown and green, medium to high plasticity fines	M - W			
					ASS-							TPB07/2.00	
			2.0		ASS-								
					ASS-							TPB07/2.50	
			2.5		ASS-				Hole terminated at 2.50 m Target depth Groundwater not encountered				
			3.0										
			3.5										

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB08

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	15/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
E			0.0		ASS-			SP	FILL: SAND: fine to medium grained, sub-angular to sub-rounded, brown, trace non-plastic fines, trace gravel, rootlets in top 200 mm	D - M		TPB08/0.00	0.00 : Surface grasses
			0.5		ASS-			SC	FILL: Clayey SAND / SAND: fine to medium grained, sub-angular to sub-rounded, brown, medium to high plasticity fines, trace gravel, trace metal	M		TPB08/0.50	
					ASS-			CI-CH	Organic Sandy CLAY: dark grey-black, medium to high plasticity fines, with some organics				
			1.0		ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey, trace non-plastic fines, trace rootlets	M - W		TPB08/1.00	
					ASS-							TPB08/1.50	
			1.5		ASS-					W			
					ASS-							TPB08/2.00	
			2.0		ASS-				Brown-dark brown, very weakly to weakly cemented				
									Hole terminated at 2.00 m Collapse due to shallow groundwater Groundwater encountered at 1.1 m				
			2.5										
			3.0										
			3.5										

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB09

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	14/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0		ASS-								
					ASB(TPB09-1)				UNCONTROLLED FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown, trace non-plastic fines, with some concrete bricks, plastic, metal, wood, pvc, trace rootlets in top 300 mm, trace asbestos	D		TPB09/0.00	0.00 : Asbestos noted in uncontrolled FILL
			0.5		ASS-			SP		M		TPB09/0.50	
					ASS-								
	E		1.0		ASS-				SAND: fine to coarse grained, sub-angular to sub-rounded, brown-grey, trace non-plastic fines	M - W		TPB09/1.00	
					ASS-								
			1.5		ASS-			SP		W		TPB09/1.50	
					ASS-								
			2.0		ASS-				Hole terminated at 2.00 m Collapse due to shallow groundwater Groundwater encountered at 1.2 m			TPB09/2.00	
			2.5										
			3.0										
			3.5										

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB10

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	14/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E-F		0.0		ASS- ASB(TPB10-1)			SP	UNCONTROLLED FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown, trace non-plastic fines, with some concrete bricks, plastic, metal, wood, pvc, trace rootlets in top 300 mm	D		TPB10/0.00	0.00 : Suface grasses, castor oil trees present across site, no asbestos observed
			0.5		ASS-					M		TPB10/0.50	
					ASS-								
			1.0		ASS-					M - W		TPB10/1.00	
	E				ASS-			CI-CH	Organic Sandy CLAY: dark grey-black, medium to high plasticity fines, with some organics				
			1.5		ASS-					W		TPB10/1.50	
	F				ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, brown-grey, trace non-plastic fines				
			2.0		ASS-				Hole terminated at 2.00 m Collapse due to shallow groundwater Groundwater encountered at 1.3 m			TPB10/2.00	
			2.5										
			3.0										
			3.5										

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB11

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	14/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
F-H			0.0		ASS- ASB(TPB11-1)			SP	UNCONTROLLED FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown, trace gravel, bricks, metal, concrete, wire, clothing, wood, asbestos fragments, trace rootlets in top 200 mm	D		TPB11/0.00	0.00 : Surface grasses
			0.5		ASS-					M		TPB11/0.50	
					ASS-								
			1.0		ASS- ASB(TPB11-2)							TPB11/1.00	
					ASS-								
			1.5		ASS-			Pt	Organic Sandy CLAY: dark grey-black, medium to high plasticity fines, with some organics	W		TPB11/1.50	
					ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey, trace non-plastic fines				
			2.0		ASS-							TPB11/2.00	
					ASS-								
			2.5		ASS-				Hole terminated at 2.50 m Collapse due to shallow groundwater Groundwater encountered at 1.6 m			TPB11/2.50	
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB12

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil
Project:	Proposed Road Widening			**Bucket:**	600 mm
				Width: 0.5 m	**Length:** 3 m

Date:	14/11/2017
Logged:	MC
Checked Date:	28/11/2017
Checked By:	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	F-H		0.0		ASS-				UNCONTROLLED FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown-dark brown, trace gravel, bricks, metal, concrete, wire, clothing, wood, asbestos fragments, trace rootlets in top 200 mm	D		TPB12/0.00	0.00 : Surface grasses
			0.5		ASS-							TPB12/0.50	
					ASS-								
			1.0		ASS-			SP		M		TPB12/1.00	
					ASB(TPB12-2)								
			1.5		ASS-							TPB12/1.50	
	E				ASS-								
			2.0		ASS-				SAND: fine to coarse grained, sub-angular to sub-rounded, dark grey-grey, trace non-plastic fines	W		TPB12/2.00	
					ASS-			SP					
			2.5		ASS-				Hole terminated at 2.50 m Collapse due to shallow groundwater Groundwater encountered at 1.9 m			TPB12/2.50	
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB13

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	14/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E-F		0.0		ASS-			SP	TOPSOIL: SAND: fine to medium grained, sub-angular to sub-rounded, dark grey-brown, trace non-plastic fines, trace organics/rootlets in top 200 mm	D - M		TPB13/0.00	0.00 : Surface grasses, no asbestos noted
			0.5		ASS-			SP	UNCONTROLLED FILL: SAND: fine to medium grained, sub-angular to sub-rounded, grey, trace bricks, concrete, wood, plastic, with some pockets of FILL/Peat	M - W		TPB13/0.50	
			1.0		ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey, trace non-plastic fines	W		TPB13/1.00	
			1.5		ASS-			Pt	Organic Sandy CLAY: dark grey-black, medium to high plasticity fines, with some organics			TPB13/1.50	
			2.0						Hole terminated at 1.80 m Collapse due to shallow groundwater Groundwater encountered at 1.4 m				
			2.5										
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB14

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	14/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E-F		0.0		ASS-			SP	FILL: SAND: fine to medium grained, sub-angular to sub-rounded, pale brown, trace gravel/cobbles, trace medium plasticity fines, trace organics and rootlets in top 400 mm	D - M		TPB14/0.00	0.00 : Surface grasses, asbestos noted throughout test pit
			0.5		ASS-							TPB14/0.50	
					ASS-			Pt	FILL: Peaty SAND: fine to coarse grained, sub-angular to sub-rounded, black-dark grey, with some organics	M - W			
			1.0		ASS-							TPB14/1.00	1.00 : No samples below 1.0 m, too wet
					ASS-			SP	FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown, trace non-plastic fines, with some bricks, wood, metal, glass, wire, hose	W			
			1.5		ASS-				Hole terminated at 1.50 m Collapse due to shallow groundwater Groundwater encountered at 1.1 m			TPB14/1.50	
			2.0										
			2.5										
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB15

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil
Project:	Proposed Road Widening			**Bucket:**	600 mm
				Width: 0.5 m	**Length:** 3 m

Date:	13/11/2017
Logged:	MC
Checked Date:	28/11/2017
Checked By:	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0		ASS- ASB(TPB15-1)			SP	UNCONTROLLED FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown-dark brown, trace gravel, bricks, metal, concrete, wire, clothing, wood, asbestos fragments, trace rootlets in top 200 mm	M		TPB15/0.00 TPB15/0.50 TPB15/1.00	
			0.5		ASS-								
			1.0		ASS-								
					ASS- ASB(TPB15-2)								
			1.5		ASS-							TPB15/1.50	
					ASS-								
			2.0		ASS-			CI-CH	Organic Sandy CLAY: dark grey-black, medium to high plasticity fines, with some organics	W		TPB15/2.00	
			2.5		ASS-				Hole terminated at 2.40 m Collapse due to shallow groundwater Groundwater encountered at 1.4 m				
			3.0										
			3.5										

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB16

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	13/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	F-H		0.0		ASS- ASB(TPB16-1)			SP	UNCONTROLLED FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown-dark brown, trace gravel, bricks, metal, concrete, wire, clothing, wood, asbestos fragments, trace rootlets in top 200 mm	D - M		TPB16/0.00 TPB16/0.50 TPB16/1.00 TPB16/1.50	0.00 : Asbestos noted in spoil throughout entire test pit
			0.5		ASS-								
			1.0		ASS-								
			1.5		ASS-								
			2.0		ASS-								
			2.5		ASS-								
			3.0		ASS-				Hole terminated at 1.75 m Collapse due to shallow groundwater Groundwater encountered at 1.4 m				
			3.5										

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPB17

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	14/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0		ASS-			SP	FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, dark grey, trace medium plasticity fines, trace rootlets in top 300 mm, trace plastic, metal, concrete and bricks	M		TPB17/0.00	0.00 : Surface grasses, no asbestos noted
			0.5		ASS-			SP	FILL: Peaty SAND: fine to coarse grained, sub-angular to sub-rounded	M - W		TPB17/0.50	
	E		1.0		ASS-			SP	Organic SAND: fine to coarse grained, sub-angular to sub-rounded, dark grey-black, with some organics	W		TPB17/1.00	
			1.5		ASS-			CI-CH	Sandy CLAY / Clayey SAND: fine to coarse grained, sub-angular to sub-rounded, pale brown, medium to high plasticity fines, trace organics	M - W		TPB17/1.50	
			2.0		ASS-				Hole terminated at 2.00 m Target depth Groundwater encountered at 1 m			TPB17/2.00	
			2.5		ASS-								
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPS01

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	13/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
E			0.0		ASS-			SP	TOPSOIL: SAND: fine to medium grained, sub-angular to sub-rounded, brown, trace non-plastic fines, with some organics/rootlets in top 200 mm	D		TPS01/0.00	0.00 : No asbestos / uncontrolled fill noted
			0.5		ASS-				SAND: fine to medium grained, sub-angular to sub-rounded, grey, trace non-plastic fines, trace rootlets			TPS01/0.50	
			1.0		ASS-			SP		M		TPS01/1.00	
			1.5		ASS-							TPS01/1.50	
			2.0		ASS-					W		TPS01/2.00	
			2.5		ASS-				Hole terminated at 2.00 m Collapse due to shallow groundwater Groundwater encountered at 1.75 m				
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TPS03

Sheet 1 OF 1

Job Number: J1702020
Client: City of Armadale
Project: Proposed Road Widening

Contractor: ANH Contracting
Location: Balannup Road, Harrisdale

Machine: JCB 3CX Backhoe
Operator: Neil
Bucket: 600 mm
Width: 0.5 m **Length:** 3 m

Date: 13/11/2017
Logged: MC
Checked Date: 28/11/2017
Checked By: PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0		ASS- ASB(TPS03-1) ASS-			SP	FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown becoming grey-brown with depth, trace non-plastic fines, trace gravel, trace rootlets in top 200 mm	D		TPS03/0.00	0.00 : No asbestos noted
			0.5		ASS-							TPS03/0.50	
					ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey-brown, trace non-plastic fines	M			
			1.0		ASS-							TPS03/1.00	
					ASS-					M - W			
			1.5		ASS-							TPS03/1.50	
	F				ASS-			SC	Clayey SAND: fine to coarse grained, sub-angular to sub-rounded, grey mottled brown, low to medium plasticity fines	M			
			2.0		ASS-				Hole terminated at 2.00 m Target depth Groundwater encountered at 1.55 m			TPS03/2.00	
					ASS-								
			2.5										
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GH_EXCAVATION J1702020.GPJ <<DrawingFile>> 07/12/2017 15:28 10.0.000 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TPS04

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	13/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0		ASS- ASB(TPS04-1)			SP	FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown, trace non-plastic fines, trace gravel, trace metal (tin can), trace organics, trace grass in top 200 mm	D - M		TPS04/0.00	
			0.5		ASS-							TPS04/0.50	
					ASS-								
			1.0		ASS-				SAND: fine to coarse grained, sub-angular to sub-rounded, black-dark grey, trace non-plastic fines, trace organics	M		TPS04/1.00	
					ASS-								
			1.5		ASS-			SP				TPS04/1.50	
	F	▼			ASS-								
			2.0		ASS-				Grey-pale brown	W		TPS04/2.00	
					ASS-								
			2.5		ASS-				Hole terminated at 2.50 m Target depth Groundwater encountered at 1.8 m			TPS04/2.50	
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GH_EXCAVATION J1702020.GPJ <<DrawingFile>> 07/12/2017 15:28 10.0.000 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TPS05

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe	**Date:**	13/11/2017
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil	**Logged:**	MC
Project:	Proposed Road Widening			**Bucket:**	600 mm	**Checked Date:**	28/11/2017
				Width:	0.5 m **Length:** 3 m	**Checked By:**	PCW

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E-F		0.0		ASS- ASB(TPS05-1)			SP	UNCONTROLLED FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown, trace bricks, wood, metal, plastic, car tyre	D - M		TPS05/0.00	0.00 : Surface grasses
			0.5		ASS-					M		TPS05/0.50	
			1.0		ASS-							TPS05/1.00	
	E		1.5		ASS-			SP	SAND: fine to coarse grained, sub-angular to sub-rounded, dark grey, trace non-plastic fines, trace organics	W		TPS05/1.50	
			2.0		ASS-				Grey mottled brown			TPS05/2.00	
			2.5		ASS-				Hole terminated at 2.50 m Collapse due to shallow groundwater Groundwater encountered at 1.3 m			TPS05/2.50	
			3.0										
			3.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GH_EXCAVATION J1702020.GPJ <<DrawingFile>> 07/12/2017 15:28 10.0.000 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TPS06

Sheet 1 OF 1

Job Number:	J1702020	**Contractor:**	ANH Contracting	**Machine:**	JCB 3CX Backhoe
Client:	City of Armadale	**Location:**	Balannup Road, Harrisdale	**Operator:**	Neil
Project:	Proposed Road Widening			**Bucket:**	600 mm
				Width: 0.5 m	**Length:** 3 m

Date:	13/11/2017
Logged:	MC
Checked Date:	28/11/2017
Checked By:	PCW

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0		ASS-			SP	UNCONTROLLED FILL: SAND: fine to coarse grained, sub-angular to sub-rounded, brown, trace non-plastic fines, trace gravel, trace rootlets and organics	D		TPS06/0.00	
			0.5		ASS-				SAND: fine to medium grained, sub-angular to sub-rounded, dark grey, trace non-plastic fines, trace organics			TPS06/0.50	
			1.0		ASS-			SP		M		TPS06/1.00	
	F-H		1.5		ASS-				Dark brown, weakly to moderately cemented, trace rootlets			TPS06/1.50	
			2.0		ASS-				Hole terminated at 2.00 m Target depth Groundwater encountered at 1.5 m			TPS06/2.00	
			2.5										
			3.0										
			3.5										

Sketch & Other Observations





Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GH_EXCAVATION J1702020.GPJ <<DrawingFile>> 07/12/2017 15:28 10.0.000 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

Appendix E

Modelling assumptions report

Prepared by Emerge Associates (2023)

Modelling Assumptions Report

Lots 600-606 Balannup Road and Lots 200-202 Skeet Road, Harrisdale

Project No: EP17-097(02)

Prepared for Hex Design and Planning
August 2023



Document Control

Doc name:	Modelling Assumptions Report Lots 600-606 Balannup Road and Lots 200-202 Skeet Road, Harrisdale				
Doc no.:	**EP20-127(09)--010**				
Version	**Date**	**Author**		**Reviewer**	
1	July 2021	Johanna Boonzaaier	JB	David Coremans	DPC
	Prepared to support Harrisdale LWMS				
A	May 2022	Johanna Boonzaaier	JB	David Coremans	DPC
	Updated to reflect the revised Structure and Drainage plans				
B	August 2023	Johanna Boonzaaier	JB	David Coremans	DPC
	Updated to reflect the revised Structure Plan				

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
AR& R	Australian Rainfall and Runoff
BOM	Bureau of Meteorology
FMDADS	Forrestdale main drain arterial drainage strategy

Table A2: Abbreviations – General terms

General terms	
AEP	Annual exceedance probability
AHD	Australian height datum
ARI	Average recurrence interval
CL	Continuing loss
CCW	Conservation category wetland
GIS	Geographical information systems
IFD	Intensity, frequency and duration
IL	Initial loss
LWMS	Local Water Management Strategy
REW	Resource enhanced wetland

Table A3: Abbreviations – units of measurement

Units of measurement	
ha	Hectare
km	Kilometre
m	Metre
m AHD	Metres in relation to the Australian height datum
m/day	Metres per day
m^2	Square metre
m^3	Cubic metre
m^3/s	Cubic metre per second
mm	Millimetre
mm/hr	Millimetres per hour
%	Percentage

Table A4: Terminology - design rainfall

Equivalent average recurrence interval (ARI) terminology	Average exceedance probability (AEP) terminology utilised
1 in 1 year ARI event	63.2% AEP event
1 in 1.5 year ARI event	50% AEP event
1 in 5 year ARI event	20% AEP event
1 in 10 year ARI event	10% AEP event
1 in 20 ARI event	5% AEP event
1 in 50 ARI event	2% AEP event
1 in 100 ARI event	1% AEP event
1 in 200 ARI event	1 in 200 AEP event
1 in 500 ARI event	1 in 500 AEP event

1 Purpose of report

This report provides a summary of the detailed hydrological water modelling that was undertaken to inform the local water management strategy (LWMS) and drainage design for the residential development located on Lots 600-606 Ballunup Road and Lots 200-202 Skeet Road, Harrisdale, located within the city of Armadale.

2 Methodology.

XPSWMM hydrological and hydraulic modelling software was used to calculate the surface water runoff volumes. The hydrological component of the software uses the Laurenson non-linear runoff-routing method to simulate runoff from design storm events. Key assumptions regarding the hydrological model include:

- Runoff is proportional to slope, area, infiltration and percentage imperviousness of a catchment.
- Sub-catchment areas and slopes are determined from surveyed topographical data and earthworks plans.
- Infiltration rates and percentage imperviousness have been selected based on experience with model preparation for similar soil conditions.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPSWMM. Generally, assumptions associated with the hydraulic component of the model include:

- Virtual links (i.e. purely for model construction, not equivalent to flow path onsite) between nodes within a sub-catchment are given a length of 10 m and slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a 'storage' node, a 'dummy intermediate' node or a conduit/link.
- Links between sub-catchment storages act as conveyance channels (e.g. sheet flow within roads in a 1% average exceedance probability (AEP) event). These links are given lengths and slopes that are representative of the site conditions and actual pathway lengths between catchments.
- All channels are designed with a width of 5 m, roughness of 0.014 (Manning's n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.
- Where relevant, soakwells, verge swales, bio-retention areas (BRAs), and flood storage areas (FSAs) are modelled as nodal-reservoirs with infiltration depth-rating curves to account for differential infiltration rates with changing depth.

2.1 Rainfall

The ensemble temporal patterns obtained from the Australian Rainfall and Runoff (AR&R) Data Hub (AR&R 2019) were used for the rainfall analysis.

Up to eight durations ranging between 1 hour and 72 hours were tested, with the peak flood elevation being assessed as the determining result.

Following the process suggested by AR&R (Ball J *et al.* 2019), the highest mean duration was selected as the critical duration for every catchment. AR&R also recommends that when it is not practical to run the entire ensemble array, the ensemble that produces the result closest to the mean (for the critical duration) should be adopted. The 2 hour duration ensemble 10 and the 4.5 hour duration ensemble 5 was adopted for the 1% AEP and 10% AEP events respectively for the pre-development scenario.

A critical duration analysis was also undertaken for the pos-development environment, and **Table 1** shows the critical durations adopted based on this analysis.

Table 1: Post-development critical durations

Catchment	20% AEP	10% AEP	1% AEP
Ct-01	6 hour ensemble 1	4.5 hour ensemble 1	6 hour ensemble 4
Ct-02	3 hour ensemble 5	4.5 hour ensemble 6	6 hour ensemble 10
Ct-03	3 hour ensemble 6	4.5 hour ensemble 6	6 hour ensemble 8

3 Pre-development

3.1 Pre-development model

Pre-development modelling was undertaken to determine the discharge to the North Forrestdale drain. An initial loss proportional loss model was adopted to account for catchment losses. Loss values, roughness and runoff coefficients were based on the assumptions used for the Forrestdale Main Drain Arterial Drainage Strategy (FMDADS) (DoW 2009) and shown in **Table 2**.

Table 2: Pre-development parameters

Land type	Initial loss (mm)	Roughness	Fixed runoff coefficient
Pervious	0	0.025	0.1
Impervious	1.5	0.015	1
Pervious (shallow water table)	15	0.025	0.5
Impervious (wet areas)	0	0.025	1

The pre-development catchment areas and land use types were digitised using aerial photography and these are shown in **Table 3**.

Table 3: Pre-development catchment areas (ha)

Land type	Impervious	Pervious (shallow water table)	Impervious (wet areas)
Ct-Pre-01	0.994	3.998	0.000
Ct-Pre-02	0.055	0.917	0.000
Ct-Pre-03	0.437	22.666	0.571

3.2 Results

The pre-development discharges from the site for the 20% AEP, 10% AEP and 1% AEP events are shown in **Table 4**.

Table 4: Predevelopment discharges

AEP event	Discharge (m^3/s)
20% AEP	0.37
10% AEP	0.47
1% AEP	0.91

4 Post development

4.1 Post development model

An initial loss continuing loss model was adopted to account for post-development catchment losses. The post-development catchment area, land types and loss values were based on the structure plan design, typical infiltration rates for the soils which occur onsite and based on project team experience. **Table 5** summarises the loss parameters used within the post-development model, with other catchment parameters detailed in

Table 6.

Table 5: Post-development parameters

Land type	Initial loss (mm)	Continual loss (mm)	Roughness
Road Surface	1	0.1	0.02
Road Verge	9	1	0.05
Lot pervious	25	3.5	0.05
Lot impervious	1	0.1	0.02
POS	20	2.5	0.05

Table 6: Post-development catchment areas (ha)

Catch-ment	Slope	Road surface	Road verge	Lot impervious	Lot Pervious	POS
Ct-01	0.001	0.217	0.093	0.070	0.070	0.173
Ct-02	0.001	2.251	0.965	0.817	0.817	0.903
Ct-02a	0.001	0.266	0.114	0.143	0.143	0.000
Ct-03	0.001	0.618	0.265	0.215	0.215	0.381
Ct-05	0.001	0.000	0.000	0.070	0.070	0.000

The catchment layout and runoff storage locations are shown in **Figure 9** of the LWMS (Emerge Associates 2021).

The following assumptions were incorporated into the post-development model:

- Lots
  - All lots will retain the first 15 mm of runoff within soakwells on lot.
  - 25% of residential lots contribute to runoff in downstream public open space (POS) during the minor and major event. This 25% represents impervious driveways/paved areas which are likely to discharge to the road network.
  - 25% of residential lots facing Reilly Road discharge to Reilly Road.

  - Residential lots will have little slope (i.e. will be flat) and pockets of storage are likely. This will effectively increase the initial loss (storage) and overall infiltration rate (continual loss).
  - Garden areas in lots will have high infiltration rates as it is likely that sand-based landscape mix or mulch will be used.
- Road reserve
  - There will be no infiltration on roads, pavements and driveways. There will however be some minor absorption storage loss which is accounted for in the initial and continuing loss values.
  - The road reserve contains 30% pervious verge and 70% impervious bitumen areas for all catchments.
- POS
  - POS are assumed to be 100% pervious.
  - POS will likely contain dense vegetation or turf over a sand-based landscape mix.
  - Conservation category wetlands (CCW) retain all runoff.
  - Resource enhanced wetlands (REW) retain all runoff.
  - Buffer areas retain all runoff.
- Commercial areas
  - Commercial areas retain and treat all runoff within the area and do not contribute to runoff treated within the site.
- Storage
  - Depth and size of storage areas based on the design contours provided by the project landscape architect team.
  - Bio-retention areas (BRAs) have 1:3 side slopes and maximum depths of 0.3 m.
  - Flood storage areas (FSAs) have 1:6 side slopes and a maximum depth of 1.2 m.
  - BRAs retain small event runoff (first 15 mm) from road reserves and some lots (e.g. any that are directly connected due to localise soil conditions).
  - FSAs retain runoff from events greater than the first 15 mm of rainfall.
- Infiltration
  - A hydraulic conductivity of 4 m/day, with a clogging factor of 50%, is assumed for the infiltration in BRAs.
  - A hydraulic conductivity of 4m/day is assumed for the infiltration in FSAs.
  - Infiltration through base area and side slopes of the BRAs and the FSA is considered in the overall infiltration rating curve for these areas.
- Evapotranspiration
  - Volumes leaving the system through evapotranspiration were assumed to be negligible when compared to the total runoff volume and since the duration of the model run was comparatively short. XPSWMM default evapotranspiration assumptions are therefore used.

4.2 Results

Table 7 shows the treatment and storage requirements in the post-development scenario.

Table 7 Storage and treatment requirements

Catchment	Storage Area	Small Event Treatment			Minor Event Storage (20%AEP)			Major Event Flood Storage		
		Depth (m)	TWL Surface Area (m^2)	Volume (m3)	Depth (m)	TWL Surface Area (m^2)	Volume (m3)	Depth (m)	TWL Surface Area (m^2)	Volume (m3)
Ct-01	BRA1	0.3	75	20	0.30	75	20	0.30	75	20
	FSA1	-	-	-	0.67	111	32	1.20	290	135
Ct-02	BRA2	0.3	1025	290	0.30	1025	290	0.30	1025	290
	FSA2	-	-	-	0.37	1445	475	1.20	2305	2015
Ct-03	BRA2	0.3	280	75	0.30	280	75	0.30	280	75
	FSA2	-	-	-	0.50	347	123	1.20	735	495
Ct-04	BRA2	0.3	175	45	0.30	175	45	0.30	175	45

Post development discharges to Reilly Road are shown in **Table 8**.

Table 8: Post development discharges to Reilly Road

Discharge from	Peak discharge (m^3)		
	20% AEP event	10% AEP event	1% AEP event
Ct-05	0.02	0.02	0.05
Ct-06	0.01	0.02	0.03
Total	*0.03*	*0.04*	*0.08*

5 References

5.1 General references

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M and Testoni I (Editors) 2019, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia).

Department of Water (DoW) 2009, *Forrestdale main drain arterial drainage strategy*.

Emerge Associates 2021, *Local Water Management Strategy - Lots 600-606 Ballanup Road and Lots 200-202 Skeet Road Harrisdale*, EP20-127(09)--007 TEM.

5.2 Online references

Bureau of Meteorology (BoM) 2021a, *Climate Data Online,* viewed 10 January 2021, Available from, < http://www.bom.gov.au/climate/data/>.

Bureau of Meteorology (BoM) 2021b, *Design Rainfall Data System (2016),* viewed 10 January 2021, Available from, <http://www.bom.gov.au/water/designRainfalls/revised-ifd/>.

Appendix F

Groundwater monitoring data

Prepared by 360 Environmental (2014-2015)

Field ID	Sample Date	Depth to Groundwater mbTOC	Well Stick Up m	Depth to Groundwater mbgl	Groundwater levels mAHD	Top of Casing mAHD	Surface Elevation mAHD
MW01	8/12/2014	1.47	0.5	0.97	21.87	23.33	22.83
	9/11/2014	1.24	0.5	0.74	22.1	23.33	22.83
	10/16/2014	1.39	0.5	0.89	21.94	23.33	22.83
	11/28/2014	1.72	0.5	1.22	21.61	23.33	22.83
	12/11/2014	1.8	0.5	1.3	21.53	23.33	22.83
	1/13/2015	2.04	0.5	1.54	21.29	23.33	22.83
	3/18/2015	2.11	0.5	1.61	21.22	23.33	22.83
	4/14/2015	2.34	0.5	1.84	20.99	23.33	22.83
	5/14/2015	2.53	0.5	2.03	20.8	23.33	22.83
	6/18/2015	2.15	0.5	1.65	21.18	23.33	22.83
	7/23/2015	1.84	0.5	1.34	21.5	23.33	22.83
	8/20/2015	1.51	0.5	1.01	21.82	23.33	22.83
	9/24/2015	1.49	0.5	0.99	21.84	23.33	22.83
	10/26/2015	1.71	0.5	1.21	21.62	23.33	22.83
	11/19/2015	1.78	0.5	1.28	21.55	23.33	22.83
	12/21/2015	2.02	0.5	1.52	21.31	23.33	22.83
MW02	8/12/2014	1.65	0.5	1.15	22.04	23.69	23.19
	9/11/2014	1.52	0.5	1.02	22.17	23.69	23.19
	10/16/2014	1.71	0.5	1.21	21.98	23.69	23.19
	11/28/2014	2.11	0.5	1.61	21.58	23.69	23.19
	12/11/2014	2.2	0.5	1.7	21.49	23.69	23.19
	1/13/2015	2.49	0.5	1.99	21.2	23.69	23.19
	3/18/2015	3.15	0.5	2.65	20.54	23.69	23.19
	4/14/2015	3.26	0.5	2.76	20.43	23.69	23.19
	5/14/2015	3.38	0.5	2.88	20.31	23.69	23.19
	6/18/2015	2.8	0.5	2.3	20.89	23.69	23.19
	7/23/2015	1.8	0.5	1.3	21.89	23.69	23.19
	8/20/2015	1.23	0.5	0.73	22.46	23.69	23.19
	9/24/2015	1.5	0.5	1	22.2	23.69	23.19
	10/26/2015	1.75	0.5	1.25	21.94	23.69	23.19
	11/19/2015	1.88	0.5	1.38	21.82	23.69	23.19
	12/21/2015	2.2	0.5	1.7	21.49	23.69	23.19
MW03	8/12/2014	1.79	0.4	1.39	21.99	23.78	23.38
	9/11/2014	1.77	0.4	1.37	22.02	23.78	23.38
	10/16/2014	1.87	0.4	1.47	21.91	23.78	23.38
	11/28/2014	1.89	0.4	1.49	21.89	23.78	23.38
	12/11/2014	1.95	0.4	1.55	21.83	23.78	23.38
	1/13/2015	2.04	0.4	1.64	21.74	23.78	23.38
	3/18/2015	2.11	0.4	1.71	21.67	23.78	23.38
	4/14/2015	2	0.4	1.6	21.78	23.78	23.38
	5/14/2015	2.12	0.4	1.72	21.66	23.78	23.38
	6/18/2015	1.95	0.4	1.55	21.83	23.78	23.38
	7/23/2015	1.43	0.4	1.03	22.35	23.78	23.38
	8/20/2015	1.27	0.4	0.87	22.51	23.78	23.38
	9/24/2015	1.48	0.4	1.08	22.3	23.78	23.38
	10/26/2015	1.78	0.4	1.38	22	23.78	23.38
	11/19/2015	1.95	0.4	1.55	21.83	23.78	23.38
	12/21/2015	2.05	0.4	1.65	21.73	23.78	23.38
MW04	8/12/2014	1.5	0.55	0.95	21.91	23.4	22.85
	9/11/2014	1.2	0.55	0.65	22.2	23.4	22.85
	10/16/2014	1.48	0.55	0.93	21.93	23.4	22.85
	11/28/2014	1.8	0.55	1.25	21.6	23.4	22.85
	12/11/2014	1.91	0.55	1.36	21.49	23.4	22.86
	1/13/2014	2.24	0.55	1.69	21.16	23.4	22.86
	3/18/2015	2.95	0.55	2.4	20.45	23.4	22.86
	4/14/2015	3.02	0.55	2.47	20.38	23.4	22.86
	5/14/2015	3.18	0.55	2.63	20.22	23.4	22.86
	6/18/2015	3.82	0.55	3.27	19.58	23.4	22.86
	7/23/2015	2.16	0.55	1.61	21.24	23.4	22.86
	8/20/2015	1.71	0.55	1.16	21.69	23.4	22.86
	9/24/2015	1.68	0.55	1.13	21.72	23.4	22.86
	10/26/2015	1.9	0.55	1.35	21.5	23.4	22.86
	11/19/2015	2	0.55	1.45	21.41	23.4	22.86
	12/21/2015	2.25	0.55	1.7	21.15	23.4	22.86
MW05	8/12/2014	1.82	0.5	1.32	22.22	24.04	23.54
	9/11/2014	1.79	0.5	1.78	22.25	24.04	23.54
	10/16/2014	1.88	0.5	1.88	22.16	24.04	23.54
	11/28/2014	1.96	0.5	1.46	22.08	24.04	23.54
	12/11/2014	2.01	0.5	1.51	22.03	24.04	23.54
	1/13/2015	2.12	0.5	1.98	21.92	24.04	23.55
	3/18/2015	2.21	0.5	1.71	21.83	24.04	23.55
	4/14/2015	2.12	0.5	1.62	21.92	24.04	23.55
	5/14/2015	2.02	0.5	1.52	22.02	24.04	23.55
	6/18/2015	2.03	0.5	1.53	22.01	24.04	23.55
	7/23/2015	1.64	0.5	1.14	22.4	24.04	23.55
	8/20/2015	1.51	0.5	1.01	22.53	24.04	23.55
	9/24/2015	1.72	0.5	1.22	22.32	24.04	23.55
	10/26/2015	1.83	0.5	1.33	22.21	24.04	23.55
	11/19/2015	1.84	0.5	1.34	22.2	24.04	23.55
	12/21/2015	1.86	0.5	1.36	22.18	24.04	23.55

MW06	8/12/2014	1.04	0.6	0.44	22.63	23.67	23.07
	9/11/2014	0.79	0.6	0.19	22.89	23.67	23.07
	10/16/2014	1.1	0.6	0.5	22.57	23.67	23.08
	11/28/2014	1.94	0.6	1.34	21.73	23.67	23.08
	12/11/2014	2.49	0.6	1.89	21.18	23.67	23.08
	1/13/2015	3.48	0.6	2.88	20.19	23.67	23.08
	3/18/2015	3.96	0.6	3.36	19.71	23.67	23.08
	4/14/2015	3.73	0.6	3.13	19.94	23.67	23.08
	5/15/2015	3.87	0.6	3.27	19.8	23.67	23.08
	6/18/2015	3.45	0.6	2.85	20.22	23.67	23.08
	7/23/2015	3.01	0.6	2.41	20.67	23.67	23.08
	8/20/2015	1.43	0.6	0.83	22.24	23.67	23.08
	9/24/2015	1.54	0.6	0.94	22.13	23.67	23.08
	10/26/2015	2.21	0.6	1.61	21.46	23.67	23.08
	11/19/2015	2.68	0.6	2.08	20.99	23.67	23.08
	12/21/2015	3.27	0.6	2.67	20.4	23.67	23.08
MW07	8/12/2014	1.48	0.5	0.98	22.32	23.8	23.3
	9/11/2014	1.22	0.5	0.72	22.59	23.8	23.3
	10/16/2014	1.33	0.5	0.83	22.47	23.8	23.3
	11/28/2014	1.61	0.5	1.11	22.19	23.8	23.3
	12/11/2014	1.72	0.5	1.22	22.08	23.8	23.31
	1/13/2015	2.06	0.5	1.56	21.74	23.8	23.31
	3/18/2015	2.72	0.5	2.22	21.08	23.8	23.31
	4/14/2015	2.91	0.5	2.41	20.89	23.8	23.31
	5/15/2015	3.07	0.5	2.57	20.73	23.8	23.31
	6/18/2015	2.9	0.5	2.4	20.9	23.8	23.31
	7/23/2015	2.49	0.5	1.99	21.32	23.8	23.31
	8/20/2015	2.05	0.5	1.55	21.76	23.8	23.31
	9/24/2015	1.83	0.5	1.33	21.97	23.8	23.31
	10/26/2015	2.07	0.5	1.57	21.73	23.8	23.31
	11/19/2015	2.17	0.5	1.67	21.63	23.8	23.31
	12/21/2015	2.43	0.5	1.93	21.37	23.8	23.31
MW08	8/12/2014	1.83	0.6	1.23	22.01	23.84	23.24
	9/11/2014	1.68	0.6	1.08	22.16	23.84	23.24
	10/16/2014	1.82	0.6	1.22	22.02	23.84	23.24
	11/28/2014	2.2	0.6	1.6	21.64	23.84	23.24
	12/11/2014	2.31	0.6	1.71	21.53	23.84	23.24
	1/13/2015	2.54	0.6	1.94	21.3	23.84	23.25
	3/18/2015	2.95	0.6	2.35	20.89	23.84	23.25
	4/14/2015	3.07	0.6	2.47	20.77	23.84	23.25
	5/15/2015	3.17	0.6	2.57	20.67	23.84	23.25
	6/18/2015	3	0.6	2.4	20.84	23.84	23.25
	7/23/2015	2.6	0.6	2	21.24	23.84	23.25
	8/20/2015	2.25	0.6	1.65	21.59	23.84	23.25
	9/24/2015	2.16	0.6	1.56	21.69	23.84	23.25
	10/26/2015	2.39	0.6	1.79	21.45	23.84	23.25
	11/19/2015	2.44	0.6	1.84	21.4	23.84	23.25
	12/21/2015	2.6	0.6	2	21.24	23.84	23.25

		Appearance	Field Parameters							
		Colour, turbidity, odour	Temperature C	pH units	Specific Electrical Conductivity µS/cm	Dissolved Oxygen mg/L	Dissolved Oxygen %	TDS g/L	Salinity PSU	Redox mV
LOR			0.1	0.01	1	0.01	1	0.01	0.01	1
Wetlands ANZECC & ARMCANZ (2000)				7-8.5						
Field ID	Sampled Date									
MW01	8/12/2014	Pale brown, low turbidity, slight sulfur odour	17	5.29	5186	1.33	14	3.98	3.36	-181
	11/28/2014	Pale brown, high turbidity, no odour	21	6.16	5815	1.88	21	3.78	3.16	-52
	3/18/2015	Pale brown, high turbidity, no odour	23	5.84	5652	2.79	26	3.67	3.06	-4
	6/18/2015	Pale brown, low turbidity, slight sulfur odour	19	5.72	7919	1.67	19	5.15	4.4	-112
	10/26/2015	Pale brown, low turbidity, strong sulfur odour	19	7.32	5869	1.47	16	3.82	3.2	-295
	12/21/2015	Pale brown, low turbidity, strong sulfur odour	22	5.57	6278	1.4	16	4.08	3.43	-162
			20.17	5.98	6119.83	1.76	18.67	4.08	3.44	-134.33
MW02	8/12/2014	Pale brown, moderate turbidity, no odour	17	6.85	1169	3.17	33	0.9	0.7	35
	11/28/2014	Grey, high turbidity, no odour	22	7.5	1582	3.53	40	1.03	0.8	-61
	3/18/2015	Grey, high turbidity, no odour	24	6.7	1335	2.49	29	0.85	0.63	-76
	6/18/2015	Pale brown, moderate turbidity, no odour	22	6.98	1800	2.44	27	1.17	0.83	33
	10/26/2015	Clear, colourless, no odour	19	8.23	1577	1.85	20	1.03	0.8	-181
	12/21/2015	Pale brown, low turbidity, no odour	23	7.12	1231	1.38	16	0.8	0.61	-134
			20.71	7.06	1361.43	2.17	24.00	0.92	0.69	-89.43
MW03	8/12/2014	Brown, low turbidity, slight sulfur odour	18	6.06	836	0.3	3	0.63	0.48	-242
	11/28/2014	Pale brown, high turbidity, no odour	19	6.02	649	2.02	22	0.42	0.32	-142
	3/18/2015	Pale brown, high turbidity, no odour	22	5.84	845	2.28	33	0.55	0.41	-131
	6/18/2015	Pale brown, high turbidity, no odour	20	6.49	1387	2.06	23	0.9	0.7	-147
	10/26/2015	Pale brown, high turbidity, strong sulfur odour	18	8.45	994	1.86	20	0.64	0.49	-372
	12/21/2015	Pale brown, high turbidity, strong sulfur odour	26	7.73	10.8	6.76	83	0.01	0	-190
			20.50	6.77	786.97	2.55	30.67	0.53	0.40	-204.00
MW04	8/12/2014	Pale brown, moderate turbidity, no odour	17	6.81	1489	0.55	6	1.15	0.9	-16
	11/28/2014	Pale brown, moderate turbidity, no odour	19	6.77	1543	2.9	32	1.03	0.81	65
	3/18/2015	Pale brown, moderate turbidity, no odour	22	6.36	815	2.37	28	1.01	0.76	35
	6/18/2015	Pale brown, moderate turbidity, no odour	20	6.55	2056	2.52	28	1.33	105	-55
	10/26/2015	Pale brown, low turbidity, no odour	18	7.94	2431	4.72	50	1.58	1.26	-113
	12/21/2015	Pale brown, low turbidity, no odour	22	7.35	2422	1.22	14	1.57	1.25	-77
			19.67	6.96	1792.67	2.38	26.33	1.28	18.33	-26.83
MW05	8/12/2014	Pale brown, high turbidity, no odour	17	5.33	704	0.75	8	0.54	0.41	-149
	11/28/2014	Pale brown, high turbidity, no odour	20	5.8	530	2.54	28	0.35	0.26	-86
	3/18/2015	Pale brown, high turbidity, no odour	22	5.68	895	1.09	13	0.59	0.44	-124
	6/18/2015	Pale brown, high turbidity, no odour	19	6.82	1198	2.23	24	0.78	0.6	-139
	10/26/2015	Pale brown, high turbidity, strong sulfur odour	18	7.83	26.5	2.67	28	0.02	0.01	-307
	12/21/2015	Pale brown, high turbidity, strong sulfur odour	22	7.52	840	0.44	5	0.55	0.41	-259
			19.67	6.50	698.92	1.62	17.67	0.47	0.36	-177.33
MW06	8/12/2014	Brown, high turbidity, no odour	17	5.36	1173	1.03	11	0.9	0.7	-21
	11/28/2014	Brown, high turbidity, no odour	20	5.79	4032	1.99	22	2.62	2.14	20
	3/18/2015			Dry						
	6/18/2015	Brown, high turbidity, no odour	20	6.41	3253	2.22	24	2.11	1.71	-84
	10/26/2015	Pale brown, high turbidity, strong sulfur odour	19	7.11	2310	0.49	5.3	1.5015	1.19	-194.3
	12/21/2015	Pale brown, high turbidity, no odour	22.6	7.6	2899	0.67	7.9	1.885	1.51	-161.6
			19.72	6.45	2733.40	1.28	14.04	1.80	1.45	-88.18
MW07	8/12/2014	Pale brown, high turbidity, no odour	17	4.37	499	0.63	7	0.38	0.29	-79
	11/28/2014	Pale brown, high turbidity, no odour	18	4.34	324	2.63	28	0.21	0.15	110
	3/18/2015	Pale brown, high turbidity, no odour	20	3.56	307	2.55	29	0.19	0.15	109
	6/18/2015	Pale brown, high turbidity, no odour	19	4.46	746	2.45	26	0.48	0.36	96
	10/26/2015	Pale brown, high turbidity, strong sulfur odour	17	6.35	764	4.02	42	0.49	0.38	-145
	12/21/2015	Pale brown, high turbidity, strong sulfur odour	22	6.41	731	1.05	12	0.47	0.36	-207
			18.83	4.92	561.83	2.22	24.00	0.37	0.28	-19.33
MW08	8/12/2014	Pale brown, moderate turbidity, no odour	17	6.69	1527			1.18	0.92	-46
	11/28/2014	Pale brown, moderate turbidity, no odour	19	6.07	1796			1.16	0.91	39
	3/18/2015	Pale brown, moderate turbidity, no odour	21	4.45	1107			0.72	0.53	58
	6/18/2015	Pale brown, moderate turbidity, no odour	19	3.76	1698			1.1	0.86	192
	10/26/2015	Pale brown, low turbidity, slight sulfur odour	17	6.96	1545			1.01	0.78	-187
	12/21/2015	Clear, colourless, no odour	26	5.89	16			0.01	0.01	-31

Sample ID			MW01						MW01	MW02						MW02
Sample Matrix																
Laboratory			MGT Eurofins							MGT Eurofins						
Laboratory Report No.			428653	440542	451224	462132	477226	484302		428653	440542	451224	462132	477226	484302	
Laboratory Sample No.			M14-Au10905	M14-De00044	M15-Ma14764	M15-Jn15967	M15-Oc19051	M15-De21805		M14-Au10906	M14-De00045	M15-Ma14765	M15-Jn15968	M15-Oc19052	M15-De21806	
Date Sampled			8/12/2014	11/27/2014	3/18/2015	6/18/2015	10/26/2015	12/21/2015	AVERAGE	8/12/2014	11/27/2014	3/18/2015	6/18/2015	10/26/2015	12/21/2015	AVERAGE
Analyte	Units	Wetlands ANZECC & ARMCANZ (2000)														
Nutrients/Inorganics																
Nitrogen (Total Oxidised)	mg/L	0.1	<0.05	<0.05	<0.05	0.06	<0.05	<0.25	0.06	2.6	<0.05	<0.05	<0.05	1.9	<0.25	1.52
Nitrogen (Total)	mg/L	1.5	5.1	6.7	6.5	4.5	4.5	5.2	5.416666667	3.9	2.2	0.7	0.7	2.9	<0.2	2.636111111
Ammonia as N	mg/L	0.04	4.3	5.2	5	3.5	3.9	5.4	4.55	0.11	1.1	0.2	0.03	0.06	<0.05	1.008333333
Kjeldahl Nitrogen Total	mg/L	----	5.1	6.7	6.5	4.5	4.5	5.2	5.416666667	1.3	2.2	0.7	0.7	1	<0.2	1.886111111
Phosphorus	mg/L	----	<0.5	<5	<5	<5	<5	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phosphate total (P)	mg/L	0.06	<0.05	<0.05	0.28	<0.05	<0.05	0.07	0.175	0.14	<0.05	0.05	<0.05	0.07	0.22	0.131
Metals																
Arsenic	mg/L	0.013	----	----	----	----	----	<0.001		----	----	----	----	----	0.006	
Boron	mg/L	0.37	----	----	----	----	----	0.15		----	----	----	----	----	0.22	
Cadmium	mg/L	0.0002	----	----	----	----	----	<0.0002		----	----	----	----	----	<0.0002	
Calcium	mg/L	----	----	----	----	----	----	84		----	----	----	----	----	240	
Chromium (III+VI)	mg/L	----	----	----	----	----	----	0.003		----	----	----	----	----	0.002	
Cobalt	mg/L	----	----	----	----	----	----	<0.001		----	----	----	----	----	0.002	
Copper	mg/L	0.0014	----	----	----	----	----	0.002		----	----	----	----	----	0.003	
Lead	mg/L	0.0034	----	----	----	----	----	<0.001		----	----	----	----	----	0.002	
Manganese	mg/L	1.9	----	----	----	----	----	0.042		----	----	----	----	----	0.14	
Mercury	mg/L	0.0006	----	----	----	----	----	<0.0001		----	----	----	----	----	<0.0001	
Molybdenum	mg/L	----	----	----	----	----	----	<0.005		----	----	----	----	----	<0.005	
Nickel	mg/L	0.011	----	----	----	----	----	<0.001		----	----	----	----	----	0.004	
Selenium	mg/L	0.011	----	----	----	----	----	<0.001		----	----	----	----	----	<0.001	
Zinc	mg/L	0.008	----	----	----	----	----	0.007		----	----	----	----	----	0.01	

			MW03			MW04						
												Water
		MGT Eurofins				MGT Eurofins						
		Laboratory Report No.	477226	484302		428653	440542	451224	462132	477226	484302	
		Laboratory Sample No.	M15-Oc19053	M15-De21807		M14-Au10908	M14-De00047	M15-Ma14767	M15-Jn15970	M15-Oc19054	M15-De21808	
		Date Sampled	10/26/2015	12/21/2015	AVERAGE	8/12/2014	11/27/2014	3/18/2015	6/18/2015	10/26/2015	12/21/2015	AVERAGE
Analyte	Units	Wetlands ANZECC & ARMCANZ (2000)										
Nutrients/Inorganics												
Nitrogen (Total Oxidised)	mg/L	0.1	<0.05	<0.05	<0.05	85	30	0.22	<0.05	13	9.8	27.604
Nitrogen (Total)	mg/L	1.5	2.4	0.9	1.366666667	89	35	11	1.4	17	13	27.73333333
Ammonia as N	mg/L	0.04	0.71	1	0.253333333	0.19	0.04	0.02	0.1	0.71	0.02	0.18
Kjeldahl Nitrogen Total	mg/L	----	2.4	0.9	1.3	3.9	4.5	11	1.4	4.4	3.4	4.766666667
Phosphorus	mg/L	----	<0.5	<0.5	<0.5	<0.5	<5	<5	<0.5	<0.5	<0.5	<0.5
Phosphate total (P)	mg/L	0.06	0.11	<0.05	0.073333333	<0.05	0.92	1.6	0.06	0.07	<0.05	0.6625
Metals												
Arsenic	mg/L	0.013	----	0.002		----	----	----	----	----	0.001	
Boron	mg/L	0.37	----	0.18		----	----	----	----	----	0.18	
Cadmium	mg/L	0.0002	----	<0.0002		----	----	----	----	----	<0.0002	
Calcium	mg/L	----	----	53		----	----	----	----	----	160	
Chromium (III+VI)	mg/L	----	----	0.002		----	----	----	----	----	0.004	
Cobalt	mg/L	----	----	<0.001		----	----	----	----	----	<0.001	
Copper	mg/L	0.0014	----	<0.001		----	----	----	----	----	0.006	
Lead	mg/L	0.0034	----	<0.001		----	----	----	----	----	0.001	
Manganese	mg/L	1.9	----	<0.005		----	----	----	----	----	<0.005	
Mercury	mg/L	0.0006	----	<0.0001		----	----	----	----	----	<0.0001	
Molybdenum	mg/L	----	----	<0.005		----	----	----	----	----	<0.005	
Nickel	mg/L	0.011	----	0.001		----	----	----	----	----	0.003	
Selenium	mg/L	0.011	----	<0.001		----	----	----	----	----	0.002	
Zinc	mg/L	0.008	----	0.003		----	----	----	----	----	0.014	

	MW05				MW05	MW06					MW06
	MGT Eurofins					MGT Eurofins					
Laboratory Report No.			477226	484302		428653	440542	462132	477226	484302	
Laboratory Sample No.			M15-Oc19055	M15-De21809		M14-Au10910	M14-De00049	M15-Jn15972	M15-Oc19056	M15-De21810	
Date Sampled			10/26/2015	12/21/2015	AVERAGE	8/12/2014	11/27/2014	6/18/2015	10/26/2015	12/21/2015	AVERAGE
Analyte	Units	Wetlands ANZECC & ARMCANZ (2000)									
Nutrients/Inorganics											
Nitrogen (Total Oxidised)	mg/L	0.1	1.4	<0.05	0.516666667	<0.05	0.05	0.08	<0.05	<0.05	1.588125
Nitrogen (Total)	mg/L	1.5	2.6	0.8	1.275	3.7	5.1	1.4	6.6	2.8	1.689666667
Ammonia as N	mg/L	0.04	0.64	0.72	0.3525	0.2	0.18	0.51	0.07	0.06	1.2436
Kjeldahl Nitrogen Total	mg/L	----	1.2	0.8	0.733333333	3.7	5	1.3	6.6	2.8	1.5035
Phosphorus	mg/L	----	<0.5	<0.5	<0.5	<0.5	<5	<0.5	<0.5	<0.5	0.711333333
Phosphate total (P)	mg/L	0.06	0.14	0.09	0.085	0.13	<0.05	0.13	0.11	0.06	0.711333333
Metals											
Arsenic	mg/L	0.013	----	0.001		----	----	----	----	0.003	
Boron	mg/L	0.37	----	0.18		----	----	----	----	0.17	
Cadmium	mg/L	0.0002	----	<0.0002		----	----	----	----	<0.0002	
Calcium	mg/L	----	----	33		----	----	----	----	10	
Chromium (III+VI)	mg/L	----	----	0.003		----	----	----	----	0.02	
Cobalt	mg/L	----	----	<0.001		----	----	----	----	0.001	
Copper	mg/L	0.0014	----	<0.001		----	----	----	----	0.007	
Lead	mg/L	0.0034	----	0.001		----	----	----	----	0.005	
Manganese	mg/L	1.9	----	<0.005		----	----	----	----	0.012	
Mercury	mg/L	0.0006	----	<0.0001		----	----	----	----	<0.0001	
Molybdenum	mg/L	----	----	<0.005		----	----	----	----	<0.005	
Nickel	mg/L	0.011	----	0.001		----	----	----	----	0.004	
Selenium	mg/L	0.011	----	<0.001		----	----	----	----	0.003	
Zinc	mg/L	0.008	----	0.001		----	----	----	----	0.015	

MW07						MW07	MW08						MW08
MGT Eurofins							MGT Eurofins						
Laboratory Report No.			477226	484302			428653	440542	451224	462132	477226	484302	
Laboratory Sample No.			M15-Oc19057	M15-De21811			M14-Au10912	M14-De00051	M15-Ma14770	M15-Jn15974	M15-Oc19058	M15-De21812	
Date Sampled			10/26/2015	12/21/2015	AVERAGE		8/12/2014	11/27/2014	3/18/2015	6/18/2015	10/26/2015	12/21/2015	AVERAGE
Analyte	Units	Wetlands ANZECC & ARMCANZ (2000)											
Nutrients/Inorganics													
Nitrogen (Total Oxidised)	mg/L	0.1	<0.05	<0.05	<0.05		7.8	3.6	<0.05	0.13	<0.05	0.08	2.9025
Nitrogen (Total)	mg/L	1.5	3.2	2.1	1.75		10	6.3	2.6	0.8	1	1.4	3.683333
Ammonia as N	mg/L	0.04	1.1	1.2	0.5875		0.42	0.27	2.5	0.48	0.24	0.16	0.678333
Kjeldahl Nitrogen Total	mg/L	----	3.2	2.1	1.833333333		2.4	2.7	2.6	0.7	1	1.3	1.783333
Phosphorus	mg/L	----	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phosphate total (P)	mg/L	0.06	0.05	<0.05	0.053333333		<0.05	0.1	0.41	<0.05	<0.05	<0.05	0.255
Metals													
Arsenic	mg/L	0.013	----	<0.001			----	----	----	----	----	0.007	
Boron	mg/L	0.37	----	0.17			----	----	----	----	----	0.13	
Cadmium	mg/L	0.0002	----	<0.0002			----	----	----	----	----	<0.0002	
Calcium	mg/L	----	----	3.4			----	----	----	----	----	74	
Chromium (III+VI)	mg/L	----	----	0.004			----	----	----	----	----	0.003	
Cobalt	mg/L	----	----	<0.001			----	----	----	----	----	0.002	
Copper	mg/L	0.0014	----	0.004			----	----	----	----	----	0.002	
Lead	mg/L	0.0034	----	0.003			----	----	----	----	----	0.001	
Manganese	mg/L	1.9	----	<0.005			----	----	----	----	----	0.022	
Mercury	mg/L	0.0006	----	<0.0001			----	----	----	----	----	<0.0001	
Molybdenum	mg/L	----	----	<0.005			----	----	----	----	----	<0.005	
Nickel	mg/L	0.011	----	0.001			----	----	----	----	----	0.003	
Selenium	mg/L	0.011	----	<0.001			----	----	----	----	----	0.001	
Zinc	mg/L	0.008	----	0.003			----	----	----	----	----	0.005	

			Field_ID	MW03	MW05
			LocCode	MW03	MW05
			Sampled_Date-Time	17/06/2021	17/06/2021
Chem_Group	**ChemName**	**Units**	**EQL**		
	Filtered Total Phosphorus as P	mg/L	0.01	0.08	1.24
NA	DO (saturated)	%		1.6	23.1
Field	Redox Potential (Field)	mV		-81.5	-5.5
Inorganics	Nitrite + Nitrate as N	mg/L	0.01	0.03	0.05
	Ammonia as N	mg/L	0.01	1.15	0.35
	Dissolved Oxygen	mg/L		0.16	2.15
	Kjeldahl Nitrogen Total	mg/L	0.1	5.1	15
	Nitrate (as N)	mg/L	0.01	0.03	0.05
	Nitrite (as N)	mg/L	0.01	<0.01	<0.01
	Nitrogen (Total)	µg/L	100	5100	15,000
	Reactive Phosphorus as P	mg/L	0.01	0.04	0.05

Field_ID
LocCode
Sampled_Date-Time

Statistical Summary

Chem_Group	ChemName	Units	EQL	Number of	Number	Minimum	Minimu
	Filtered Total Phosphorus as P	mg/L	0.01	2	2	0.08	0.08
NA	DO (saturated)	%		2	2	1.6	1.6
Field	Redox Potential (Field)	mV		2	2	-81.5	ND
Inorganics	Nitrite + Nitrate as N	mg/L	0.01	2	2	0.03	0.03
	Ammonia as N	mg/L	0.01	2	2	0.35	0.35
	Dissolved Oxygen	mg/L		2	2	0.16	0.16
	Kjeldahl Nitrogen Total	mg/L	0.1	2	2	5.1	5.1
	Nitrate (as N)	mg/L	0.01	2	2	0.03	0.03
	Nitrite (as N)	mg/L	0.01	2	0	<0.01	ND
	Nitrogen (Total)	µg/L	100	2	2	5100	5100
	Reactive Phosphorus as P	mg/L	0.01	2	2	0.04	0.04

Field_ID
LocCode
Sampled_Date-Time

Chem_Group	ChemName	Units	EQL	Maximum	Maximu	Average	Median	Standard
	Filtered Total Phosphorus as P	mg/L	0.01	1.24	1.24		0.66	
NA	DO (saturated)	%		23.1	23.1		12.35	
Field	Redox Potential (Field)	mV		0	ND		-43.5	
Inorganics	Nitrite + Nitrate as N	mg/L	0.01	0.05	0.05		0.04	
	Ammonia as N	mg/L	0.01	1.15	1.15		0.75	
	Dissolved Oxygen	mg/L		2.15	2.15		1.155	
	Kjeldahl Nitrogen Total	mg/L	0.1	15	15		10.05	
	Nitrate (as N)	mg/L	0.01	0.05	0.05		0.04	
	Nitrite (as N)	mg/L	0.01	<0.01	ND		0.005	
	Nitrogen (Total)	µg/L	100	15000	15000		10050	
	Reactive Phosphorus as P	mg/L	0.01	0.05	0.05		0.045	

Field_ID
LocCode
Sampled_Date-Time

Chem_Group	ChemName	Units	EQL	Number of	Number of
	Filtered Total Phosphorus as P	mg/L	0.01	2	2
NA	DO (saturated)	%		2	2
Field	Redox Potential (Field)	mV		0	0
Inorganics	Nitrite + Nitrate as N	mg/L	0.01	2	2
	Ammonia as N	mg/L	0.01	2	2
	Dissolved Oxygen	mg/L		2	2
	Kjeldahl Nitrogen Total	mg/L	0.1	2	2
	Nitrate (as N)	mg/L	0.01	2	2
	Nitrite (as N)	mg/L	0.01	0	0
	Nitrogen (Total)	µg/L	100	2	2
	Reactive Phosphorus as P	mg/L	0.01	2	2

Appendix G

Educational material

Planning your planting

Create 'watering zones' in your garden by grouping plants with similar watering needs. This will allow you to make more efficient use of your garden water by ensuring that no plants are over or under watered.

The Waterwise 'Drop Zone' system makes it easy to identify a plant's water requirements. This system divides plants into one of three groups depending on their watering needs. 'Three Drop' plants require the most watering (usually every second day in summer), whereas 'Two Drop' and 'One Drop' plants require less watering respectively.

It's also important to reticulate only once on your allocated days, either before 9am or after 6pm. Look for the Waterwise 'Drop Zone' system at your local Waterwise garden centre. To find the centre closest to you, visit www.watercorporation.com.au or call the Waterwise Helpline on 13 10 39.

Remember, a small amount of planning now can save plenty of water in the future.

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Government of **Western Australia**
Department of **Water**

Planting a local native garden

Looking after all our water needs









In an era of rising temperatures and decreasing rainfall it is important to look at how we use water in our gardens.

Did you know?

About half of the water typically used in our homes is actually used to water the garden (and of that almost all is used to water lawns).

Many of us water lawns that we simply don't use, or water more than we need to. Similarly, often the plant species in our gardens are exotic and not entirely suitable to our climate – needing more water to survive.

Why go native?

- Local native plants are best suited to the local climate, conditions and soil. Therefore they require minimal inputs such as water, fertiliser and maintenance.
- They attract local wildlife, insects and birds and provide corridors of biodiversity in developed areas.
- They have minimal impact on the environment – unlike many introduced species, which have become bushland weeds and prove difficult and expensive to eradicate.
- They represent local heritage, teaching us about nature and our local identity.

Mulch. Mulch. Mulch.

If everyone fully utilised mulch in the garden, a much lower percentage of household water usage would end up on the garden.

The even better news is that mulching is very easy! Raw materials like woodchips and tree clippings are best, but any organic mulch will suffice. Simply spread at least 50mm of mulch over the whole planting area, leaving a small amount of breathing space at the base of the stem. This mulch won't need to be topped up again until autumn. Be sure not to turn or disturb the mulch as this will break the fine feeder roots that develop between the mulch and the soil.

In addition to mulch, a wetting agent can help overcome water repellence in soils, allowing water to penetrate the soil more quickly and in larger amounts. You can find wetting agents at your local nursery or garden centre.

Want to know more?

The Department of Water is committed to making sure that the water needs of Western Australia are met now, and in the future. Small steps we each take can make a big difference to the sustainability of our precious water supply. If you would like to know more, visit the Department of Water website – www.water.wa.gov.au.

Key tips for reducing groundwater use

- Design gardens and landscaping to enhance absorption of rain into the ground and to minimise evaporation – by using local native garden beds, mulch and subsurface irrigation etc.
- Keep planted areas dense and group plants with similar water needs together and make use of windbreaks.
- Prepare the soil before planting to ensure that plants can make the most of the water they need.
- Re-use water from the home in the garden – this includes bucketing greywater from the laundry and bathroom as well as water from downpipes connected to your house gutters. You can also install a subsurface greywater reuse system. For further information, contact your local council or visit www.water.wa.gov.au

Key tips for protecting our groundwater

- **Reduce your reliance on bore water.** Our rainfall has reduced, which means less water to recharge our aquifers. Continued housing development in some areas can increase the number of new garden bores and the use of groundwater.

  The Department of Water has drawn up a map of Perth's groundwater area with boundaries showing which areas are better suited for bores.

- **Design gardens and landscaping to enhance maximum absorption of rainfall into the groundwater and minimise evaporation.** Use local native plants, mulch and subsurface irrigation.
- **Reduce your use of fertilisers and chemicals.** These can contaminate groundwater, particularly products high in phosphate.
- **Reduce water use through a variety of water saving mechanisms in the home and garden.**
- **Re-use water from the home in the garden – this includes bucketing greywater from the laundry and bathroom as well as water from downpipes connected to your house gutters. You can also install a subsurface greywater reuse system. For further information, contact your local council or visit www.water.wa.gov.au**

For your watering days and other information on water saving in homes and gardens visit www.watercorporation.com.au or call 1800 508 55

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Government of **Western Australia**
Department of **Water**

Looking after all our water needs

Extracting groundwater





Water quality

The quality of groundwater can be affected in many ways.

- The use of lawn and garden fertilisers heavy in phosphate is a major issue in Perth. Phosphates easily soak through the sand plain into the aquifer, rivers, ocean, creeks and swamps. This results in aquatic life dying and the growth of dangerous algae in freshwater lakes and rivers.
- Oils, paint thinners, various workshop chemicals – if poured into the sandy soil – will soak through to the aquifer and create long-term pollution issues.
- Heavy metal particles are dangerous to our health, as are hydrocarbons. These come from vehicle fuel systems, brake linings and exhaust systems. When vehicles are parked on private driveways and carports, such material will wash into your private soak wells and eventually into the aquifer. Remember to clean out your soak wells annually, to remove any leaf and pollutant build-up. This will also aid in the efficiency of your soak wells and reduce internal flooding problems.

Groundwater – the situation

Over two-thirds of Perth's water supply comes from groundwater. The Perth region has an underground geology which includes large areas of deep sand and limestone. Rain falling over this area and running off the hills builds up underground as a shallow semi-freshwater aquifer, which is available for household bores in some areas.

The freshwater aquifer is renewed each year with rainfall. With rainfall continuing to decline in Perth, and more homes being equipped with bores, the draw on the aquifer is increasing, thus creating a threat to ongoing bore water supply.

Groundwater recharge

Traditionally, stormwater run-off from roofs and roads and other surfaces has been collected in drainage pipes and exported into the ocean or waterways.

This 'lost' water can be a valuable resource to recharge a shallow groundwater aquifer. Sandy soils are extremely permeable and well suited to infiltration of stormwater to increase groundwater levels.

Recharging the groundwater aquifer with stormwater helps manage the local water cycle balance and prevents problems associated with increased bore water extraction, acid sulphate soils, salinity and waterlogging.

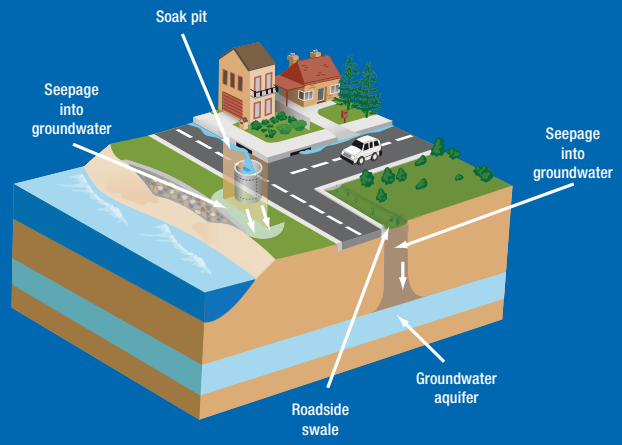


Managing local stormwater

'Stormwater' is a term used to describe the water which runs off surfaces such as houses and driveways and flows down into drains and stormwater pipes.

Poor stormwater management can damage not only individual properties but the environment in general. Local councils invest significant amounts of money into operating and maintaining the stormwater network.

Maximising infiltration of stormwater into groundwater can be achieved by replacing traditional drainage pipes with infiltration devices such as soakage pits and bioretention swales, as illustrated below.



Government of Western Australia
Department of Water

Looking after all our water needs

Water sensitive urban design

Rainwater storage and reuse systems

Summary

Rainwater storage systems are a simple method of capturing rainwater, traditionally from roofs, for use as an alternative water supply source and to reduce consumption of scheme water. When installed and maintained in accordance with recommended guidelines, they can provide a high quality source of water.

This brochure is part of a series that explain various aspects of water sensitive urban design. Please see *Water sensitive urban design in Western Australia* for background information on water sensitive urban design.

Main benefits

- Rainwater storage systems reduce the demand on potable water supplies.
- More rainwater is harvested when the tank is plumbed inside the house for uses such as toilet flushing. This creates a consistent drawdown on the tank supply, so there is always space to collect rainwater.
- They reduce the amount of directly connected impervious areas.
- They reduce stormwater peak flow rates and volumes.
- They reduce water supply peak flow rates and volumes.
- They can be retrofitted in houses and other buildings, including in high density urban areas.
- They can provide a water supply for (water sensitive) urban gardens and reduce the heat island effect in high density urban landscapes.

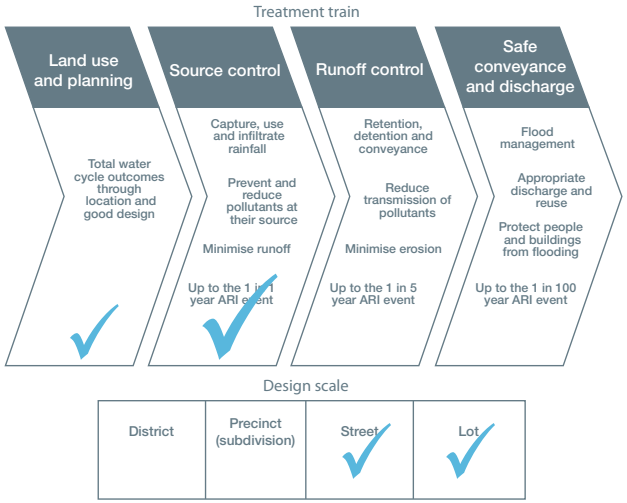
Design factors

- Put 'first flush' devices and mesh screens over all inlets and outlets to minimise maintenance requirements and preserve water quality.
- Designs for stormwater management include an air gap with trickle feed discharge level control and may include an infiltration trench or soakwell, depending on site characteristics.
- Storage can be above or below ground.
- Match storage size to collection area, end use, rainfall quantity and seasonal variability.
- Larger storage sizes are required where rainfall is unreliable and alternative supplies are not available.

Target pollutants

Rainwater storage systems are not designed to achieve direct improvements in stormwater quality.

Where they can be used in the water sensitive urban design process





Concrete underground tank



Slimline domestic rainwater tank

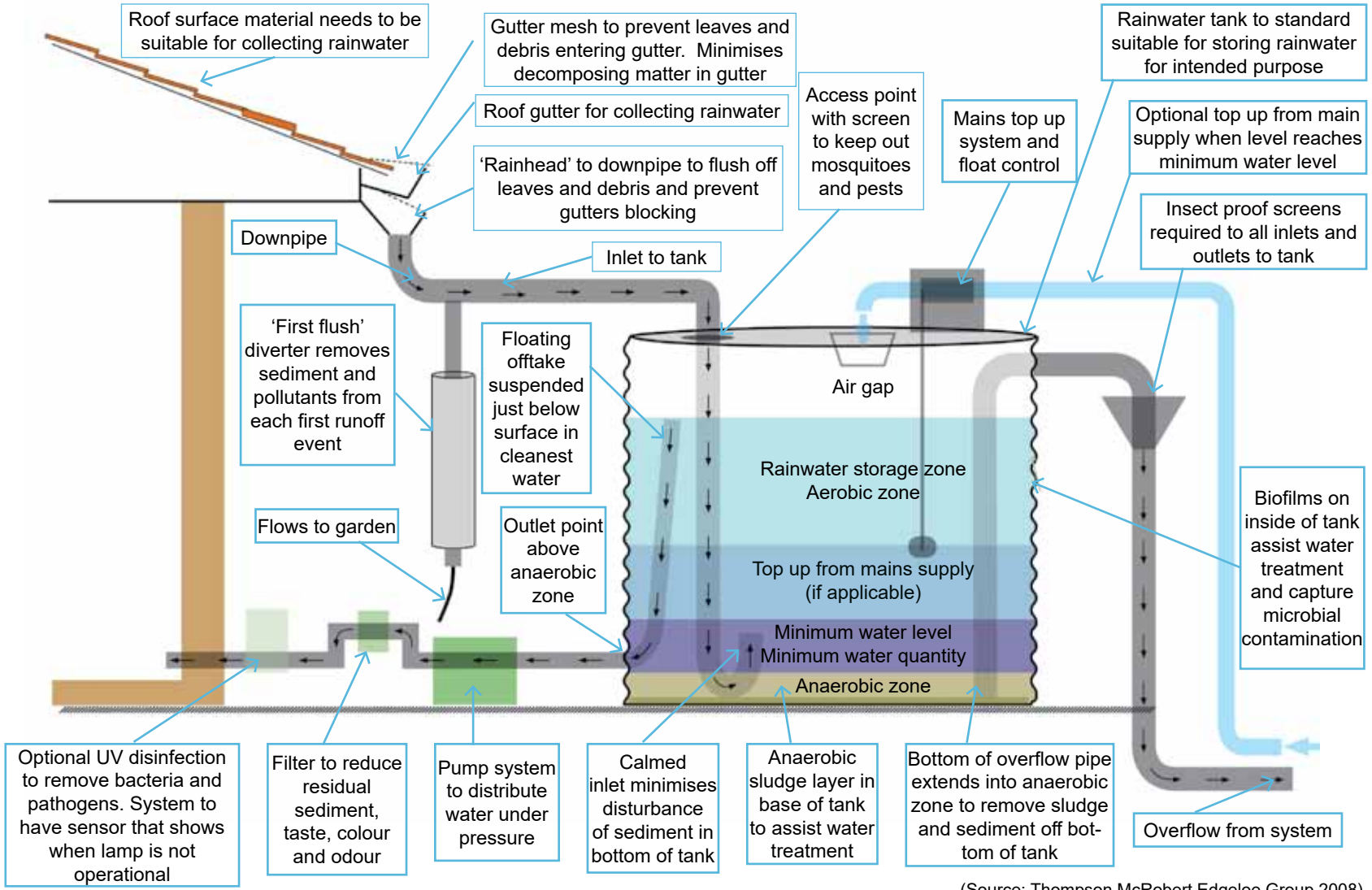


Poly domestic rainwater tanks

Water sensitive urban design

Rainwater storage and reuse systems

Example of above ground rainwater tank



(Source: Thompson McRobert Edgeloe Group 2008)

Required reading

Australian runoff quality: a guide to water sensitive urban design, 2006, Engineers Australia, available at <www.arq.org.au>.

Rainwater tank design and installation handbook, 2008, HB230-2008, Standards Australia.

Stormwater management manual for Western Australia, 2004–07, Department of Water, available at <www.water.wa.gov.au>. See Section 2.1 of Chapter 9 – Structural controls.

Testing of products for use in contact with drinking water, 2005, AS/NZS 4020:2005, Standards Australia.

Urban rainwater collection guidelines, Department of Health, Western Australia.

The department acknowledges the past project contributions of the Leschenault Catchment Council.

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Government of **Western Australia**
Department of **Water**

Saving water in the garden.

Did you know?

Pot plants use a lot more water than plants in the ground. They're more exposed to the sun and wind, only store a small amount of water and dry out faster, so you water them more.







- Reduce your lawn cover. Most of the water used in our homes goes on the lawn.
- Plant local natives. They require less water and fertiliser.
- Mulch. Organic mulches reduce evaporation and restrict weed growth.
- Collect rainwater. This will save scheme water.
- Water deeply. Watering slower, for longer, less often encourages deep root growth.
- Use greywater. Re-use your laundry and bathroom water on your garden.
- Install a drip irrigation system. This will deliver water straight to the root system.
- Landscape. Group plants to suit watering needs. Keep high water use plants together.
- Use a pool cover. It will reduce evaporation by up to 97%, saving water and money.
- Maintain. Check taps and reticulation regularly for leaks and blockages.

Government of **Western Australia**
Department of **Water**

Grow local native plants and save water.

Did you know?

About half the water typically used in our homes is used to water the garden, generally lawns. Many of us water a large lawn and only use part of that lawn. Some of us overwater even those parts of the lawn we do use regularly. Think about the areas of lawn you use regularly and whether you can reduce the amount of watering. Similarly, often the plant species in our gardens are exotic and not suitable to our climate, needing more water to survive. These can be regrouped together and more waterwise plants put in their place.





- Local native plants are best suited to the local climate, conditions and soil.
- They require less water, fertiliser and maintenance.
- They attract local wildlife, insects and birds.
- They have minimal impact on the environment, unlike some introduced species which have become bushland weeds.
- Local plants represent local heritage, teaching us about nature and our local identity.

Government of **Western Australia**
Department of **Water**

Protect and maintain our local water supplies. FertiliseWISE.



Did you know?

Fertilisers are a major contributor to surface and groundwater contamination. They run off into the stormwater system through roadside drains, collect in sumps and leach into the groundwater system. They also wash into the rivers and sea, creeks and swamps where they can do major damage to reefs and aquatic life.







WHAT YOU CAN DO TO HELP

• Minimise lawn areas and use plants that don't use fertiliser • Grow local native plants – they require less water and fertiliser • Where possible, use organic fertilisers • If you must use a chemical fertiliser, look for one that is phosphorus free. Use a nitrogen to phosphorus to potassium (N:P:K) ratio of 10:0:6. • Use a slow release fertiliser • Only apply in spring or early autumn, not in winter or summer • Fertilise only when symptoms of deficiency occur (e.g. yellowing) • Use liquid fertiliser if you have a subsurface irrigation system • Compost your garden waste • Don't fertilise near waterways or road verges • Don't let grass clippings or leaves go down the drain • Wash your car on the lawn (if you have any) not on the driveway • Pick up after your dog • Use phosphorus-free detergents (always read the labels)

Top 5 tips for saving water in the kitchen

Did you know the kitchen is a major consumer of water in the home using around 10 per cent of total household water for consumption for cooking, cleaning, washing or drinking?

If you follow these simple tips you can reduce your use dramatically.

- If you have a leaking tap, replace the washer or other components as required. Dripping taps can waste 30 – 200 litres of water per day.
- Look for dishwashers that have a National Water Conservation or WELS Label. The best water rating achieved by dishwashers is 5 stars.
- To avoid wasting warm water from a running tap when you first turn it on, collect it in a bottle or a jug and store it in the fridge until it is cool enough to drink.
- Only use dishwashers when you have full load.
- When boiling vegetables, use enough water to cover them and keep the lid on the saucepan. Your vegetables will boil quicker and it will save you water and power.

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Copies of this document are also available in alternative formats on request for those with special needs. The Department of Water is committed to quality service to its customers and makes every attempt to ensure accuracy, currency and reliability of the data contained in this document. However, changes in circumstances after time of publication may impact the quality of this information.

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Government of **Western Australia**
Department of **Water**

WATER SAVING TIPS

Saving water in the home

Looking after all our water needs









In southern Western Australia, water resources are under pressure due to reduced rainfall, increased population and other factors.

With the current pressure on Western Australia's water resources, it's time for us all to do our bit to protect and maintain them.

Did you know?

In the typical house, the use of showers, clothes washing machines and toilets can consume more than three quarters of all indoor water use. In the majority of homes, all of this quality drinking water is used once then goes to the sewer. There are now simple, low cost ways of reducing this water use whilst saving on your water costs.



Water use in the home and garden

Consider the following to reduce water use:

- Don't use drinking quality water to water your garden. Use bore water and/or water recycled from showers and clothes washing machines (grey water).
- Use covers on swimming pools and spas, to reduce evaporation. Evaporation can remove more water from a pool per year than toilet use in a home.
- A home can be cooled in summer using good orientation, window shading, natural ventilation and fans. This could remove the need for an air conditioner, particularly evaporative, where large amounts of water are used.
- All new houses must adhere to the criteria of 5 Star Plus for water efficiency, but the guidelines can also be used when renovating to help create a more waterwise home.
- Install flow control aerators on taps. They are inexpensive and can reduce water flow by 50 per cent.

Find out more

For information on greywater use and systems visit the Department of Health website at www.health.wa.gov.au
For waterwise tips see the Water Corporation website at www.watercorporation.com.au and follow the "Being Waterwise" links.
To find out more visit www.water.wa.gov.au

What you can do to help?

- **Buy and install water smart fittings and appliances in the kitchen, bathroom and laundry.** Low flow showers and taps, systems that store colder water while the hot tap is reaching the desired temperature, toilets with lower flush volumes, waterless toilets, front loading washing machines etc are all modern ways of saving on water use and cost.
- **Consider installing rainwater tanks.** The stored water can be used in a number of ways, even in Perth where there are less summer rain events. Such water can be plumbed into toilets and reduce the use of high-quality treated scheme water for flushing.
- **Install a waterwise garden and/or irrigation system.** The garden and irrigation system can be designed to minimize water use.

Use products and services with the Smart Approved WaterMark label. This is a water saving program for outdoor water use and ensures any product bearing the label will save water.

Visit www.smartwatermark.org for more information

APPENDIX 10 – TRAFFIC IMPACT ASSESSMENT

Porter
Consulting Engineers

TRAFFIC ASSESSMENT
REPORT

SKEET ROAD
DEVELOPMENT SITE
HARRISSDALE

STRUCTURE PLAN

Porter

REPORT PREPARED FOR

Yolk Property Group

Prepared by	**Porter Consulting Engineers**
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Job number	20-02-020
Date	25/08/2023
Our reference	R37.21
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Revision	Date issued	Author	Issued to	Revision type
Rev A	08/07/2021	JH	Yolk Property Group	First Issue
Rev B	04/07/2022	JH	Yolk Property Group	Amended Structure Plan
Rev C	25/08/2023	JH	Yolk Property Group	Amended Structure Plan

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1.0 INTRODUCTION

1.1 Background

Porter Consulting Engineers has been engaged to prepare a Transport Impact Assessment (TIA) for the Local Structure Plan for the lots bounded by Ranford Road, Balannup Road, Reilly Road and Skeet Road in Harrisdale, City of Armadale. The Site comprises of the creation of approximately 280 residential dwellings with some commercial lots. **Figure 1.1** shows an aerial view of the Site and its immediate surrounds.

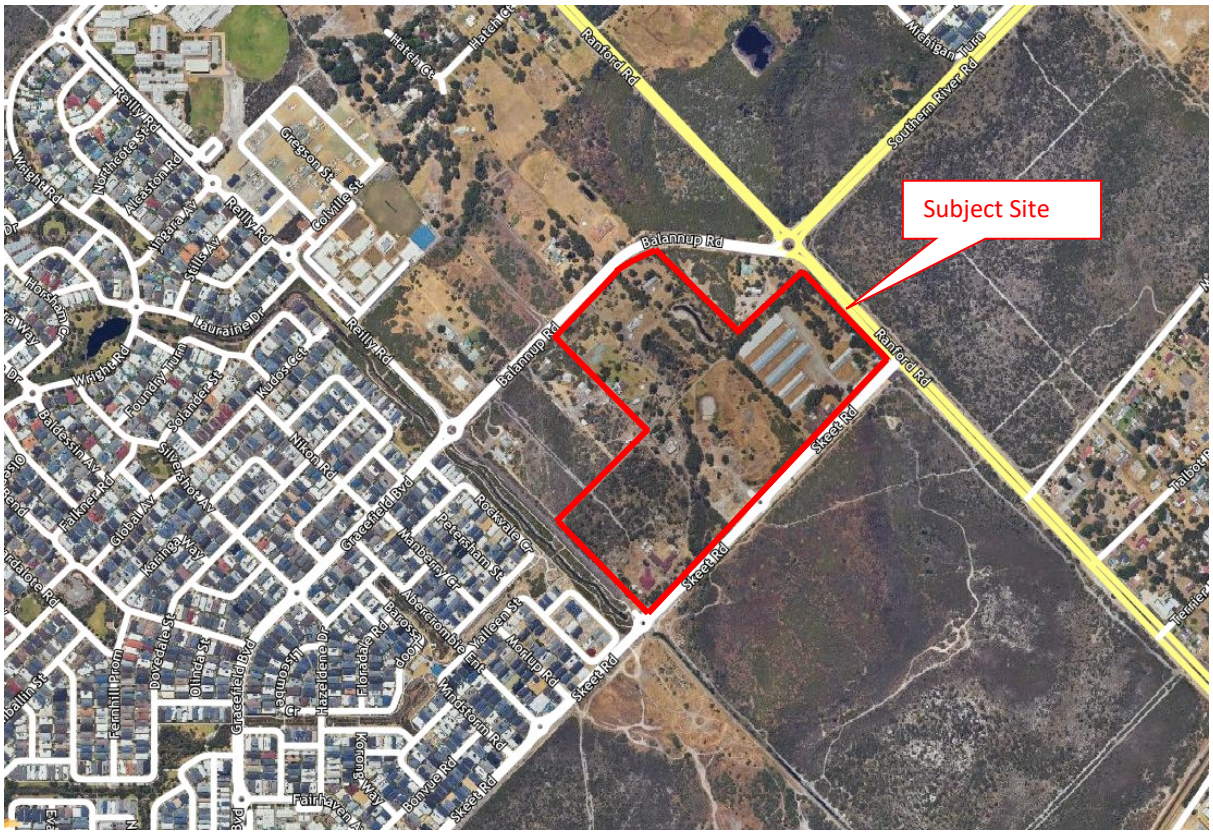


Figure 1.1: Aerial View of Site

1.2 Scope of Assessment

The intent of this assessment is to provide the approving authority with sufficient traffic information to confirm that the proponent has adequately considered the traffic aspects of the development.

2.0 STRUCTURE PLAN PROPOSAL

2.1 Structure Plan Context

The subject Site is currently zoned *"urban"* under the Metropolitan Region Scheme. The Site is subject to the provisions under the City of Armadale Town Planning Scheme No.4 where it is zoned as *General Rural.* To the southwest of the Site is a newly developed residential area, to the northwest is also a similarly zoned general rural and urban deferred land, to the southeast and northeast the area is zoned *Parks and Reserves.*

Figure 2.1 shows the subject Site in a local zoning context.



Figure 2.1: Structure Plan Lots (*City of Armadale Intramaps*)

The Site is situated approximately 28 km to the southeast of the Perth CBD and 33 km northeast of Rockingham Centre. Major regional roads within close proximity include Ranford Road, Nicholson Road, Tonkin Highway and Armadale Road. **Figure 2.2** shows the Site in a regional context.

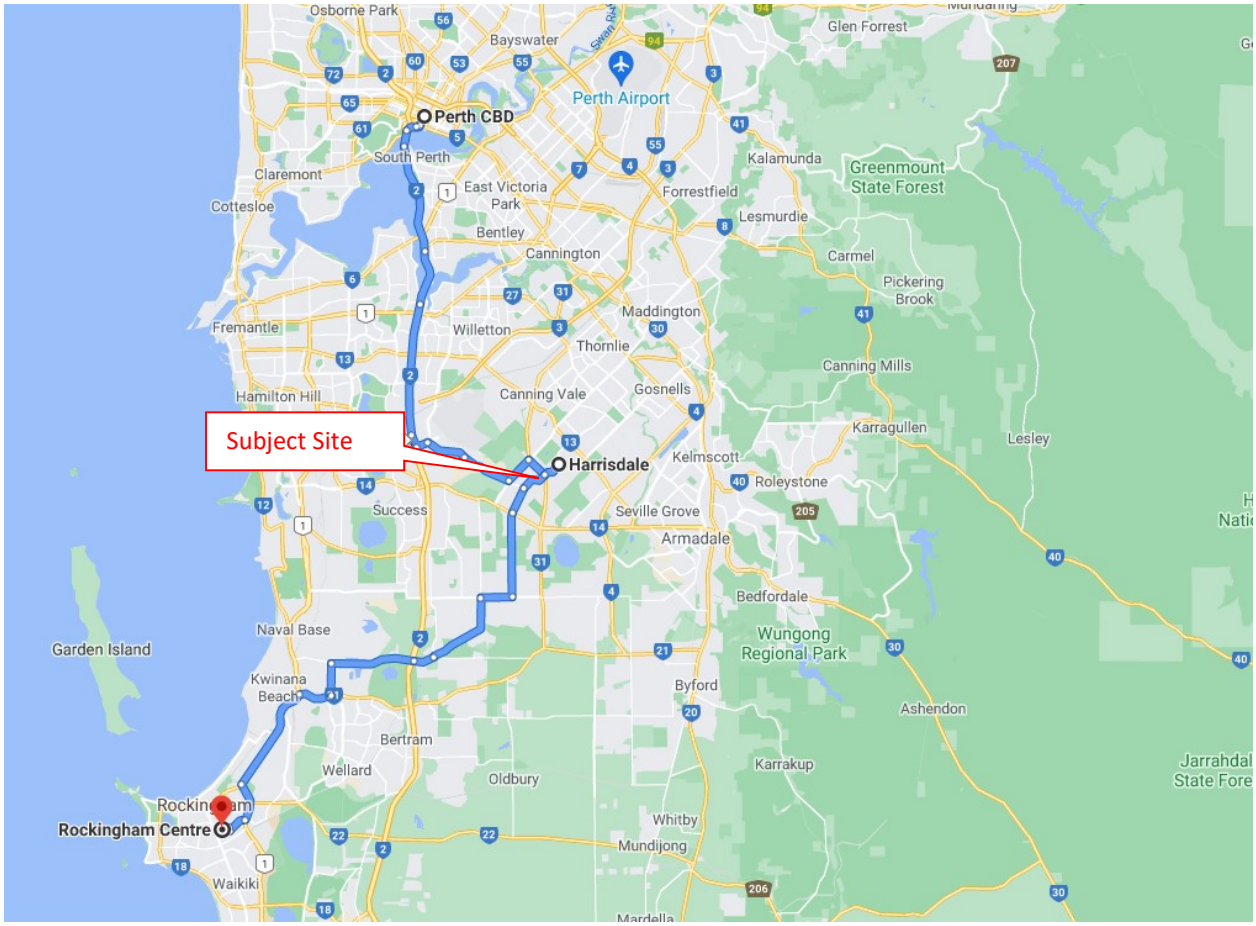


Figure 2.2: Location in a Regional Context

2.2 Proposed Land Uses

The indicative lot yield for the purpose of the traffic assessment is for 280 residential dwellings with a small number of commercial lots (total area 8,000 m^2) also proposed fronting Ranford Road. For the purpose of the Structure Plan the indicative land uses for the commercial lots are assumed to be general low use commercial. The development application process would confirm the ultimate commercial types of land use.

Table 2.1: Proposed Land Uses

Land Use	
Single Residential	280 dwellings
Commercial	8,000 m^2 (4,000m2 GFA)

A copy of the Structure Plan layout is included in **Appendix A.**

2.3 Major Attractors and Generators of Traffic

Within the proposed Structure Plan, the residential dwellings are the major traffic generating land use. Surrounding attractors within close proximity to these residential dwellings are shown in **Figure 2.3** and include:

- Carey Baptist College, Harrisdale
- North Harrisdale Primary School
- Harrisdale Primary School
- Harrisdale Senior High School
- Harrisdale Community Sporting Pavilion and Oval
- Southern River Shopping Centre
- Stockland Harrisdale Shopping Centre

The Structure Plan will also include Public Open Space (POS). The majority of the POS is likely to be passive and is driven by the environmental site conditions. A small active POS is to be provided however it is not envisaged to be a major attractor for external trips with its purpose to primarily service the Structure Plan local residential dwellings only.

The small commercial zone fronting Ranford Road would be a trip attractor however these trips would primarily remain on the existing external road network.

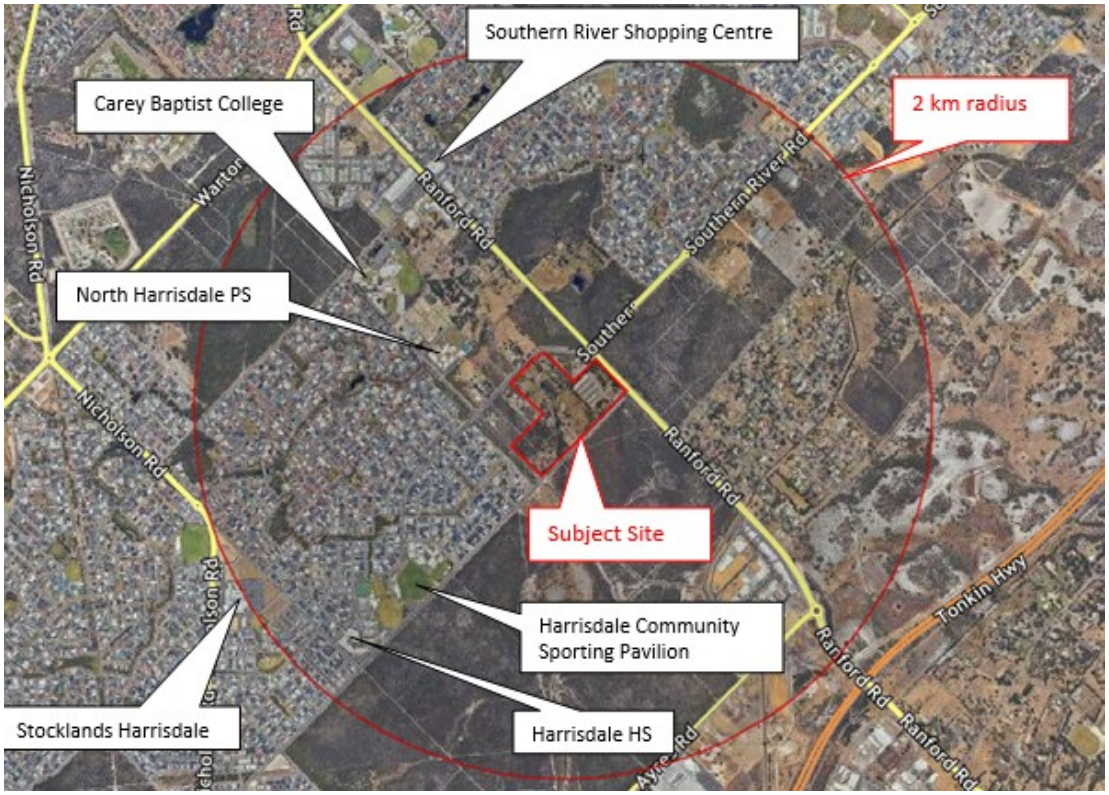


Figure 2.3: Major Attractors within 2 km

3.0 ROAD NETWORK SITUATION

3.1 Existing Road Network

The Site is bounded on the northeast by Ranford Road, on the northwest by Balannup Road, on the southwest by Reilly Road reserve (carriageway is yet to be constructed) and on the southeast by Skeet Road.

Figure 3.1 illustrates the road network within approximately 2 kilometres surrounding the Site. Key distributor roads surrounding the Site include: Ranford Road, Nicholson Road, Warton Road, Tonkin Highway and Southern River Road. Local distributor roads include Balannup Road and Wright Road.



Figure 3.1: Existing Surrounding Road Network

3.2 Road Infrastructure and Road Hierarchy Classification

The road hierarchy classification of the surrounding road network as defined by the Main Roads WA functional road hierarchy is shown in **Figure 3.2**.

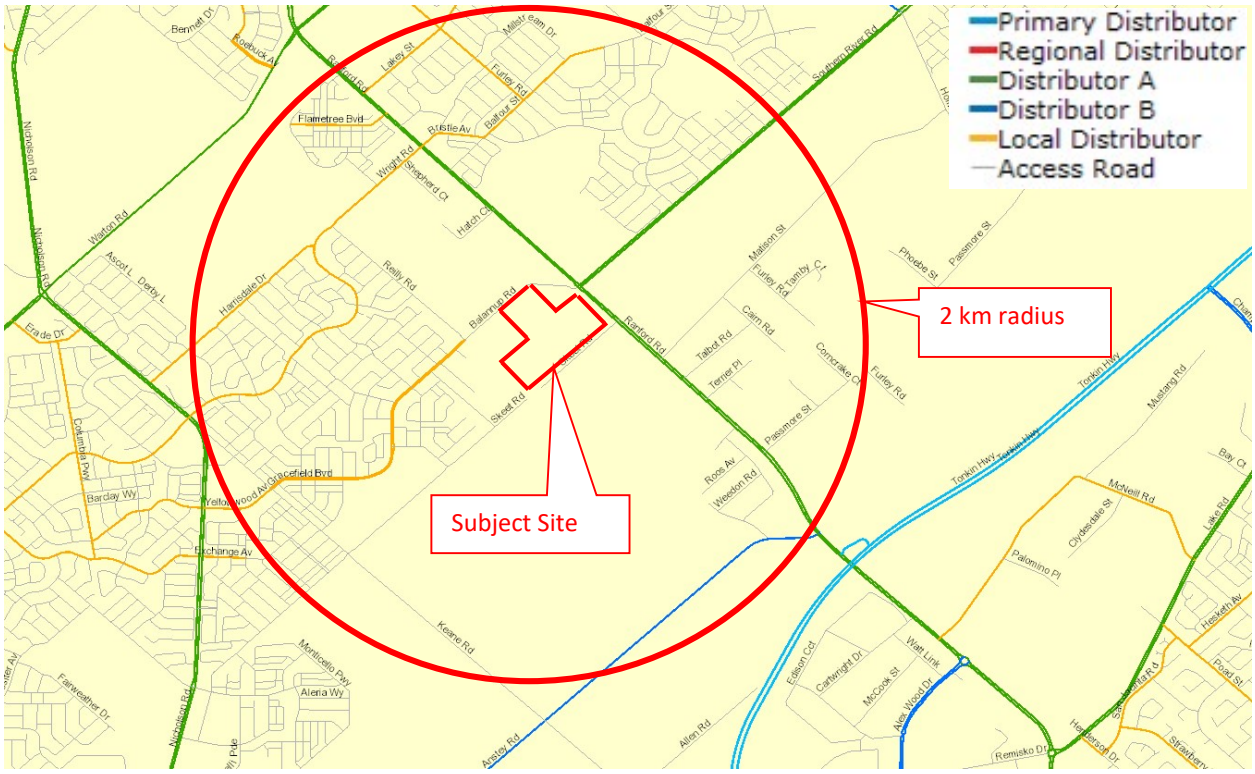


Figure 3.2 Functional Road Hierarchy (MRWA)

Ranford Road

Ranford Road forms part of the District Distributor (A) Road network and as such is controlled by the City of Armadale. By definition its function is to "*carry traffic between industrial, commercial and residential areas and generally connect to Primary Distributors.*" This road runs in a generally northwest - southeast direction and forms the north-eastern boundary of the Site. To the northwest Ranford Road transitions to South Street near Roe Highway. South Street forms part of the Primary Distributor network and as such is controlled by Main Roads WA. Ranford Road forms part of the State Road Network No 13. Ranford Road is designated as a blue road (other regional road) under the Metropolitan Region Scheme.

Ranford Road adjacent to the Site is constructed to a four lane median-divided standard and includes sealed shoulders. To the northwest adjacent to the Site Ranford Road connects to Balannup Road controlled via a dual lane roundabout and to the southeast of the Site Skeet Road forms the minor leg of a channelised T-junction controlled by give way with Ranford Road.

The existing sign posted speed limit is 80km/hr adjacent to the Site.

There are current concepts to ultimately upgrade Ranford Road to 6 lanes divided carriageway standard. DPLH are currently investigating the future intersection control associated with the Ranford Road upgrade at Balannup Road/Southern River Road and at Skeet Road.



Figure 3.3 Ranford Road, looking northwest toward Balannup Road roundabout



Figure 3.4 Ranford Road, looking southeast toward Skeet Road

Balannup Road

Balannup Road (and Gracefield Boulevard – west of Reilly Road) is classified as a Local Distributor road whose role is to "*carry traffic within a cell and link District Distributors or Primary Distributors at the boundary, to access roads*." These roads should discourage through traffic and therefore primarily carrying local traffic. They should accommodate buses, but discourage trucks. Balannup Road is classified as a bus route. Balannup Road is classified as a Neighbourhood Connector A as outlined by *Liveable Neighbourhoods.*

Balannup Road runs in a southwest - northeast direction and forms the northern boundary of the Site. Its south-western end forms the minor road of the T-junction with Nicholson Road whilst its north-eastern end forms a 4-way roundabout with Ranford Road and Southern River Road.

Balannup Road and Gracefield Boulevard is constructed to a two lane standard with a solid median. On road cycle lanes are included along its length. Directly adjacent to the Site there is no path constructed however a dual use path is located on the northwest side. Where Balannup Road transitions to Gracefield Boulevard (at Reilly Road) the dual use path is typically located on the southeast side with a narrower footpath located on the northwest side.

Typically, intersections created with Balannup Road/Gracefield Boulevard are restricted to left turn movements only with the exception of strategically placed roundabouts along its length that permit all movements. Direct property access occurs along this local distributor road.

Balannup Road/Gracefield Boulevard is subject to the default urban speed limit of 50km/hr.



Figure 3.5 Balannup Road, looking southwest adjacent to the Site

Skeet Road

Skeet Road forms the southeast boundary of the Site. Skeet Road is currently classified as a local access road whose role is defined as "*to provide access to abutting properties with amenity, safety and aesthetic aspects having priority over the vehicle movement function."* It is envisaged with increased development in the region and traffic flows the function of Skeet Road would be more in line with the definition of a local distributor road i.e. similar to Balannup Road.Skeet Road is classified as a Neighbourhood Connector A as outlined by *Liveable Neighbourhoods.*

Skeet Road runs in a southwest - northeast direction and forms the south-eastern boundary of the Site. Its south-western end links to Riva Entrance near Nicholson Road whilst its north-eastern end forms the minor leg of a T-junction with Ranford Road.

Skeet Road is constructed to a two lane standard with a solid median. On road cycle lanes are included along its length. At the time of the assessment Skeet Road between Reilly Road and Ranford Road was under construction and had not yet been re-opened to traffic. A dual use path is located along its northwest side directly abutting the Site.

As per Balannup Road, intersections created with Skeet Road are restricted to left turn movements only with the exception of strategically placed roundabouts that permit full movements. Unlike Balannup Road existing property access along Skeet Road, west of Keane Road generally occurs via rear laneways. East of Keane Road direct access along Skeet Road is permitted from residential dwellings.

Skeet Road is subject to the built up area default speed limit of 50km/h.



Figure 3.6 Skeet Road, looking southwest towards Abercrombie Entrance roundabout

Reilly Road

The unconstructed section of Reilly Road between Balannup Road and Skeet Road forms the southeast boundary of the Site.

Reilly Road is currently classified as a local access road whose role is defined as "*to provide access to abutting properties with amenity, safety and aesthetic aspects having priority over the vehicle movement function."* Reilly Road is classified as a Neighbourhood Connector B as outlined by *Liveable Neighbourhoods.*

Reilly Road runs in a northwest - southeast direction and forms the southwest boundary of the Site. Its northwest end links to Wright Road as a T-junction whilst its southeast end currently ends at Balannup Road however is ultimately proposed to extend to Skeet Road.

Reilly Road is constructed to a two lane standard. Within the unconstructed road length there is an existing dual use path constructed on the southwest side of the road reserve.

Reilly Road is subject to the built up area default speed limit of 50km/h.

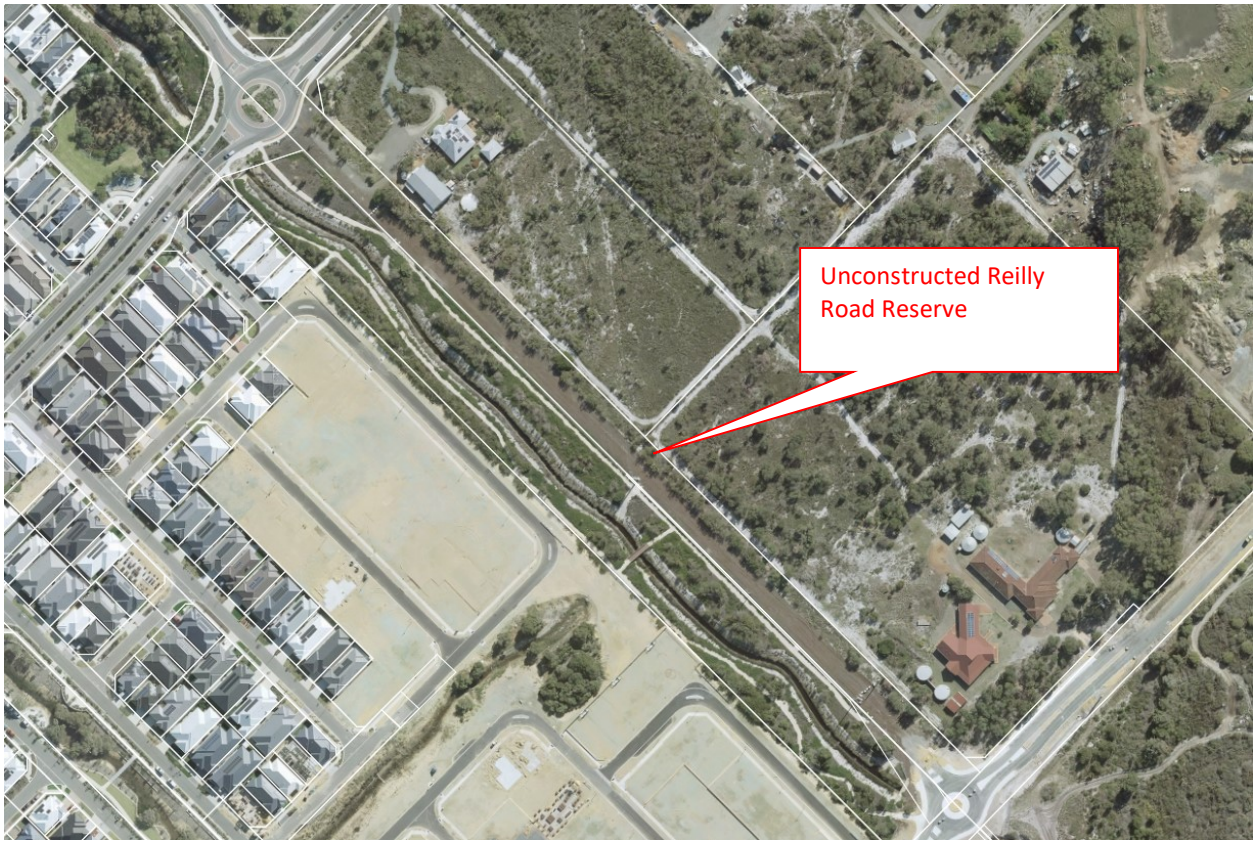


Figure 3.7 Unconstructed Reilly Road link between Balannup Road and Skeet Road

3.3 Existing Traffic Volumes

Table 3.1 and **Figure 3.8** show the traffic flows recorded on the road network surrounding the development Site obtained from Main Roads WA traffic map website and the City of Armadale.

Table 3.1: Recorded Traffic Volumes on the Surrounding Road Network

Location	Date	AWT (veh/day)	ADT (veh/day)	Heavy Vehicles (%)	85%ile Speed (km/h)	Mean Speed (km/h)
Ranford Road, south of Southern River Rd	2019/20	29,337 14,976 (N) 14,361 (S)	26,692 13,626 (N) 13,066 (S)	8.0	75.0	67.9
Southern River Rd, east of Ranford Rd	2019/20	9,277 4,811 (E) 4,466 (W)	8,440 4,377 (E) 4,063 (W)	7.3	73.3	66.3
Balannup Road, northeast of Reilly Road	Aug 2020	5,668 2,787 (E) 2,881 (W)	5231 2,575 (E) 2,656 (W)	2.3 2.7	67.0 67.5	59.8 59.9
Gracefield Bvd, north of Gleeson Way	Sept 2020	1,910 (N)	1,865 (N)	1.5	55.6	48.8
Gracefield Bvd, Btw Nikon Rd and Abercrombie Ent	Feb 2019	2,382 (N) 2,453 (S)	2,162 (N) 2,239 (S)	1.9 1.9	57.8 54.5	50.5 47.7
Gracefield Bvd, West of Argo Way	Mar 2018	1,932	1,782	4.8	58.0	50.8
Wright Road, south of Harrisdale Drive	Dec 2019	4,122	4,115	3.9	54.2	47.9
Wright Road, south of Reilly Road	Dec 2019	6,535	6,461	2.7	45.9	41.4
Harrisdale Drive, west of Wright Road	Aug 2018	3,103	2,916	1.3	47.2	42.0
Reilly Road, North of Balannup Road	Mar 2018	1,380	1,277	5.4	63.2	55.2
Reilly Road, North of Mingara Road	April 2018	1,242	1,134	1.3	40.0	33.5
Silvershot Avenue, Near Wright Rd	Mar 2018	2,408	2,282	1.8	40.1	34.8
Skeet Road, West of Limestone Rise	Aug 2020	1,266 (E)	1,191 (E)	4.1	49.1	42.9

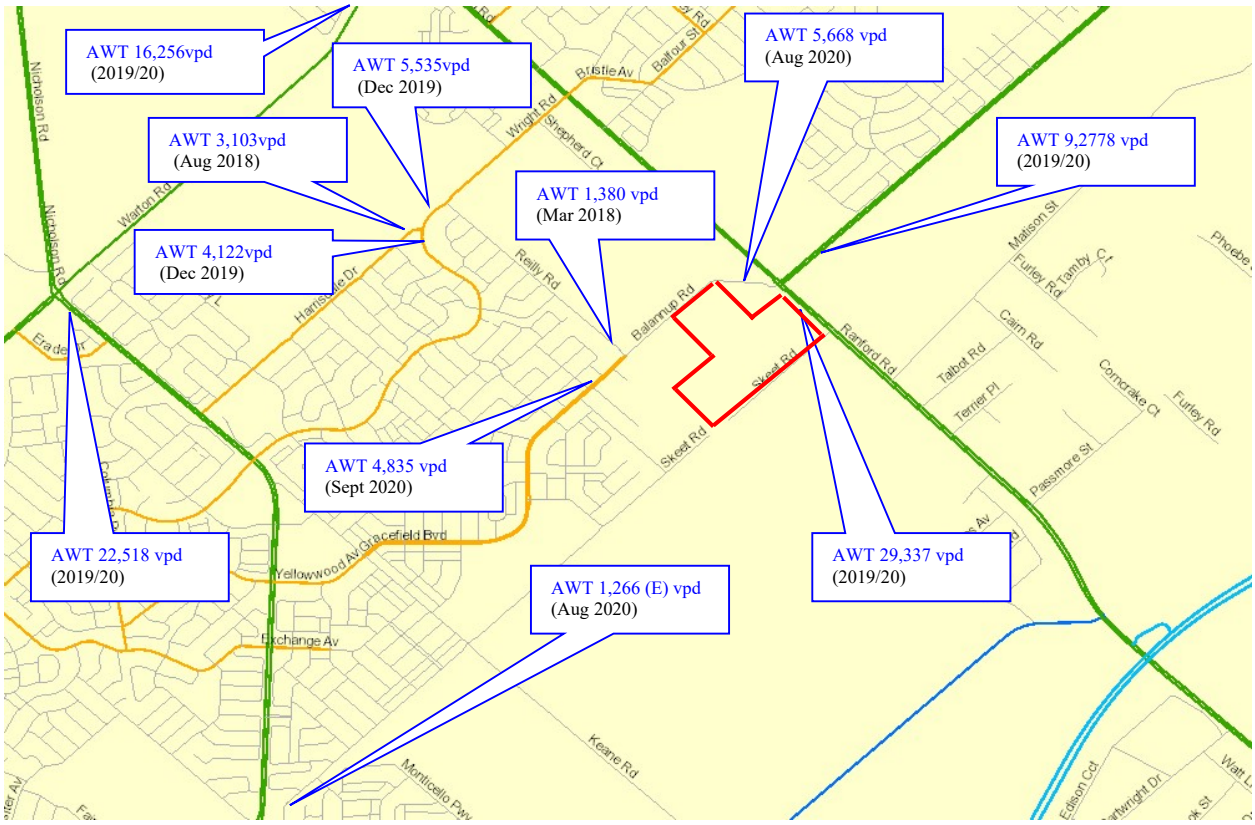


Figure 3.8. Existing Traffic Volumes on the Surrounding Road Network

3.4 Existing Traffic Counts

Existing traffic counts were undertaken on Thursday 27th May 2021 during the typical am and pm peak hours at:

- Balannup Road, Ranford Road and Southern River Road roundabout;
- Balannup Road and Reilly Road roundabout.

Appendix C includes the detailed intersection turn counts for the peak hours.

3.5 Crash History

A study of the recent crash history for Ranford Road, Balannup Road, Skeet Road in the vicinity of the Site has been conducted for the five year period to the end of December 2022 from the Main Roads Western Australia Integrated Road Information System (IRIS) crash database. There were a total of 91 crashes in the vicinity of the Site, with the majority of these occurring at the existing roundabout of Ranford Road and Balannup Road. The database records the crashes as outlined in **Table 3.2 and Figure 3.9.**

Table 3.2: Summary of Crashes in the vicinity of the Site

		Crash Severity				
Crash Nature	**Total**	**Fatal**	**Hospital**	**Medical**	**PDO Major**	**PDO Minor**
Balannup Road/Ranford Road	***82***	***-***	***1***	***11***	***50***	***20***
Right Angle	26	-	-	3	17	6
Right turn thru	11	-	-	1	10	-
Rear End	31	-	1	7	15	8
Sideswipe same direction	8	-	-	-	6	2
Hit Object	3	-	-	-	1	2
Non Collision	2	-	-	-	1	1
Not Known	1	-	-	-	-	1
Balannup Road/ Reilly Road	***1***	***-***	***-***	***-***	***1***	***-***
Hit Object	1	-	-	-	1	-
Skeet Road / Ranford Road	***3***	***-***	***-***	***-***	***2***	***1***
Right Angle	1	-	-	-	2	1
Mid block / Balannup Road	***1***	***-***	***-***	***-***	***1***	***-***
Hit Object	1	-	-	-	1	-
Mid Block / Ranford Road	***4***	***-***	***-***	***-***	***4***	-
Rear End	1	-	-	-	1	-
Sideswipe same direction	1	-	-	-	2	-
Non Collision	1	-	-	-	1	-



Figure 3.9. Location of crashes in the vicinity of the Site

3.6 RAV Network

The existing adjacent road network does not allow for the movements of Restricted Access Vehicles (RAV). Typically, the existing road network will accommodate RAV 2, RAV 3 and RAV 4 combinations along Ranford Road, between Armadale Road and Allen Road located approximately 880m to the south of Skeet Road. Refer **Figure 3.10.** Access via RAV vehicles would not be required by the Structure Plan.

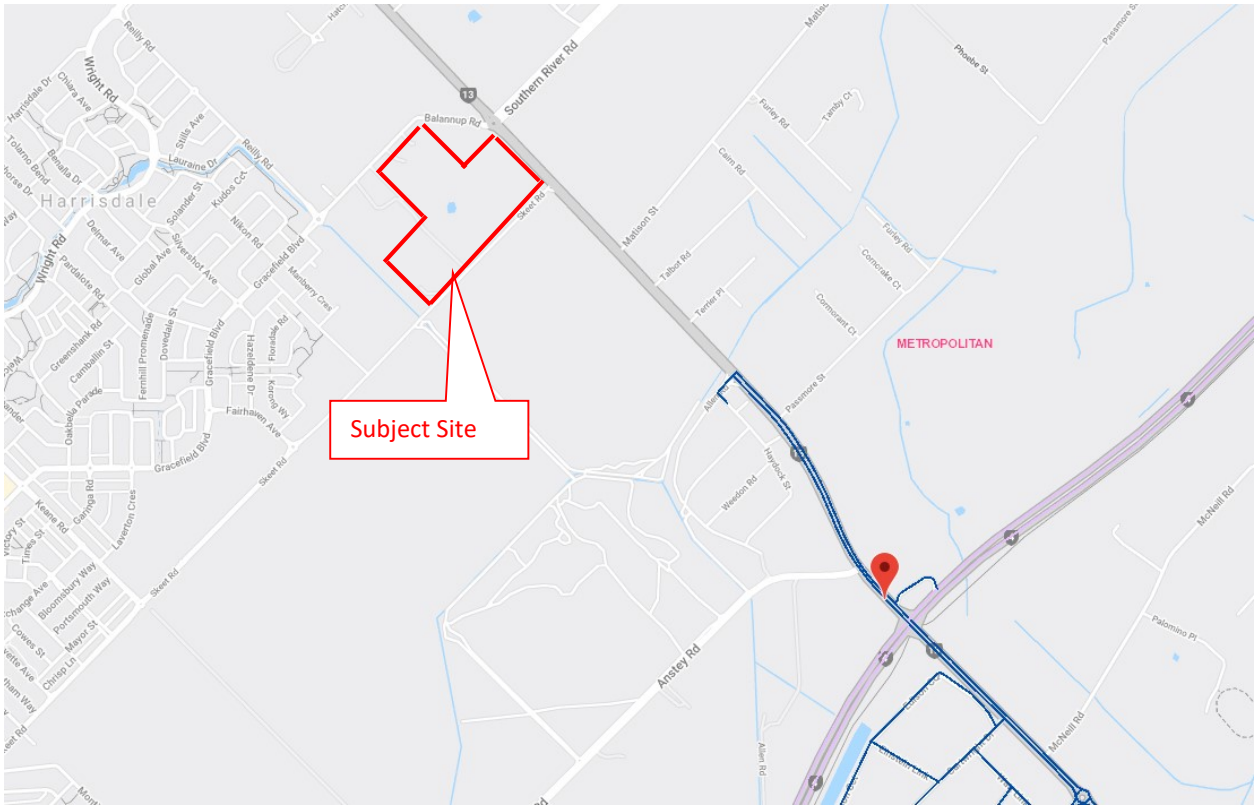


Figure 3.10. RAV Network (MRWA)

3.7 Public Transport

Route 233 is currently the closest service for the development. Public Transport Authority (PTA) have advised that this service is likely to be the only option until the local area expands and demand increases.

Route 233 operates between Gosnells Station and Cockburn Central Station via Balannup Rd/ Gracefield Bvd. This service commenced at the beginning of 2021 with a service every 15 minutes in the peak and every 60 minutes at all other times and operates 7 days a week.

The nearest operational stops for Route 233 are Stops 28333 / 28335 on Gracefield Bvd. Only a portion of the Structure Plan falls within a 400m radius of these stops with the majority of

this being Public Open Space. (Refer **Figure 3.11**) PTA have indicated that new additional stops could be considered with the development of the Structure Plan.

In the longer term, PTA advise the future Route 260 is planned to operate along Ranford Rd along the north eastern boundary of the site. This route would operate between Armadale Station and Murdoch Station via the future Ranford Station.

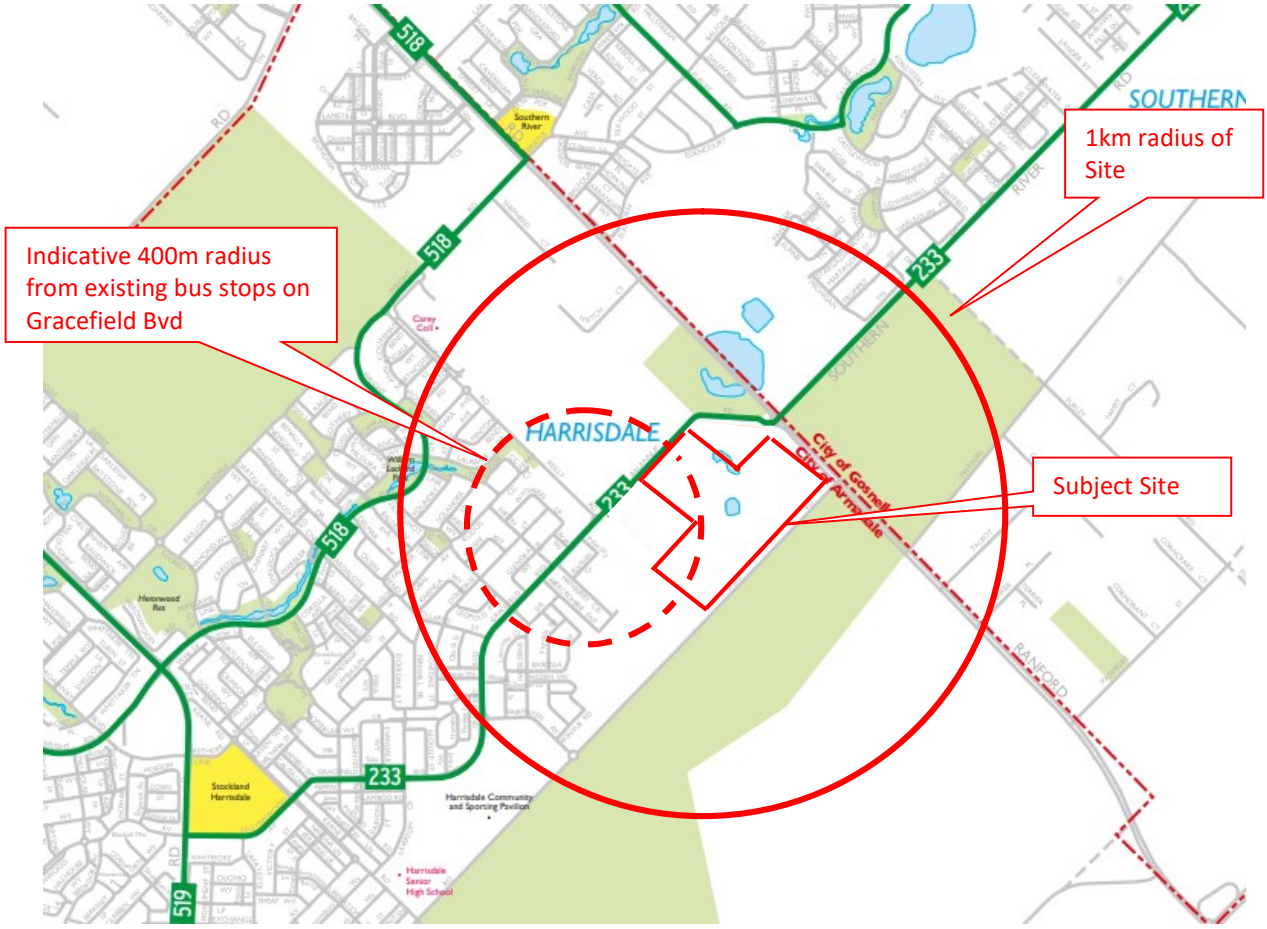


Figure 3.11: Existing Public Transport Routes Surrounding the Site (*PTA Network Maps)*

3.8 Pedestrian and Cyclist Network

The recently constructed Skeet Road includes a 2.5m path on the same side as in the Structure Plan whilst on Balannup Road a path is provided on the opposite side to the Structure Plan. Whilst Reilly Road between Skeet Road and Balannup Road is not constructed there is a path link constructed along this link to cater for cyclists and pedestrians.

Ranford Road currently includes a Principle Shared Path (PSP) along its southwestern side, northwest of Balannup Road. To the south of Balannup Road on road cycle lanes are

provided only. **Figure 3.12** outlines the existing path network surrounding the Structure Plan. On road cycle lanes are provided along both Skeet Road and Balannup Road.



Figure 3.13 outlines the long term cycling network in proximity to the Structure Plan indicating that the Structure Plan will continue in the long term and have good access to cycling infrastructure.

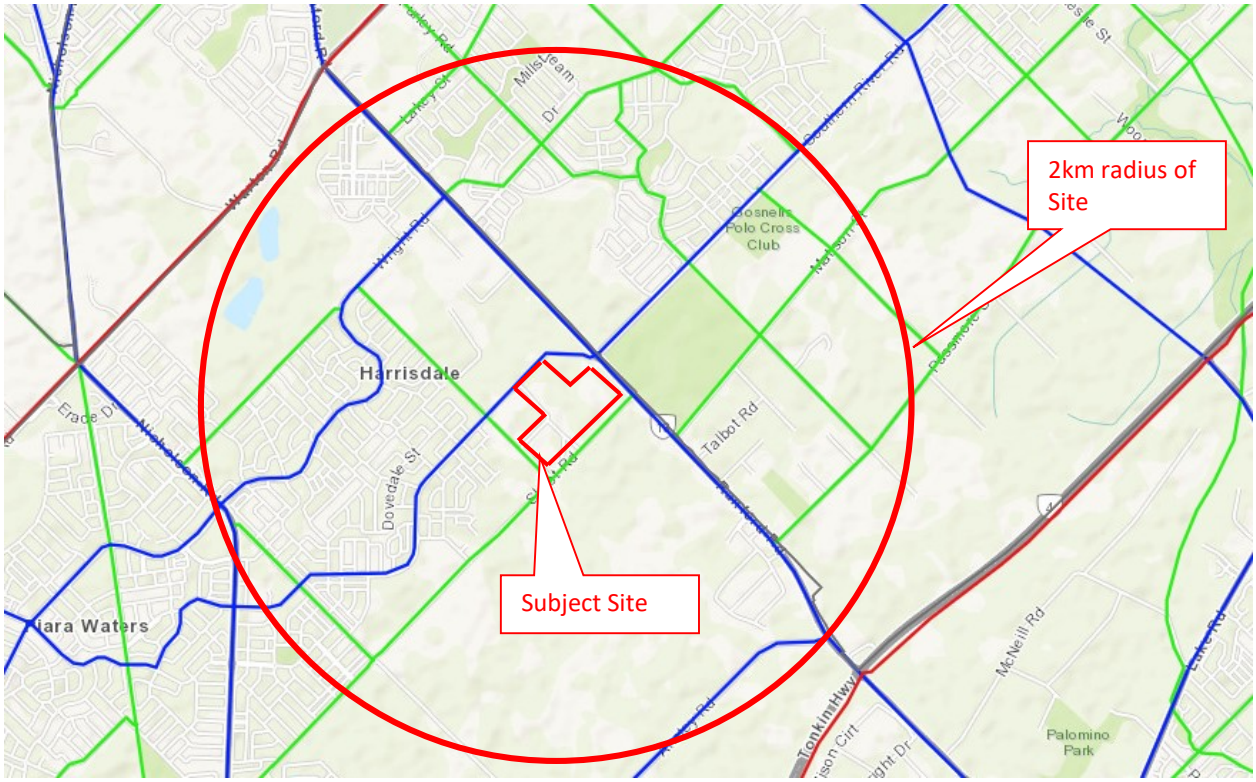


Figure 3.13: Long Term Cycle Path Network Surrounding the Site (*Department of Transport)*

4.0 PROPOSED INTERNAL ROAD TRANSPORT NETWORK

4.1 Connections to the Existing Road Network

The Site does not currently have any existing roads located within it. The Site abuts Ranford Road to the northeast, Balannup Road to the northwest, Skeet Road to the southeast and unconstructed road reserve for Reilly Road to the southwest.

Five new road network connections from the Structure Plan are proposed as follows:

- Balannup Road – new T-junction, full movements, roundabout;
- Balannup Road – new T-junction, left in and left out only;
- Skeet Road – new T-junction, full movements, roundabout;
- Skeet Road – new T-junction, left in left out; and
- Reilly Road (yet to be constructed) – new T-junction, full movements.

The new Balannup Road T-junction left in and left out is proposed to be located to the southwest of an existing horizontal curve. Austroads *"Guide to Road Design Part 4A: Unsignalised and Signalised Intersections"* makes recommendations for Safe Intersection Sight Distance. Based on a design speed of 60km/h (default urban speed limit +10km/h) along Balannup Road the sight distance required is 123m for this left in left out t-junction based on a reaction time of 2 seconds. Preliminary checks indicate that appropriate sight lines can be provided. The verge area will need to remain predominantly clear of obstructions (including vegetation) to ensure sight lines are maintained. Refer **Figure 4.1**.



Figure 4.1: Indicative Sight Lines from Proposed Left in Left out T-Junction on Balannup Road

4.2 Road Hierarchy, Road Reserve Widths and Road Cross Sections

Accordingly to Liveable Neighbourhoods standards Balannup Road and Skeet Road abutting the Structure Plan function as Neighbourhood Connector (type A) roads. They carry traffic from within the neighbourhood, have frequent local street connections, facilitate pedestrian and cyclists, (on road cycle lanes), accommodate buses (Balannup Road) and link to Integrator Arterial Roads i.e. Ranford Road and Nicholson Road and are up to 3km in length. Both roads typically comprise of a central median, on road cycle lanes (given traffic volumes are >3,000vpd), and paths abutting development where it occurs on both sides. The road reserves of Balannup Road and Skeet Road are approximately 25m and 20m respectively.

Reilly Road between Wright Road and Balannup Road and in the future to Skeet Road also functions as Neighbourhood Connector Road (type B). Unlike Skeet Road and Balannup Road it does not link higher order Integrator Arterial road and will ultimately be some 1.5km in length. It comprises of a of single carriageway (no median) with paths on both sides of the road with a road reserve of approximately 20m.

Figure 4.2 outlines the proposed road classification of the Structure Plan road with respect to the existing road network based on Liveable Neighbourhood principles. The main north - south spine road of the Structure Plan (between Balannup Road and Skeet Road) functions as a local access road approximately 500m in length that primarily provides access to residential lots and other internal local access roads within the Structure Plan.

A 20m road reserve is proposed for the main north-south spine road. This road reserve is envisaged to provide on street parking adjacent to the POS and rear access properties between Skeet Road and the first internal side road as shown in **Figure 4.3**. On road cycle lanes are not envisaged with traffic volumes estimated to be less than 3,000 vpd. Where on street parking is not provided on both sides of the road it is envisaged that the cross section will revert to a single carriageway as shown is **Figure 4.4** with parking embayments provided adjacent to the POS only**.** The 20m reserve width creates the opportunity for occasional traffic islands for traffic calming and/or landscaping subject to detailed design.

All internal road (other than the main spine road) have proposed road reserve width of 15m or 13m where abutting POS as shown in **Figure 4.2**. The widths adhere to those documented within the *Liveable Neighbourhoods (WAPC, 2009)* which outline a range of acceptable road reserve widths for various categories of access roads. Road cross sectional elements are to be agreed during the detailed design process in consultation with the City and should consider the following:

- 5.5-7.2m wide pavement i.e. the lower the traffic volumes the narrower the pavement width may be;

- 7.2m wide pavement to be adopted where on street parking may occur on both sides of the street so that traffic flow can be maintained between occasional parked vehicles;
- path provided on at least one side of the road or as required by the City; and
- sufficient verge width for the provision of utility services and infrastructure.



Figure 4.2: Proposed Road Classification – Liveable Neighbourhoods

All roads within the new internal road network would be designated as local access roads (i.e. <3,000 vehicles per day). The main northwest - southeast spine road connecting to Balannup Road (to the northwest) and Skeet Road (to the southeast) both under roundabout control will facilitate full vehicular movements onto the existing external road network. This main northwest-southeast spine road will carry the highest volume of traffic (1,400 vehicles per day) with each internal access road progressively carrying less as traffic is distributed along the internal network.

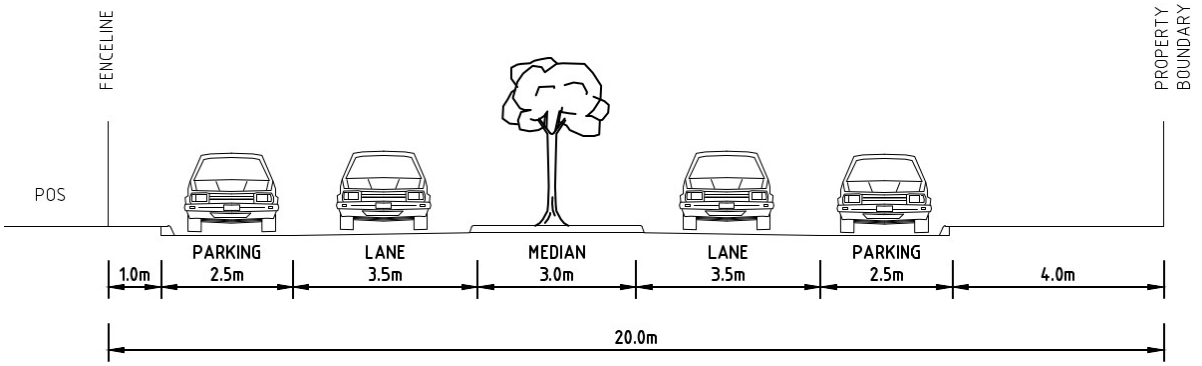


Figure 4.3: Indicative Cross Section: Access Street A, Avenue, <3,000 vpd, Skeet Road to first access road.

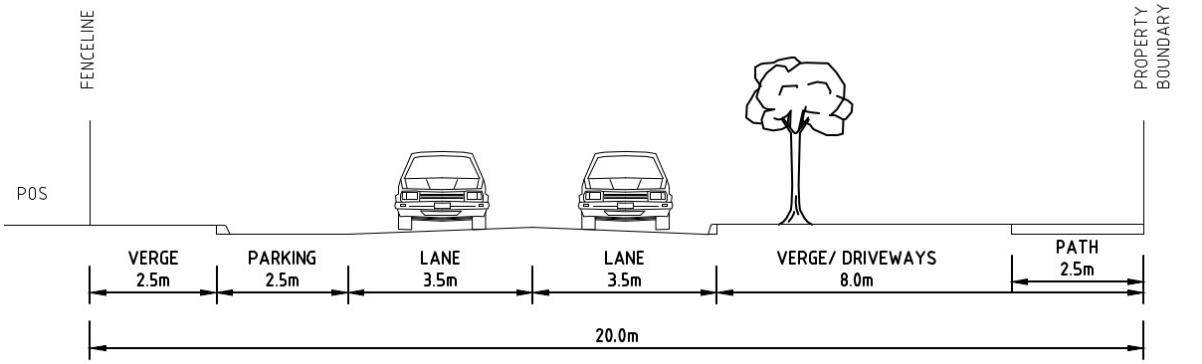


Figure 4.4: Indicative Cross Section: Modified Access Street parking embayments on one side only, <3,000 vpd, Balannup Road to last side road before Skeet Road

There are a number of right angle bends incorporated within the Structure Plan. Bends can assist with reducing the speed limit however they can also result in drivers "corner cutting" which can increase the head-on crash risk. Based on the low volume of traffic on the internal road network and the subsequent design speed, the bends are likely to be considered "low risk". Good practice would be to include carriageway widening and traffic treatments to clearly define and separate opposing vehicle movements. These details would need to be addressed within the detailed design. Similarly, sight distance at the intersections for approaching vehicles near bends will need to be confirmed during the detailed design process.

4.3 Intersection Control

Intersection spacing has been guided by the indicative lot sizes to be incorporated within the road network grid.

A traditional grid layout has been adopted creating T-junctions. All internal intersections throughout the internal road network will operate under standard give way control. Consideration to the use of traffic calming device i.e. blister islands should be considered along this length of road which can be accommodated within the proposed 20m road reserve.

4.4 Proposed Road Access Strategies

Residential Lots

Lots bounding both Balannup Road and Skeet Road do not require direct road access as the indicative internal lot layout includes an alternative frontage to an internal local access road.

The lot layout incorporates a number of short road stubs that provides access to 2-3 residential properties. Garbage vehicle access will not be possible on these stubs hence bin pads will need to be provided on the connecting road to ensure these properties are serviced during the detailed design process.

Local Centre Zone

A small commercial zone (8,000m^2 or 4,000m^2 GFA) is proposed within the Structure Plan on the corner of Skeet Road and Ranford Road. Future access arrangements to the Local Centre zone will be investigated at the subdivision development stage once the proposed land uses are resolved. As a minimum provision for a left in and left out only will need to be provided via the minor road being Skeet Road.

Preliminary SIDRA analysis outlined in section 6.7 indicates that the 95% queue length at the future signalised intersection of Skeet Road and Ranford Road ranges from 23m-50m during the peak hours in 2041 (3 lanes on Ranford Road). These 95th queue lengths would typically occur immediately prior to the commencement of the green signal but would be less at the end of the green signal creating opportunities for vehicles to exit onto Skeet Road. It is notable that these estimated queue lengths will occur during the peak hours of the adjacent road network and therefore queue lengths during other hours will be less which provides separation to the crossover. On this basis the queues at the traffic signals would not adversely impact the operation of the proposed local centre access. It should be noted also be noted that the queue lengths on Skeet Road are higher during the am peak (50m) and typically for commercial type land uses the outbound movement is low.

4.5 Pedestrian and Cycle Networks

Paths within the local internal road network should be provided on at least one side in accordance with *Liveable Neighbourhoods (WAPC, 2009)*. There is the option of providing a path on both sides of the main north-south spine road with the second path being located within the adjacent POS.

Key attractors outside of the Structure Plan within close proximity such that walking and/or cycling trips may be a preferred travel mode include the following:

- North Harrisdale Primary School - Reilly Road – 1km
- Carey Baptist College – Reilly Road – 1.5km
- Harrisdale Primary School – Gracefield Road – 1.5km
- Harrisdale Playing Field – Skeet Road/Gracefield Road - 1.6km
- Harrisdale Senior High School – Skeet Road/Keane Road -2.2km
- Stockdale Shopping Centre – Nicholson Road/Yellowwood Avenue/Keane Road – 2.5km
- Southern River Shopping Centre – Ranford Road, via Reilly Road and Wright Road 2.7km.

All these locations can be accessed by the existing path network. Path links from the internal north south spine road at the Balannup Road roundabout as well as the Skeet Road roundabout will allow access to these attractors along the existing path network once departing the Structure Plan area.

An indicative path network also highlighting the connection point to the existing path network at the Balannup Road and Skeet Road roundabouts are shown in **Figure 4.5**. Paths are proposed generally as a minimum along one side of the road with the option to provide an additional path within the POS.

4.6 Public Transport Routes

No public transport routes are proposed within the internal road network of the Structure Plan. As outlined in section 3.6 liaison with the PTA indicates that an additional stop may be considered along Balannup Road (if appropriate) for Route 233 to better service the new residential dwellings. In the long term, Route 260 along Ranford Road abutting the north-eastern boundary of the site may also be able to service the Structure Plan.



Figure 4.5: Existing and Proposed Path Network with Connections

5.0 PROPOSED CHANGES TO THE EXTERNAL ROAD NETWORK

There are concepts to ultimately upgrade Ranford Road to a 6 lane divided carriageway standard. The intersection layouts for Ranford Road with Balannup Road/Southern River Road and with Skeet Road are still not confirmed by DPLH. DPLH commissioned a detailed study in February 2022 to investigate various scenarios incorporating intersection control options in conjunction with the upgrade of Ranford Road entitled *"Traffic Modelling Report, Ranford Road ORR Reservation between Balannup Road and Skeet Road."*

The preferred scenario within the report was for the installation of two set of traffic signals along Ranford Road at both intersections i.e. Balannup Road/Southern River Road/ and Skeet Road. The option of left in and left out only at Skeet Road under give way control was also investigated with traffic signals only at Balannup Road/ Southern River Road however the traffic load from additional right turn movements resulted in unsatisfactory operating conditions at the Balannup Road/Souther River Road intersection.

It is understood that DPLH are currently investigating the option of a signalised intersection at only Ranford Road /Southern River Road/Balannup Road with priority controlled intersection at Skeet Road that prohibits the right turn from Skeet Road onto Ranford Road. This option allows for a reduced right turning traffic demand at Ballanup Road hence initial draft results indicate the traffic signals at Balannup Road can operate satisfactorily however the priority controlled intersection at Skeet Road with the right turn in movement yield unsatisfactory operating conditions. This testing of options is ongoing with final outcomes not confirmed.

6.0 ANALYSIS OF TRANSPORT NETWORK

6.1 Assessment Year

The Structure Plan is assumed to be fully developed by 2041 hence the traffic assessment will be undertaken for this scenario.

6.2 Traffic Generation

The traffic generated by the proposed Local Structure Plan is forecast using rates suggested in the *Guide to Traffic Generating Developments, Roads and Traffic Authority, NSW, 2000, "ITE Trip Generation Rates"* and *WAPC Transport Impact Assessment Guidelines Volume 2*. **Table 6.1** outlines the indicative land uses, trip generation rates and source document.

The Structure Plan makes provision for 280 residential dwellings. A small parcel of land abutting Ranford Road is proposed to be developed as a local centre commercial zone. For the purpose of the Structure Plan the indicative land uses are assumed to be general low use commercial such as showrooms.

Table 6.1 outlines the land uses and adopted trip generation rates including the trip generation rate document source. Adopting these trip generation rates, the proposed local Structure Plan will generate in the order of 3,320 vehicle trips per weekday with approximately 258 and 346 vehicle trips during the am and pm peak hours respectively as summarised in **Table 6.2.**

Table 6.1. Summary of Trip Generation Rates

Land Use	Item	Unit	Daily	AM Peak	PM Peak	Source
Single Residential	280 dwelling	/dwelling	9	0.85	0.85	RTA
Local Centre - Showroom	4000m^2 GFA	/100m2 GFA	17	0.5	2.7	RTA

Table 6.2. Estimated Trip Generation

Land Use	Item	No. of Trips		
		Daily	AM Peak	PM Peak
Single Residential	280 dwelling	2,520	238	238
Local Centre- Showroom	4000m^2 GFA	680	20	108
	Total =	3,320	258	346

6.3 Traffic Distribution

The residential trips will typically comprise of various trip purposes including: work, education, shopping and recreational/social. Therefore the traffic distribution patterns take into account the following:

- workforce catchment area (based on data for the existing City of Armadale workforce);
- surrounding educational facilities (i.e. North Harrisdale Primary School, Harrisdale Senior High School, Carey Baptist College),
- shopping centres (i.e. Stockland Harrisdale Shopping Centre, Southern River shopping Centre)
- recreational/social facilities (i.e. Harrisdale Community Oval, Sutherlands Park)

The resulting trip distribution patterns have subsequently been estimated to be as follows:

- Ranford Road (north) 35%
- Ranford Road (south) 35%
- Southern River Road (east) 10%
- Skeet Road (west) 10%
- Balannup Road (west) 10%

The peak hour traffic distribution for residential trips is typically split 20% inbound and 80% outbound during the am peak hour with the reverse during the pm peak hour which is reflective of the dominant arrival and departure patterns of residents travelling to/from work. Conversely, the commercial trips (indicatively a showroom) are typically split 70% inbound and 30% outbound during the am peak hour with 48% inbound/52%outbound during the pm peak hour.

The indicative daily and peak hour traffic flows and the anticipated approach and departure routes are shown in **Figure 6.1.**

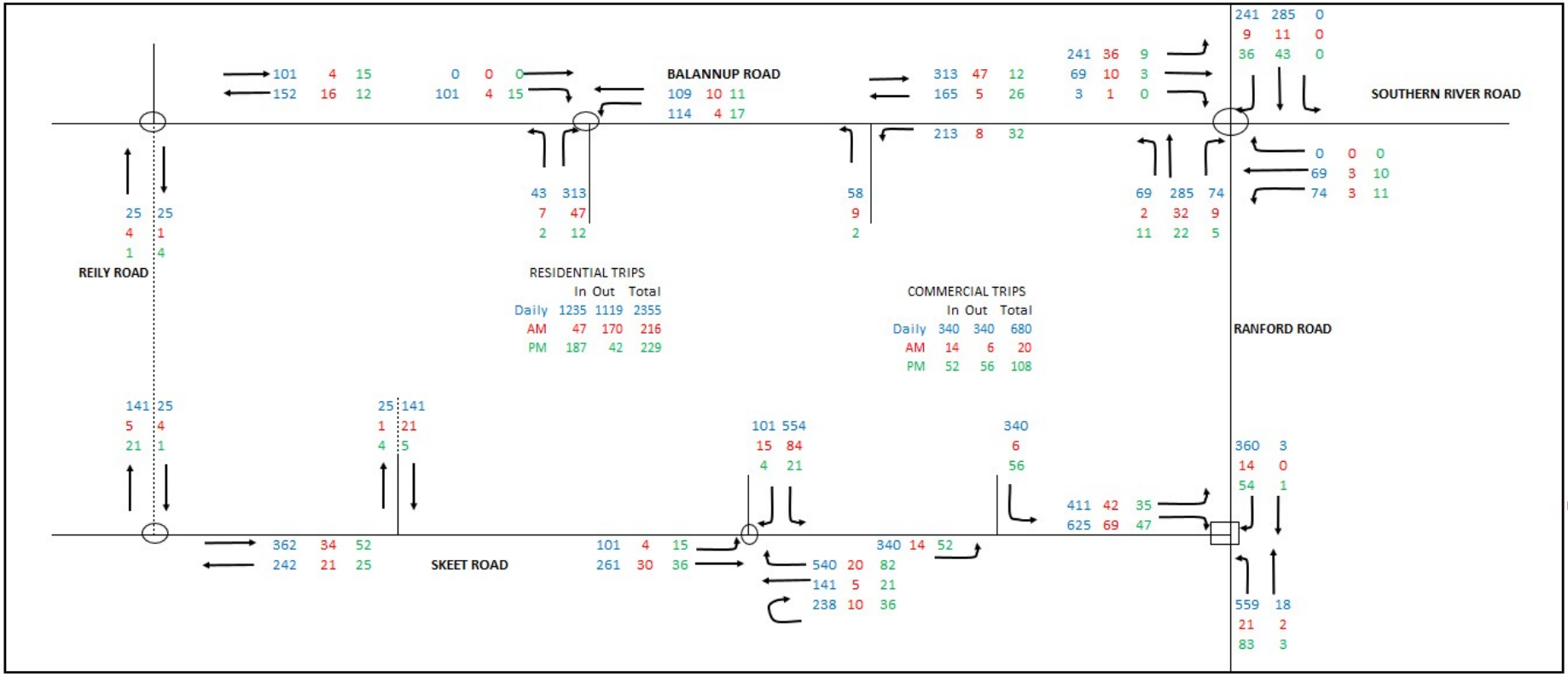


Figure 6.1: Development Traffic Distribution – Full Movement at Skeet Road

6.4 Non- Structure Plan Traffic

Minimal through traffic (if any) is expected through the Structure Plan due to the proposed layout of the surrounding road network and the land use composition of the Structure Plan i.e. predominantly residential. Reilly Road, to the west is envisaged to be the main north-south route through Harrisdale ultimately from Skeet Road through to Wright Road.

It is acknowledged that given Reilly Road between Skeet Road and Balannup Road is currently unconstructed there is the potential for some through traffic to temporarily occur through the Structure Plan should all turning movements not be permitted at the future Skeet Road and Ranford Road intersection as is currently being investigated by DPLH until such time as Reilly Road is constructed.

Under the aforementioned scenario the majority of traffic along Skeet Road from adjacent residential areas can be expected to alter their route at their origin and travel along Balannup Road and not Skeet Road. Assuming that up to 30% of traffic do not alter their route at their origin and transfer to Balannup Road prior and still continue to travel along Skeet Road until the north-south spine road of the Structure this would potentially result in approximately say 800 vehicles per day using the main spine road until such time as Reilly Road was constructed. Should this be the case the temporary indicative traffic volumes would still be lower than 3,000 vehicles per day in line with *Liveable Neighbourhood* traffic volume guidelines.

6.5 Design Traffic Flows

The internal road network and the proposed size and location of lots suggest that the majority of traffic will use the roundabout connections that facilitate all vehicular movements from either Balannup Road or Skeet Road. **Figure 6.2** shows the indicative daily traffic flows at the external connections to the Site. The maximum daily internal traffic flow is expected along the northwest-southeast spine road with up to 1,300 vehicles per day. Internal traffic flows are expected to decrease from these maximum flows near the external connections as the internal local road network distributes traffic within the Structure Plan.

A two lane two-way single carriageway road throughout the Structure Plan can adequately cater for these indicative design traffic flows.

As outlined in section 5.0 DPLH are currently investigating the future restriction of various turning movements at the intersection of Skeet Road and Ranford Road in conjunction with its upgrade to a 6 lane divided standard, for example no right turn from Skeet Road onto Ranford Road. **Table 6.1** shows the indicative redistribution of development traffic should this occur. Similarly, there is likely to be a slight redistribution of development traffic both

with and without the construction of Reilly Road in the short term. On this basis a number of trip distribution scenarios have been estimated to confirm that traffic volumes will remain within the general road hierarchy classification. These were are follows:

- Scenario 1: Reilly Rd Constructed, Full Movements at Skeet Rd/Ranford Ro Intersection
- Scenario 2 Reilly Rd Not Constructed, Full Movements at Skeet Rd/Ranford Rd Intersection
- Scenario 3: Reilly Rd Constructed, No right turn from Skeet Rd onto Ranford Rd
- Scenario 4: Reilly Rd Not Constructed, No right turn from Skeet Rd onto Ranford Rd

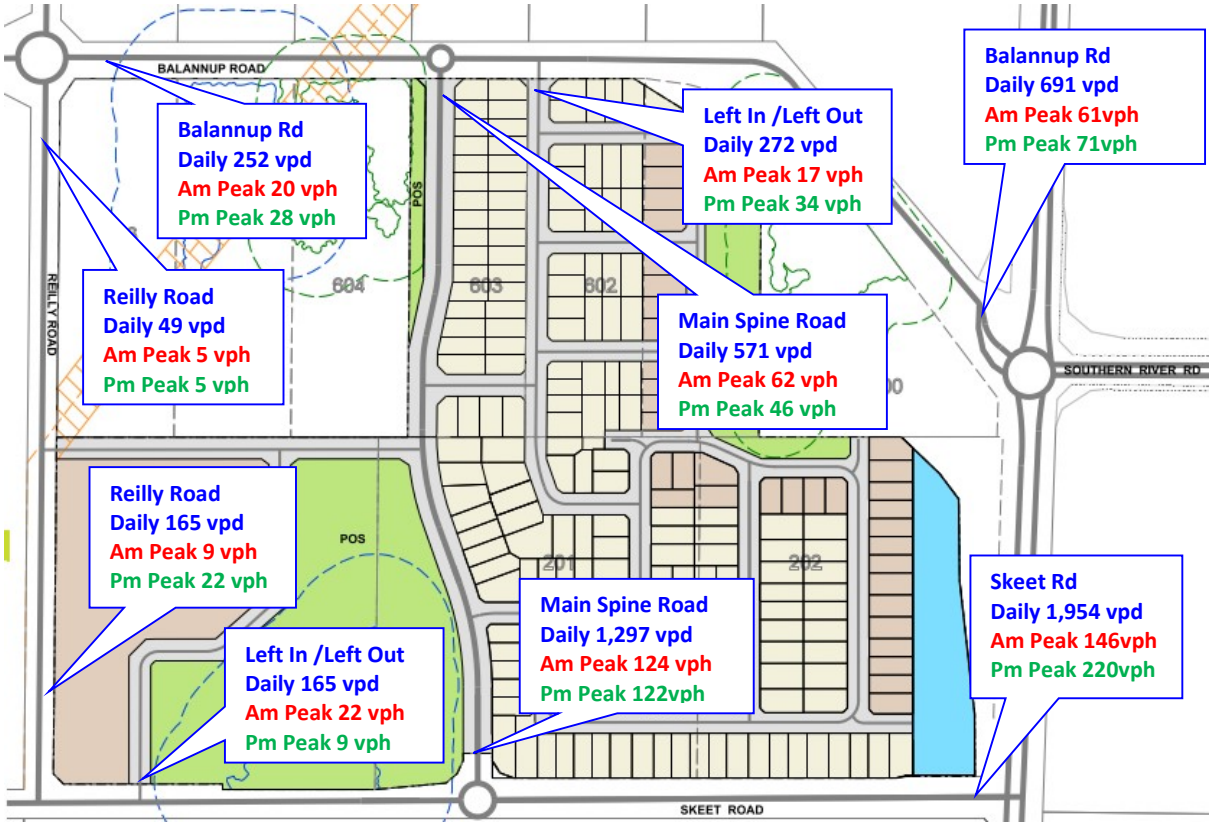


Figure 6.2: Development Traffic Distribution – All Movements at Skeet Road

It is understood that the future access arrangements to the Local Centre zone will be investigated at the subdivision development stage once the proposed land uses are resolved. For the purpose of the Structure Plan assessment it has been assumed that a left in left out is permitted to this zone. An indicative layout is shown in **Figure 6.2.**

Table 6.1: Development Traffic Distribution for Various Scenarios

Location	1	2	3	4
Balannup Rd, east of Reilly Road	254	303	254	303
Reilly Rd, south of Balannup Road	49	0	49	0
Main Spine Road, south of Balannup Road	571	620[1)]	1,009	1,058[1)]
Left in/out, south of Balannup Road	272	272	272	272
Balannup Rd, west of Ranford Road	691	691	1,129	1,129
Skeet Road, west of Ranford Road	1,954	1,954	1,516	1,516
Main Spine Road, north of Skeet Road	1,297	1,392[1)]	945	1,040[1)]
Reilly Road, north of Skeet Road	165	0	165	0
Left in/out north of Skeet Road	165	236	80	291

1) Excludes redistribution of non structure plan traffic should the right turn from Skeet Road onto Ranford Road be prohibited and the Reilly Road link between Skeet Road and Balannup Road not yet be constructed

6.6 ROM Model Outputs

The *"Traffic Modelling Report, Ranford Road ORR Reservation between Balannup Road and Skeet Road."* commissioned by DPLH has been sourced for the 2041 ROM outputs and calibrated peak hour volumes on the adjacent road network. Indicative growth patterns on the adjacent road network based on the ROM output is as shown in **Table 6.2** and extract contained within **Appendix B.** The 2041 ROM model is understood to be based on the land use data associated with the MRS and therefore is anticipated to include urban development as included in this Structure Plan by 2041.

Table 6.2 ROM Model Indicative Growth Patterns

Location	%Growth /Annum 2021-2041	%Growth /Annum 2041-2051
Ranford Road, west of Balannup Rd	3.0%	0.9%
Ranford Rd, east of Balannup Rd	1.8%	0.4%
Southern River Rd, north of Ranford Rd	2.7%	4.6%
Balannup Rd/Skeet Rd link	2.5%	0.1%

Figures 6.3 to 6.5 show the peak hour traffic flows on the surrounding road network derived from the existing intersection turn counts, trip generation and distribution, ROM traffic growth and 2041 calibrated traffic models as sourced from the aforementioned report.

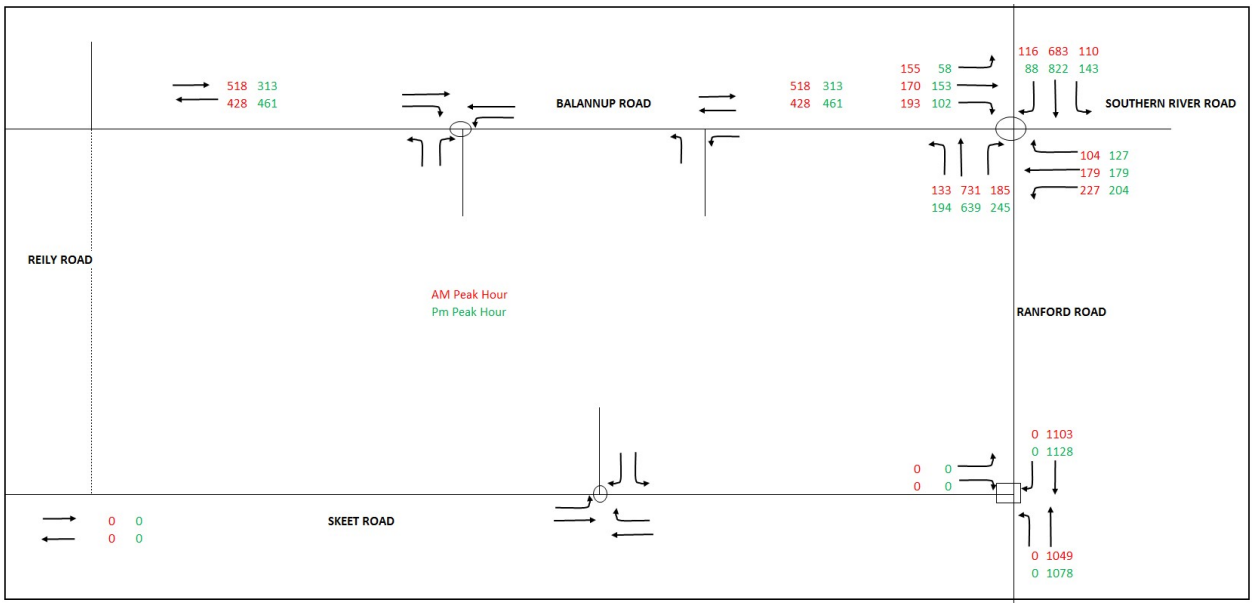


Figure 6.3: Existing Base Traffic Flows (2021) - Skeet Road Closed

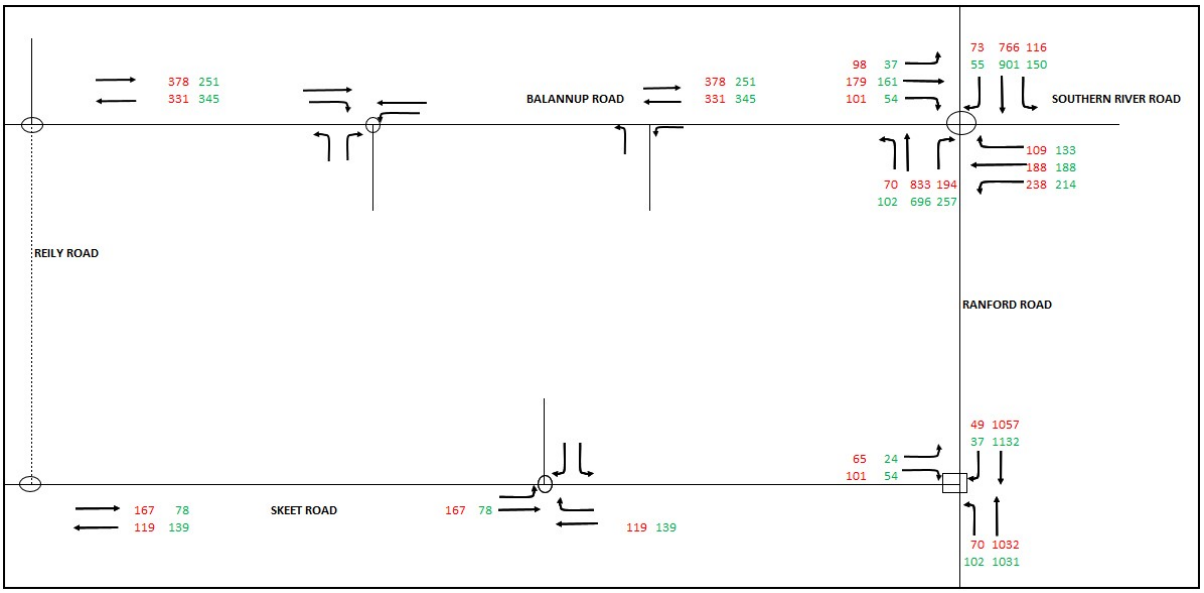


Figure 6.4: Base Traffic Flows 2023 -without development

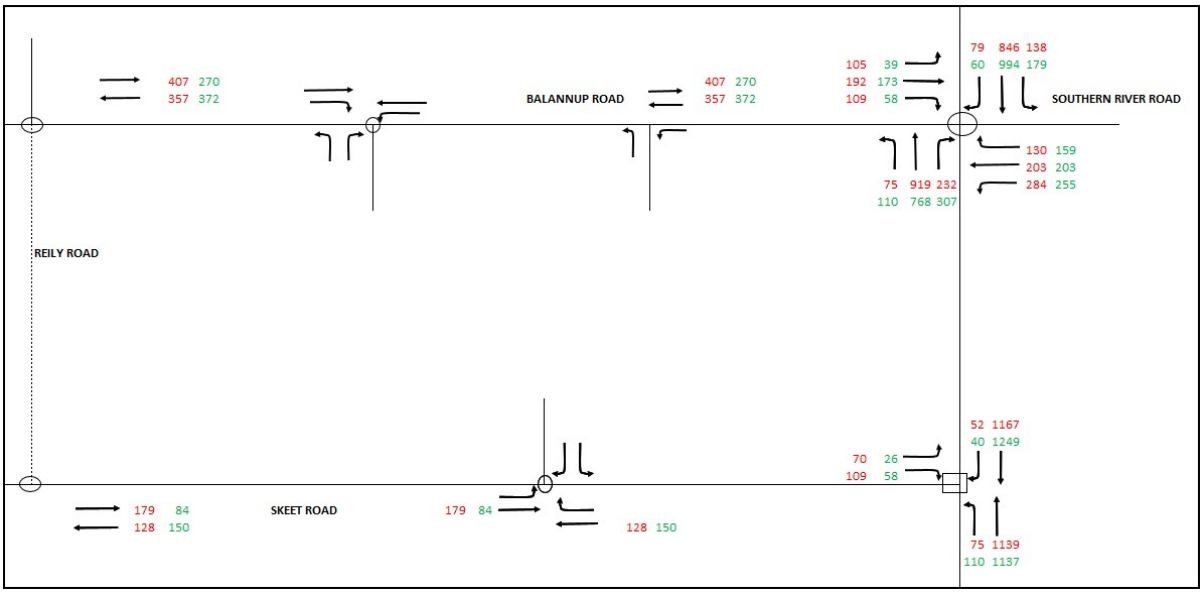


Figure 6.5: Base Traffic Flows 2026 -without development

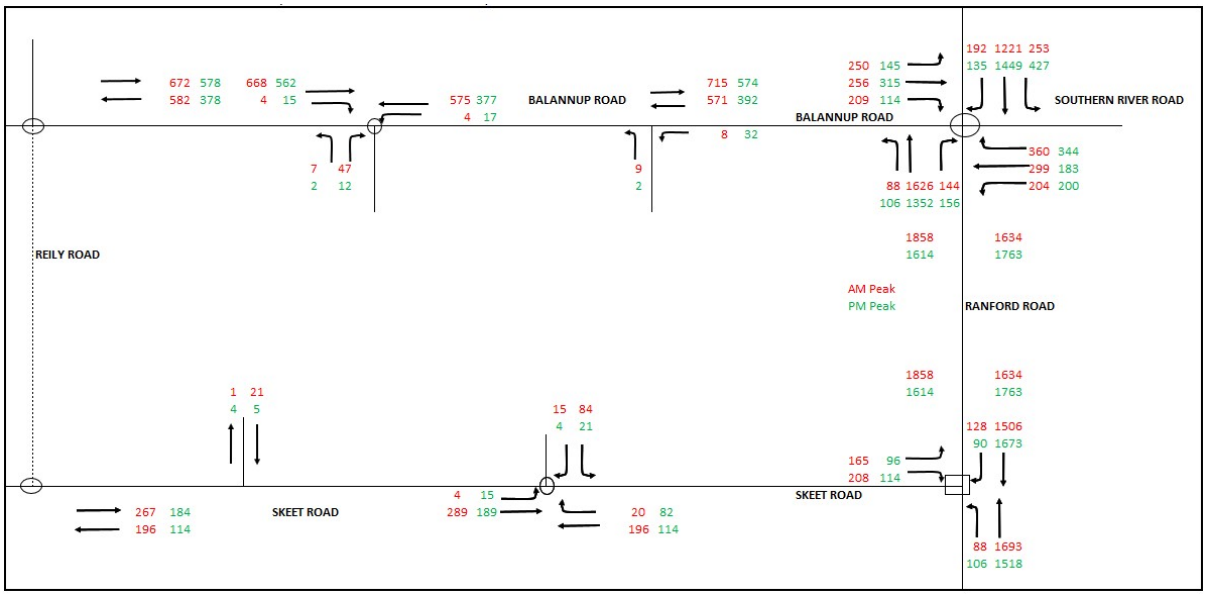


Figure 6.5: ROM 2041 Traffic Flows – includes development

6.7 Intersection Analysis

SIDRA is a traffic simulation modelling tool used by traffic engineers for analysing intersections. The key SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. Those characteristics are defined as follows:

Degree of Saturation (DOS): is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for extremely low traffic flow up to one for saturated flow or at capacity.

Level of Service (LOS): is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of services, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).

Average Delay: is the average of all travel time delays for vehicles through the intersection.

95% Queue: is the queue length below which 95% of all observed queue lengths fall.

New Balannup Road Roundabout and Skeet Road Roundabout

The main north south spine road through the Structure Plan is proposed to connect to Balannup Road and Skeet Road at each end and to operate under roundabout control. SIDRA analysis for the 2041 scenario indicates that both of those roundabouts will operate at LOS A and with spare capacity.

Ranford Road and Skeet Road

The SIDRA analysis for the intersection of Skeet Road and Ranford Road indicates that the right turn from Skeet Road onto Ranford Road is likely to have unacceptable average delays of 62 seconds during the am peak hour by 2026 without the proposed development. Drivers subject to long delays will typically start to look for smaller gaps within the Ranford Road traffic stream and therefore there is a potential for increased right turn through crashes. The degree of saturation is 0.876 confirming that improvements will be required based on the projected traffic growth without the development traffic.

As outlined in section 5.0, the intersection of Skeet Road/Ranford Road (as well as Balannup Road/Southern River Road/Ranford Road) are the subject of current investigations with respect to intersection control with the proposed upgrade of Ranford Road from 4 lanes to 6 lanes within DPLH. The "*Traffic Modelling Report, Ranford Road ORR Reservation between Balannup Road and Skeet Road."* outlines that the preferred scenario is for the installation of traffic signals at both intersections in the future. It is understood that DPLH are still investigating other options although preliminary assessments suggest that the installation of traffic signals at both locations may still be warranted.

On this basis, a SIDRA assessment for traffic signals at Skeet Road and Ranford Road has been undertaken for 2041 assumed to be the year for full development. The intersection

operated at an overall level of service B during both peak hours. Under signal control the estimated queue lengths along the Skeet Road approach during 2041 with 3 lanes in both directions on Ranford Road range from 23m-50m during the peak hours.

It should be noted that in 2041 that the proposed development represents approximately 4-6% of the total peak hour traffic travelling through this intersection whilst the general traffic growth in the region represents approximately 30% of the intersection traffic.

The results of the various SIDRA analysis undertaken are summarised in **Table 6.4** with detailed results contained in **Appendix C**.

Table 6.4 – Summary of SIDRA analysis for Ranford Road/Skeet Road

	Am Peak				Pm Peak			
	Highest DoS	Worst LoS	Highest Average Delay (sec)	Longest 95% Queue (m)	Highest DoS	Worst LoS	Highest Average Delay (sec)	Longest 95% Queue (veh)
Priority Control T-Junction								
2023	0.575	E	37	18	0.307	D	30	8
2026 – no development	0.876	F	71	33	0.426	E	40	11
Traffic Signal Control								
2041 – with development	0.860	C	35	138	0.726	C	32	99

Ranford Road/ Balannup Road/Southern River Road

The SIDRA analysis indicates that the existing roundabout layout will operate satisfactorily in 2026 with increased traffic flows from growth in the region. A SIDRA design life assessment with the indicative growth factors of 3% per annum on Ranford Road, 2.5% on Balannup Road and 4.6% on Southern River Road as suggested by the ROM outputs was undertaken of the existing roundabout. This assessment indicates that the roundabout will likely exceed its practical degree of saturation of 0.85 by 2033. The design life results for the existing roundabout are shown in **Appendix C.** This concurs with DPLH current investigations that this intersection will likely require upgrades in some form in the future to cater for traffic growth in the region. It should be noted that in 2041 that the proposed development represents approximately 2-3% of the total peak hour traffic travelling through this intersection hence its impact is expected to be minimal as the general traffic growth in the region represents approximately 40% of the intersection traffic.

7.0 SUMMARY AND CONCLUSION

The Local Structure Plan within the locality of Harrisdale in the City of Armadale allows for a residential estate comprising of approximately 280 dwellings and a small local commercial zone (8,000m^2) fronting Ranford Road.

Internal road reserves widths range from 13m to 20m and will allow a typical two lane single carriageway with pavement widths to suit subject to detailed design. A path should be provided on at least one side of all internal roads. Three is the option to provide a second path along the main north – south spine within the adjacent POS. There is likely to be an on street parking demand in the vicinity of the dual frontage properties for visitor parking and potentially the POS. Formalised embayed on street parking within the 20m road reserve would prove beneficial for this purpose. This road reserve width of 20m also creates other opportunities for traffic calming devices and/or street tree planting during the detailed design process.

There are a number of right angle bends incorporated within the Structure Plan. It is understood that the purpose of the sinuous design at locations is to assist in maintaining a low speed environment. Based on the low volume of traffic on the internal road network and the subsequent design speed, the bends are likely to be considered "low risk". Good practice would be to include local road widening and traffic treatment to clearly define and separate opposing vehicle movements. These details would need to be addressed within the detailed design. Similarly, sight distance at intersections for approaching vehicles near bends will need to be confirmed during the detailed design process.

The Structure Plan is estimated to generate in the order of 3,320 vehicle trips per weekday with approximately 258 and 346 vehicle trips during the am and pm peak hours respectively.

The maximum daily flow is expected on the main northwest-southeast internal link road and it is estimated to carry up to 1,300 vehicles per day. Internal traffic flows are expected to decrease from these maximum flows near the external connections as the local internal road network distributes traffic within the residential estate. These internal traffic flows are in line with those expected for local access roads.

There are concepts to ultimately upgrade Ranford Road to a 6 lane divided carriageway standard. The intersection layouts for Ranford Road with Balannup Road/Southern River Road and with Skeet Road are still not confirmed by DPLH. DPLH commissioned a detailed study in February 2022 to investigate various scenarios incorporating intersection control options in conjunction with the upgrade of Ranford Road entitled *"Traffic Modelling Report, Ranford Road ORR Reservation between Balannup Road and Skeet Road."* The preferred

scenario within the report was for the installation of two set of traffic signals along Ranford Road at both intersections i.e. Balannup Road/Southern River Road/ and Skeet Road. DPLH are still investigating other options although preliminary assessments suggest that the installation of traffic signals at both locations may still be warranted.

SIDRA analysis indicates that the future intersection of Skeet Road and Ranford Road under give way control is likely to result in unacceptable delays on the Skeet Road approach by 2026 and require upgrading. For the purpose of the Structure Plan assessment at full development (i.e. 2041) it has been assumed that traffic signals will be installed. The results indicate satisfactory operation under traffic signal control.

SIDRA analysis confirms that this intersection of Ranford Road and Balannup Road will operate adequately with a dual lane roundabout for 2026 however the existing layout is anticipated to reach its capacity by 2033 due to increased traffic flows in the region. It is noted that the development traffic represents only 2-3% of the intersection traffic whilst general traffic growth in the region represents up to 40% of traffic.

In summary the traffic assessment as documented within this report with various recommendations throughout confirms that the proposed Structure Plan can be accommodated by the proposed internal road network as well as the proposed external road network configurations expected in 2041 with full development.

APPENDIX A

Structure Plan Layout



Legend

- Subject Site
- Parent Lot
- CCW
- 50m Buffer to CCW
- REW
- 30m Buffer to REW
- Easement (30m Width)
- Residential R25
- Residential R30
- Public Open Space (POS)
- Local Centre
- Access Streets
- Neighbourhood Connector

22001001B

0m 50 100 200m

HARRISDALE NORTH STRUCTURE PLAN

Harrisdale. Armadale, WA

Project YOLHA 22001001B | Scale 1:2500 @ A3 | Date: June 2023

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APPENDIX B

ROM Outputs

Figure 2-2 ROM24 – 2021 Forecast Year (note: vehicles displayed in x100 vehicles per day for each direction)



Source: Main Roads WA

Figure 2-3 ROM24 – 2041 Forecast Year



Source: Main Roads WA

Source: "*Traffic Modelling Report, Ranford Road ORR Reservation between Balannup Road and Skeet Road, Draft February 2022 for DPLH"*

Figure 2-4 ROM24 – 2051 Forecast Year (Ultimate)



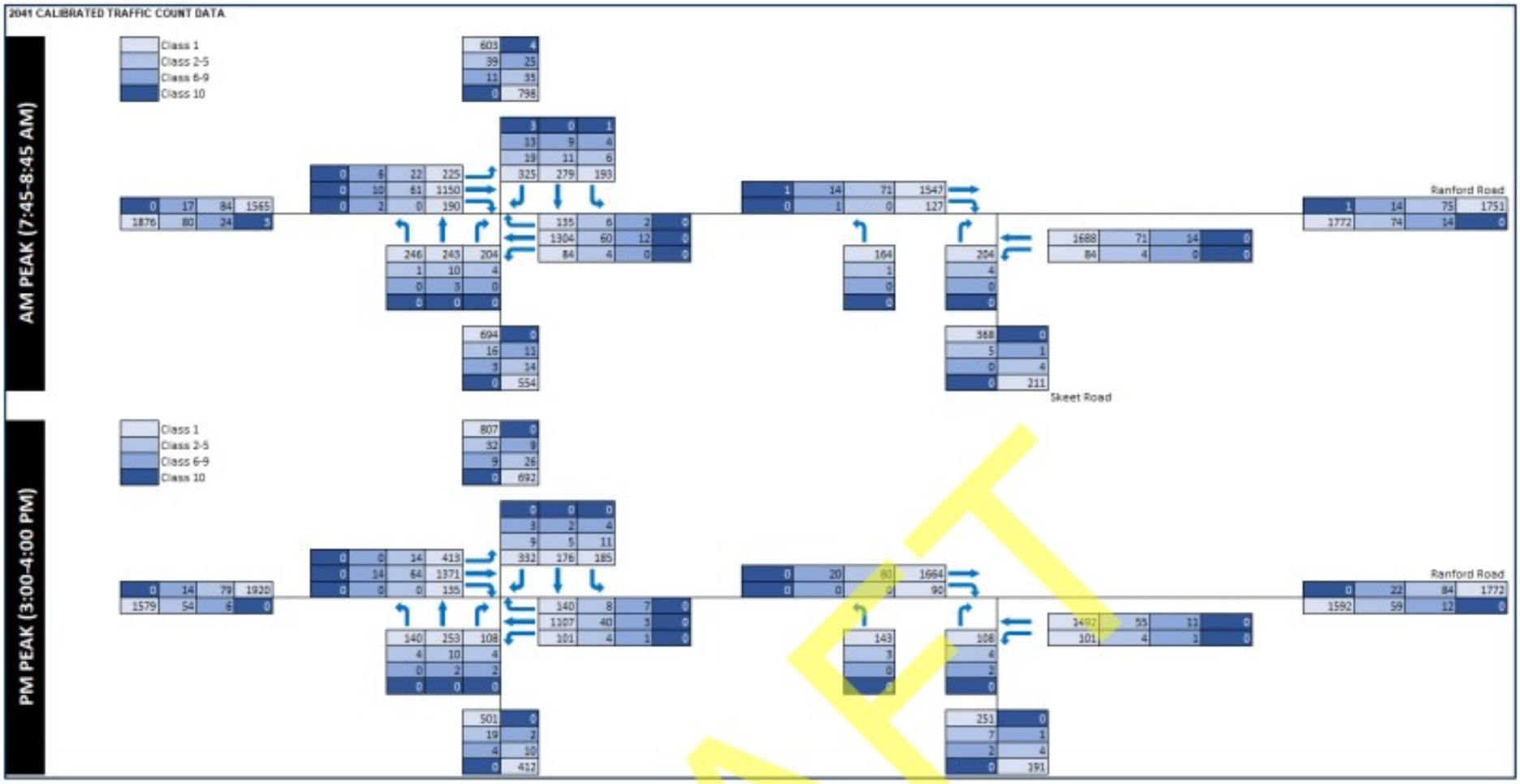
Source: Main Roads WA

2041 Calibrated Intersection Turning Volumes

Table 2-15 2041 Peak Hour Volumes

2041 AM	A	B	C	D
A	0	320	1093	253
B	413	0	417	256
C	1463	176	0	144
D	360	299	204	0
2041 PM	A	B	C	D
A	0	225	1359	427
B	241	0	228	315
C	1256	212	0	156
D	344	183	200	0

Source: "*Traffic Modelling Report, Ranford Road ORR Reservation between Balannup Road and Skeet Road." Draft February 2022 for DPLH*



Source: "*Traffic Modelling Report, Ranford Road ORR Reservation between Balannup Road and Skeet Road." Draft February 2022 for DPLH*

APPENDIX C

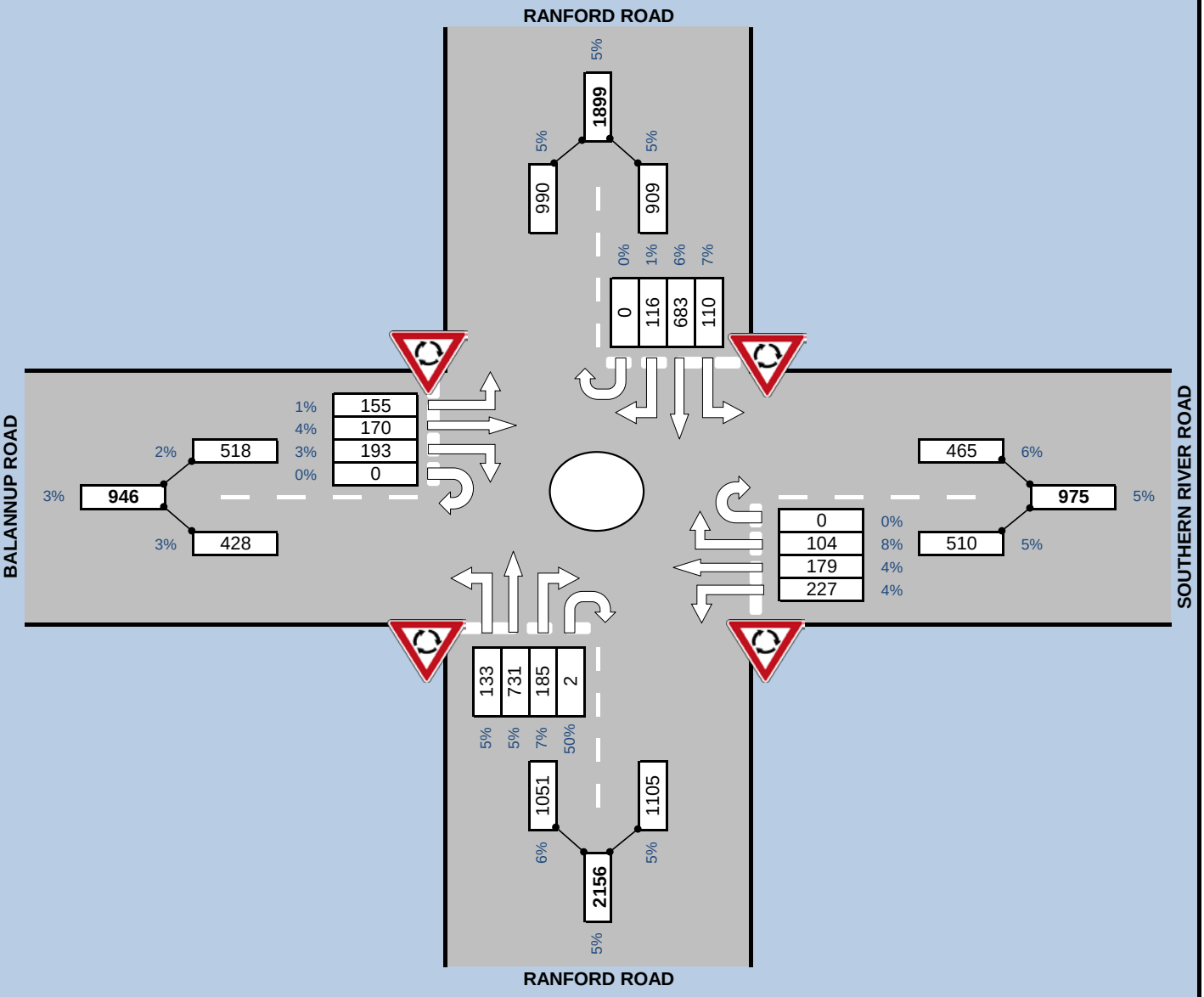
Intersection Turn Counts

Project :	Harrisdale Survey	**Date :**	Thu 27th May 2021
Intersection:	Ranford Rd / Balannup Rd	**Weather :**	Fine

Survey Time: AM Peak Hour - 0745 - 0845

All Vehicles

(% Heavy Vehicles)

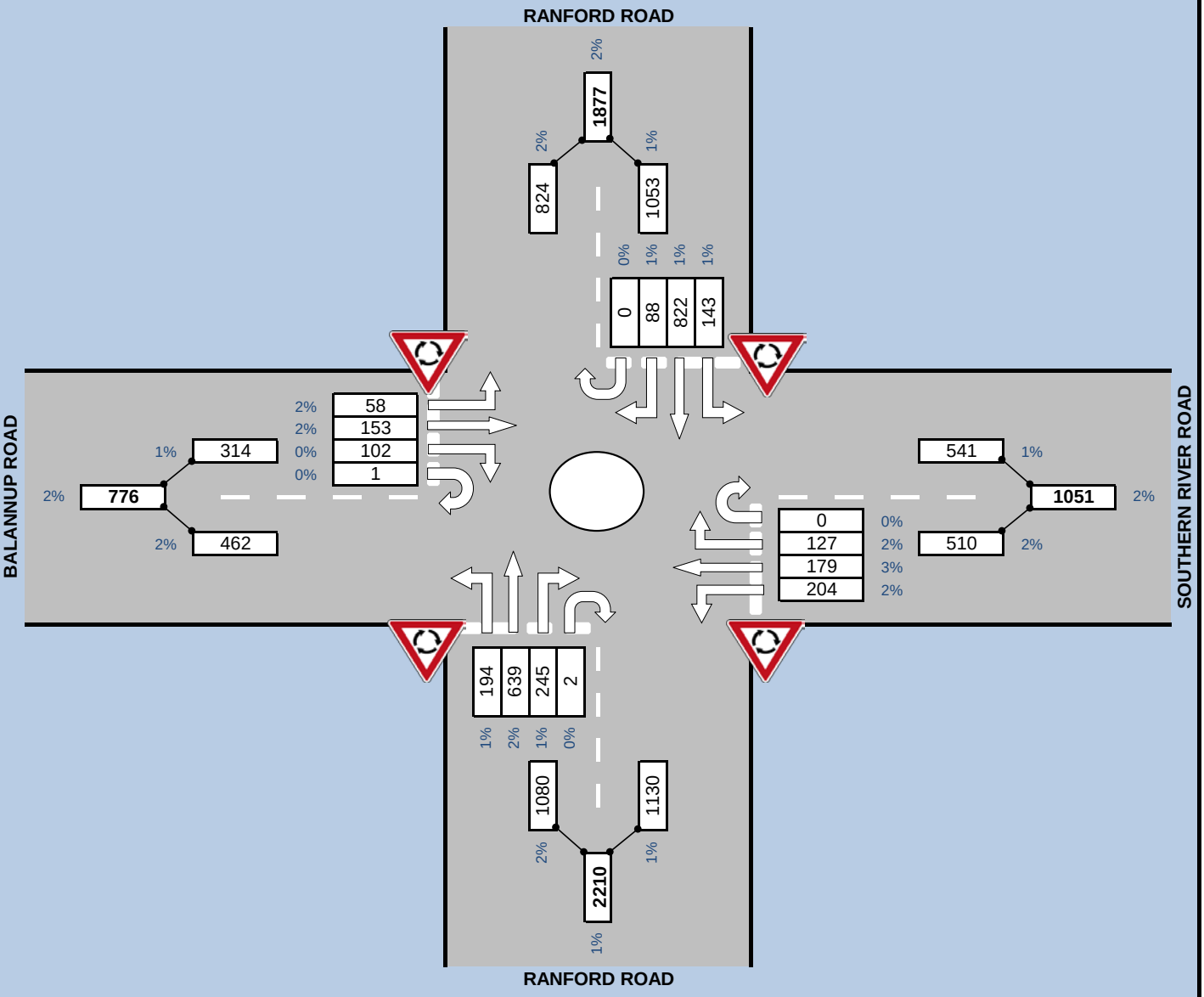


Project :	Harrisdale Survey	**Date :**	Thu 27th May 2021
Intersection:	Ranford Rd / Balannup Rd	**Weather :**	Fine

Survey Time: PM Peak Hour - 1615 - 1715

All Vehicles

(% Heavy Vehicles)



APPENDIX D

SIDRA Detailed Results

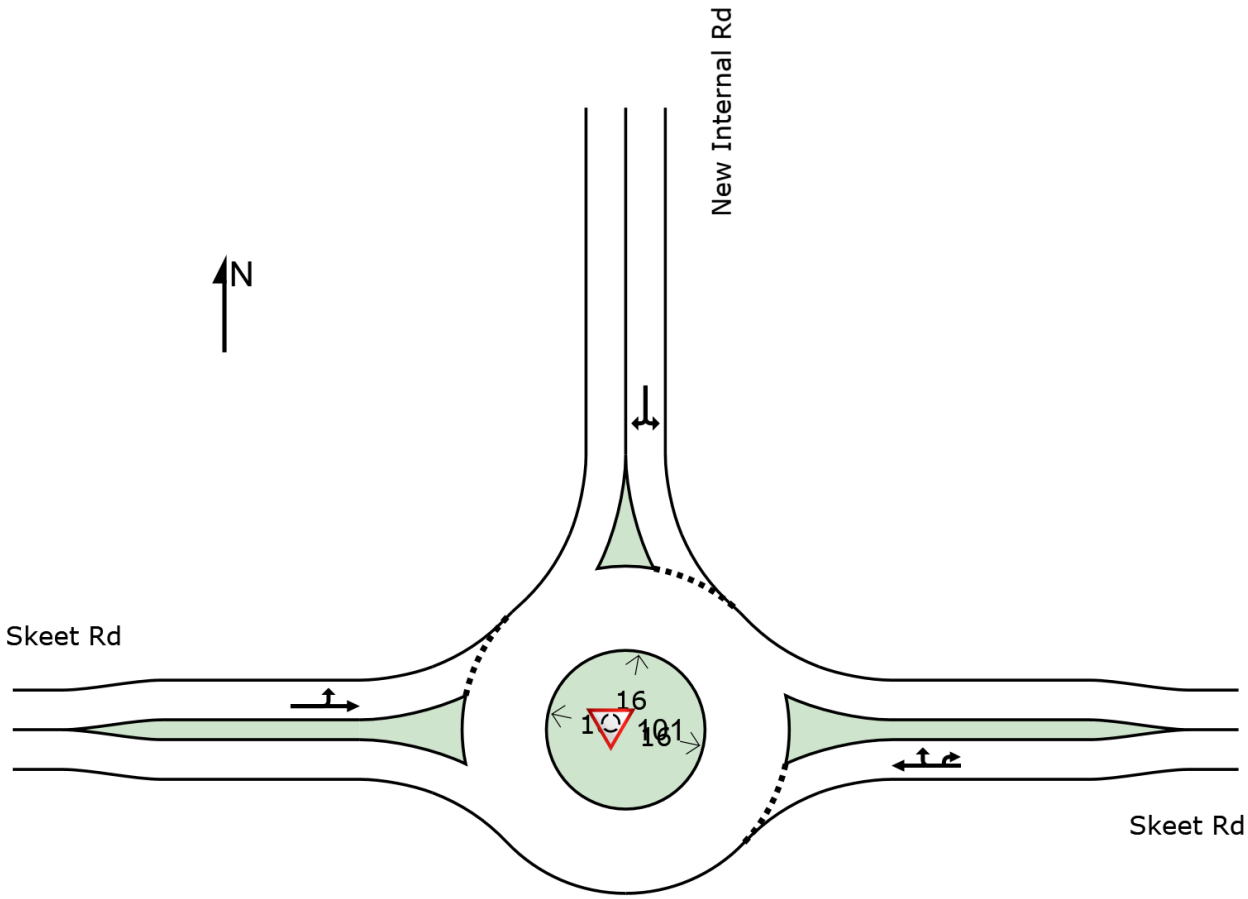
Balannup Road Roundabout and Skeet Road Roundabout - SIDRA

SITE LAYOUT

Site: 101 [Skeet Rd New Roundabout AM 2041 (Site Folder: Skeet Rd Internal Roundabout)]

New Site
Site Category: (None)
Roundabout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

MOVEMENT SUMMARY

Site: 101 [Skeet Rd New Roundabout AM 2041 (Site Folder: Skeet Rd Internal Roundabout)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
East: Skeet Rd															
11	T1	All MCs	206	3.0	206	3.0	0.155	3.2	LOS A	0.8	6.1	0.08	0.39	0.08	45.5
12	R2	All MCs	21	1.0	21	1.0	0.155	7.2	LOS A	0.8	6.1	0.08	0.39	0.08	45.9
12u	U	All MCs	11	0.0	11	0.0	0.155	10.5	LOS B	0.8	6.1	0.08	0.39	0.08	48.0
Approach			238	2.7	238	2.7	0.155	3.9	LOS A	0.8	6.1	0.08	0.39	0.08	45.7
North: New Internal Rd															
1	L2	All MCs	88	1.0	88	1.0	0.099	4.7	LOS A	0.5	3.8	0.45	0.55	0.45	45.2
3	R2	All MCs	16	1.0	16	1.0	0.099	8.8	LOS A	0.5	3.8	0.45	0.55	0.45	44.4
Approach			104	1.0	104	1.0	0.099	5.3	LOS A	0.5	3.8	0.45	0.55	0.45	45.1
West: Skeet Rd															
4	L2	All MCs	4	1.0	4	1.0	0.208	3.2	LOS A	1.3	9.5	0.14	0.34	0.14	46.0
5	T1	All MCs	304	3.0	304	3.0	0.208	3.3	LOS A	1.3	9.5	0.14	0.34	0.14	45.6
Approach			308	3.0	308	3.0	0.208	3.3	LOS A	1.3	9.5	0.14	0.34	0.14	45.6
All Vehicles			651	2.6	651	2.6	0.208	3.8	LOS A	1.3	9.5	0.17	0.39	0.17	45.5

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 [Skeet Rd New Roundabout PM 2041 (Site Folder: Skeet Rd Internal Roundabout)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
East: Skeet Rd															
11	T1	All MCs	120	3.0	120	3.0	0.148	3.1	LOS A	0.7	5.6	0.04	0.53	0.04	44.7
12	R2	All MCs	86	1.0	86	1.0	0.148	7.2	LOS A	0.7	5.6	0.04	0.53	0.04	45.2
12u	U	All MCs	38	0.0	38	0.0	0.148	10.5	LOS B	0.7	5.6	0.04	0.53	0.04	47.2
Approach			244	1.8	244	1.8	0.148	5.7	LOS A	0.7	5.6	0.04	0.53	0.04	45.3
North: New Internal Rd															
1	L2	All MCs	22	1.0	22	1.0	0.024	4.2	LOS A	0.1	0.9	0.39	0.50	0.39	45.4
3	R2	All MCs	4	1.0	4	1.0	0.024	8.2	LOS A	0.1	0.9	0.39	0.50	0.39	44.6
Approach			26	1.0	26	1.0	0.024	4.8	LOS A	0.1	0.9	0.39	0.50	0.39	45.3
West: Skeet Rd															
4	L2	All MCs	16	1.0	16	1.0	0.172	3.7	LOS A	1.0	7.5	0.29	0.38	0.29	45.4
5	T1	All MCs	199	3.0	199	3.0	0.172	3.8	LOS A	1.0	7.5	0.29	0.38	0.29	44.9
Approach			215	2.9	215	2.9	0.172	3.8	LOS A	1.0	7.5	0.29	0.38	0.29	44.9
All Vehicles			485	2.2	485	2.2	0.172	4.8	LOS A	1.0	7.5	0.17	0.46	0.17	45.1

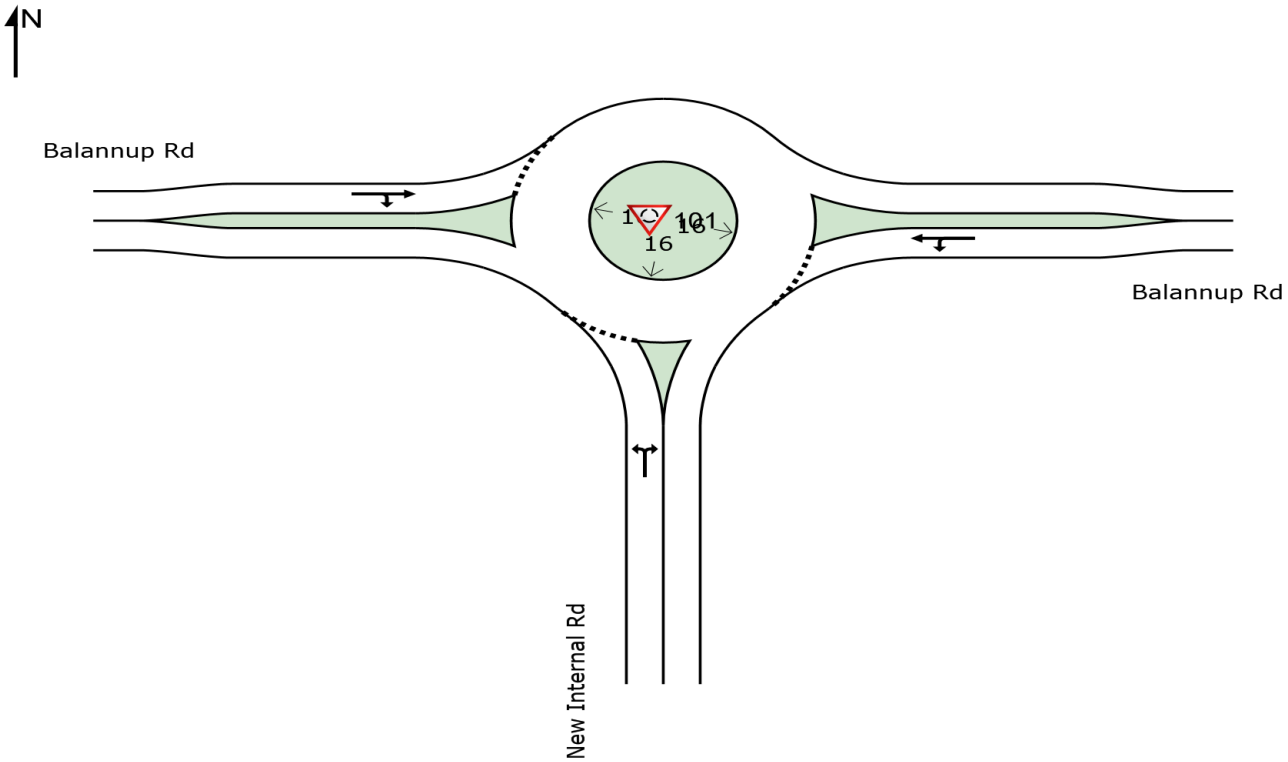
Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SITE LAYOUT

Site: 101 [Balannup Rd New Roundabout AM 2041 (Site Folder: Balannup Rd Internal Roundabout)]

New Site
Site Category: (None)
Roundabout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 101 [Balannup Rd New Roundabout AM 2041 (Site Folder: Balannup Rd Internal Roundabout)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: New Internal Rd															
1	L2	All MCs	7	1.0	7	1.0	0.064	6.8	LOS A	0.4	2.7	0.56	0.66	0.56	43.3
3	R2	All MCs	49	1.0	49	1.0	0.064	10.9	LOS B	0.4	2.7	0.56	0.66	0.56	43.0
Approach			57	1.0	57	1.0	0.064	10.3	LOS B	0.4	2.7	0.56	0.66	0.56	43.1
East: Balannup Rd															
4	L2	All MCs	4	1.0	4	1.0	0.362	3.1	LOS A	2.3	17.6	0.04	0.35	0.04	47.1
5	T1	All MCs	605	3.0	605	3.0	0.362	3.1	LOS A	2.3	17.6	0.04	0.35	0.04	47.3
Approach			609	3.0	609	3.0	0.362	3.1	LOS A	2.3	17.6	0.04	0.35	0.04	47.3
West: Balannup Rd															
11	T1	All MCs	703	3.0	703	3.0	0.478	3.5	LOS A	4.4	33.2	0.28	0.35	0.28	46.5
12	R2	All MCs	4	1.0	4	1.0	0.478	7.5	LOS A	4.4	33.2	0.28	0.35	0.28	46.0
Approach			707	3.0	707	3.0	0.478	3.5	LOS A	4.4	33.2	0.28	0.35	0.28	46.5
All Vehicles			1374	2.9	1374	2.9	0.478	3.6	LOS A	4.4	33.2	0.19	0.36	0.19	46.7

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 [Balannup Rd New Roundabout PM 2041 (Site Folder: Balannup Rd Internal Roundabout)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: New Internal Rd															
1	L2	All MCs	2	1.0	2	1.0	0.015	5.0	LOS A	0.1	0.6	0.49	0.58	0.49	42.8
3	R2	All MCs	13	1.0	13	1.0	0.015	9.1	LOS A	0.1	0.6	0.49	0.58	0.49	43.9
Approach			15	1.0	15	1.0	0.015	8.5	LOS A	0.1	0.6	0.49	0.58	0.49	43.8
East: Balannup Rd															
4	L2	All MCs	18	1.0	18	1.0	0.263	3.1	LOS A	1.4	10.7	0.08	0.35	0.08	47.0
5	T1	All MCs	397	3.0	397	3.0	0.263	3.2	LOS A	1.4	10.7	0.08	0.35	0.08	46.4
Approach			415	2.9	415	2.9	0.263	3.2	LOS A	1.4	10.7	0.08	0.35	0.08	46.5
West: Balannup Rd															
11	T1	All MCs	592	3.0	592	3.0	0.374	3.2	LOS A	2.9	22.0	0.11	0.35	0.11	46.3
12	R2	All MCs	16	1.0	16	1.0	0.374	7.2	LOS A	2.9	22.0	0.11	0.35	0.11	45.6
Approach			607	2.9	607	2.9	0.374	3.3	LOS A	2.9	22.0	0.11	0.35	0.11	46.3
All Vehicles			1037	2.9	1037	2.9	0.374	3.3	LOS A	2.9	22.0	0.10	0.35	0.10	46.3

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

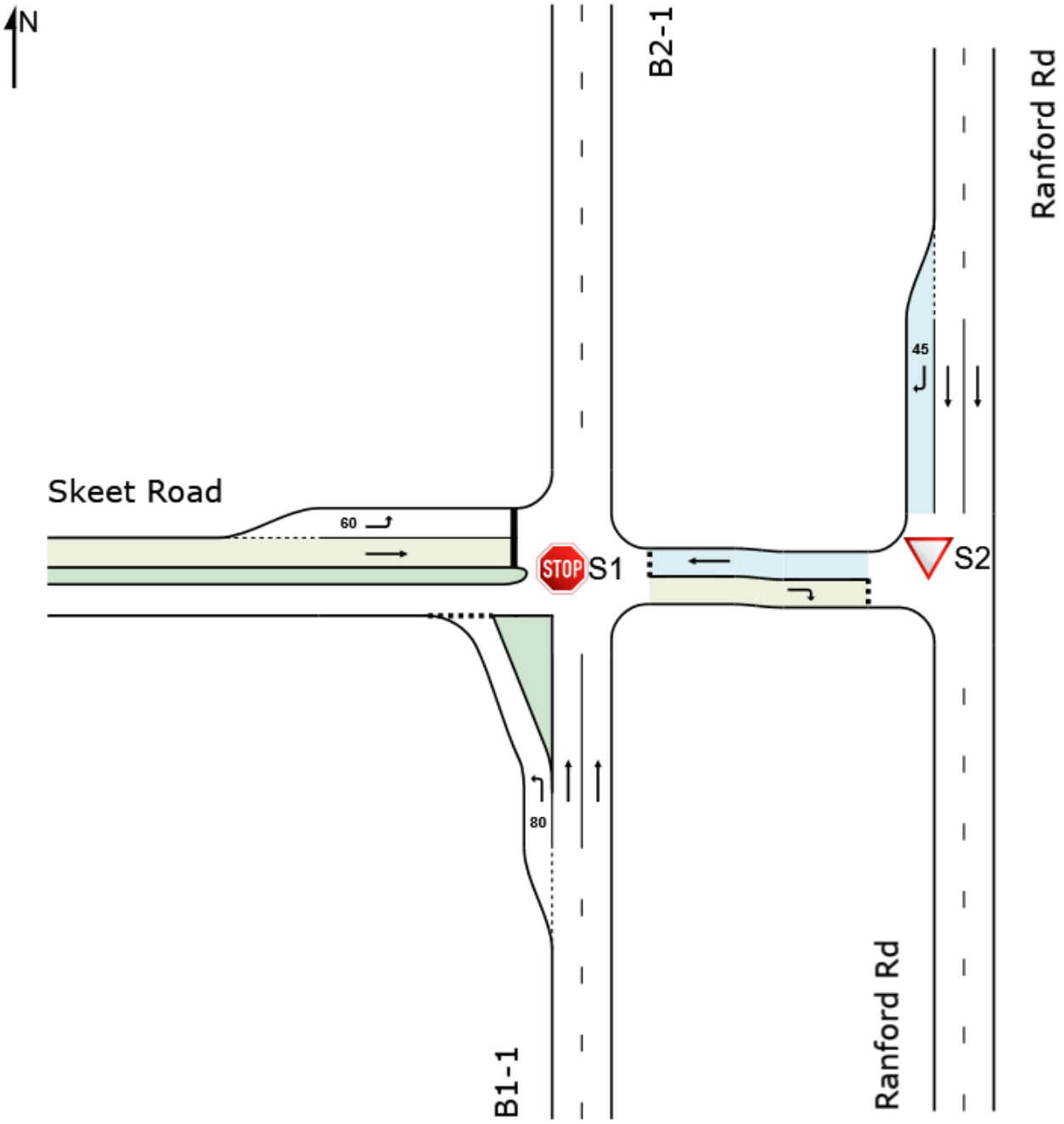
Ranford Road and Skeet Road – SIDRA

NETWORK LAYOUT

Network: TSTIC [2023 Basecase Am Peak without development (Network Folder: Skeet Road Ranford Rd)]

Sign controlled T-intersection with Median Storage for two-staged turn movements
Major Road Turn opposes Stage 1 of the Minor Road turn movement (Type B)
Network Category: (None)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



SITES IN NETWORK		
Site ID	**CCG ID**	**Site Name**
S1	NA	2023 Basecase Stage 1 AM
S2	NA	2023 Basecase Stage 2 AM

MOVEMENT SUMMARY

Site: S1 [2023 Basecase Stage 1 AM (Site Folder: Skeet Ranford)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Network: TSTIC [2023 Basecase Am Peak without development (Network Folder: Skeet Road Ranford Rd)]

Type B Two-Stage T-Intersection Crossing
Site Category: (None)
Stop (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: B1-1															
3	L2	All MCs	74	5.0	74	5.0	0.055	7.6	LOS A	0.2	1.7	0.14	0.57	0.14	54.0
4	T1	All MCs	1086	9.7	1086	9.7	0.293	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.4
Approach			1160	9.4	1160	9.4	0.293	0.6	LOS A	0.2	1.7	0.01	0.04	0.01	77.0
East: Median Storage															
5	T1	All MCs	52	2.0	52	2.0	0.119	7.3	LOS A	0.4	2.9	0.73	0.74	0.73	41.9
Approach			52	2.0	52	2.0	0.119	7.3	LOS A	0.4	2.9	0.73	0.74	0.73	41.9
West: Skeet Road															
1	L2	All MCs	68	2.0	68	2.0	0.093	10.8	LOS B	0.3	2.6	0.54	0.95	0.54	43.6
2	T1	All MCs	106	3.0	106	3.0	0.575	36.7	LOS E	2.3	18.0	0.92	1.15	1.40	20.8
Approach			175	2.6	175	2.6	0.575	26.6	LOS D	2.3	18.0	0.77	1.07	1.06	28.9
All Vehicles			1386	8.3	1386	8.3	0.575	4.1	NA	2.3	18.0	0.13	0.20	0.17	67.3

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: S2 [2023 Basecase Stage 2 AM (Site Folder: Skeet Ranford)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Network: TSTIC [2023 Basecase Am Peak without development (Network Folder: Skeet Road Ranford Rd)]

Type B Two-Stage T-Intersection Crossing
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Ranford Rd															
2	T1	All MCs	1113	8.7	1113	8.7	0.299	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
3	R2	All MCs	52	2.0	52	2.0	0.028	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	44.8
Approach			1164	8.4	1164	8.4	0.299	0.3	NA	0.0	0.0	0.00	0.03	0.00	59.5
West: Median Storage															
1	R2	All MCs	106	2.0	106	2.0	0.239	8.1	LOS A	0.8	6.0	0.74	0.85	0.82	41.9
Approach			106	2.0	106	2.0	0.239	8.1	LOS A	0.8	6.0	0.74	0.85	0.82	41.9
All Vehicles			1271	7.9	1271	7.9	0.299	1.0	NA	0.8	6.0	0.06	0.10	0.07	58.1

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: S1 [2023 Basecase Stage 1 PM (Site Folder: Skeet Ranford)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Network: TSTIC [2023 Basecase Pm Peak without development (Network Folder: Skeet Road Ranford Rd)]

Type B Two-Stage T-Intersection Crossing
Site Category: (None)
Stop (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: B1-1															
3	L2	All MCs	107	5.0	107	5.0	0.079	7.5	LOS A	0.3	2.6	0.12	0.57	0.12	54.1
4	T1	All MCs	1085	9.7	1085	9.7	0.293	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.4
Approach			1193	9.3	1193	9.3	0.293	0.8	LOS A	0.3	2.6	0.01	0.06	0.01	76.0
East: Median Storage															
5	T1	All MCs	39	2.0	39	2.0	0.090	7.2	LOS A	0.3	2.2	0.72	0.73	0.72	42.1
Approach			39	2.0	39	2.0	0.090	7.2	LOS A	0.3	2.2	0.72	0.73	0.72	42.1
West: Skeet Road															
1	L2	All MCs	25	2.0	25	2.0	0.034	10.6	LOS B	0.1	0.9	0.53	0.90	0.53	43.7
2	T1	All MCs	57	3.0	57	3.0	0.307	30.1	LOS D	1.1	8.1	0.88	1.05	1.03	23.4
Approach			82	2.7	82	2.7	0.307	24.1	LOS C	1.1	8.1	0.77	1.00	0.87	29.5
All Vehicles			1314	8.6	1314	8.6	0.307	2.4	NA	1.1	8.1	0.08	0.14	0.09	71.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: S2 [2023 Basecase Stage 2 PM (Site Folder: Skeet Ranford)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Network: TSTIC [2023 Basecase Pm Peak without development (Network Folder: Skeet Road Ranford Rd)]

Type B Two-Stage T-Intersection Crossing
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Ranford Rd															
2	T1	All MCs	1192	8.7	1192	8.7	0.320	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
3	R2	All MCs	39	2.0	39	2.0	0.021	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	44.8
Approach			1231	8.5	1231	8.5	0.320	0.2	NA	0.0	0.0	0.00	0.02	0.00	59.6
West: Median Storage															
1	R2	All MCs	57	2.0	57	2.0	0.144	8.5	LOS A	0.4	3.2	0.75	0.81	0.75	41.6
Approach			57	2.0	57	2.0	0.144	8.5	LOS A	0.4	3.2	0.75	0.81	0.75	41.6
All Vehicles			1287	8.2	1287	8.2	0.320	0.6	NA	0.4	3.2	0.03	0.05	0.03	58.8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: S1 [2026 Basecase Stage 1 AM (Site Folder: Skeet Ranford)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Network: TSTIC [2026 Basecase Am Peak without development (Network Folder: Skeet Road Ranford Rd)]

Type B Two-Stage T-Intersection Crossing
Site Category: (None)
Stop (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: B1-1															
3	L2	All MCs	79	5.0	79	5.0	0.059	7.6	LOS A	0.2	1.9	0.15	0.57	0.15	54.0
4	T1	All MCs	1199	9.7	1199	9.7	0.324	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.4
Approach			1278	9.4	1278	9.4	0.324	0.6	LOS A	0.2	1.9	0.01	0.04	0.01	77.0
East: Median Storage															
5	T1	All MCs	55	2.0	55	2.0	0.152	9.2	LOS A	0.5	3.6	0.78	0.79	0.78	39.5
Approach			55	2.0	55	2.0	0.152	9.2	LOS A	0.5	3.6	0.78	0.79	0.78	39.5
West: Skeet Road															
1	L2	All MCs	74	2.0	74	2.0	0.109	11.4	LOS B	0.4	3.1	0.57	0.97	0.57	43.1
2	T1	All MCs	115	3.0	115	3.0	0.876	71.2	LOS F	4.3	33.2	0.98	1.41	2.38	13.2
Approach			188	2.6	188	2.6	0.876	47.8	LOS E	4.3	33.2	0.82	1.24	1.68	21.0
All Vehicles			1521	8.3	1521	8.3	0.876	6.7	NA	4.3	33.2	0.14	0.22	0.24	63.1

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: S2 [2026 Basecase Stage 2 AM (Site Folder: Skeet Ranford)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Network: TSTIC [2026 Basecase Am Peak without development (Network Folder: Skeet Road Ranford Rd)]

Type B Two-Stage T-Intersection Crossing
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Ranford Rd															
2	T1	All MCs	1228	8.7	1228	8.7	0.330	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
3	R2	All MCs	55	2.0	55	2.0	0.030	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	44.8
Approach			1283	8.4	1283	8.4	0.330	0.3	NA	0.0	0.0	0.00	0.03	0.00	59.5
West: Median Storage															
1	R2	All MCs	115	2.0	115	2.0	0.307	10.5	LOS B	1.0	7.9	0.80	0.95	0.95	39.8
Approach			115	2.0	115	2.0	0.307	10.5	LOS B	1.0	7.9	0.80	0.95	0.95	39.8
All Vehicles			1398	7.9	1398	7.9	0.330	1.1	NA	1.0	7.9	0.07	0.10	0.08	57.8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: S1 [2026 Basecase Stage 1 PM (Site Folder: Skeet Ranford)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Network: TSTIC [2026 Basecase Pm Peak without development (Network Folder: Skeet Road Ranford Rd)]

Type B Two-Stage T-Intersection Crossing
Site Category: (None)
Stop (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: B1-1															
3	L2	All MCs	116	5.0	116	5.0	0.086	7.5	LOS A	0.4	2.8	0.13	0.57	0.13	54.1
4	T1	All MCs	1197	9.7	1197	9.7	0.323	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.4
Approach			1313	9.3	1313	9.3	0.323	0.8	LOS A	0.4	2.8	0.01	0.05	0.01	76.0
East: Median Storage															
5	T1	All MCs	42	2.0	42	2.0	0.116	9.0	LOS A	0.4	2.8	0.77	0.78	0.77	39.7
Approach			42	2.0	42	2.0	0.116	9.0	LOS A	0.4	2.8	0.77	0.78	0.77	39.7
West: Skeet Road															
1	L2	All MCs	27	2.0	27	2.0	0.041	11.2	LOS B	0.1	1.1	0.55	0.93	0.55	43.3
2	T1	All MCs	61	3.0	61	3.0	0.426	40.3	LOS E	1.5	11.3	0.92	1.07	1.17	19.6
Approach			88	2.7	88	2.7	0.426	31.3	LOS D	1.5	11.3	0.81	1.03	0.98	25.9
All Vehicles			1443	8.7	1443	8.7	0.426	2.9	NA	1.5	11.3	0.08	0.14	0.09	70.4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: S2 [2026 Basecase Stage 2 PM (Site Folder: Skeet Ranford)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Network: TSTIC [2026 Basecase Pm Peak without development (Network Folder: Skeet Road Ranford Rd)]

Type B Two-Stage T-Intersection Crossing
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Ranford Rd															
2	T1	All MCs	1315	8.7	1315	8.7	0.353	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
3	R2	All MCs	42	2.0	42	2.0	0.023	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	44.8
Approach			1357	8.5	1357	8.5	0.353	0.2	NA	0.0	0.0	0.00	0.02	0.00	59.5
West: Median Storage															
1	R2	All MCs	61	2.0	61	2.0	0.188	10.8	LOS B	0.6	4.2	0.80	0.87	0.84	39.5
Approach			61	2.0	61	2.0	0.188	10.8	LOS B	0.6	4.2	0.80	0.87	0.84	39.5
All Vehicles			1418	8.2	1418	8.2	0.353	0.7	NA	0.6	4.2	0.03	0.06	0.04	58.7

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

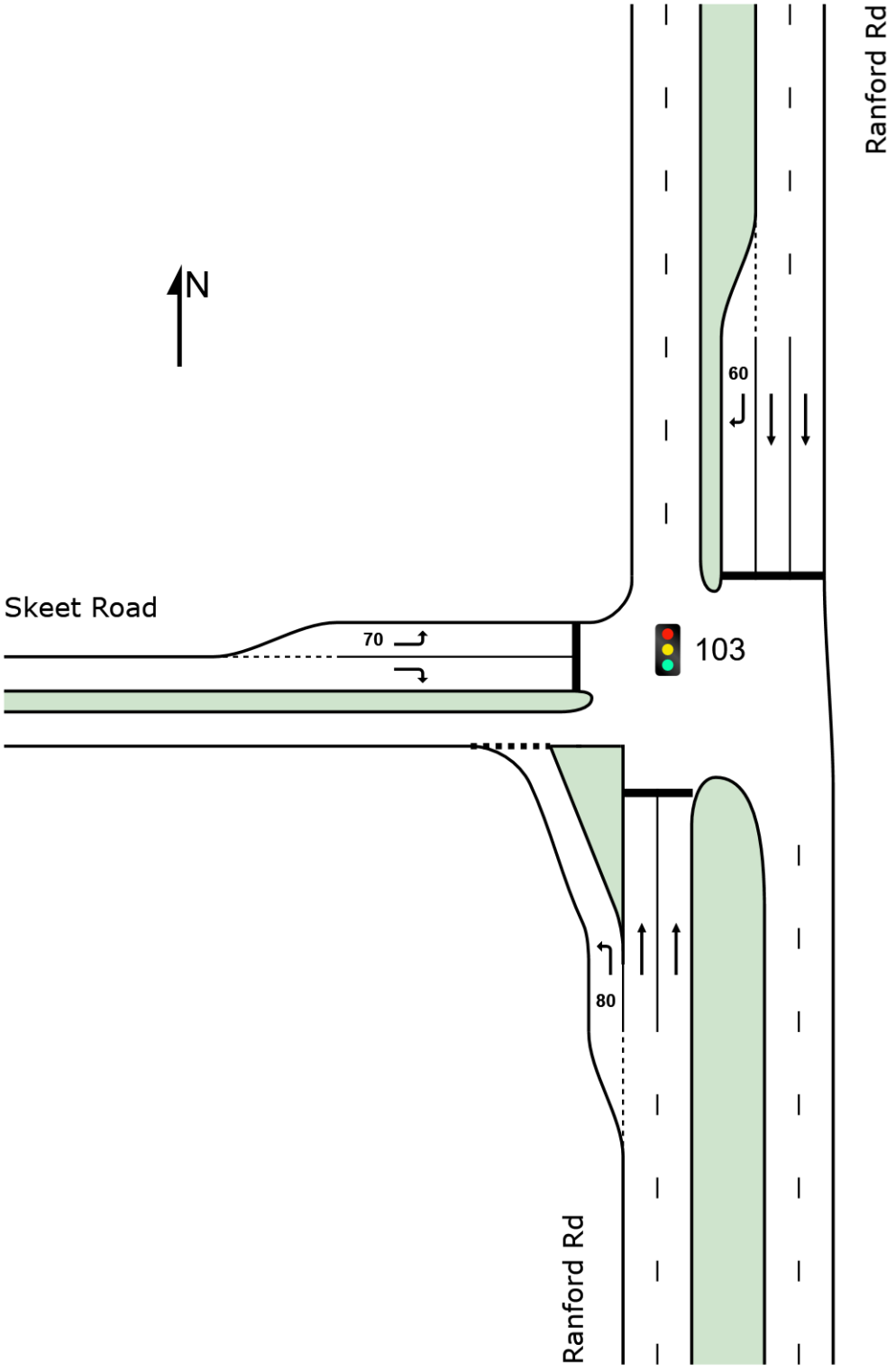
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SITE LAYOUT

Site: 103 [Ranford Rd Skeet Rd 2041 With Development Am (Site Folder: Skeet Rd Ranford Rd Signals)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 103 [Ranford Rd Skeet Rd 2041 With Development Am (Site Folder: Skeet Rd Ranford Rd Signals)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 80 seconds (Site Practical Cycle Time)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Ranford Rd															
1	L2	All MCs	93	5.0	93	5.0	0.064	22.3	LOS C	0.6	4.5	0.23	0.65	0.23	48.6
2	T1	All MCs	1782	9.7	1782	9.7	* 0.894	32.2	LOS C	38.8	318.5	0.96	1.02	1.15	38.2
Approach			1875	9.5	1875	9.5	0.894	31.8	LOS C	38.8	318.5	0.92	1.00	1.10	38.6
North: Ranford Rd															
8	T1	All MCs	1585	8.7	1585	8.7	0.610	6.7	LOS A	15.8	128.1	0.55	0.51	0.55	64.5
9	R2	All MCs	135	2.0	135	2.0	* 0.841	54.4	LOS D	6.0	45.5	1.00	0.94	1.40	25.0
Approach			1720	8.2	1720	8.2	0.841	10.4	LOS B	15.8	128.1	0.59	0.54	0.62	56.7
West: Skeet Road															
10	L2	All MCs	174	2.0	174	2.0	0.690	42.9	LOS D	7.0	52.8	1.00	0.86	1.10	27.1
12	R2	All MCs	219	3.0	219	3.0	* 0.876	50.9	LOS D	10.0	76.4	1.00	1.07	1.41	25.8
Approach			393	2.6	393	2.6	0.876	47.4	LOS D	10.0	76.4	1.00	0.98	1.27	26.3
All Vehicles			3987	8.2	3987	8.2	0.894	24.1	LOS C	38.8	318.5	0.79	0.80	0.91	42.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

MOVEMENT SUMMARY

Site: 103 [Ranford Rd Skeet Rd 2041 With Development Pm (Site Folder: Skeet Rd Ranford Rd Signals)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 60 seconds (Site Practical Cycle Time)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Ranford Rd															
1	L2	All MCs	112	5.0	112	5.0	0.079	12.7	LOS B	0.5	4.0	0.26	0.66	0.26	48.7
2	T1	All MCs	1598	9.7	1598	9.7	* 0.879	25.7	LOS C	27.2	223.2	0.96	1.02	1.21	41.3
Approach			1709	9.4	1709	9.4	0.879	24.9	LOS C	27.2	223.2	0.92	1.00	1.15	41.8
North: Ranford Rd															
8	T1	All MCs	1761	8.7	1761	8.7	0.686	5.9	LOS A	15.0	121.7	0.62	0.57	0.62	65.8
9	R2	All MCs	95	2.0	95	2.0	* 0.517	37.7	LOS D	2.9	21.7	0.99	0.77	1.00	30.2
Approach			1856	8.4	1856	8.4	0.686	7.5	LOS A	15.0	121.7	0.64	0.58	0.64	61.7
West: Skeet Road															
10	L2	All MCs	101	2.0	101	2.0	0.552	34.9	LOS C	3.1	23.4	0.99	0.79	1.04	29.9
12	R2	All MCs	120	3.0	120	3.0	* 0.660	35.9	LOS D	3.8	28.9	1.00	0.85	1.15	30.5
Approach			221	2.5	221	2.5	0.660	35.4	LOS D	3.8	28.9	1.00	0.83	1.10	30.2
All Vehicles			3786	8.5	3786	8.5	0.879	17.0	LOS B	27.2	223.2	0.79	0.79	0.90	48.1

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

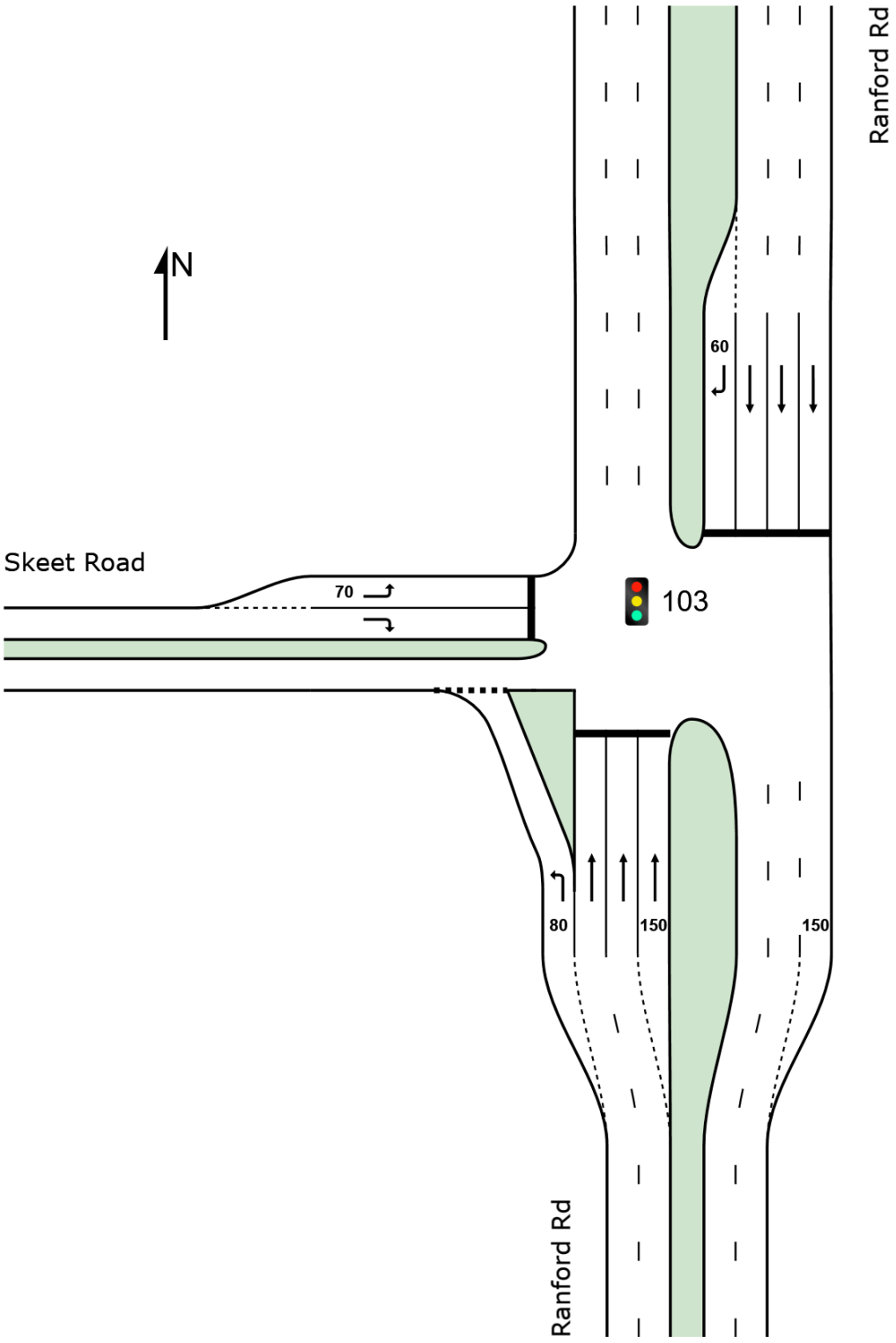
* Critical Movement (Signal Timing)

SITE LAYOUT

Site: 103 [Ranford Rd Skeet Rd 2041 With Development Am - 3 lanes (Site Folder: Skeet Rd Ranford Rd Signals)]

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 103 [Ranford Rd Skeet Rd 2041 With Development Am - 3 lanes (Site Folder: Skeet Rd Ranford Rd Signals)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 50 seconds (Site Practical Cycle Time)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Ranford Rd															
1	L2	All MCs	93	5.0	93	5.0	0.071	8.8	LOS A	0.5	3.6	0.33	0.66	0.33	48.3
2	T1	All MCs	1782	9.7	1782	9.7	* 0.853	22.9	LOS C	16.8	137.7	0.98	1.01	1.28	42.7
Approach			1875	9.5	1875	9.5	0.853	22.2	LOS C	16.8	137.7	0.95	1.00	1.23	43.0
North: Ranford Rd															
8	T1	All MCs	1585	8.7	1585	8.7	0.494	6.2	LOS A	7.6	61.9	0.57	0.51	0.57	66.0
9	R2	All MCs	135	2.0	135	2.0	* 0.613	32.3	LOS C	3.5	26.3	0.99	0.82	1.10	32.4
Approach			1720	8.2	1720	8.2	0.613	8.3	LOS A	7.6	61.9	0.61	0.53	0.61	60.5
West: Skeet Road															
10	L2	All MCs	174	2.0	174	2.0	0.678	29.4	LOS C	4.5	34.1	1.00	0.88	1.16	32.1
12	R2	All MCs	219	3.0	219	3.0	* 0.860	34.7	LOS C	6.5	49.4	1.00	1.09	1.53	31.1
Approach			393	2.6	393	2.6	0.860	32.4	LOS C	6.5	49.4	1.00	0.99	1.37	31.5
All Vehicles			3987	8.2	3987	8.2	0.860	17.2	LOS B	16.8	137.7	0.81	0.80	0.98	46.9

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

MOVEMENT SUMMARY

Site: 103 [Ranford Rd Skeet Rd 2041 With Development Pm - 3 lanes (Site Folder: Skeet Rd Ranford Rd Signals)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 50 seconds (Site Practical Cycle Time)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Ranford Rd															
1	L2	All MCs	112	5.0	112	5.0	0.083	8.6	LOS A	0.5	3.9	0.31	0.66	0.31	48.5
2	T1	All MCs	1598	9.7	1598	9.7	* 0.726	15.6	LOS B	12.0	98.5	0.90	0.83	0.98	50.2
Approach			1709	9.4	1709	9.4	0.726	15.1	LOS B	12.0	98.5	0.87	0.82	0.94	50.1
North: Ranford Rd															
8	T1	All MCs	1761	8.7	1761	8.7	0.531	6.1	LOS A	8.4	68.5	0.57	0.51	0.57	66.6
9	R2	All MCs	95	2.0	95	2.0	* 0.431	31.2	LOS C	2.3	17.7	0.97	0.77	0.97	32.9
Approach			1856	8.4	1856	8.4	0.531	7.4	LOS A	8.4	68.5	0.59	0.52	0.59	62.9
West: Skeet Road															
10	L2	All MCs	101	2.0	101	2.0	0.460	28.6	LOS C	2.5	18.9	0.97	0.77	0.97	32.5
12	R2	All MCs	120	3.0	120	3.0	* 0.550	29.0	LOS C	3.0	23.2	0.98	0.80	1.03	33.4
Approach			221	2.5	221	2.5	0.550	28.8	LOS C	3.0	23.2	0.98	0.78	1.00	33.0
All Vehicles			3786	8.5	3786	8.5	0.726	12.1	LOS B	12.0	98.5	0.74	0.67	0.77	53.5

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

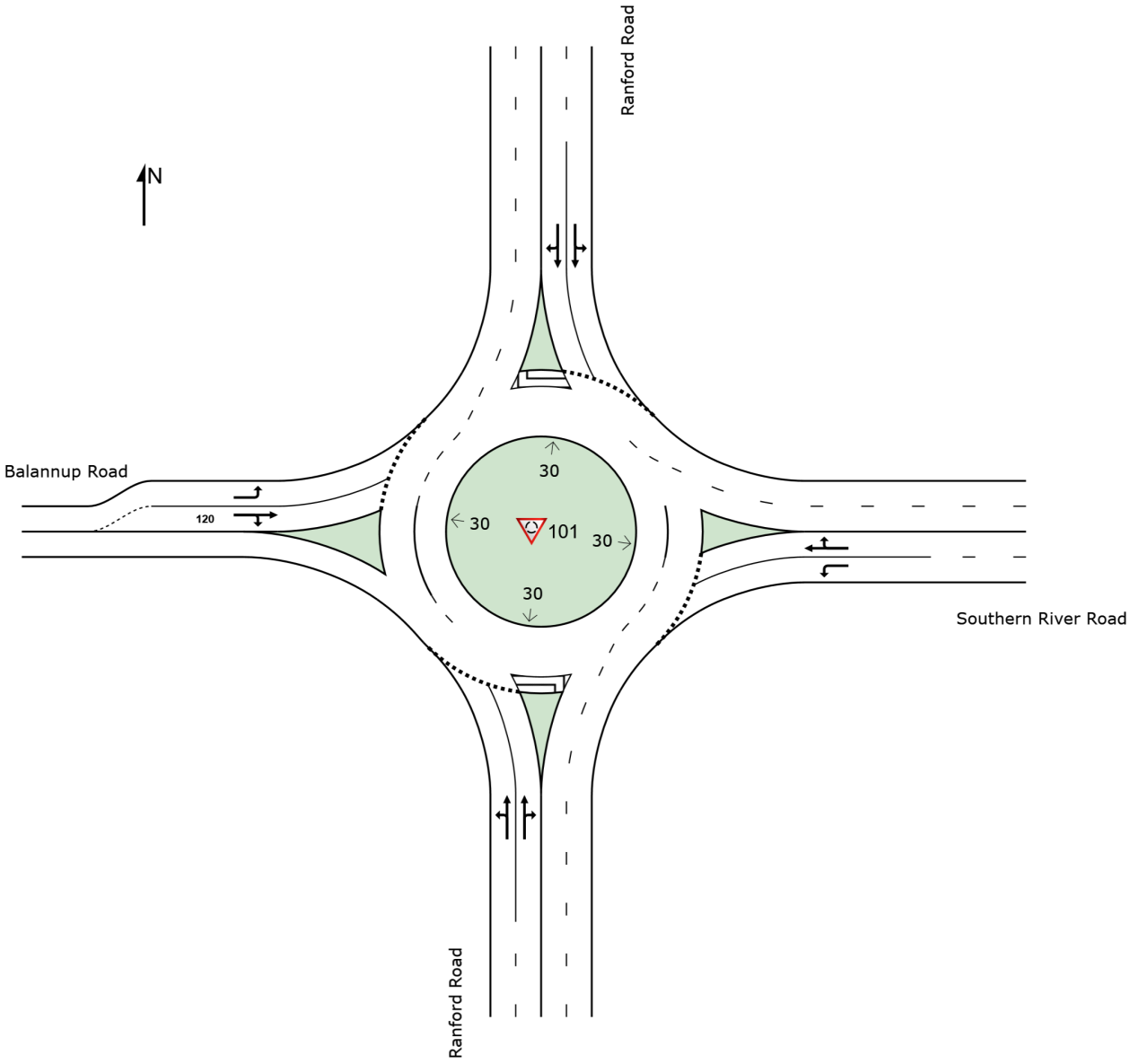
Ranford Road and Balannup Road Roundabout - SIDRA

SITE LAYOUT

Site: 101 [Ranford Rd Balannup Rd 2026 AM (Site Folder: Ranford Rd Balannup Rd)]

New Site
Site Category: (None)
Roundabout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



SITE VARIABLE RUN - Demand (Design Life) Analysis

Results for Intersection (Vehicles)

Site: 101 [Ranford Rd Balannup Rd 2026 AM (Site Folder: Ranford Rd Balannup Rd)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 15 years

Intersection Performance (Design Life - Vehicles) - Hourly Values

Year	Dem Flow (Tot)	Deg Satn *	Prop Spr Cap	Del (Wr Mv) **	Del (Av Ctl)	LOS	95% Back Que	95% Back Que	Stop Rate	Trvl Spd (Veh)	Del (Tot)	Eff Stp (Tot)	Trav Dist (Tot)	Trav Time (Tot)	Cost (Tot)	Fuel (Tot)	CO2 (Tot)	CO (Tot)
	veh/h		%	sec	sec		veh	m		km/h	veh-h/h	veh/h	veh-km/h	veh-h/h	$/h	L/h	kg/h	kg/h
0	3486	0.574	48.2	20.5	9.5	LOS A	5.5	42.2	0.74	50.0	9.24	2577	2660.5	53.2	2529.31	341.5	809.5	1.04
1	3599	0.602	41.2	21.3	10.0	LOS B	6.2	47.7	0.77	49.8	10.03	2762	2747.3	55.2	2624.83	354.1	839.3	1.07
2	3716	0.633	34.3	22.1	10.6	LOS B	7.0	54.3	0.80	49.4	10.97	2972	2837.1	57.4	2727.99	367.5	871.0	1.11
3	3836	0.666	27.6	23.1	11.3	LOS B	8.0	62.0	0.83	49.0	12.09	3201	2929.9	59.8	2839.80	381.6	904.6	1.15
4	3961	0.702	21.0	24.2	12.2	LOS B	9.3	71.5	0.87	48.4	13.48	3458	3025.9	62.5	2964.32	396.9	940.8	1.20
5	4090	0.742	14.6	25.5	13.4	LOS B	10.8	83.5	0.92	47.5	15.28	3745	3125.2	65.9	3112.44	413.9	981.1	1.24
6	4223	0.794	7.1	27.2	15.1	LOS B	12.9	99.4	0.97	46.1	17.69	4107	3227.9	70.0	3290.75	432.8	1025.6	1.29
7	4361	0.867	-2.0	30.6	17.5	LOS B	15.8	122.1	1.05	44.3	21.20	4594	3334.1	75.2	3511.54	453.6	1074.9	1.34
8	4504	0.938	-9.4	36.6	21.5	LOS C	20.5	158.2	1.17	41.6	26.90	5281	3444.0	82.7	3815.02	477.8	1132.3	1.40
9	4651	1.014	-16.2	65.1	29.8	LOS C	29.2	225.5	1.38	37.0	38.52	6407	3557.7	96.2	4340.21	512.6	1214.4	1.47
10	4804	1.097	-22.5	121.4	46.8	LOS D	45.9	354.2	1.73	30.1	62.40	8289	3675.3	122.0	5320.12	568.1	1345.7	1.58
11	4961	1.188	-28.5	196.6	72.9	LOS F	70.6	544.7	2.17	23.4	100.43	10788	3797.0	162.1	6823.44	646.7	1531.6	1.73
12	5124	1.288	-34.0	283.5	96.3	LOS F	81.7	630.8	2.56	19.5	137.03	13138	3923.0	200.8	8272.31	721.4	1707.8	1.87
13	5293	1.403	-39.4	385.2	122.5	LOS F	102.9	779.8	2.96	16.5	180.12	15683	4053.3	246.0	9958.59	804.9	1905.1	2.04
14	5467	1.467	-42.0	441.7	150.7	LOS F	117.9	893.8	3.38	14.1	228.81	18503	4188.2	296.9	11861.51	901.0	2132.1	2.22
15	5648	1.516	-43.9	485.3	181.7	LOS F	131.0	993.2	3.83	12.2	285.08	21650	4327.7	355.5	14047.53	1010.2	2390.3	2.42

* Largest for Vehicles or Pedestrians
** Highest delay for any vehicle or pedestrian movement
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

SITE VARIABLE RUN - Demand (Design Life) Analysis

Results for Intersection (Vehicles)

Site: 101 [Ranford Rd Balannup Rd 2026 PM (Site Folder: Ranford Rd Balannup Rd)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 15 years

Intersection Performance (Design Life - Vehicles) - Hourly Values

Year	Dem Flow (Tot)	Deg Satn *	Prop Spr Cap	Del (Wr Mv) **	Del (Av Ctl)	LOS	95% Back Que	95% Back Que	Stop Rate	Trvl Spd (Veh)	Del (Tot)	Eff Stp (Tot)	Trav Dist (Tot)	Trav Time (Tot)	Cost (Tot)	Fuel (Tot)	CO2 (Tot)	CO (Tot)
	veh/h		%	sec	sec		veh	m		km/h	veh-h/h	veh/h	veh-km/h	veh-h/h	$/h	L/h	kg/h	kg/h
0	3479	0.631	34.7	22.5	10.3	LOS B	7.1	54.6	0.76	49.6	10.00	2654	2657.0	53.5	2533.27	338.0	801.1	1.02
1	3592	0.661	28.5	23.5	11.0	LOS B	8.0	61.6	0.80	49.2	10.95	2859	2744.4	55.7	2635.59	351.1	832.1	1.06
2	3709	0.695	22.3	24.9	11.8	LOS B	9.1	70.1	0.83	48.7	12.13	3092	2834.9	58.2	2749.54	365.2	865.7	1.10
3	3831	0.730	16.4	26.5	12.8	LOS B	10.5	80.6	0.87	48.0	13.61	3350	2928.5	61.1	2879.00	380.6	901.9	1.14
4	3956	0.768	10.6	28.6	14.2	LOS B	12.2	93.8	0.93	46.9	15.56	3660	3025.3	64.5	3028.72	397.3	941.7	1.18
5	4085	0.809	5.0	31.4	16.0	LOS B	14.5	111.7	0.99	45.6	18.12	4041	3125.4	68.5	3205.04	415.5	984.6	1.23
6	4219	0.851	-0.1	35.4	18.6	LOS B	17.6	135.2	1.08	43.7	21.76	4545	3229.1	73.9	3427.06	435.6	1032.2	1.28
7	4358	0.904	-6.0	41.3	22.8	LOS C	22.1	169.7	1.20	41.0	27.58	5242	3336.3	81.5	3732.65	459.8	1089.6	1.34
8	4501	0.972	-12.5	51.3	30.9	LOS C	29.4	226.0	1.41	36.6	38.61	6346	3447.2	94.3	4233.29	493.2	1168.4	1.41
9	4649	1.045	-18.6	83.7	46.5	LOS D	41.8	321.8	1.75	30.3	60.11	8137	3562.0	117.7	5123.16	544.3	1289.4	1.51
10	4803	1.088	-21.9	114.2	65.3	LOS E	60.6	466.4	2.11	25.1	87.10	10122	3680.8	146.6	6219.44	605.5	1434.0	1.62
11	4961	1.123	-24.3	141.3	88.9	LOS F	84.1	647.4	2.52	20.7	122.46	12509	3803.7	184.0	7627.98	681.2	1612.8	1.76
12	5125	1.163	-26.9	174.7	114.6	LOS F	108.2	832.9	2.94	17.3	163.10	15062	3930.9	226.8	9231.90	765.0	1810.9	1.92
13	5295	1.200	-29.1	219.5	143.3	LOS F	135.0	1038.9	3.38	14.7	210.82	17894	4062.6	276.7	11103.16	862.3	2040.7	2.09
14	5471	1.243	-31.6	242.9	174.2	LOS F	149.5	1150.6	3.85	12.6	264.64	21038	4198.9	332.7	13196.00	967.1	2288.4	2.28
15	5652	1.288	-34.0	284.4	208.2	LOS F	175.8	1352.4	4.31	10.9	326.84	24356	4340.0	397.3	15599.02	1085.1	2567.3	2.49

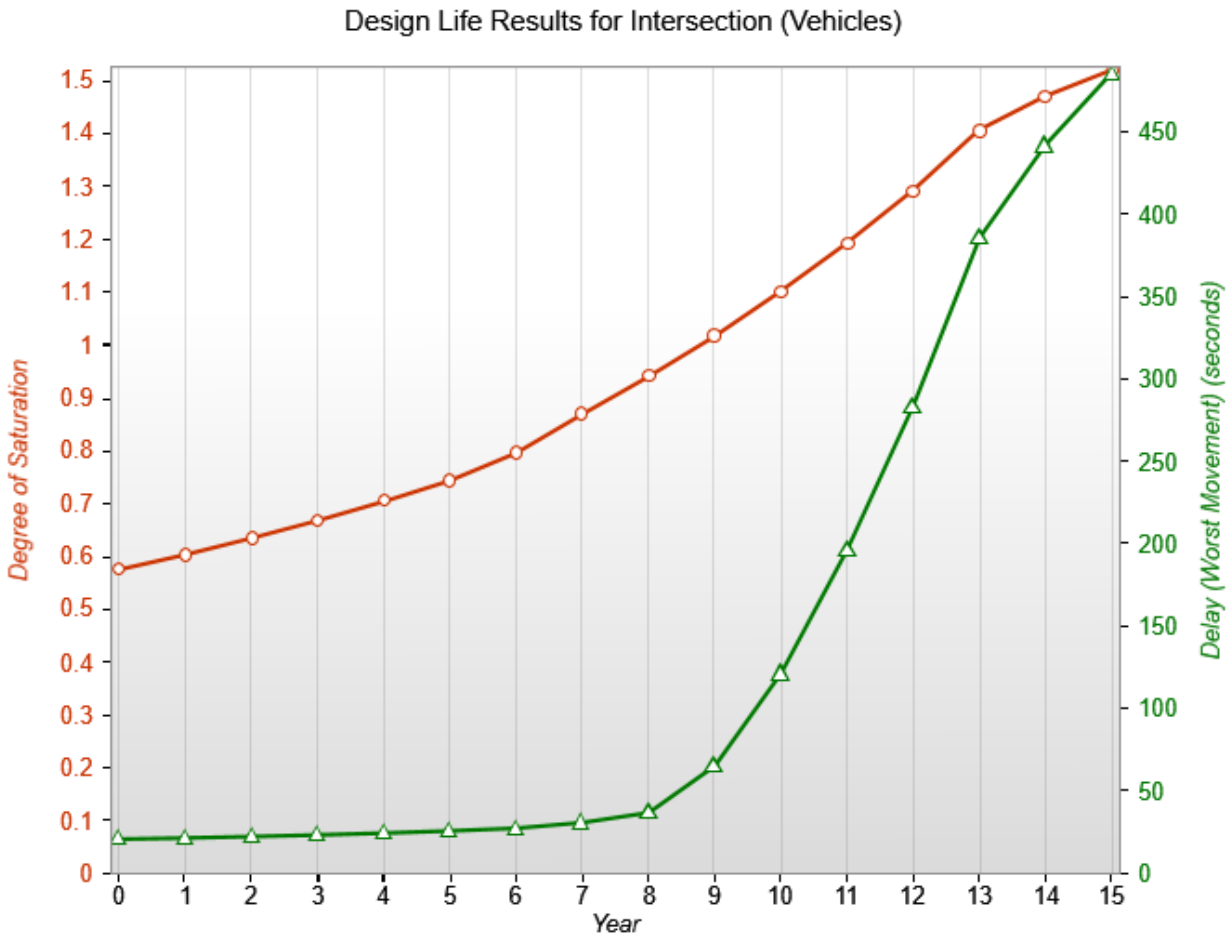
* Largest for Vehicles or Pedestrians
** Highest delay for any vehicle or pedestrian movement
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

SITE GRAPHS - Demand (Design Life) Analysis

Site: 101 [Ranford Rd Balannup Rd 2026 AM (Site Folder: Ranford Rd Balannup Rd)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

New Site
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 15 years

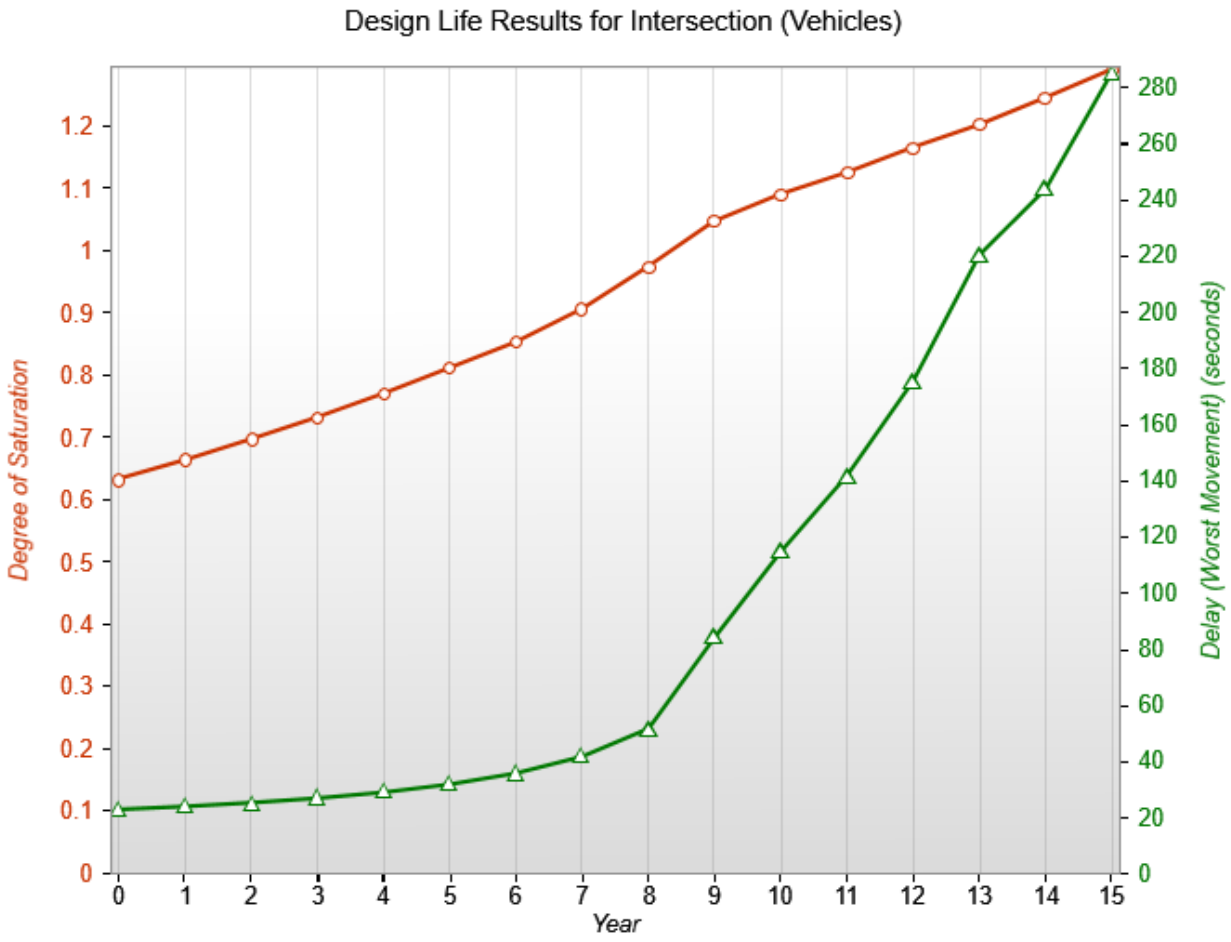


SITE GRAPHS - Demand (Design Life) Analysis

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APPENDIX 11 – ECONOMIC REPORT

URBIS

HARRISDALE (CORNER RANFORD ROAD / SKEET ROAD) ECONOMIC ASSESSMENT



Prepared for Yolk Property Group
July 2021

CONTENTS

Executive Summary	3
Introduction	4
Site Context	5
Site Suitability Assessment	9
Commercial Zone Assessment	12

EXECUTIVE SUMMARY

This study was undertaken to inform decision makers as to the rationale for the proposed Commercial zone within the proposed structure plan for lots at the corner of Ranford Road and Skeet Road in Harrisdale.

Key findings of our market and economic assessment are summarised below.

- Analysis of the existing stock of commercial zoned land in the study area (suburbs of Harrisdale, Piara Waters, Forrestdale and Southern River) demonstrates that there is an existing and forecast undersupply in the area (equivalent to 31 ha and growing to 53 ha over the next decade).
- The supply of commercial zoned land is not equitably supplied throughout the area which leads to limited local amenities for resident in the area surrounding and including the subject site.

Analysis of the attributes of the subject site was undertaken and demonstrates the suitability to accommodate a Commercial zone as part of a subdivision.

In particular, the subject site has the following attributes that support its identification for Commercial zone uses.

- **High Exposure / Visibility**: This site is located on the corner of Skeet Road and Ranford Road. Ranford Road currently experiences more than 29,000 daily vehicle movements. This supports accessibility to a wide catchment of residents.
- **Ease of Accessibility**: The two proposed connections to the commercial area within the subject site will support accessibility.
- **Large and Growing Catchment**: The defined study area has experienced strong population growth over the past decade and is expected to continue to grow as Harrisdale develops.

Based on these findings, a Ccommercial zone for local retail and service amenities is supported. This rezoning will deliver a range of short- and long-term benefits.

BENEFITS OF COMMERCIAL ZONE



Job creation and economic activity

The site is expected to create employment opportunities during and post construction.



Commercial amenities

The site will provide commercial amenities undersupplied in the area and complement the existing offering within the activity centre heirarchy. It will additionally enable prospective local business to occupy new, modern, well-serviced and fit-for-purpose space



Liveability

The site will support the attractiveness of the area for residents.

INTRODUCTION

STUDY PURPOSE AND APPROACH

Urbis was engaged to prepare a market assessment to explore the potential need for additional commercial zoned land within the area.

This study provides an evidence-based demand and supply assessment of commercial uses. In particular, the study seeks to understand:

- The need for additional commercial zoned land; and
- Whether the subject site is best placed to meet the need for commercial zoned land.

This study included the following tasks.

- **Site assessment** to understand whether the attributes of the site support the viability of the commercial zoned land use.
- **Market analysis** to understand the need for commercial zoned land use in the area.
- **Benefits and impact summary** to understand the potential employment and economic activity that could be supported by the commercial zone.

REPORT STRUCTURE

This report includes the following sections.

- **Site context** – overview of the site and its surrounding land use attributes.
- **Site suitability assessment** – analysis of the suitability of the subject site for commercial zoned land uses.
- **Commercial zone assessment** – current and forecast undersupply of comparable zoned land and assessment of potential employment generation and benefits of a commercial zone in the subject site.

01

SITE CONTEXT



SUBJECT SITE CONTEXT

Site Overview

The subject site is bounded by Balannup Road to the north, Ranford Road to the east, Skeet Road to the south and Reilly Road to the west. The proposed commercial zone is on the corner of the site with an approximately land area of 8,000 sq.m.

The commercial zone possesses opportunity for good access and movement, with the southern and eastern boundary fronting Skeet Road and Ranford Road respectively.

The existing urban area to the west of the subject site features a neighbourhood shopping centre (Harrisdale Shopping Centre), traditional detached housing and a range of population amenities such as schools and recreation space.

Subject Site Map



STUDY AREA CONTEXT

Study Area Definition

For the purposes of this assessment, a study area was defined which encompassed the suburbs of Harrisdale, Forrestdale, Piara Waters and Southern River.

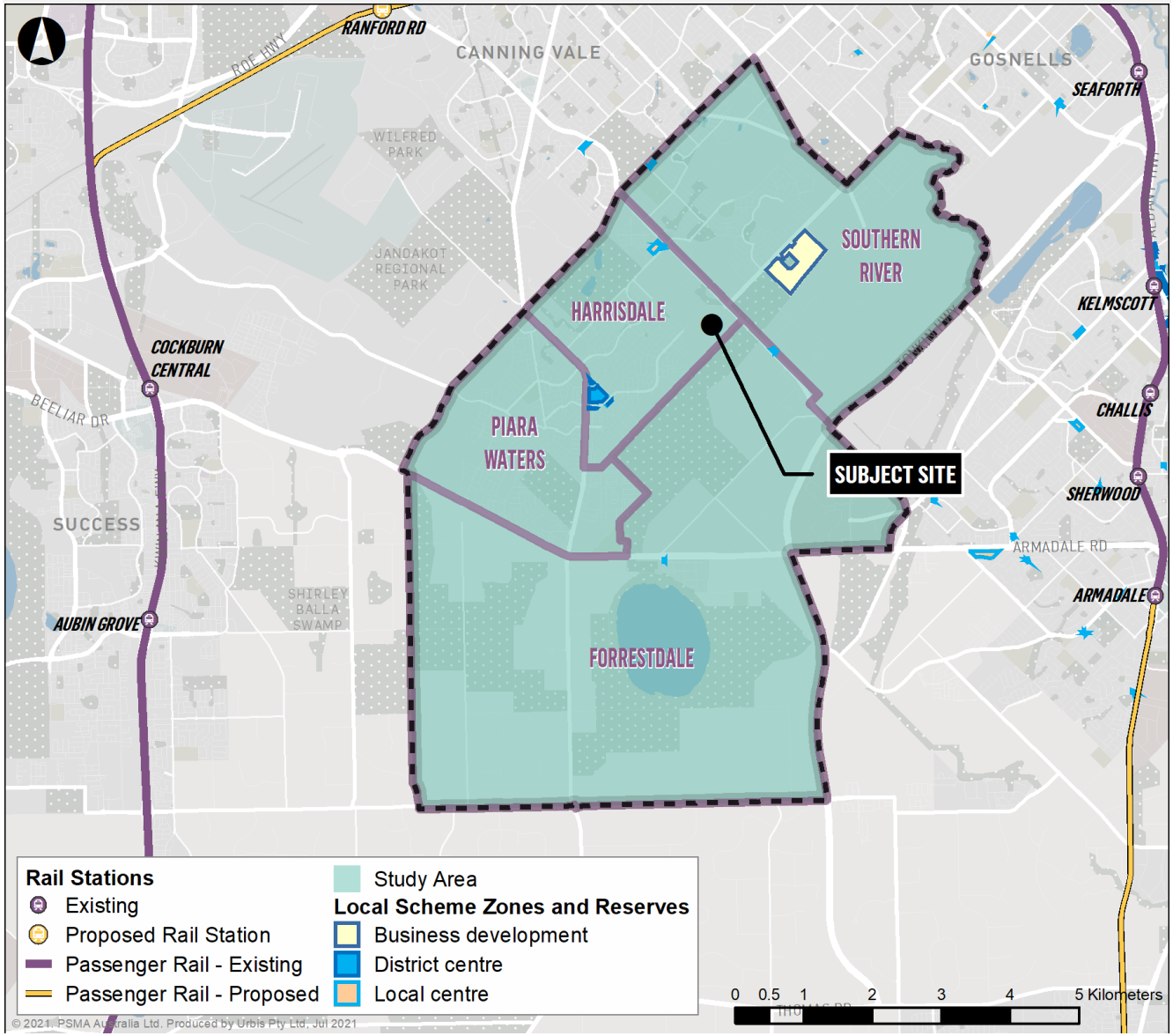
This study area reflects the likely resident draw for the proposed commercial zone given its accessibility via Ranford Road and Skeet Road.

The mapping illustrates a large Business Development zone in Southern River which is expected to support a significant light commercial development. Part of the land was formerly a liquid waste disposal site and the City has remediated the land. This 45 ha business park is expected to cater to a broad regional catchment and accommodate warehouse, showroom and workshop typology uses.

The Harrisdale District Centre is located to the west of the subject site and caters to convenience shopping requirements.

There are limited opportunities to accommodate local service commercial and road-based retail services in the area (e.g. petrol station, fast food, tyre repair shop etc.).

Study Area Map



POPULATION GROWTH

Key Findings

The population of the study area is anticipated to grow from 42,747 residents in 2021 to 74,069 residents in 2036. This residential growth, combined with real per capita spending growth, will support the need for a commensurate increase in commercial amenities.

Population Growth, Study Area, 2016-36

STUDY AREA	2016	2021	2026	2031	2036
Harrisdale	9,479	12,632	14,718	16,223	16,914
Forrestdale	1,115	1,195	2,725	5,356	8,019
Piara Waters	9,517	14,458	17,056	19,147	20,400
Southern River	10,712	14,462	19,230	24,015	28,736
Total	30,823	42,747	53,729	64,741	74,069

Source: Forecast .id

02

SITE SUITABILITY ASSESSMENT



COMMERCIAL ZONE SUCCESS DRIVERS

Key Findings

There is a strong opportunity for the site to help to accommodate commercial land uses. In particular, the site has the following advantages.

- **High Exposure / Visibility**: This corner site is located on Skeet Road and Ranford Road which currently experiences more than 29,000 daily vehicle movements. Exposure is expected to increase as the wider urban area develops.
- **Ease of Accessibility**: With the proposed left in-left out access at Ranford Road and left in on Skeet Road, the site will be easily accessible. These roads are major connections to existing and planned residential areas as well as other key arterial roads including Nicholson Road and Southern River Road.
- **Large and Growing Catchment**: The surrounding area has an established population of 30,800 residents (2016). Urban development around the area will see an increase in the population to approximately 74,000 residents (2036).
- **Lot Attributes**: The site supports suitable floorplates and flexible configuration that can accommodate a range of commercial uses such as showrooms, consulting rooms, petrol station and fast food.
- **Community Benefit**: The 8,000 sq.m scale supports a local provision of road-based uses which complements activity centre hierarchy.

Overall, the site is well-positioned to help meet a need for commercial uses and can complement other activity centres and industrial / light commercial areas within the broader area.

Key Commercial Zone Location Success Drivers

	SUCCESS DRIVER	DESCRIPTION
	**Exposure**	▪ Visibility and exposure to highways or main road frontage
	**Transport Access**	▪ Access to highways or main roads for vehicle transport ▪ Ability to avoid stop / start traffic (e.g. traffic lights) ▪ Ease of getting in and out
	**Surrounding Resident Population**	▪ The size, demographic profile and spending capacity of surrounding residents and workers for the commercial viability of land uses.
	**Lot Size**	▪ Ability to accommodate appropriately sized lots and flexibility of design configuration.
	**Net Community Benefit**	▪ The development occurs in a manner consistent with the achievement of a net community benefit without undermining the activity centres hierarchy.

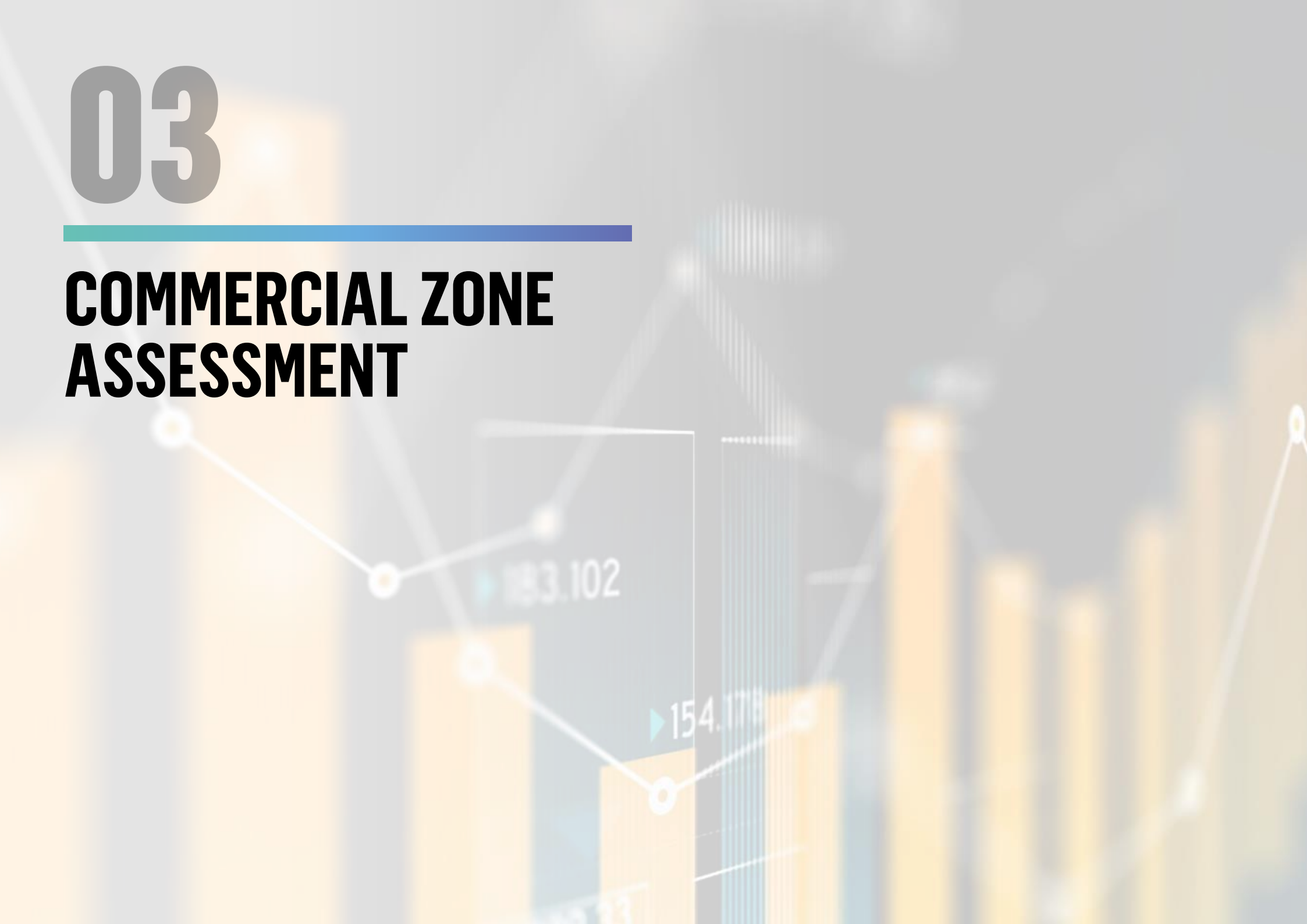
COMMERCIAL ZONE POTENTIAL

Site Assessment Findings for Highway Commercial

LOCATION DRIVER	IMPLICATIONS FOR SUBJECT SITE	RATING
Exposure	▪ Corner site with high exposure to both Ranford Road and Skeet Road which are main roads. ▪ Intersection of Ranford Road and Southern River Road had average daily traffic of 29,337 vehicles Monday to Friday in 2019/20 (Main Roads WA).	**Strong**
Transport Access	▪ Left-in/left-out access at Ranford Road, as well as left in on Skeet Road (with potential for left out). ▪ There is an existing roundabout at the intersection of Ranford Road and Southern River Road, which improves accessibility to site.	**Moderate**
Surrounding Resident Population	▪ Established high residential population and strong growth forecast within the study area.	**Strong**
Lot Size	▪ Overall commercial zone land area of 8,000 sq.m of which 2,000 sq.m of floorspace and 1-2 pad sites for fast food / petrol station could be used for commercial uses.	**Strong**
Net Community Benefit	▪ The site's location and ease of access support its ability to meet the needs of existing and future residents. ▪ The site could provide important local employment opportunities to the community. ▪ There is a demonstrated need for additional Commercial zoned land that caters directly to the residents of Southern River, Harrisdale, Forrestdale and Piara Waters. ▪ The proposed road based uses (e.g. showrooms, petrol station, fast food) complement shop retail and commercial uses within the activity centre network.	**Strong**
Overall Site Appropriateness		**Strong**

03

COMMERCIAL ZONE ASSESSMENT



SUPPLY AND DEMAND FOR COMMERCIAL ZONED LAND

Key Findings

There is currently estimated to be an undersupply of approximately 31 ha of commercial land. In the coming years, the undersupply is expected to continue to grow as the wider area develops. Including the proposed Southern River Business Park and 8,000 sq.m of commercial zoned land in the subject site, the level of undersupply is estimated to increase notionally to 53 ha.

This analysis demonstrates that there is sufficient excess demand and leakage to support the broader activity centre and commercial zone provision across the wider area (for instance, large commercial precincts such as Cockburn will cater to a large portion of this demand). Additionally, the analysis demonstrates that residents have to travel notable distances to access required commercial land areas.

Indicative Supply and Demand for Commercial Zoned Land, Study Area

	UNITS	2021	2031
Study Area Resident Population	*persons*	42,747	64,741
Demand for Commercial Floorspace	*Sq.m*	222,284	336,653
Demand for Commercial Zoned Land	*ha*	52	78
Supply of Commercial Zoned Land (estimate)	*ha*	20	25
Estimated Under (Over) Supply	***ha***	**31**	**53**

Source: Urbis, DPLH Land Use and Employment Survey 2015-17, Forecast .id
** Future supply includes proposed 8,000 sq.m commercial zone in subject site and 3.7 ha of mixed business zone within Southern River business park (the remaining land in the business park is proposed as light industry and public open space).*
*** Demand based on floorspace per capita approach using a floorspace benchmark of 5.2 sq.m per capita. This is the Perth average supply per capita for retail and commercial uses. A floorspace to land area ratio of 0.43 was adopted based on a review of established commercial zoned areas.*

BENEFITS AND IMPACT SUMMARY

Key Findings

The commercial zoned land is expected to generate benefits to the local area.

A key benefit is employment generation / economic activity through the construction and operation phases.

The proposal will also increase local commercial amenities for the growing area and enable prospective local business to occupy new, modern, well-serviced and fit-for-purpose space.

In addition, the use could support the liveability of the area and the space.

Key Commercial Zone Benefits

	BENEFIT	DESCRIPTION
	**Employment and Economic Activity**	▪ The commercial zone will provide increased and diverse employment opportunities to residents in the area through the construction and operation phases. ▪ Indicatively, the site could support construction phase investment (site, building and fit-out works) of approximately $10-15 million. ▪ The operation of 2,000 sq.m of commercial floorspace and 1-2 pad sites for petrol station and / or fast food uses could indicatively support 35-45 ongoing employment opportunities (based on employment to floorspace ratios for comparable uses)
	**Commercial Amenity**	▪ The site will provide commercial amenities to surrounding areas as well as being able to leverage / support existing and new businesses.
	**Liveability**	▪ With the increasing demand currently and in the future, the commercial zone will help reduce the level of leakage (and associated travel times and costs). This could support increased population attraction.

COVID-19 AND THE POTENTIAL IMPACT ON DATA INFORMATION

The data and information that informs and supports our opinions, estimates, surveys, forecasts, projections, conclusion, judgments, assumptions and recommendations contained in this report (Report Content) are predominantly generated over long periods, and is reflective of the circumstances applying in the past. Significant economic, health and other local and world events can, however, take a period of time for the market to absorb and to be reflected in such data and information. In many instances a change in market thinking and actual market conditions as at the date of this report may not be reflected in the data and information used to support the Report Content.

The recent international outbreak of the Novel Coronavirus (COIVID-19), which the World Health Organisation declared a global health emergency in January 2020 and pandemic on 11 March 2020, is causing a material impact on the Australian and world economies and increased uncertainty in both local and global market conditions.

The effects (both directly and indirectly) of the COVID-19 Outbreak on the Australian real estate market and business operations is currently unknown and it is difficult to predict the quantum of the impact it will have more broadly on the Australian economy and how long that impact will last. As at March 2020, the COVID-19 Outbreak is materially impacting global travel, trade and near-term economic growth expectations. Some business sectors, such as the retail, hotel and tourism sectors, are already reporting material impacts on trading performance now and potentially into the future. For example, Shopping Centre operators are reporting material reductions in foot traffic numbers, particularly in centres that ordinarily experience a high proportion of international visitors.

The Report Content and the data and information that informs and supports it is current as at the date of this report and (unless otherwise specifically stated in the Report) necessarily assumes that, as at the date of this report, the COVID-19 Outbreak has not materially impacted the Australian economy, the asset(s) and any associated business operations to which the report relates and the Report Content. However, it is not possible to ascertain with certainty at this time how the market and the Australian economy more broadly will respond to this unprecedented event. It is possible that the market conditions applying to the asset(s) and any associated business operations to which the report relates and the business sector to which they belong could be (or has been) materially impacted by the COVID-19 Outbreak within a short space of time and that it will have a lasting impact. Clearly, the COVID-19 Outbreak is an important risk factor you must carefully consider when relying on the report and the Report Content.

Any Report Content addressing the impact of the COVID-19 Outbreak on the asset(s) and any associated business operations to which the report relates or the Australian economy more broadly is (unless otherwise specifically stated in the Report) unsupported by specific and reliable data and information and must not be relied on.

To the maximum extent permitted by law, Urbis (its officers, employees and agents) expressly disclaim all liability and responsibility, whether direct or indirect, to any person (including the Instructing Party) in respect of any loss suffered or incurred as a result of the COVID-19 Outbreak materially impacting the Report Content, but only to the extent that such impact is not reflected in the data and information used to support the Report Content.

This report is dated August 2021 and incorporates information and events up to that date only and excludes any information arising, or event occurring, after that date which may affect the validity of Urbis Pty Ltd's (Urbis) opinion in this report. Urbis prepared this report on the instructions, and for the benefit only, of the Yolk Property (Instructing Party) for the purpose of an Economic Assessment (Purpose) and not for any other purpose or use. Urbis expressly disclaims any liability to the Instructing Party who relies or purports to rely on this report for any purpose other than the Purpose and to any party other than the Instructing Party who relies or purports to rely on this report for any purpose whatsoever (including the Purpose).

In preparing this report, Urbis was required to make judgements which may be affected by unforeseen future events including wars, civil unrest, economic disruption, financial market disruption, business cycles, industrial disputes, labour difficulties, political action and changes of government or law, the likelihood and effects of which are not capable of precise assessment.

All surveys, forecasts, projections and recommendations contained in or made in relation to or associated with this report are made in good faith and on the basis of information supplied to Urbis at the date of this report. Achievement of the projections and budgets set out in this report will depend, among other things, on the actions of others over which Urbis has no control.

Urbis has made all reasonable inquiries that it believes is necessary in preparing this report but it cannot be certain that all information material to the preparation of this report has been provided to it as there may be information that is not publicly available at the time of its inquiry.

In preparing this report, Urbis may rely on or refer to documents in a language other than English which Urbis will procure the translation of into English. Urbis is not responsible for the accuracy or completeness of such translations and to the extent that the inaccurate or incomplete translation of any document results in any statement or opinion made in this report being inaccurate or incomplete, Urbis expressly disclaims any liability for that inaccuracy or incompleteness.

This report has been prepared with due care and diligence by Urbis and the statements and opinions given by Urbis in this report are given in good faith and in the belief on reasonable grounds that such statements and opinions are correct and not misleading bearing in mind the necessary limitations noted in the previous paragraphs. Further, no responsibility is accepted by Urbis or any of its officers or employees for any errors, including errors in data which is either supplied by the Instructing Party, supplied by a third party to Urbis, or which Urbis is required to estimate, or omissions howsoever arising in the preparation of this report, provided that this will not absolve Urbis from liability arising from an opinion expressed recklessly or in bad faith.

Urbis staff responsible for this report were:

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Project code	P0034915
Report number	Draft

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APPENDIX 12 – ENGINEERING REPORT



HARRISDALE NORTH DEVELOPMENT SERVICING REPORT

PREPARED FOR YOLK PROPERTY GROUP

Porter
Consulting Engineers

REPORT PREPARED FOR

YOLK PROPERTY GROUP

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1.0 INTRODUCTION

Porter Consulting Engineers have been engaged by Yolk Property Group to complete a Development Servicing Report to support the Structure Plan submission for the landholdings that border Skeet Road, Ranford Road, Balannup Road and Reilly Road in Harrisdale.

2.0 SITE

Site consists of 6 parent title lots, namely lots 601-603 Balannup Road plus lots 200-202 Skeet Road.

2.1 Site Location

The site is bounded by Skeet Road, Ranford Road, Balannup Road and Reilly Road as shown below in **Figure 1**. The site area totals approximately 21.2 hectares. To the south west of the site is the Heron Park development by Satterley.



Figure 1 – Site Location

2.2 Development Layout

Presented in **Appendix A** is the Structure Plan. It consists of a series of road, public open spaces (POS's) and residential and commercial lots. It is anticipated the overall yield will be circa 280 lots.

3.0 LANDFORM

The existing site has various houses, sheds as well as an old chicken farm on the corner of Skeet Road and Ranford Road. There is vegetation across the site. Lot 201 Skeet Road appears to have various stockpiles of construction rubble scattered across it. Refer to the Environmental Report for further details.

There are parcels of environmentally sensitive vegetation in and around the site as shown below in **Figure 2**. These include Conservation Category Wetland (CCW) as shown in green and Bush Forever (grey hatch – south of Skeet Road and east of Ranford Road). Refer to the Environmental Report for further details regarding the CCW and the associated buffers.

These sensitive areas are protected via POS as shown in the Structure Plan (**Appendix A**).



Figure 2 – Vegetation Mapping

A detailed geotechnical investigation is being completed by Galt Geotechnical at the time of writing this report. Advice from Galt confirms approximately 200mm of topsoil was found over clean sand. Clay was found at depth (+1.5m) however this will have no impact on the development. It is expected the topsoil will be stripped, screened, blended and then used as structural fill.

Uncontrolled fill was found across parts of the site however Galt indicated this can be used as structural fill at depth with only a small portion (5%) requiring disposal off site.

On line mapping confirms there is a risk of acid sulphate soil across parts of the site. Ground disturbing works including dewatering will require the management of acid sulphate. It is expected this can be done via standard construction techniques. The sewer servicing of the estate (Appendix D) suggests ground disturbance would be minimal.

A feature survey, as prepared by MNG, confirms the ground levels varying between RL22m and RL24m. Refer **Appendix B** for details.

The Perth Groundwater Atlas confirms the groundwater level is typically shallow and flows from the north down to the south. Emerge have completed the LWMS, refer to this document for the maximum ground water level contours. The maximum ground water level for this site is 22.7m. The site will require filling and likely to require subsoil drains to achieve minimum groundwater separation.
Parallel to Reilly Road is the Balannup Drain. The Forrestdale Main Drain Arterial Drainage Strategy (November 2009) completed a detailed investigation of the greater catchment and confirms 1% AEP drain flood levels including those of the Balannup Drain. This was further refined in the LWMS to determine the 1% AEP flood levels for the site.

Emerge have completed the preliminary site investigation. Refer to this document for further details.

Balannup Road and Skeet Road have been recently constructed by the City of Armadale. Reilly Road is unmade and Ranford Road is an existing dual lane, median separated dual carriageway Distributor A road.

3.1 Earthworks and Siteworks

Site clearing and demolition works will be required to enable development. It is expected this will include detailed works based on Emerge's investigation.

The POS areas will remain undisturbed except for the drainage disposal zones.

Poorer ground conditions are noted in the geotechnical investigation. These will require work prior to any structural fill to ensure development requirements are met.

It is expected structural fill will be required as typical with a development in this area. The filling criteria include:

- 1% AEP flood separation,
- site classification requirements,
- separation to ground water and
- sewer servicing requirements.

Filling will also have to tie in with the site's perimeter including Skeet and Balannup Roads.

It is expected fill will be sourced from local sand extraction pits as typical with other development sites in the area.

Retaining will be required in between the commercial and residential to allow at grade Ranford Road frontage for the commercial lot. Based on lot configurations and engineering detail, it is probable retaining walls will be required to manage level differences. Internal retaining is expected to be minimal however perimeter retaining may be more substantial. Refer **Appendix C** for the Concept Earthworks Plan.

3.2 Wastewater

The Water Corporation wastewater planning was sourced and an extract is below.

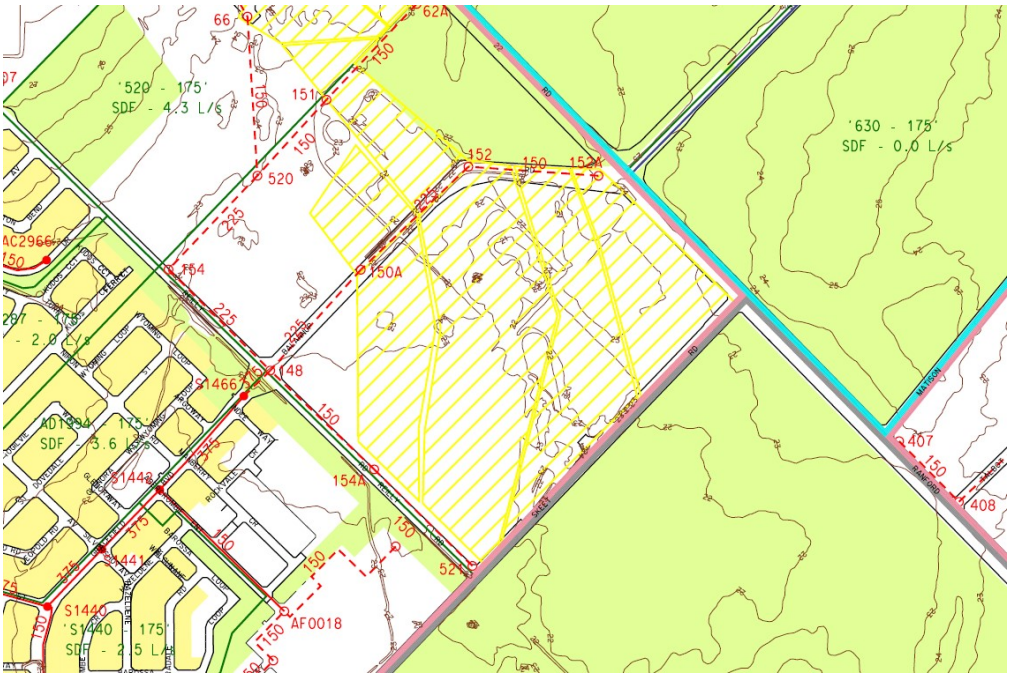


Figure 3 – Wastewater Planning

The point of connection is at the intersection of Balannup and Reilly Roads. The gravity sewer network extends out to service the site. Filling is required to enable a gravity sewer service. Refer **Appendix D** for the Concept Wastewater Servicing Plan.

A request has been made with the Water Corporation for a flatter grade sewer prior to the site. This will save a significant quantity of fill which has many added benefits including environmental, traffic impact, aesthetic and cost. The specifics of this request will be resolved at detailed design stage.

3.3 Water

Water Corporation planning advice confirms the site can be serviced off the existing water infrastructure in the adjoining road network. The proposed water main network will be reticulated through the site such that all lots will have a service. Refer **Appendix E** for the Concept Water Servicing Plan. The exact layout of the larger diameter water main will be resolved at detailed design stage.

3.4 Power

Western Power mapping, as presented in **Figure 4**, confirms the site has in the order of 15-20MVA spare capacity (2021 forecast). This is more than sufficient to serve the site.

There are large overhead high voltage power lines that traverse the western portion of site (shown in **Figure 4**). These overheads will remain and be protected via POS. It is possible Western power will require this asset to be placed within an easement.

There are large overhead high voltage power lines that run in the southern verge of Skeet Road. These will remain.

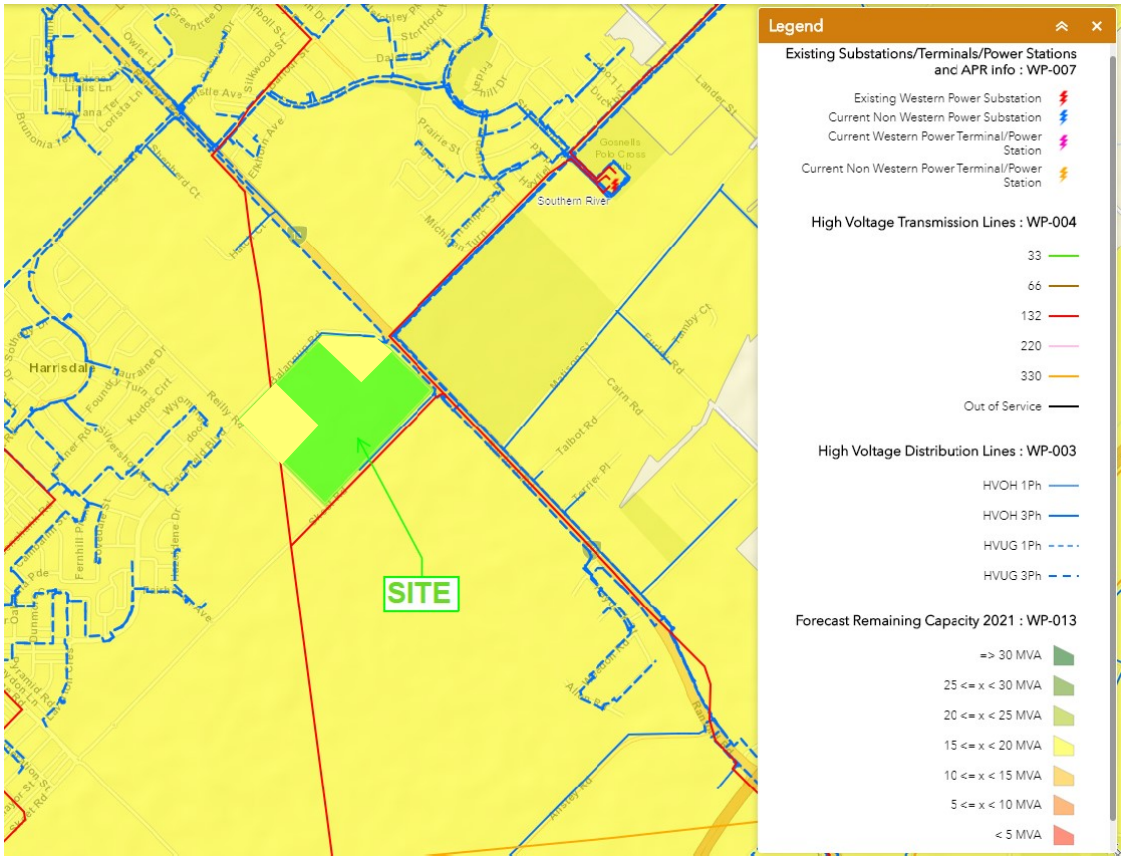


Figure 4 – Western Power Mapping

There are existing high and low voltage infrastructure in the road network surrounding the site. It is expected high voltage connections will be made to this network to power new transformers and switch gears. A low voltage network will then service each lot plus the street lighting and any POS furniture.

3.5 Communication

The existing road network contains communications infrastructure. This will be connected to, and extended throughout the estate.

There is a mobile phone communication tower along the Ranford Road frontage. This is being retained as part of the development.

3.6 Gas

The surrounding road network contains existing gas infrastructure. This will be extended throughout the estate.

3.7 Drainage

The road network will contain typical pit and pipe network to collect stormwater and convey it to drain disposal areas. Depending on the extent of filling, lot connection pits may be required if onsite disposal cannot be achieved.

Drainage disposal areas will be required throughout the site. These will be positioned within the strategic public open spaces. It is likely part of the site will have a direct connection to the Balannup Drain, water quality improvement techniques need to be implemented to ensure clean water leaves the site.

Depending on the extent of filling, it is probable parts for the site will require subsoil drains to manage groundwater separation. The level of the subsoil drains need to be set to ensure they day light to their basin or the Balannup Drain.

Subsoil drains have been detailed along Skeet Road. These are based about the Balannup Drain levels and extend for the extent that minimum cover can be achieved.

Due to the extent of fill, it is likely some lots will hold and dispose runoff on site, whereas some of the lower lying lots will have direct lot connection.

Refer to Emerge's LWMS for more details. A Concept Roads and Drainage Plan is presented in **Appendix F**.

3.8 Roads and Paths

3.8.1 Roads

Balannup and Skeet Roads have recently been upgraded by the City of Armadale. Ranford Road was upgraded in 2009. It is not anticipated this development will require any upgrade works here.

The unmade Reilly Road road reserve separates the Balannup Drain and the site. It is expected Reilly Road will be constructed by the developer of the lots adjacent to this.

An internal road network will be required to provide frontage to each of the proposed lots. Standard subdivision requirements are expected.

It is noted the final Ranford Road land resumption has not been resolved yet. A conservative boundary has been shown for the lifting of urban deferment purposes (Appendix A). The final land take will be resolved in due course which will result in the commercial lot increasing in size.

It is expected a left turn pocket will be provided off Ranford Road for an entry only crossover to the commercial lot. It is expected the pocket will be in the order of 100-120m long which places the crossover clear of the existing communications tower. A crossover on Skeet Road is needed to facilitate both entry and exit movements.

3.8.2 Paths

There is an existing path network that runs parallel to the Balannup Drain. Balannup Road has a footpath, as does Skeet Road. It is expected the subdivision roads will include paths that link the development to these perimeter path networks.

3.8.3 Public Transport

A review of the Transperth network indicates limited public transport for the suburb of Harrisdale. There is currently one bus route (518) that runs through Harrisdale plus the 517 that runs through Southern River. There are also public transport routes to and from the Armadale train line, however these end in Seville Grove.

The Transperth mapping only shows 50% of the already developed Harrisdale and it is possible the Public Transport Authority will review their servicing as the demand increases.

3.8.4 Traffic

Ranford Road is a Distributor A and Balannup Road is a Local Distributor. Skeet Road is currently noted as a Local Access road. It is expected Reilley Road will also be a Local Access road once it has been constructed.

The recently constructed Balannup Road and Skeet Road make allowances for vehicle traffic from this site.

The Structure Plan (**Appendix A**) shows perimeter intersections that allow entry and exit to the site. These will be designed as per the standard process taking into consideration road safety and sightline requirements.

Porter Consulting Engineers completed the Traffic Impact Assessment that supports this Structure Plan application. Refer to the Traffic Impact Assessment for more details.

4.0 CONCLUSION

The outcome of this investigation confirms this site can be developed. Some preparatory work will be required as detailed in the geotechnical investigation. Areas of sensitive vegetation will be protected.

Filling will be required across the site as typical with developments in this area.

The existing road network contains sufficient infrastructure to provide points of supply for the subdivision of the site. All services are located in the road reserve resulting in direct and unencumbered access.

The existing large overhead power lines that traverse the western portion of the site will remain and be protected via a POS and road reserve. The large communications tower near Ranford Road will remain.

The existing road network is sufficient to handle traffic from this site.

There appears to be no constraints or capacity limitations that would prohibit the site from being developed.

BALANNUP ROAD

REILLY ROAD

SOUTHERN RIVER RD

RANFORD ROAD

SKEET ROAD

606

605

604

603

602

601

600

POS

POS

POS

200

201

202

98

171

1771

Legend

- Subject Site
- Parent Lot
- CCW
- 50m Buffer to CCW
- REW
- 30m Buffer to REW
- Easement (30m Width)
- Residential R25
- Residential R30
- Public Open Space (POS)
- Local Centre
- Access Streets
- Neighbourhood Connector

22001001B

0m 50 100 200m

HARRISDALE NORTH STRUCTURE PLAN

Harrisdale. Armadale, WA

Project YOLHA 22001001B | Scale 1:2500 @ A3 | Date: June 2023

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Rev.	Description	Drawn	Date	Checked
A	Initial Issue	KJB	13/04/2023	NS

SCALE 1:1200 @ A1

0 15 30 45 60 75 150

ALL DISTANCES ARE IN METRES

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The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plans currency by contacting the McMullen Nolan Group.

Surveyor:- KJB
Survey Date:- 31/03/2023
Precal/Cad:- 01/04/2023

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The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.

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LOT 601-603 AND 200-202 SKEET ROAD FEATURE SURVEY HARRISDALE

CLIENT:
YOLK PROPERTY GROUP

Project Mngr.	NIGEL SIMPSON	Datum	PCG94 / AHD

105596	DE	004	A
Job Number	Type	Plan Number	Revision

BALANNUP ROAD

REILLY ROAD

RANFORD ROAD

SKEET ROAD

POS

POS

COMMERCIAL

23.0mAHD

22.5mAHD

22.0mAHD

LEGEND

- STUDY AREA
- EXISTING CONTOURS
- 23.5 EXTERNAL ROAD LEVEL
- 25.5 FINISHED LOT LEVEL
- 23.5 EXISTING POS LEVEL
- 2.0mAHD MAXIMUM GROUND WATER LEVEL
- PROPOSED KERB
- PROPOSED RETAINING WALL

1:1200 0m 24.0 48.0 72.0m

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HARRISDALE NORTH STRUCTURE PLAN

No.	DATE	REVISION	BY
F	1-8-2023	LAYOUT UPDATED AS PER STRUCTURE PLAN DATED 11-6-2022	MEG
E	12-5-2022	PROPOSED CADASTRAL BOUNDARIES ALTERED, LEVELS ADJUSTED, KERBS ADJUSTED TO SUIT	MEG
D	3-8-2021	MAXIMUM GROUND WATER LEVELS ADDED	MEG
C	29-6-2021	PROPOSED CADASTRAL BOUNDARIES ALTERED, WALLS ADJUSTED, KERBS ADJUSTED	MEG
B	14-6-2021	LOGO ADDED, TITLE BLOCK UPDATED, LEVELS UPDATED	MEG
A	24-5-2021	ISSUED FOR CONCEPT	MEG

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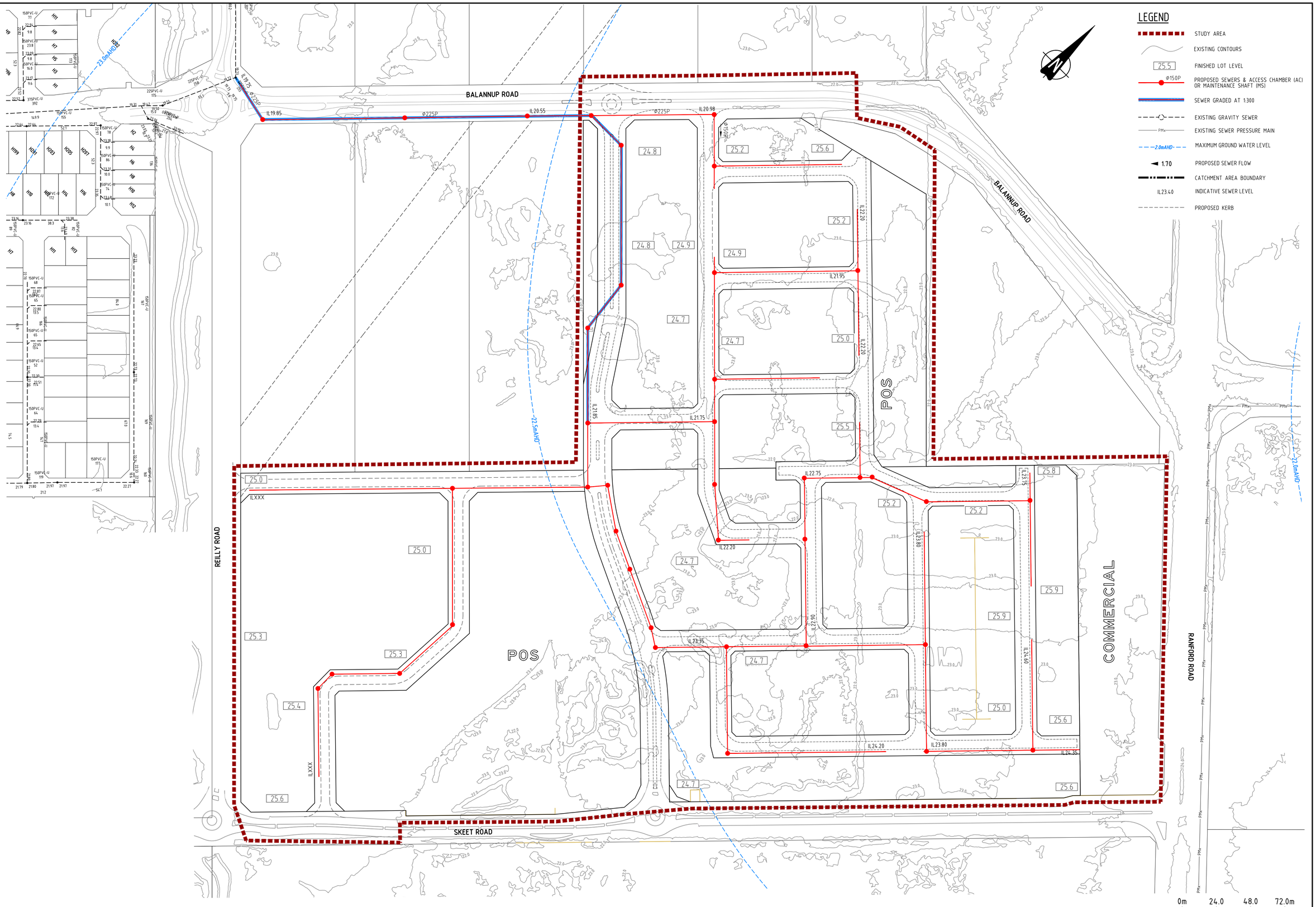
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E	2021-08-13	SEWER LAYOUT AND LEVELS ADJUSTED	MEG
D	3-8-2021	MAXIMUM GROUND WATER LEVELS ADDED	MEG
C	29-6-2021	PROPOSED BOUNDARIES ADJUSTED, SEWER ADJUSTED, KERBS ADJUSTED	MEG
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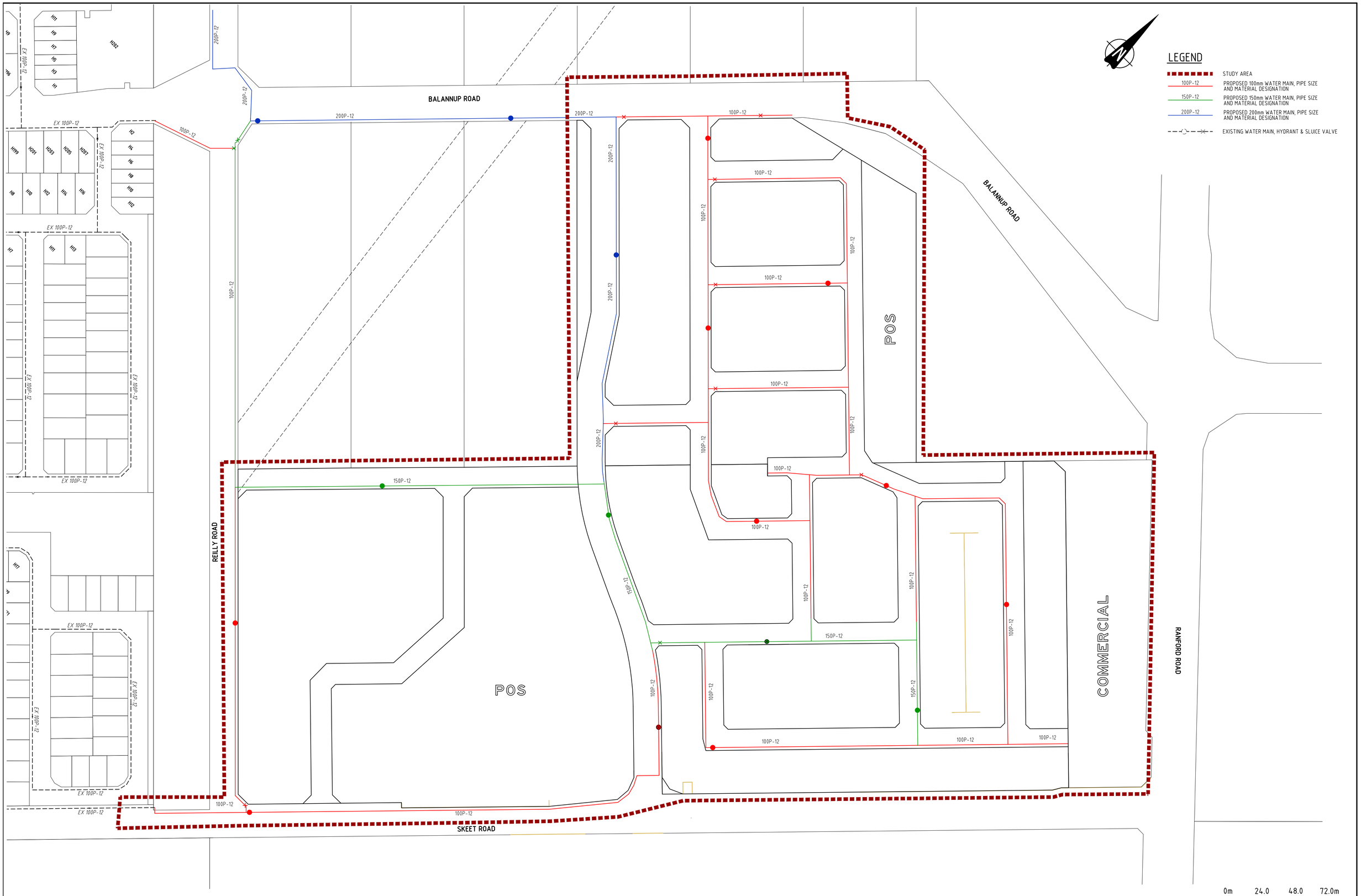
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E	1-8-2023	LAYOUT UPDATED AS PER STRUCTURE PLAN DATED 11-6-2022	MEG
D	12-5-2022	PROPOSED CADASTRAL UPDATED AND WATER ADJUSTED TO SUIT	MEG
C	29-6-2021	PROPOSED BOUNDARIES ALTERED, WATER ADJUSTED	MEG
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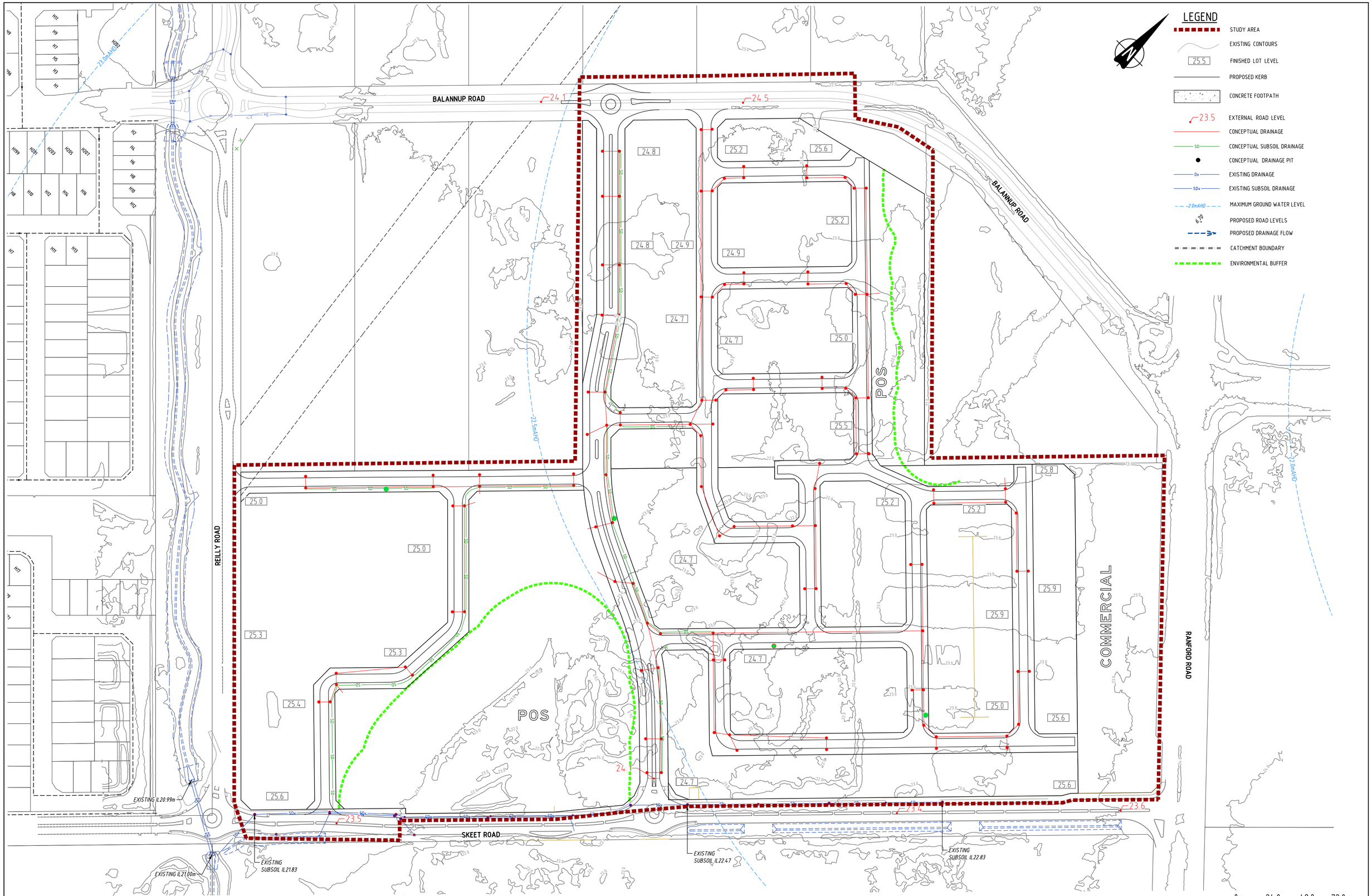
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E	12-5-2022	PROSED CADASTRAL UPDATED, DRAINAGE ADJUSTED TO SUIT	MEG
D	3-8-2021	MAXIMUM GROUND WATER LEVELS ADDED	MEG
C	29-6-2021	PROPOSED BOUNDARIES ALTERED, ROADS, DRAINAGE AND PATHS ADJUSTED TO SUIT	MEG
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