



COTERRA
ENVIRONMENT

**Native Vegetation Clearing Permit
Application Supporting Information**

Perth Surf Park

Revision 1

February 2023



CALIBRE | COMMITMENT | COLLABORATION

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1 Introduction

1.1 Location

As trustee for the Perth Surf Park Property Trust, PSP Properties Pty Ltd (the **Developer**) is a wholly owned subsidiary of Aventura, Inc. which is a global surf park developer and operator. The Developer is proposing to construct and operate a surf sports, recreation and leisure facility (**Facility**) in the City of Cockburn.

The proposed location for the Facility is on Lots 800 and 9001 Prinsep Road, Jandakot (the **Site**), which is bound by Prinsep Road to the north and east, Knock Way to the south and Kwinana Freeway to the west (Figure 1).

It should be noted that at the date of this report a deposited plan (DP425623) consolidating the above noted lots onto one land parcel (Lot 9502) has been drafted and submitted to the Western Australian Planning Commission (WAPC) and the Department of Planning, Lands and Heritage (DPLH) for approval. A lot plan illustrating this consolidated lot has been included in Appendix 1.

The Site is 5.75 ha in area and is approximately 18.5 km south of the Perth Central Business District, 12.5 km south-east of the Fremantle city centre, and 1 km north-east of the Cockburn Gateway Shopping Centre. The Site was determined by the Western Australian Government to be the preferred location for the development of the Facility due to the following aspects:

- the Site's proximity to the Cockburn Central rail station;
- accessibility provided by the adjacent Kwinana Freeway and Armadale Road;
- the absence of sensitive nearby land uses; and
- zoning appropriate for the proposed development and land use.

1.2 Development overview

The proposed Facility will feature a next generation Wavegarden™ "Cove" open water surfing lagoon that is 2.2 ha in area. The surfing lagoon will create consistent high-quality surfing waves of variable height in quick succession for up to 84 guests at any one time.

The world class Facility is proposed to be used by Perth locals, and domestic and international tourists. It will also include ancillary amenity features, such as short-term accommodation, food and beverage venues, a function centre, events lawn, pump track, surf-skate bowl, outdoor gym, a health, fitness and wellness offering, a children's playground, and car parking (Appendix 2).

Construction of the Facility will require the clearing of native vegetation within the Site and includes:

- Clearing the Site;
- Importing fill to create the wave lagoon; and
- Construction of roads, carparking, amenity buildings and associated facilities.

The Facility has been designed to minimise the impact of future operations on the environment by incorporating sustainable principles and initiatives which will include the use of photovoltaic cells on rooftops to power the built forms almost exclusively on renewable energy and utilising low embodied carbon concrete for all structures (Cundall 2022). The Developer is also exploring options to operate the surfing lagoon using 100% renewable power sources (Cundall 2022) and has committed to achieving a 5 Star Greenstar Certified rating for the Facility's built forms.

1.3 Planning and Environmental Approvals

1.3.1 Zoning

The Site is appropriately zoned Industrial under the Metropolitan Region Scheme (**MRS**) and Development under the City of Cockburn's Town Planning Scheme No. 3 (**TPS3**).

1.3.2 Cockburn Central East Structure Plan

The Site is within the Cockburn Central East Structure Plan which seeks to diversify the local economy and reduce reliance on private vehicle usage (Lateral Planning 2022). To achieve this the Facility is located in close proximity to the Cockburn Central rail station and has been integrated into the existing pedestrian and cyclist movement network. Furthermore, provision of a high quality recreation and entertainment venue will ensure a strong diversification of land uses within the Cockburn precinct.

1.3.3 Development Application

The proposed Facility is designated a State Significant Project in Western Australia with the Department of Jobs, Tourism, Science and Innovation (**JTSI**) being appointed under the lead agency framework to provide assistance with the development.

In accordance with the *Planning and Development Act 2005 (PD Act)*, a Development Application (**DA**) for the Facility has been prepared and submitted to the City of Cockburn and the Metropolitan Outer Joint Development Assessment Panel (**JDAP**) for assessment and approval. Public consultation for the DA closed on 24 October 2022 and we are advised by the City of Cockburn that this resulted in an overwhelmingly positive response from the public (of approximately 200 submissions received, none were negative). It is anticipated that a decision on the approval of the DA will be provided by about the end of February 2023.

1.3.4 Cadastral information

The Site comprises the following two land parcels (Lateral Planning 2022):

- Lot 800 on Deposited Plan 50212, Certificate of Title Volume 2628 and Folio 662;
- Lot 9001 on Deposited Plan 65564, Certificate of Title Volume 2795 and Folio 400.

The Western Australian Planning Commission (**WAPC**) owns Lots 800 and 9001.

1.3.4.1 Proposed amalgamation

As noted above, the owner of Lots 800 and 9001, the State is currently progressing an amalgamation of the lots, with the purpose of (Lateral Planning 2022):

- Creating a lot (Lot 9502) that generally corresponds to the 'Site Boundary' as shown on Figures 1 to 9;
- Identifying and dedicating the Knock Way road alignment as road reservation; and
- Separating the Main Roads Western Australia drainage basin located immediately north west of the Site.

It is understood that the amalgamation is being progressed by the Department of Planning, Lands and Heritage (**DPLH**) concurrently with the assessment and approval of the DA.

1.3.5 Lease Agreement

The Site is subject to a long-term lease agreement (executed on 12 June 2022) between Aventura Pty Ltd and the WAPC.

1.3.6 Federal environmental approval

The proposed action to clear native vegetation to construct the Facility was referred in March 2022 to the Commonwealth Department of Climate Change, Energy, the Environment and Water (**DCCEEW**) under the *Environment Protection and Biodiversity Conservation Act (EPBC Act)* (EPBC 2022/09267). Following the Department's consideration of the referral information, the proposed action was determined to not have a significant impact on Matters of National Environmental Significance.

On 18 July 2022 the Department published its referral decision that the proposed action was 'not a controlled action' (Appendix 3).

1.3.7 Part IV of the Environmental Protection Act 1986

In November 2022, the Developer referred the proposed Facility under section 38 of the *Environmental Protection Act 1986 (EP Act)*. The 7-day public comment period on the referral closed on 4 December 2022. Part V of the Environmental Protection Act 1986 – Native Vegetation Clearing Permit

With the exception of riparian vegetation, the following items under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (Regulations)* exempt clearing to the extent that the total combined clearing under any of these exemptions does not exceed 5 ha in any financial year (DWER 2019):

- Clearing to construct a building (Regulation 5, Item 1)
- Clearing for vehicular tracks (Regulation 5, Item 12)

However, should the EPA determine that the proposed Facility does not require formal assessment under Part IV of the EP Act and can instead be dealt with through other decision-making processes, such as Part V Division 2 (Clearing of native vegetation) of the EP Act, the Developer will waive these clearing exemptions and apply to clear up to 5.23 ha of native vegetation within the Site. That is, to ensure any required mitigation, management and offsetting measures are appropriately conditioned through the permit approval notice.

A Native Vegetation Clearing Permit (**NVCP**) application for the Facility and the proposal to clear up to 5.23 ha of native vegetation within the Site has been prepared and submitted with the Department of Water and Environmental Regulation (**DWER**) for assessment and approval under Part V Division 2 of the EP Act.

1.4 Environmental Management Framework

To ensure the proposed development is appropriately managed during the clearing, construction and operational phases, an environmental management framework has been developed establishing the various environmental management plans that will be implemented and regulated through various decision-making authorities (Table 1-1) (PGV Environmental 2022a).

Table 1-1: Environmental Management Framework (PGV Environmental 2022a)

Management Plan	Status and Approval Required	Legislation or Agreement Regulating the Activity	Relevant Decision-Making Authority	Environmental Management Outcome
Water Management Plan	Prepared to support DA and current groundwater licence application	<i>Planning and Development Act 2005</i> implemented as a condition of the approval of DA	City of Cockburn with advice from DWER	Implementation of the plan will mitigate the risk of offsite impacts during dewatering, manages the responsible use of water during construction and operation and provides management measures for identified risks.
Monitoring and Maintenance Plan	Proposed within the Water Management Plan	<i>Planning and Development Act 2005</i> implemented as a condition of the approval of DA	City of Cockburn with advice from DWER	Provides a framework to ensure management measures are effective and that contingency plans can be implemented if required to manage any risks to the surrounding environment.
Bushfire Management Plan	Prepared to support DA	<i>Planning and Development Act 2005</i> implemented as a condition of the approval of DA	City of Cockburn	Implementation of the plan will ensure that bushfire risks to the surrounding environment and public safety are maintained
Construction Environmental Management Plan	To be prepared as a condition of the approval of the DA	<i>Planning and Development Act 2005</i> implemented as a condition of the approval of DA	City of Cockburn	Implementation of the plan will ensure appropriate management of a number of environmental factors and mitigate the risk to the surrounding environment as outlined in Section 1.4.1.
Fauna Trapping and Relocation Plan	To be prepared as a condition of the approval of the DA	<i>Planning and Development Act 2005</i> implemented as a condition of the approval of DA and/or under the <i>Environmental Protection Act 1986</i> as a condition of the Native Vegetation Clearing Permit	City of Cockburn on advice from DBCA with license to be issued and regulated by DBCA	Implementation of the plan will mitigate impacts to native fauna during the clearing and construction phase and ensure that all activities are undertaken in accordance with requirements under the <i>Biodiversity Conservation Act 2016</i> .
Tree Retention Plan	To be prepared as condition of the approval of the DA	<i>Planning and Development Act 2005</i> implemented as a condition of the approval of DA	City of Cockburn	Implementation of plan to identify significant vegetation assets to retained through the development of the Site.
Operational Management Plan	To be prepared as a condition of the approval of the DA	<i>Planning and Development Act 2005</i> implemented as a condition of the approval of DA	City of Cockburn with advice from DBCA and DWER	Implementation of the plan provides the framework for environmental management in the operational phase and outlines management of factors that could impact on the surrounding environment to mitigate risks
Acid Sulphate Soil (ASS) Investigation and, if required, Management Plans	To be prepared, if required, as a condition of the approval of the DA	<i>Planning and Development Act 2005</i> implemented as a condition of the approval of DA	If required conditioned by the City of Cockburn and approved for implementation by DWER	Implementation of the plan mitigate the risk of any disturbance to ASS has a detrimental impact on the surrounding environment.

1.4.1 Construction Environmental Management Plan

The Construction Environmental Management Plan will be prepared in accordance with the City of Cockburn Construction Management Plan Guidelines (City of Cockburn 2021) and relevant policies.

Key management factors to be addressed in the management plan will include, but is not limited to (PGV Environmental 2022a):

- Objectives
- Legislative Requirements
- Project Program
- Hours of Operation
- Environmental Management
 - Noise and Vibration Management
 - Air Quality Management including dust management
 - Visual Amenity and Lighting Management Plan
 - Traffic Management including parking management during construction
 - Water Management
 - Land Management
 - Waste Management Plan including building waste and onsite rubbish
 - Flora and Vegetation Management
 - Weed Management
 - Dieback Management
 - Fauna Management
 - Aboriginal Heritage
- Protection of council assets including surrounding roads
- Roles and Responsibilities
- Environmental Induction and Training
- Incidents and Emergencies
 - Complaints Management
 - Incident Prevention Management
 - Incident Investigation
 - Compliance
 - Environmental Inspections
 - Environmental Monitoring
 - Auditing
- Corrective Actions and Adaptive Management
- Reporting

1.4.2 Operational Management Plan

The Operational Management Plan will address, at a minimum, the following factors (PGV Environmental 2022a):

- Overview of Operations
- Objectives
- Induction and Training
- Hours of Operations
- Licensing
- Management Plans
 - Air Quality Management Plan
 - Traffic Management Plan
 - Solid Waste Management Plan including both facility waste and back washed waste from the wave garden filters
 - Noise and Vibration Management Plan
 - Emergency Response Management Plan
 - Maintenance Management
 - Feral Fauna Management Plan
 - Native Fauna Management Plan
 - Tree Retention Plan
 - Landscaping Management Plan
 - Avifauna Management Plan
 - Dangerous Goods Management Plan
 - Water and Wastewater Management Plan
 - Energy Management Plan
- Key Performance Indicators
- Roles and Responsibilities
- Complaints Management
- Compliance
 - Environmental Inspections
 - Environmental Monitoring
 - Auditing
- Corrective Actions and Adaptive Management
- Reporting

1.5 Purpose of report

This environmental report has been prepared to provide supporting information to DWER on the NVCP application and includes the following:

- Size and location of the NVCP application area
- Site conditions
- Environmental values present within the NVCP application area
- Number and nature of any nearby environmentally sensitive receptors
- Proposed end-purpose of the clearing
- Anticipated/proposed public benefit of the clearing and its final land use
- Assessment against the Clearing Principles listed in Schedule 5 of the EP Act
- Measures proposed to avoid, mitigate and/or offset environmental impacts
- Planning and other relevant matters.

1.6 Stakeholder Engagement

1.6.1 Initial Consultations

Stakeholder consultation for the Facility has been extensive, with State departments including DWER, EPA Services, DPLH, and JTSI, together with City of Cockburn at a local government level.

The State Government has endorsed the Site as being the most appropriate for the proposed Facility due to its transport connectivity (including proximity to the existing freeway and supporting rail infrastructure), surrounding existing land uses, and land zoning being deemed appropriate for the development and surrounding land uses and zoning appropriate to the development in the Government of Western Australia Media statement (<https://www.mediastatements.wa.gov.au/Pages/McGowan/2021/09/Surfs-up-as-Developerchosen-to-deliver-Cockburn-Wave-Park.aspx>).

The location was identified with the assistance from the office of Honourable Ben Wyatt Treasurer; Minister for Finance; Aboriginal Affairs; Lands and is being facilitated by JTSI.

As previously advised, the City of Cockburn has also been extensively consulted as part of the Development Application process and provided a platform for public comments on the proposed Surf Park on their Facebook page with a link to a public survey.

There has been consultation during the leasing process and further consultation with relevant stakeholders will be undertaken through the Planning Approval assessment process of the Development.

1.6.2 Ongoing Consultation

The Developer has recently conducted meetings with appropriate agencies EPA Services, DWER – Water Licensing Branch and DWER – Native Vegetation Clearing Branch. These agencies were consulted to ensure all relevant factors under EP Act and *Rights in Water and Irrigation Act 1914 (RIWI Act)* have been addressed in the proposal.

The proposal has also been developed in consultation with the City of Cockburn and DPLH, Surfing WA, Ocean Heroes and other governmental and community groups, and is ongoing. A market survey to determine the key demographic that may use the Facility was undertaken in December 2021. The market survey comprised 37 questions about the proposed Facility and involved more than 1,000 respondents, who were screened to ensure an accurate representation of the Perth resident population, and statistically significant results.

73% of respondents to the survey indicated they would be likely (39%), or extremely likely (34%), to attend the surf park. This represents 860,000 Perth residents. Only 14% of respondents indicated they would be unlikely, or extremely unlikely to attend the Facility.

The proposal to develop the Facility at the Site has received extensive media coverage over the past 18 months since the joint announcement by the Minister of Lands and the Minister of Planning that the Developer had been nominated as the preferred proponent for the development. Over the space of this time there has been more than 110 articles, posts, tv and radio coverage pertaining to the Perth Surf Park with an estimated accumulative audience reach of over 5.5 million. The commentary to the wide variety of published news articles on the proposed Facility have been almost entirely positive.

The recently published news articles surrounding coverage of the DA submission (October 2022) reached approximately 320,000 people, showcasing the public interest in this project. Advertising of the DA resulted in 215 submissions with overwhelming support for the project, of which 213 supported the development and 2 were unsure/neutral.

Public consultation and engagement has been positive to date with widespread community advocacy for the project. This was endorsed by the City of Cockburn and was of heightened significance given the public profile of the Project and the extensive media coverage to date.

Community consultation will be ongoing to ensure the Facility meets the expectations of the public and provides the amenity mix that responds to the perceived need and expectations of the public.

1.6.3 Indigenous Consultation

The Developer commissioned Soft Earth to provide a cultural framework document to accompany the DA. This report included an overview of the Site and its locality as relevant to the Whadjuk Noongar people. The framework was commissioned to explore historical and contemporary Whadjuk Noongar cultural contexts and stories relevant to the facility and to curate a Vision and Themes to guide the design and development of the Facility. The framework is designed to facilitate ongoing consultation and engagement with Whadjuk Noongar people throughout the development process and indicates the Developer's commitment to ongoing consultation.



2 Perth Surf Park Proposal

2.1 Surf Lagoon

The 'Perth Surf Park' will feature a next generation Wavegarden™ "Cove" open water surfing lagoon that can create consistent high-quality surfing waves of variable height in quick succession. The plans for the Surf Park are provided as Appendix 1.

The surfing lagoon contains a central wave generator that creates a left-handed break and a righthanded break, each with two zones (known as the 'Peak Zone' and the 'Bay Zone') within which waves of differing heights are produced. The various zones allow for beginner through to advanced level surfers to be accommodated simultaneously.

The 'Peak' zones will provide up to 2.0 metre-high, 18 second-long, steep left and right-hand pitching waves enabling the highest levels of performance surfing. Waves in this zone will form cleanly and break with constant power and shape throughout the ride, comparable to riding high quality ocean waves of similar sizes. Surfers will typically enjoy a longer, higher quality and more consistent surfing experience than can be enjoyed at any Perth metropolitan beaches.

The 'Bay' zones produce reformed, smooth, green-faced waves at 1.0 m in height which are preferred for beginner and novice surfers. The 'Bays' are also an ideal location for children and other users with limited knowledge or sense of open water safety, enabling the acquisition of the basic skills required for surfing. The 'Bays' are well suited for both surfing lessons and free-surfing sessions.

The maximum capacity of the lagoon is approximately 84 participants per hour, comprising 36 intermediate-to-advanced surfers in the 'Peak' zones, and up to 48 beginner-to-novice surfers in the 'Bay' zones. The lagoon can accommodate all forms of surf craft, together with body surfing.

2.2 Lagoon-side Ancillary Features

The Facility will provide a range of services such as personalised coaching, fitness and surf skate programs, surfboard shaping courses, regular board riders club rounds and cultural events, including outdoor surf movie nights, music events, and art and photography exhibitions.

The Facility will also provide a range of unique experiences for non-surfers, from yoga and meditation retreats to foundational training programs, live music and cultural festivals and charitable events. Associated with the Facility will be short-term accommodation, food and beverage venues, events lawn, function centre, pump track, surf-skate bowl, children's playground and car parking, providing a world class facility for locals and tourists.

2.3 Operations

The Facility is intended to operate from 6am to 9pm (10pm on Friday and Saturday nights) for nine months of the year (September to May), and 9am to 6pm in winter (June to August inclusive). Corporate and private functions may see specific spaces (excluding the surf lagoon) used to midnight on occasion.

The project will create up to an estimated 200 jobs during planning and construction and is expected to employ more than 100 people once operational. Employment opportunities will be provided for youth, and older members of the local community. Casual and part-time vocational training programs (for example, lifesaving and surf coaching and instruction) will also be delivered within the Facility.

2.4 Sustainability Initiatives

The proposed Facility has incorporated a number of sustainability initiatives and is targeting the achievement of a 5-star Green Star performance rating for its built forms. Green Star is an Australian Green Building Rating

Tool which assesses the design, construction and operation of buildings, ensuring sustainable design and construction practices. The innovations that have been incorporated into the design and operation of the Surf Park include, but are not limited to (Cundall 2022):

- Rooftops of the built forms, where practical, will be occupied by green roofs or photo voltaic solar panels to limit greenhouse emissions and reduce urban heat island effects;
- Use of high-performance glazing and external shading;
- Design initiatives to ensure maximum energy efficiency;
- Installation of water efficient fixtures and fittings;
- Provision of alternative water sources for non-drinking water demands;
- Minimisation of water demand through the use of Water Sensitive Urban Design principles, including the promotion of passive irrigation with stormwater runoff wherever possible;
- Utilising low or zero-embodied carbon concrete for all structures;
- Limiting the use of single use plastics on site;
- Installing electric vehicle charging stations;
- Providing end of trip facilities and storage for bicycles and e-scooters; and
- Use of endemic, drought tolerant, native species as part of the landscape design.

2.5 Location Selection

The proposed Facility has undergone previous extensive iterations as part of the strategic planning process with numerous locations in Perth being studied to test suitability. During this time, with the engagement of other Local Government Areas, several different locations for the proposed Surf Park were explored.

Lot 800 Prinsep Road, Jandakot was identified as the preferred location by the State Government due to its transport connectivity and proximity to the existing freeway and supporting rail infrastructure, surrounding existing land uses, and land zoning being deemed appropriate for the development.

The proposed location has been endorsed by:

- Premier of Western Australia, the Honourable Mark McGowan;
- Planning and Transport Minister, the Honourable Rita Saffioti;
- Minister for Tourism, and Deputy Premier, the Honourable Roger Cook;
- Sport and Recreation Minister, the Honourable David Templeman;
- Minister for Lands, the Honourable John Carey;
- Jandakot MLA, the Honourable Yaz Mubarakai; and
- City of Cockburn Mayor, the Honourable Logan Howlett.

The Site location was originally identified in 2019 with assistance from the office of the Honourable Ben Wyatt Treasurer; Minister for Finance; Aboriginal Affairs; Lands.

The design and orientation of the Surf Park has been carefully considered to ensure that there will be no impact on surrounding developments and no shading of vegetation on the neighbouring lots, or on the vegetation to be retained (Plate 2-1).

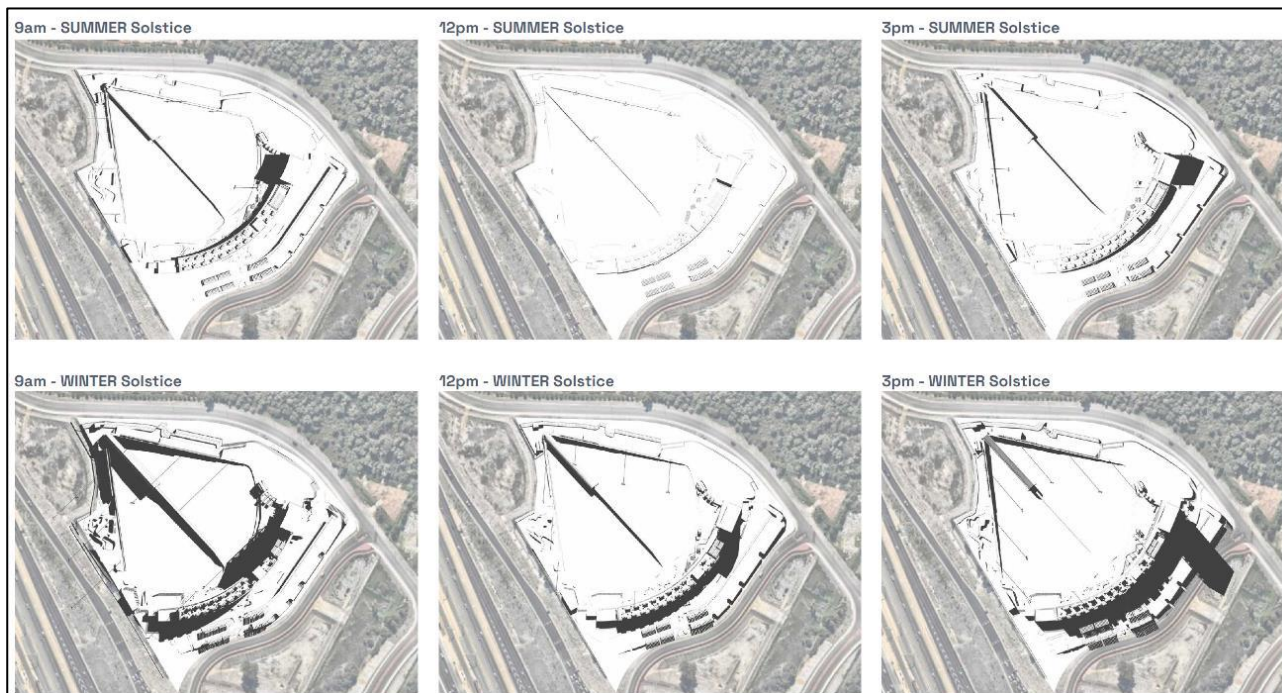


Plate 2-1: Shade Diagrams (MJA Studio 2022)

3 Proposed Clearing

3.1 Schedule

Initial vegetation clearing works are proposed to commence in Q3 of 2023 and will be staged over a period of approximately 2 months. Operations will be governed by the Development Approval issued by the JDAP and Building Licence issued by the City of Cockburn.

3.2 Proposed works

The proposed works will involve:

- Clearing of native vegetation
- Earthworks for creation of appropriate levels within the development footprint
- Installation of services (water, power, electricity, gas, sewer and communications)
- Road construction to establish transport networks
- Landscaping of facility, streetscapes and public open spaces
- Implementation of conservation management measures for retained vegetation.

3.3 Pre-clearing

Prior to the commencement of clearing, the construction boundary between the Development Area and the Tree Retention Area will be surveyed and fenced to ensure it is accurately located and demarcated. This demarcation will ensure over-clearing does not occur (Figure 2).

All personnel on site will undertake an induction, which will outline the environmental values of the site and the importance of remaining within defined clearing areas.

A fauna relocation program will be undertaken prior to the commencement of clearing.

3.4 Clearing

Clearing of vegetation will be undertaken as follows:

- Fencing will be installed around the entire perimeter of the landholding to be disturbed and will be in place for the duration of site works across all stages of development
- A fauna handler will be present during on site clearing activities to facilitate the capture and relocation of fauna
- Topsoil will be stripped (where possible) and tested for potential re-use on site within landscaped and retained areas
- Vegetation will be mulched and for use on site within retained areas and landscaping
- Balgas will be salvaged and used on site within retained areas and landscaping.

Clearing will be done in accordance with the 10 Clearing Principles. Additional information providing an assessment against the clearing principles is provided in Section 5.

3.5 Alternatives Considered / Actions to Avoid and Minimise Clearing Actions

In order to avoid and minimise clearing actions the following was or will be undertaken:

- Setting aside Tree Retention Areas (0.46 ha) around the perimeter of the Site (Figures 5 to 8) with further avoidance actions including enhanced native plantings and the use of salvaged Balga trees from the Site.
- The design and orientation of the Surf Park has been carefully considered to ensure that there will be no impact on surrounding developments and no shading of vegetation on the neighbouring lots, or on the trees to be retained on Site.
- Preparation and implementation of a Construction Environmental Management Plan (CEMP) and Operational Management Plan (OMP) to protect the retained trees on the Site and ensure no offsite impacts to surrounding vegetation.
- Preparation and implementation of a Tree Retention Plan which will identify the significant vegetation assets to be retained within the Tree Retention Areas as part of detailed design, which will also be managed through the Building Permit plans and updated Landscape Plan.

4 Site Description

4.1 Topography

Topographic elevations range from 30 m Australian Height Datum (AHD) at the southern end to 26 mAHD along the north-western boundary of the Site. Topographic contours are shown on Figure 3.

4.2 Geology and soils

Two geological units are represented at the Site (Figure 3) (Gozzard 1986):

- S8: SAND – very light grey at surface, yellow at depth, fine to medium-grained, subrounded quartz, moderately well sorted, of eolian origin.
- S10: SAND – as S8 which is referred to as Thin Bassendean Sand over Guildford Formation and comprises grey to yellow quartz sand.

The Department of Primary Industry and Regional Development (**DPIRD**) maps the following soils on Site (DPIRD 2023):

- Bassendean B1 phase (212Bs_B1) – 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. Mapped within the central, western and southern portion of the Site.
- Bassendean B2 phase (212Bs_B2) – Flat to very gently undulating sandplain with well to moderately well drained deep bleached grey sands with a pale yellow B horizon or a weak iron-organic hardpan 1-2 m. Mapped within the south eastern portion of the Site.
- Bassendean B4 phase (212Bs_B4) – 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. Mapped within the northern and eastern portion of the Site.

Table 4-1 lists the land degradation risk categories for each of the above soils.

Table 4-1: Land degradation risk categories (DPIRD 2023)

Land Degradation Risk Category	Bassendean B1 phase	Bassendean B2 phase	Bassendean B4 phase
Water Erosion	<3% of map unit has a high to extreme water erosion risk	<3% of map unit has a high to extreme water erosion risk	<3% of map unit has a high to extreme water erosion risk
Wind Erosion	50-70% of map unit has a high to extreme wind erosion risk	30-50% of map unit has a high to extreme wind erosion risk	10-30% of map unit has a high to extreme wind erosion risk
Waterlogging	3-10% of map unit has a moderate to very high waterlogging risk	3-10% of map unit has a moderate to very high waterlogging risk	>70% of map unit has a moderate to very high waterlogging risk
Flooding	<3% of the map unit has a moderate to high flood risk	<3% of the map unit has a moderate to high flood risk	<3% of the map unit has a moderate to high flood risk
Salinity risk	<3% of map unit has a moderate to high salinity risk or is presently saline	<3% of map unit has a moderate to high salinity risk or is presently saline	<3% of map unit has a moderate to high salinity risk or is presently saline

Geotechnical investigations undertaken by Galt (2021) confirms the Site is predominantly underlain by fine to medium grained sand.

The above geological units and soils are recognised as being Class II which have a moderate to low risk of Acid Sulfate Soils (ASS) occurring within 3 m of the natural soil surface but high to moderate risk of ASS beyond 3 m of natural soil surface (DER 2015).

ASS field testing undertaken by Galt (2021) confirm that soils from surface to a depth of approximately 3 m are not ASS and therefore, excavations to a depth of 3 m is unlikely to disturb any ASS.

4.3 Hydrology

4.3.1 Groundwater

Groundwater flows generally from south-east to north-west (Urbaqua 2022).

Regional groundwater mapping indicates the maximum groundwater level varies between approximately 25 mAHD and 26.5 mAHD across the site, which translate to the depth to groundwater ranging from approximately 1 m to 5 m (Figure 4) (DWER 2023a; Urbaqua 2022).

As part of Main Roads Western Australia (MRWA) construction of Armadale Road, GHD undertook an assessment to determine design groundwater levels in 2018 (Urbaqua 2022). Based on the assessment undertaken by GHD, it appears the maximum groundwater level varies between approximately 25.6 mAHD and 27.1 mAHD across the Site, which translates to depth to groundwater ranging from approximately 0.5 m to 2 m (Urbaqua 2022).

Six ground water monitoring bores with down hole piezometers have been installed across the site to establish more precise ground water levels and to test the quality of the ground water (Urbaqua 2022).

Additional groundwater monitoring was also performed over the site by Galt (2022) to ascertain localised maximum ground water levels factoring in rainfall over the winter months (to ensure the maximum was recorded), this analysis ran from May to November 2022 and has been included in Appendix 4. The conclusion of this was a maximum groundwater level of 26.52 mAHD (Galt 2022).

4.3.2 Surface water and drainage

The Site contains no surface water features. North-west of the site is a constructed drainage basin, which was installed during the works for the Kwinana Freeway off-ramp and Prinsep Road (PGV Environmental 2022a).

4.3.3 Wetlands

The Department of Biodiversity, Conservation and Attractions (DBCA) geomorphic wetland dataset for the Swan Coastal Plain maps one multiple use wetland within the northern portion of the site (Landgate 2023) (Table 4-2) (Figure 4). The wetland management category definitions are provided in Table 4-3

Table 4-2: Wetlands (Landgate 2023)

Wetland Name	Unique Feature ID	Landform	Wetland Type	Management Category	Total Area (ha)	Area on site (ha)
unnamed	6652	Basin	Dampland	Multiple Use	47.65	1.1

Table 4-3: Wetland management categories (EPA 2008)

Management Category	General Description	Management Objective
Conservation	Wetlands which support a high level of attributes and functions	Highest priority wetlands. Objective is to preserve and protect the existing conservation values of the wetlands through various mechanisms including: <ul style="list-style-type: none"> reservation in national parks, crown reserves and State-owned land,

Management Category	General Description	Management Objective
		<ul style="list-style-type: none"> protection under Environmental Protection Policies, and wetland covenanting by landowners. <p>No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate.</p>
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions	<p>Priority wetlands. Ultimate objective is to manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored to Conservation category. This can be achieved by restoring wetland function, structure and biodiversity.</p> <p>Protection is recommended through a number of mechanisms.</p>
Multiple Use	Wetlands with few remaining important attributes and functions	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare.

It is worthwhile to note that whilst approximately 1.1 ha of the multiple use wetland is mapped on Site, most (approximately 97%) of the multiple use wetland (UFI: 6652) occurs offsite and extends east, north and west of the site. The actual extent of the multiple use wetland on Site is likely to correspond with the area of *Melaleuca preissiana* open low woodland (Mp) defined and mapped by PGV Environmental (2023) as being approximately 1.39 ha and in Degraded to Good condition (Section 4.4.6).

4.3.4 Water resources

The Site is located within the South Lakes sub area of the Jandakot groundwater management area (DWER 2023b). The groundwater aquifers present at the site are identified as fully allocated; however, it is understood through past consultation with DWER that groundwater previously allocated may be available for reallocation (Urbaqua 2022).

A groundwater licence application for 75,000kL has been lodged with DWER and is currently being assessed. It is worthwhile to note the Developer will supplement groundwater use with scheme water, if required. Additional water supplies and sources have been identified to supply the facility, which is documented in the Water Management Plan prepared by Urbaqua (2022) (Appendix 5).

The site is not located within a Public Drinking Water Source Area (DWER 2023b).

4.4 Vegetation and flora

4.4.1 Pre-European vegetation

Broad scale mapping of pre-European vegetation was undertaken by Beard (1976) which recorded 75 major categories of plants. Shepherd et al. (2002) reassessed the Beard's mapping and divided some of the larger vegetation units into smaller units, which then resulted in a total of 819 vegetation types being mapped across the State.

The Site is mapped as containing the following broad vegetation type (Landgate 2023):

- Bassendean 1001: Medium very sparse woodland; jarrah, with low woodland; banksia and casuarina

The status of this vegetation system association at state, regional and local level is presented in Table 4-4. The remnant native vegetation (BmBa, Mp and Xp) within the Site (5.23 ha) represents approximately 0.05% of the current extent of Bassendean Complex – Central and South.

Table 4-4: Bassendean 1001 – Vegetation Statistics (GoWA 2019a)

Area	Pre-European extent	Current Extent	Current Extent Protected for Conservation	Site Representation
Western Australia (1b)	53,283.54 ha	11,394.19 ha (21.38%)	1,602.84 ha (3.01%)	0.05%
Swan Coastal Plain (2b)	53,283.54 ha	11,394.19 ha (21.38%)	1,602.84 ha (3.01%)	0.05%
City of Cockburn (4b)	7,328.39 ha	2,002.93 ha (27.33%)	298.85 ha (4.08%)	0.26%

4.4.2 Vegetation Complex

The Site is mapped as containing native vegetation which forms part of the Bassendean Complex – Central and South (Landgate 2023) and is described as:

- Vegetation ranges from woodland of Jarrah (*Eucalyptus marginata*) – Sheoak (*Allocasuarina fraseriana*) – Banksia (*Banksia* spp.) to low woodland of Paperbark (*Melaleuca* spp.), and sedgeland on moister sites (Hedde et al., 1980).

The status of this vegetation complex is presented in Table 4-5. The remnant native vegetation (BmBa, Mp and Xp) within the Site (5.23 ha) represents approximately 0.02% of the current extent of Bassendean Complex – Central and South.

Table 4-5: Bassendean Complex, Central and South – Vegetation Statistics (GoWA 2019b)

Area	Pre-European extent	Current Extent	Current Extent Protected for Conservation	Site Representation
Swan Coastal Plain	87,476.26 ha	23,508.66 ha (26.87%)	1,881.84 ha (2.15%)	0.02%
Perth Metro. Region	46,278.62 ha	10,175.30 (21.99%)	1,637.53.34 ha (3.54%)	0.05%
City of Cockburn	6,809.99 ha	1,730.87 ha (25.42%)	-	0.30%

4.4.3 Flora and vegetation assessments

The following flora and vegetation assessments have been undertaken:

- A level 1 flora and vegetation survey was undertaken by Focused Vision Consulting (FVC) in spring (27 and 29 September) 2016 for the Cockburn Central East Local Structure Plan (CCE LSP) area, which included the Site (FVC 2019) (Appendix 6).
- Targeted *Caladenia Huegelii* survey was undertaken by FVC on 27 September 2017 for the broader CCE LSP area, which included the Site (FVC 2019) (Appendix 6).
- Vegetation assessment and surveys undertaken on 30 September 2021 and 3 December 2021 to determine the presence of Banksia Woodlands of the Swan Coastal Plain ecological community (PGV Environmental 2023) (Appendix 7)

The key findings from the flora and vegetation assessments are summarised below.

4.4.4 Flora

FVC (2019) recorded a total of 107 flora species from 90 genera and 44 families during the 2016 spring field, of which 62 (57.9%) were native species and 45 (42.1%) were introduced (weed) species. Fabaceae and Myrtaceae were recorded as the most dominant families (FVC 2019).

4.4.5 Conservation significant flora

No flora species listed as Threatened under the *Biodiversity Conservation Act 2016 (BC Act)* or under the EPBC Act were recorded, and no Priority flora listed under the BC Act were recorded as well.

A targeted flora survey for *Caladenia huegelii* was undertaken by FVC within areas of suitable habitat on 27 September 2017 and no flowering individuals were observed or recorded.

4.4.6 Vegetation type

FVC defined and mapped the following four vegetation types within the Site (FVC 2019):

- **Mp** – Low Woodland A of occasional *Eucalyptus rudis* over *Melaleuca preissiana* over occasionally dominant patches of *Kunzea glabrescens*, with *Xanthorrhoea preissii* and **Acacia longifolia*, over mostly weeds, dominated by **Ehrharta calycina*, in brown loamy sands.
- **BaEt** – Low Woodland A of *Banksia attenuata* and *Eucalyptus todtiana* over *Xanthorrhoea preissii* over *Dasyopogon bromeliifolius* and *Phlebocarya ciliata* in pale grey sands.
- **BaXp** – Low Woodland A of *Banksia attenuata* and *Banksia ilicifolia* over occasionally dominant patches of *Kunzea glabrescens*, with *Xanthorrhoea preissii* and **Acacia longifolia*, over mostly weeds, dominated by **Ehrharta calycina* and **Actothea calendula*, in grey sands
- **Xp** – Low Scrub A of *Xanthorrhoea preissii* over *Dasyopogon bromeliifolius*, *Phlebocarya ciliata* and **Ehrharta calycina*, in grey sands

PGV Environmental (2023) undertook a vegetation assessment of the Site on 30 September and 3 December 2021. The following three vegetation types were defined and mapped within the Site (Figure 5) (PGV Environmental 2023):

- **BmBa** – *Banksia menziesii*/*B. attenuata* Low open Woodland over *Xanthorrhoea preissii* Open Shrubland over *Phlebocarya ciliata* Open Low Heath
- **Xp** – *Xanthorrhoea preissii* Shrubland over *Phlebocarya ciliata* Closed Low Heath
- **Mp** – *Melaleuca preissiana* Low Open Woodland over *Kunzea glabrescens* Tall Shrubland over *Astartea affinis*/*Hypocalymma angustifolium* Open Low Heath

The purpose of PGV Environmental's assessment was to confirm the Site's vegetation type and condition, and whether the *Banksia* vegetation types previously mapped by FVC are part of the *Banksia* Woodlands of the Swan Coastal Plain ecological community, which is a Federally listed TEC and State listed PEC. PGV Environmental mapped the boundary of the *Banksia* dominated vegetation with the assistance of a tree survey undertaken by MNG surveyors and use of a hand-held Global Positioning System (PGV Environmental 2023).

It is worthwhile to note that the vegetation types mapped by PGV Environmental are similar to those mapped by FVC, with the following slight differences in terminology (PGV Environmental 2023):

- PGV Environmental recorded *Eucalyptus todtiana* on the Site but it was not considered to be in great abundance and therefore, not included in the vegetation type description
- PGV Environmental recorded more *Banksia menziesii* on site than *Banksia attenuata*, and so both species were used in the vegetation type description.

The above differences are considered to be small and technical in nature and are of no conservation consequence (PGV Environmental 2023).

The portion of Lot 9001, which is included in the development footprint does not contain any native plants; however, some Victorian Teatree and a Cape Lilac tree occur in this area.

The vegetation descriptions and extent within the clearing footprint is based on PGV Environmental's vegetation assessment and mapping, and is summarised in Table 4-6. Vegetation type locations and proposed clearing extent are shown on Figure 5 with breakdown of areas provided in Table 4-6.

Table 4-6: Vegetation Types (PGV Environmental 2022a)

Vegetation Type	Vegetation Description	Site Boundary (ha)	Development Area (ha)	Tree Retention Area (ha)
BmBa	Banksia menziesii/B. attenuata Low open Woodland over Xanthorrhoea preissii Open Shrubland over Phlebocarya ciliata Open Low Heath	3.11	2.88	0.23
Xp	Xanthorrhoea preissii Shrubland over Phlebocarya ciliata Closed Low Heath	0.73	0.73	0
Mp	Melaleuca preissiana Low Open Woodland over Kunzea glabrescens Tall Shrubland over Astartea affinis/Hypocalymma angustifolium Open Low Heath	1.39	1.28	0.11
Cleared		0.52	0.40	0.12
	Total	5.75	5.29	0.46

4.4.7 Vegetation Condition

In accordance with the Keighery system and as described in Bush Forever (Table 4-7) (GoWA 2000), PGV Environmental assessed the condition of the vegetation within the Site (Figure 6) (Table 4-7).

Table 4-7: Vegetation Condition Rating Scale (GoWA 2000)

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

PGV Environmental (2023) rated the Banksia woodland (BaBm) as being in Good to Very Good condition (Figure 6). It is worthwhile to note that if not for the presence of weed species (i.e. Bridal Creeper (*Asparagus asparagoides*) in some places and abundant presence of Perennial Veldtgrass (*Erharta calycina*)) the Banksia woodland would have been rated as Excellent condition (PGV Environmental 2023).

The area of *Xanthorrhoea preissii* Shrubland (Xp) lacked tree cover but had an intact understory, and examination of historic aerial photographs identified this area may have been cleared of trees in the past and therefore, was rated as being in Good condition to reflect the change in structure from past clearing (PGV Environmental 2023).

The Paperbark wetland vegetation (Mp) was rated as being in Degraded to Good condition due to the abundance of Sydney Wattle (*Acacia longifolia*) mixed with the Paperbark trees (*Melaleuca preissii*) and high weed cover in the understory such as grassy weeds Annual Veldtgrass (*Erharta longiflora*) and Blowfly Grass (*Briza maxima*).

The spatial extent of the vegetation condition classifications is shown on Figure 6. The areas to be cleared within each vegetation type and condition classification is listed in Table 4-8.

Table 4-8: Vegetation Types and Condition

Condition Rating	Site Boundary (ha)	Development Area (ha)	Tree Retention Area (ha)
Good – Very Good	3.07	2.85	0.22
Good	0.61	0.61	0
Degraded – Good	1.48	1.37	0.12
Degraded	0.06	0.06	0
Completely Degraded	0.53	0.40	0.12
Total	5.75	5.29	0.46

4.4.8 Floristic community types

FVC assessed the intact vegetation communities recorded on Site and inferred the following (FVC 2019):

- **BaEt** and **Xp** corresponds with Floristic Community Types (FCT) Swan Coastal Plan 23a – Central *Banksia attenuata* – *Banksia menziesii* woodlands
- **BaXp** corresponds with FCT SCP21a Central *Banksia attenuata* – *Eucalyptus marginata* woodlands
- **Xp** corresponds with FCT SCP4 – *Melaleuca preissiana* damplands

None of the above inferred FCTs are listed TECs or PECs.

4.4.9 Banksia Woodlands of the Swan Coast Plan ecological community

PGV Environmental (2023) undertook an assessment to confirm the presence (and extent) of Banksia Woodlands of the Swan Coastal Plain ecological community, which is listed by the Commonwealth as Endangered and listed as a Priority 3 PEC by the DBCA.

As the Banksia woodland vegetation type (BmBa) is in Good or better condition it was assessed as being part of the Banksia Woodlands of the Swan Coastal Plain ecological community (PGV Environmental 2023). Vegetation type Xp which adjoins BmBa, and does not contain any Banksia trees, is considered to be a buffer vegetation to the Banksia woodland, and in accordance with the Approved Conservation Advice for Banksia Woodlands (TSSC 2016) it is not considered to form part of the ecological community and is not formally protected as part of the matter of national environmental significance (PGV Environmental 2023).

Figure 7 and Table 4-9 presents the outcome of PGV Environmental's Banksia Woodlands assessment, which confirms the presence and extent of Banksia Woodlands of the Swan Coastal Plain ecological community on Site

Table 4-9: Assessment of the Banksia Woodlands of the Swan Coastal Plain ecological community (PGV Environmental 2023)

Feature	Characteristic	BmBa vegetation type
Banksia species	The patch must include at least one of the following diagnostic species: <ul style="list-style-type: none"> • <i>Banksia attenuata</i> (Candlestick Banksia) • <i>Banksia menziesii</i> (Firewood Banksia) • <i>Banksia prionotes</i> (Acorn Banksia) • <i>Banksia ilicifolia</i> (Holly-Leaved Banksia). 	Area mapped as BmBa contain both <i>Banksia attenuata</i> and <i>Banksia menziesii</i>
Vegetation structure	<ul style="list-style-type: none"> • A distinctive upper sclerophyllous layer of low trees (occasionally large shrubs more than 2 m tall) typically dominated or codominated by one or more of the Banksia species (<i>B. attenuata</i>, <i>B. menziesii</i>, <i>B. ilicifolia</i>, <i>B. prionotes</i>). • An emergent tree layer of medium or tall (>10 m) height Eucalyptus or Allocasuarina (Sheoak) species may sometimes be present above the Banksia canopy. • An understorey that is often highly species-rich consists of: <ul style="list-style-type: none"> ▪ A layer of sclerophyllous shrubs of various heights; and, ▪ A herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs, that sometimes includes grasses. The development of a ground layer may vary depending on the density of the shrub layer and disturbance history. 	<i>Banksia attenuata</i> and <i>Banksia menziesii</i> very common tree layer with Eucalyptus todtiana and Allocasuarina fraseriana occasionally present. Understorey not highly species rich but contain sclerophyllous shrubs of various heights as well as rushes, sedges and forbs.
Vegetation condition	An area of Banksia woodland needs to be at least in Good condition to be considered the TEC.	Condition rated as Good-Very Good which is above the minimum condition category
Patch size	The Banksia woodland TEC needs to meet a minimum ‘patch’ size depending on its condition to qualify as the TEC, as follows: <ul style="list-style-type: none"> • ‘Pristine’ – no minimum patch size • ‘Excellent’ – 0.5ha • ‘Very Good’ – 1ha • ‘Good’ – 2ha 	Area of BmBa vegetation calculated at 3.156ha within the PGV Environmental survey area (and 3.11 ha within the Site boundary) (Figure 7). The area of Xp vegetation is contiguous with the BmBa type does not contain any Banksia trees and therefore is not part of the Banksia patch. The size of the BmBa vegetation type is larger than the minimum criteria of 2ha for Good condition vegetation.
Conclusion		Meets the criteria for Banksia Woodlands of the Swan Coastal Plain ecological community

4.4.10 Wetland vegetation

As previously advised, approximately 1.1 ha of the northern portion of Site is mapped as a multiple use wetland (Figure 4) (UFI: 6652); however, the actual extent of the wetland on Site is more likely to correspond with the area of *Melaleuca preissiana* open low woodland (Mp) defined and mapped by PGV Environmental (2023) (Figure 5) (Section 4.4.6) as being approximately 1.40 ha within the survey area (and 1.39 ha within the Site boundary) and in Degraded to Good condition (Figure 6). Given the condition of the wetland, the current classification of multiple use is considered appropriate (PGV Environmental 2022a).

In 2021, PGV Environmental (2022b) surveyed the vegetation within the same multiple use wetland (UFI: 6652) located on Lot 802 north of Prinsep Road. The following wetland vegetation types were recorded within Lot 802 (PGV Environmental 2022b):

- **MpAaHa** – *Melaleuca preissiana* Woodland to Low Woodland over *Acacia longifolia* Low Open Woodland over *Astartea affinis* Shrubland over *Hypocalymma angustifolium* Low Shrubland to Open Heath
- **MpXbXp** – *Melaleuca preissiana* Low Woodland over *Xanthorrhoea brunonis*/*Xanthorrhoea preissii* Shrubland to Closed Low Heath
- **MpXpHa** – *Melaleuca preissiana* Low Open Woodland over *Xanthorrhoea preissii*/*Hypocalymma angustifolium* Closed Low Heath

The vegetation within Lot 802 was recorded as being in Very Good to Excellent condition (apart from the edges being in Degraded to Completely Degraded condition) and considered more likely to be classified as a conservation category wetland (PGV Environmental 2022a). Due to the marked differences in the vegetation condition, the wetland vegetation on Site does not have the same vegetation values as the wetland on Lot 802 (PGV Environmental 2022a).

4.5 Fauna

4.5.1 Fauna assessments

The following fauna assessment have been undertaken:

- A level 1 (Basic) fauna survey was undertaken by FVC in spring (27 and 29 September) 2016 for the CCE LSP area, which included the Site (FVC 2019) (Appendix 6).
- A Black Cockatoo habitat assessment was undertaken by PGV Environmental for the Site on 3 March and 7 October 2021 (PGV Environmental 2023) (Appendix 7).

The key findings from the fauna assessments are summarised below.

4.5.2 Fauna

FVCs (2019) desktop assessment identified 143 native animals as potentially occurring within the CCE LSP area. A total of 27 native vertebrate fauna species (including 1 reptile, 25 birds and 1 mammal) were recorded during the field assessment (FVC 2019; Appendix D1).

4.5.3 Conservation significant fauna

The following conservation significant species are identified as possibly being present on Site (PGV Environmental 2023):

- Carnaby's Cockatoo (*Calyptorhynchus (Zanda) latirostris*) (Endangered)
- Forest Red-tailed Black Cockatoos (*Calyptorhynchus (Zanda) banksii naso*) (Vulnerable)
- Rainbow Bee-eater (*Merops ornatus*) (Marine)

- Perth Slider, Lined Skink (*Lerista lineata*) (Priority 3)
- Southern Brown Bandicoot, Quenda (*Isodon fusciventer*) (Priority 4)

In addition, habitat may also occur on Site for the following fauna (PGV Environmental 2023):

- Baudin's Cockatoo (*Calyptorhynchus (Zanda) baudinii*) (Endangered) which is increasingly being recorded on the Swan Coastal Plain
- Black-striped Snake (*Neelaps calonotos*) (Priority 3).

4.5.4 Fauna habitat

The following fauna habitats were identified on Site (FVC 2019):

- Banksia Woodland habitat – corresponds with BmBa vegetation type
- Paperbark Woodland/Swamp habitat – corresponds with Mp vegetation type
- Open Heath habitat – corresponds with Xp vegetation type

The Open Heath habitat was identified as providing some limited habitat, with the woodland habitats providing more value. The Paperbark Woodland/ Swamp habitat would provide for a number of native birds, small mammals and reptiles, and is likely to support populations of the Quenda (Priority 4). The Banksia Woodland habitat was identified as being of greatest significance due to the vegetation condition and suitability for Black Cockatoo foraging (FVC 2019).

PGV Environmental (2023) assessed the fauna habitat on Site utilising a number of factors, including size of the habitat, level of connectivity, availability of specific resources (such as tree hollows) and overall vegetation quality. Table 4-10 lists the fauna habitat categories and their corresponding characteristics.

Based on the Site's characteristics, and largely due to the intact vegetation and connectivity with habitat to the north, the fauna habitat was considered to be Good Fauna Habitat (PGV Environmental 2023).

Table 4-10: Fauna habitat categories (Coffey Environments 2009 as cited in PGV Environmental 2023)

Category	Characteristics
High Quality Fauna Habitat	These areas closely approximate the vegetation mix and quality that would have been in the area prior to any disturbance. The habitat has connectivity with other habitats and is likely to contain the most natural vertebrate fauna assemblage.
Very Good Fauna Habitat	These areas show minimal signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) and generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be minimally affected by disturbance.
Good Fauna Habitat	These areas showed signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be affected by disturbance.
Disturbed Fauna Habitat	These areas showed signs of significant disturbance. Many of the trees, shrubs and undergrowth are cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, contain weeds or have been damaged by vehicle or machinery. Habitats are fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.
Highly Degraded Fauna Habitat	These areas often have a significant loss of vegetation, an abundance of weeds, and a large number of vehicle tracks or are completely cleared. Limited or no fauna habitat connectivity. Faunal assemblages in these areas are likely to be significantly different to what might have been in the area pre-disturbance.

4.5.5 Black cockatoo habitat

In accordance with the (then) EPBC Act referral guidelines for three threatened Black Cockatoo species: Carnaby's Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksii naso* (DSEWPac 2012) (Black Cockatoo Referral Guidelines), PGV Environmental undertook a Black Cockatoo habitat assessment on 3 March and 7 October 2021.

The Site was traversed on foot and information on foraging, roosting and breeding habitats for Black Cockatoos were assessed by determining the (PGV Environmental 2023):

- extent, type and quality of vegetation present
- presence and extent of plants known to be used by Black Cockatoos.

4.5.5.1 Foraging habitat

PGV Environmental recorded four native species on Site that are known to be foraging habitat for Black Cockatoos (Table 4-11) (Davies 1966; Saunders 1980; Johnstone and Storr 1998; Johnstone and Kirkby 1999; Valentine and Stock 2008; Groom 2011; Johnstone et al. 2011; DSEWPac 2012; Johnstone et al. 2013; Johnstone et al. 2016 as cited in PGV Environmental 2023).

The total area of foraging habitat within the Site boundary is 3.11ha (Figure 8). Publicly available datasets indicate that approximately 9,105 ha of Black Cockatoo foraging habitat occurs within 12 km of the Site and of this 4,861 ha (53%) occurs within Bush Forever (PGV Environmental 2022a) (Figure 9). The Black Cockatoo foraging habitat (3.11 ha) represents 0.034% within a 12 km radius of the Site.

Table 4-11: Foraging species for Black Cockatoos found on Site (PGV Environmental 2023)

Species	Common Name	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo	Baudin's Cockatoo
<i>Allocasuarina fraseriana</i>	Sheoak	None	Low	High
<i>Banksia attenuata</i>	Candlestick Banksia	High	High	None
<i>Banksia menziesii</i>	Firewood Banksia	High	High	None
<i>Eucalyptus tottiana</i>	Blackbutt	Moderate	Moderate	Moderate

PGV Environmental scored the foraging habitat value using Bamford Consulting Ecologist's (BCEs) (2020) *Scoring system for the assessment of foraging value of vegetation for Black Cockatoos*. BCEs scoring system is designed to provide a numerical value that reflects the significance of vegetation as foraging habitat for black cockatoos. The total score (out of 10) is derived from three components (site condition, site context and species stocking rate) and a fourth (moderation) component (BCE 2020).

Based on BCEs scoring system, the foraging habitat value for the Site was assigned a total score of 3 out of 10 (PGV Environmental 2023).

The Banksia woodland vegetation type (BmBa) contains foraging habitat for Carnaby's Cockatoo and Baudin's Cockatoo and limited foraging habitat for Forest Red-tailed Black Cockatoos (PGV Environmental 2022c). It is worthwhile to note that based on the modelled distribution mapping for Baudin's Cockatoo (DAWE 2022; Map 2), it appears the Site is located outside of the modelled distribution for this species.

4.5.5.2 Roosting

It is recognised that Black Cockatoos roost overnight in tall trees, which may include native and introduced pine trees and eucalypts, and generally in close proximity to a fresh water source (PGV Environmental 2023). The Site does not contain roosting habitat for Black Cockatoos and roosting has never been recorded on the Site (DoP 2011; Peck et al. 2018; National Map 2022 as cited in PGV Environmental 2023). The nearest

confirmed roosting sites are reported to be around 1.9 km to the north west, 1.8 km to the south west and 3.4 km to the south east (PGV Environmental 2023).

4.5.5.3 Breeding

Black cockatoos are known to breed in hollows of large eucalypts, such as Jarrah, Tuart and Marri; however, there are no trees on site that meet the definition of breeding habitat or potential breeding habitat (PGV Environmental 2023). Furthermore, there is no confirmed breeding sites within 12km of the Site (PGV Environmental 2022a).

4.6 Conservation Areas

The Site is not mapped as an Environmentally Sensitive Area (ESA) and the nearest mapped ESA is less than 500m south of the Site and is fully developed (Landgate 2023). The Site does not form part of any Bush Forever sites, with the closest Bush Forever sites being 1.6 km east of the Site (Bush Forever 390) and 1.7 km south west of the Site (Bush Forever 391) (Landgate 2023).

The Site is not mapped as a local conservation area, with the closest local conservation reserve being approximately 750 m east of the Site (Verde Reserve) and 600 m west of the Site (Yandi Park) (City of Cockburn 2023).

4.7 Ecological Linkages

Apart from the wetland vegetation on Lot 802, the Site is an isolated fragment of bushland within a commercial precinct that is mostly developed. There are no regional ecological linkages that pass through or are in close proximity to the Site (PGV Environmental 2022a).

With respect to local ecological corridors and linkages, the City of Cockburn's (2018) *Natural Area Management Strategy 2012 – 2022 (2018 Review)* identifies possible ecological linkages and corridors based on proximity and connection to existing conservation areas. Based on the mapping provided within the Strategy, none of the possible ecological linkages and corridors pass through or are in close proximity to the Site (City of Cockburn 2018).

4.8 Heritage

No sites of Aboriginal or European heritage as listed on the DPLH Aboriginal Heritage Enquiry System (DPLH 2023) or the Heritage Council InHerit database (GoWA 2023) are identified within the Site or surrounds.

5 Assessment Against Clearing Principles

An assessment of the proposed vegetation clearing against the ten native vegetation Clearing Principles contained in Schedule 5 of the EP Act is provided in Sections 5.1 to 5.10. Based on the assessment of the environmental values of the clearing area, it is deemed that the development is unlikely to be at variance with one of the ten Clearing Principles. However, the development could be considered to potentially be at variance to Principles (b).

5.1 Comprises high level of biological diversity

Principle (a): Native vegetation should not be cleared if it comprises a high level of biological diversity

As identified in Section 4.4.6, there is a total of three vegetation types in varying condition, which range from Good - Very Good to Degraded. Within the CCE LSP area, FVC (2019) recorded a total of 107 flora species, of which 62 (57.9%) were native species and 45 (42.1%) were weed species. Therefore, the Site's flora diversity is considered moderately low.

No flora species listed as Threatened under the BC Act or under the EPBC Act were recorded, and no Priority flora listed under the BC Act were recorded as well.

As identified in Section 4.5.4, there is a total of three fauna habitats recorded within the site, which showed signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) and varied in quality and value (PGV Environmental 2023). Within the CCE LSP area, a total of 27 native vertebrate fauna species (including 1 reptile, 25 birds and 1 mammal) were recorded during the field assessment (FVC 2019; Appendix D1). The Site's fauna diversity is also considered moderately low.

Given the condition, weed presence and moderately low diversity of flora and fauna species, clearing is considered unlikely to reduce the biological diversity in this area.

Therefore, the proposed clearing is not considered to be at variance with this principle.

5.2 Potential impact to any significant habitat for fauna indigenous to Western Australia

Principle (b): Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia

Within the CCE LSP area, a total of 27 native vertebrate fauna species (including 1 reptile, 25 birds and 1 mammal) were recorded during the field assessment (FVC 2019; Appendix D1). Of these native fauna species, three are conservation listed; Carnaby's Cockatoo, Forest Red-tailed Black Cockatoo and Quenda. A further two species are considered likely to be present on Site; Rainbow Bee eater and Perth Slider. Additionally, habitat may occur for Baudin's Cockatoo and Black-striped Snake (PGV Environmental 2023).

The proposed clearing of up to 5.23 ha of remnant vegetation (BmBA, Mp and Xp; Section 4.4.6) within the Site will cause the removal of actual or potential habitat for these conservation listed species. Clearing of fauna habitats on Site has potential to cause mortality or forced relocation of individuals (if present) away from the development area. A fauna relocation program will be undertaken prior to the commencement of clearing. A fauna handler will be present during on site clearing activities to facilitate the capture and relocation of fauna. The Developer proposes the following avoidance and mitigation measures to reduce the impact to fauna:

- Tree Retention Areas being established around the perimeter of the site (0.46 ha)
- Salvage of Balgas to be incorporated into landscaped areas of the Facility
- Enhancement of retained trees by additional planting of native vegetation and salvaged Balgas

The Site contains 3.11 ha of Black Cockatoo foraging habitat (low to moderate value) but does not contain any roosting habitat or potential breeding habitat for Black Cockatoos (PGV Environmental 2023).

The Banksia woodland vegetation type (BmBa) contains foraging habitat for Carnaby's Cockatoo and Baudin's Cockatoo and limited foraging habitat for Forest Red-tailed Black Cockatoos (PGV Environmental 2022c). It is worthwhile to note that based on the modelled distribution mapping for Baudin's Cockatoo (DAWE 2022; Map 2), the Site is located outside of the modelled distribution for this species.

As a result, the Developer has committed to providing an offset package to offset the loss of Carnaby's Cockatoo low to moderate quality foraging habitat through a condition of a Native Vegetation Clearing Permit. The Developer has investigated various options for the offset package using the DWER Offset Calculator (Appendix 8) (PGV Environmental 2022a). The final package is subject to further consultation with DWER and DBCA, but is likely to consist of revegetating 1 ha of a nearby local conservation reserve as well as purchasing a site containing Banksia Woodland PEC and ceding the land to the conservation estate, as well as a 10-year duration of offset implementation and management (PGV Environmental 2022a).

It is proposed that the environmental offset is imposed as a condition of a Native Vegetation Clearing Permit with DWER as the regulator. Further discussion of the proposed environmental offset is provided in Section 6 and Appendix 8.

Given the above and the residual impact to Black Cockatoo foraging habitat, the proposed clearing is considered to be at variance to this Principle.

5.3 Potential impact to any rare flora

Principle (c): Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, Rare flora

No flora species listed as Threatened or Priority under the BC Act under the BC Act were recorded on Site, the proposed clearing is not considered to be at variance with this Principle.

5.4 Presence of any threatened ecological communities

Principle (d): Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community

As discussed in Section 4.4.8, none of the defined vegetation types are representative of any State listed TECs. Part of the vegetation is Banksia Woodlands on the Swan Coastal Plain ecological community, which is a State listed PEC (Priority 3) and Federal listed TEC.

Given there are no State listed TECs within the Site, the proposed clearing is not considered to be at variance with this Principle.

It is worthwhile to note that based on the requirements of DWERs (2021) *Environmental offsets metric: Quantifying environmental offsets in Western Australia*, the Developer proposes to offset the loss of Banksia Woodlands PEC. The Developer has investigated various options for the offset package using the DWER Offset Calculator (Appendix 8) (PGV Environmental 2022a). The final package is subject to further consultation with DWER and DBCA but is likely to consist of revegetating 1 ha of a nearby local conservation reserve as well as purchasing a site containing Banksia Woodland PEC and ceding the land to the conservation estate, as well as a 10-year duration of offset implementation and management (PGV Environmental 2022a).

It is proposed that the environmental offset is imposed as a condition of a Native Vegetation Clearing Permit with DWER as the regulator. Further discussion of the proposed environmental offsets is provided in Section 6 and Appendix 8.

5.5 Significance of remnant native vegetation

Principle (e): Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared

Table 4-4 and Table 4-5 represents the extent statistics associated with vegetation within the Bassendean 1001 vegetation system and the Cottesloe – Central and South vegetation complex. As noted in these table, the Site contains:

- 0.05% of the current extent of Bassendean 1001 within the Swan Coastal Plain, which has 11,394.19 ha (21.38%) remaining.
- 0.02% of the current extent of Bassendean Complex – Central and South within the Swan Coastal Plain, which has 23,508.66 (26.87%) remaining.

Consistent with the National Objectives and Targets for Biodiversity Conservation (Commonwealth of Australia 2001), the EPA has an objective to retain 30% of the pre-clearing extent of each ecological community; however, the EPA has a modified objective to retain at least 10% of the preclearing extent of each ecological community within defined constrained areas including the Perth Metropolitan Region (EPA 2015). Vegetation complexes are used by the EPA as the basis for regional representation of biodiversity (EPA 2015).

Of the original extent of Bassendean 1001 and Bassendean Complex – Central and South remaining on the Swan Coastal Plain, both are above 10% of their pre-European extent.

Given the size of the clearing area represents 0.05% of Bassendean 1001 and 0.02% of Bassendean Complex – Central and South, the proposed clearing will not reduce the extent of these vegetation communities below 10% of their pre-European extent. The proposed clearing is not considered to be at variance with this Principle.

5.6 Potential impact on watercourses and/or wetlands

Principle (f): Native vegetation should not be cleared if it is growing in, or in association with, and environment associated with a watercourse or a wetland

As discussed in Section 4.3.3 and depicted in Figure 4, the DBCA geomorphic wetland dataset for the Swan Coastal Plain maps one multiple use wetland (UFI: 6652) within the northern portion of the Site (1.1 ha), with most of the wetland (97%) occurring offsite and extending east, north and west of the Site.

The actual extent of the wetland on Site is more likely to correspond with the area of *Melaleuca preissiana* open low woodland (Mp) defined and mapped by PGV Environmental (2023) (Figure 5) as being approximately 1.402 ha within the survey area (and 1.39 ha within the Site Boundary) and in Degraded to Good condition (Figure 6) and therefore, consistent with the current classification of multiple use (PGV Environmental 2022a).

The wetland vegetation within Lot 802 and north of the Site and Prinsep Road, which falls within part of the same multiple use wetland (UFI: 6652), was surveyed by PGV Environmental (2022b) and found to be mostly in Very Good to Excellent Condition and considered more likely to be classified as a conservation category wetland. Based on the marked differences in the vegetation condition, the wetland vegetation on Site is not considered to have the same vegetation values as the wetland on Lot 802 (PGV Environmental 2022a).

Table 4-3 lists the wetland management categories and their corresponding management objectives. The management objective for multiple use wetlands allows for land use and development, provided management is considered in the context of ecologically sustainable development and best management practice catchment planning (EPA 2008). Furthermore, the wetland vegetation located on Site is not conservation significant nor does it provide habitat for any conservation significant flora or fauna.

There are areas identified for tree retention (0.46 ha) on the perimeter of the Site (Figure 2). The Tree Retention Area includes some of the multiple use wetland adjacent to Prinsep Road (Figure 4). These areas are proposed to be enhanced with additional planting and the inclusion of salvaged Balgas where possible.

Potential indirect impacts on trees located within the retained areas on Site and wetland vegetation located within Lot 802 will be managed during construction in accordance with an approved Construction Environmental Management Plan (Table 1-1 and Section 1.4.1) which will include the following measures (PGV Environmental 2022a):

- Clearing protocols such as boundary demarcation, detailed plans and onsite induction to avoid over clearing
- Dust management to ensure that retained and surrounding vegetation is not coated in dust, impacting on photosynthesis and adversely impacting plant health
- Waste management to ensure that construction debris does not impact on the retained and surrounding vegetation
- Hygiene protocols to prevent the spread of disease or weeds to adjoining natural areas.

During operations, management of the wetland vegetation retained on Site and within Lot 802 will be guided by the Operation Management Plan (Table 1-1; Section 1.4.2) which will include (PGV Environmental 2022a):

- ongoing management measures, such as waste management to ensure vegetation is not impacted by rubbish
- a Landscape Management Plan that will ensure:
 - all planting is sympathetic to the surrounding environment, waterwise and sustainable
 - the landscaping is maintained to a high standard and there.

Additionally, management of potential offsite impacts such as surface water and groundwater changes are also proposed in the Water Management Plan (Table 1-1; Appendix 5) and the proposed Monitoring and Maintenance Plan to ensure that the wetland vegetation retained on Site and within Lot 802 is appropriately protected (PGV Environmental 2022a). Further detail regarding the management of groundwater levels is provided in the Water Management Plan (Appendix 5; Section 7) and includes the following (Urbaqua 2022):

- Pump testing at the site will be completed to determine achievable pumping rates and confirm aquifer parameters. Bores will be located, and pumping rates established to prevent impacts to wetland vegetation;
- Initial filling of the lagoon will be undertaken during winter months to minimise the potential impact of drawdown and ensure that aquifer recovery occurs as fast possible, which will be aided by winter recharge;
- Initial filling of the lagoon may include 50% scheme water to further reduce the potential drawdown if required;
- Topping up will be limited to up to 8 hours at a pumping rate of 10L/s or 3 hours at up to 25L/s; and
- Establish observation bores at the northern boundary of the Site to monitor potential impacts during the initial fill as well as for ongoing groundwater level and quality monitoring.

Given the above, the proposed clearing on Site is not considered to be at variance with this Principle.

5.7 Potential to cause appreciable land degradation

Principle (g): Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation

Following clearing, soils on site will be stabilised through construction or buildings, landscaping or placement of mulch/hydromulch over these areas. The lagoon layout and orientation has been designed to make use of the existing Site topography and thus minimise earthworks (PGV Environmental 2022a). Potential impacts to soils will be minimised and managed during construction in accordance with an approved Construction Environmental Management Plan (Table 1-1 and Section 1.4.1) which will include the following measures (PGV Environmental 2022a):

- Clearing boundaries will be clearly demarcated on the ground to avoid unauthorised soil disturbance;
- Stabilisation of batters during construction to prevent sedimentation in the area to be retained;
- Dust management during construction; and
- Management of surface hydrology to prevent run-off into surrounding areas.

The above actions will prevent soil movement and appreciable land degradation, the proposed clearing is not considered to be at variance with this Principle.

5.8 Potential impact on adjacent or nearby conservation areas

Principle (h): Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation areas

The Site does not form part of any Bush Forever sites, with the closest Bush Forever sites being 1.6 km east of the Site (Bush Forever 390) and 1.7 km south west of the Site (Bush Forever 391) (Landgate 2023).

The closest mapped local conservation reserves are (City of Cockburn 2023):

- Verde Reserve which is located approximately 750 m east of the Site.
- Yandi Park which is located approximately 620 m south west of the Site.

Given the distance of the Site from the above Bush Forever sites and local conservation reserves, the proposed clearing is not considered to be at variance with this Principle.

5.9 Potential deterioration in the quality of surface or underground water

Principle (i): Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of the surface or underground water

The Site contains no surface water features. North west of the site is a constructed drainage basin, which was installed during the works for the Kwinana Freeway off-ramp and Prinsep Road (PGV Environmental 2022a). The Site's soils are free draining Bassendean sand and therefore, likely that surface water will rapidly infiltrate the soil.

The depth to groundwater ranges from approximately 0.5 m to 2 m (Urbaqua 2022). The northern portion of the Site contains a wetland (UFI: 6652) which is considered to be consistent with the current classification of multiple use, is not conservation significant nor does provide habitat for any conservation significant flora or fauna (PGV Environmental 2022a).

Potential indirect impacts on surface water and groundwater quality will be mitigated through implementation of the following management plans, which is set out in the Environmental Management Framework (Section 1.4; Table 1-1), to ensure surface water and groundwater quality is protected during vegetation clearing as well as during construction and operation of the Facility:

- Water Management Plan (Appendix 5);
- Monitoring and Maintenance Plan (requirement of Water Management Plan);
- Construction Environmental Management Plan (Section 1.4.1);

- Operation Management Plan (Section 1.4.2); and
- ASS investigation and Management Plans (if required).

Furthermore, best practice water harvesting and water sensitive design will be incorporated to ensure all stormwater discharge from the Site will meet the objectives of the WAPCs 'Better Urban Water Management Guidelines' (Urbaqua 2022).

The Water Management Plan estimates that the lagoon will require 26 ML to initially fill the lagoon followed by annual top-ups of approximately 35.7 ML/yr (Urbaqua 2022). To minimise potential impacts on the groundwater resources, the Water Management Plan proposes initial filling of the lagoon be undertaken during the winter months to ensure aquifer recovery occurs quickly, and potentially use up to 50% scheme water (if required) and apply top up limits (Urbaqua 2022).

In relation to wastewater treatment and disposal, some wastewater will be generated from daily cleaning of the surf lagoon surrounds, machinery operation in the water treatment process and housekeeping of the plant area; however, the wastewaters generated will pass through a gravity settling tank which will result in a concentrated pumpable sludge that will be discharged to sewer in accordance with Water Corporation requirements (Urbaqua 2022). The backwash water is produced daily will be sent to a clarifying tank, with the majority of water skimmed off the top of the clarifier and re-introduced to the filtration system, re-treated, and chlorinated before it re-enters the lagoon. The recovered solid material is then stored to dry out which then becomes a crumbly clay. Once the Facility is operational this waste will be thoroughly tested to determine if it can be used for landscaping purposes, or otherwise will be disposed of to an appropriate waste treatment facility (Urbaqua 2022).

It is necessary to be able to discharge from the lagoon if significant repairs are required; however, it should be noted that there are no circumstances that will lead to an uncontrolled discharge taking place. Instead, the flow rate for discharge will be controlled to prevent downstream issues and can be terminated immediately in the event of significant rainfall or any other unforeseen issue (Urbaqua 2022).

The following methods may be used to discharge the lagoon on a controlled basis (Urbaqua 2022):

- Discharge to sewer;
- Discharge to underground infiltration system, which is design as part of the stormwater management system; or
- Discharge by injection into the superficial aquifer.

The lagoon water quality is required to meet the Australian Government National Health and Medical Research Council (NHMRC) and therefore, none of the above options is likely to result in adverse water quality impacts (Urbaqua 2022). Furthermore, the water lagoon's water quality is also required to meet the Department of Health's (2020) *Code of Practice for the Design, Construction, Operation, Management and Maintenance of Aquatic Facilities*.

Given the above, the proposed clearing is not considered to be at variance with this principle.

5.10 Potential for clearing to cause or exacerbate the incidence of flooding

Principle (j): Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding

As noted in Section 4.2, the soils on Site predominantly consist of Bassendean B1, B2 and B4 phases, which identifies that for all three Bassendean phases have only <3% moderate to high flood risk (DPIRD 2023).

Potential impacts on surface water and groundwater quantity will be mitigated through implementation of the following which is set out in the Environmental Management Framework (Section 1.4; Table 1 1), to ensure the incidence of flooding is not caused by vegetation clearing and construction of the Facility:



- Water Management Plan (Appendix 5)
- Monitoring and Maintenance Plan (requirement of Water Management Plan)
- Construction Environmental Management Plan (Section 1.4.1)

Given the above, clearing of vegetation is not likely to cause or exacerbate the incidence or intensity of flooding, the proposed clearing is not considered to be at variance with this principle.

6 Proposed Environmental Offset

The Developer is proposing a mix of revegetation in an existing reserve and acquisition of an offset site. Further detail on the proposed environmental offset package is provided below and in Appendix 8 (PGV Environmental 2022c).

6.1 Carnaby's Cockatoo

The Banksia woodland vegetation type (BmBa) contains foraging habitat for Carnaby's Cockatoo and Baudin's Cockatoo and limited foraging habitat for Forest Red-tailed Black Cockatoos (PGV Environmental 2022c). It is worthwhile to note that based on the modelled distribution for Baudin's Cockatoo (DAWE 2022; Map 2), the Site is located outside of the modelled distribution for this species. Therefore, the proposed environmental offset package proposes to offset only Carnaby's Cockatoo.

To achieve 100% direct offset, application of the DWER offset calculator indicates that the following is required (Appendix 8) (PGV Environmental 2022c):

- Regenerate 1 ha within Rose Shanks Reserve (will achieve 47.3% of the offset); and
- Acquisition of an offset site that is 4.2 ha in area (will achieve 53.0% of the offset).

Please refer to Appendix 8 for further detail on the above offset calculations.

6.2 Banksia Woodlands of the Swan Coastal Plain ecological

To achieve 100% direct offset, application of the DWER offset calculator indicates that the following is required (Appendix 8) (PGV Environmental 2022c):

- Regenerate a 1 ha within Rose Shanks Reserve (will achieve 22.5% of the offset); and
- Acquisition of an offset site that is 14.2 ha in area (will achieve 77.6% of the offset).

Please refer to Appendix 8 for further detail on the above offset calculations.

6.3 Offset management

The proposed regeneration of vegetation in Rose Shanks reserve will also require a number of management measures including management of weeds, pest fauna if they are impacting on the regenerated area, hygiene to prevent pathogen introduction or spread, planting and infill planting for a 10-year duration of offset implementation and management (PGV Environmental 2022a).

Implementation of appropriate management measures will ensure that the objective of the offset, which is to improve environmental values of an existing reserve with Banksia woodland that will provide high quality foraging for Black Cockatoos, is achieved (PGV Environmental 2022a).

7 Conclusions

The 'Perth Surf Park' is a highly anticipated facility that will be a unique development providing a wide range of amenities to the people of Western Australia, as well as being an important tourist destination.

Construction of the Facility will involve the following:

- Clearing of native vegetation on Site, which includes 3.11 ha of low to moderate quality Black Cockatoo foraging habitat that is also Banksia Woodlands of the Swan Coastal Plain ecological community (Priority 3) and 1.39 ha of wetland vegetation in poor condition and considered to be consistent with the classification of a multiple use wetland.
- Importing fill to create the wave lagoon, installation of roads and car parks, and constructing amenity buildings and associate facilities.
- Setting aside Tree Retention Areas (0.46 ha) around the perimeter of the Site with further avoidance actions including enhanced native plantings and the use of salvaged Balga trees from the Site.
- Preparation and implementation of the following management plans, as per the Environmental Management Framework (Section 1.4; Table 1-1) to ensure the proposed development is appropriately managed during the clearing, construction and operational phases:
 - Water Management Plan (Appendix 5)
 - Monitoring and Maintenance Plan
 - Bushfire Management Plan
 - Construction Environmental Management Plan (1.4.1)
 - Fauna Trapping and Relocation Plan
 - Operational Management Plan (1.4.2)
 - ASS Investigation and Management Plan (if required).
- Preparation and implementation of a Tree Retention Plan which will identify the significant vegetation assets to be retained within the Tree Retention Area and Development Area as part of detailed design, which will also be managed through the Building Permit plans and updated Landscape Plan.
- Preparation and implementation of several management plans to ensure the surrounding vegetation (located on Lot 802) is protected and any potential offsite impacts are appropriately managed for the long-term.
- Provision of an environmental offset package which may include a mix of revegetation in an existing reserve and acquisition of an offset site.

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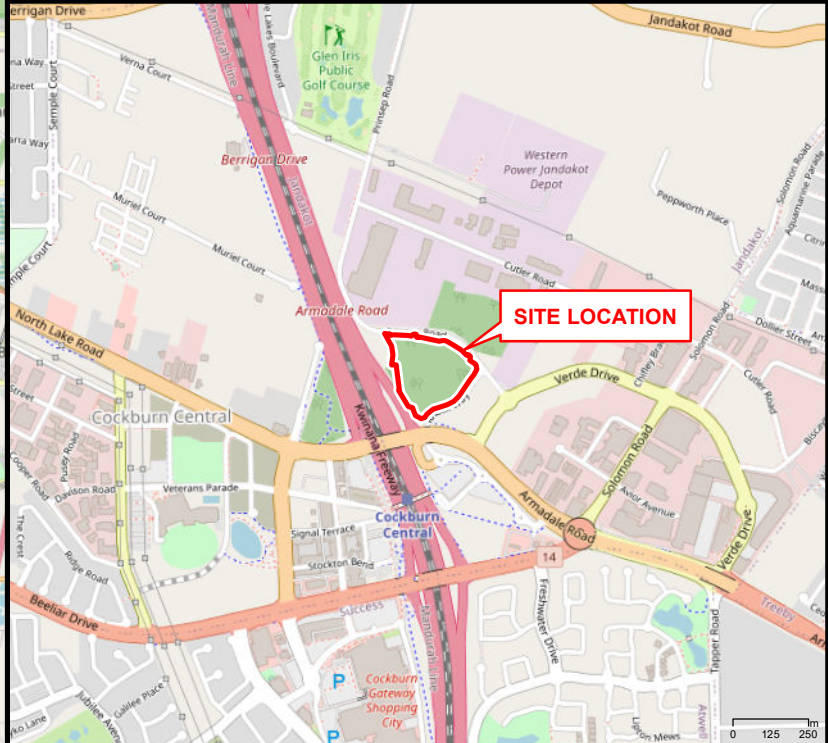
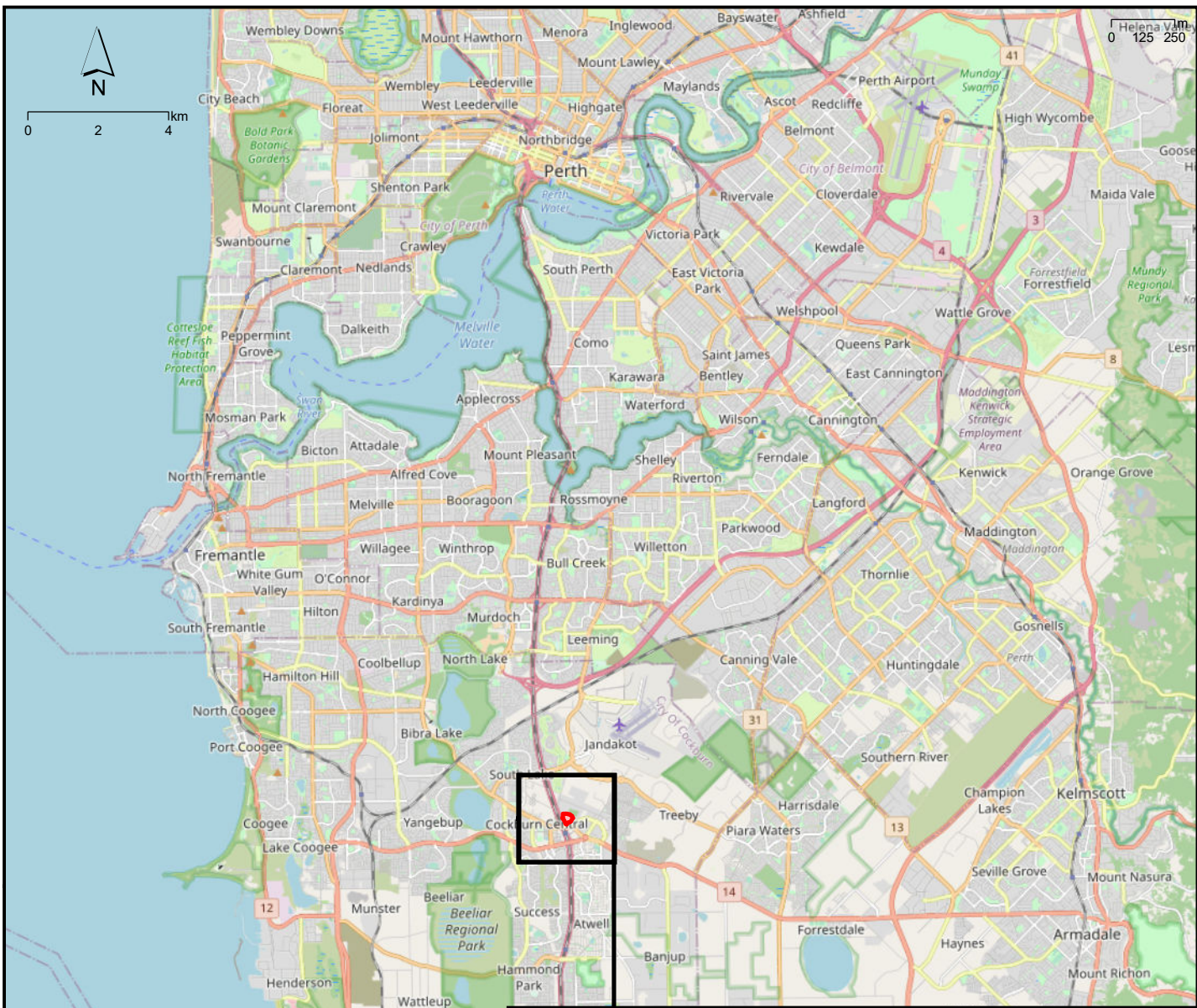
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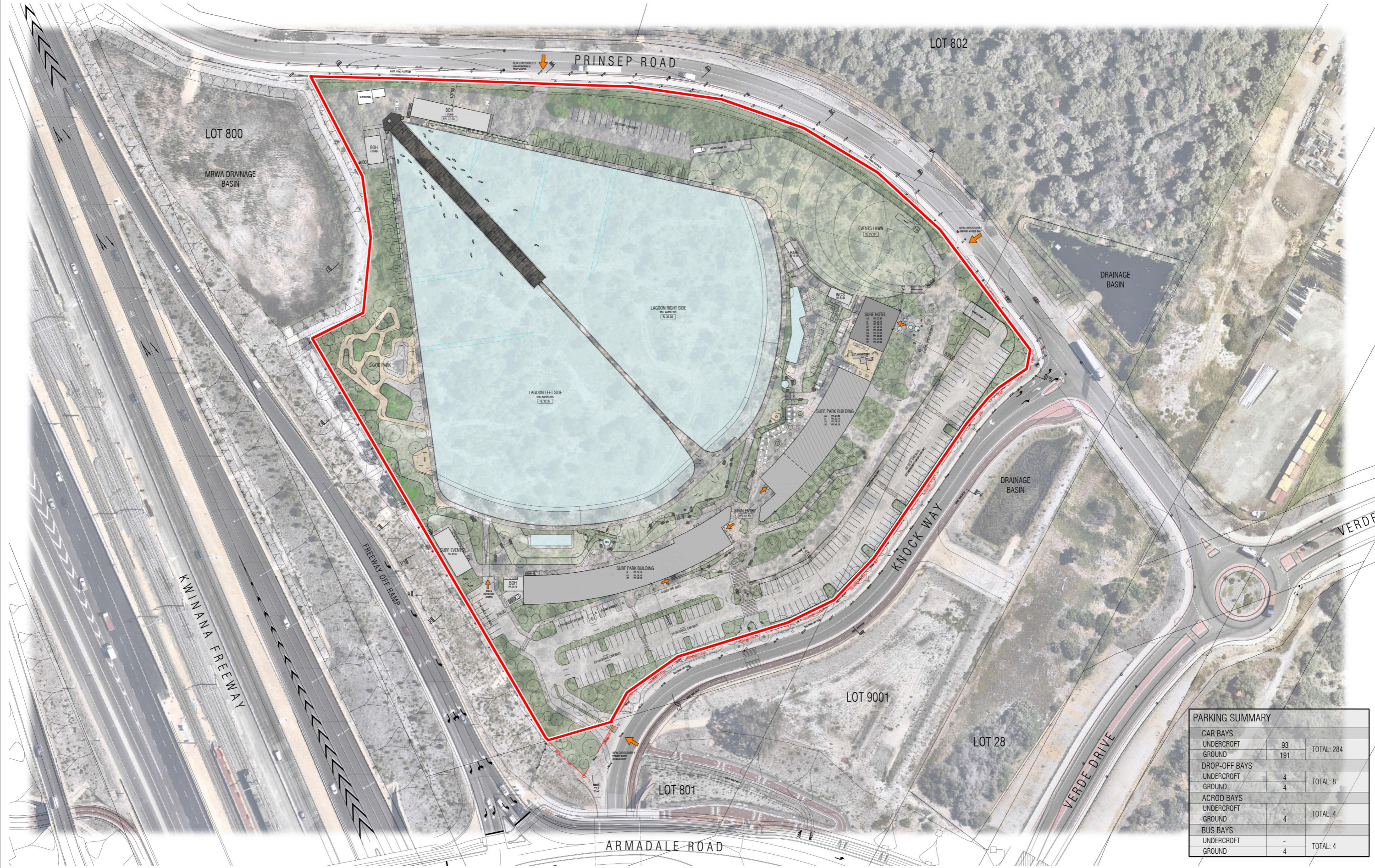
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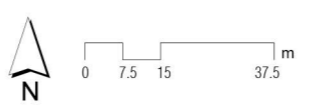
FIGURES





PARKING SUMMARY		
CAR BAYS		
UNDERCROFT	93	TOTAL: 284
GROUND	191	
DROP-OFF BAYS		
UNDERCROFT	4	TOTAL: 8
GROUND	4	
ACROD BAYS		
UNDERCROFT	-	TOTAL: 4
GROUND	4	
BUS BAYS		
UNDERCROFT	-	TOTAL: 4
GROUND	4	

LEGEND
 Site Boundary



COTERRA
 ENVIRONMENT

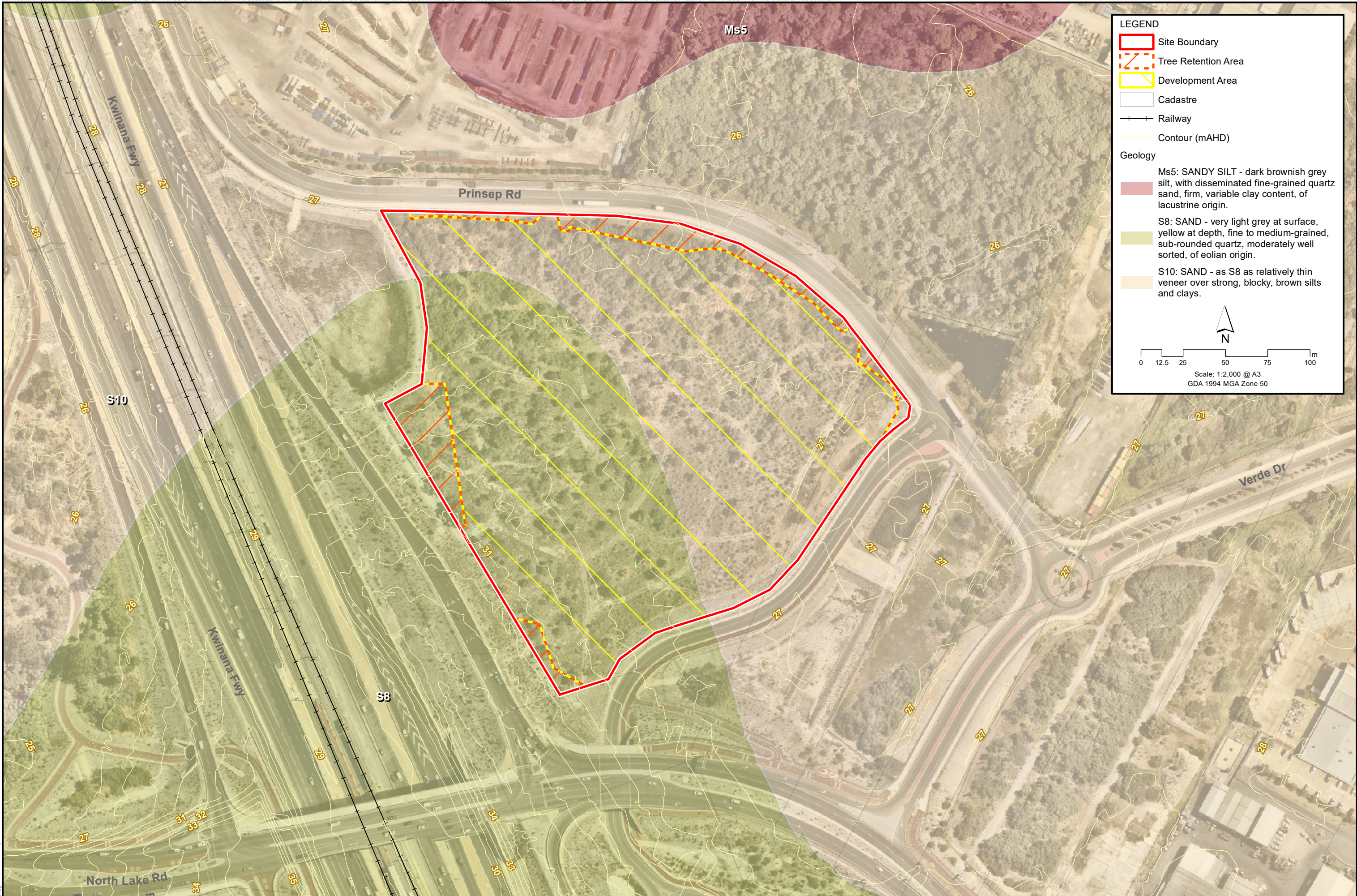
Job: ATRJAN01
 Doc: 002
 Date: 15.02.23
 Ph: (08) 9381 5513
 Fax: (08) 9381 5514
 E: info@coterra.com.au

PSP Properties Pty Ltd
 NVCP SUPPORTING INFORMATION
 PERTH SURF PARK

AERIAL PHOTOGRAPH & EXTENT OF CLEARING

Figure 2

Source: MJA STUDIO, 09.09.22



LEGEND


- Site Boundary
- Tree Retention Area
- Development Area
- Cadastre
- Railway
- Contour (mAHd)

Geology

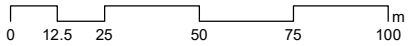
Ms5: SANDY SILT - dark brownish grey silt, with disseminated fine-grained quartz sand, firm, variable clay content, of lacustrine origin.

S8: SAND - very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well sorted, of eolian origin.

S10: SAND - as S8 as relatively thin veneer over strong, blocky, brown silts and clays.

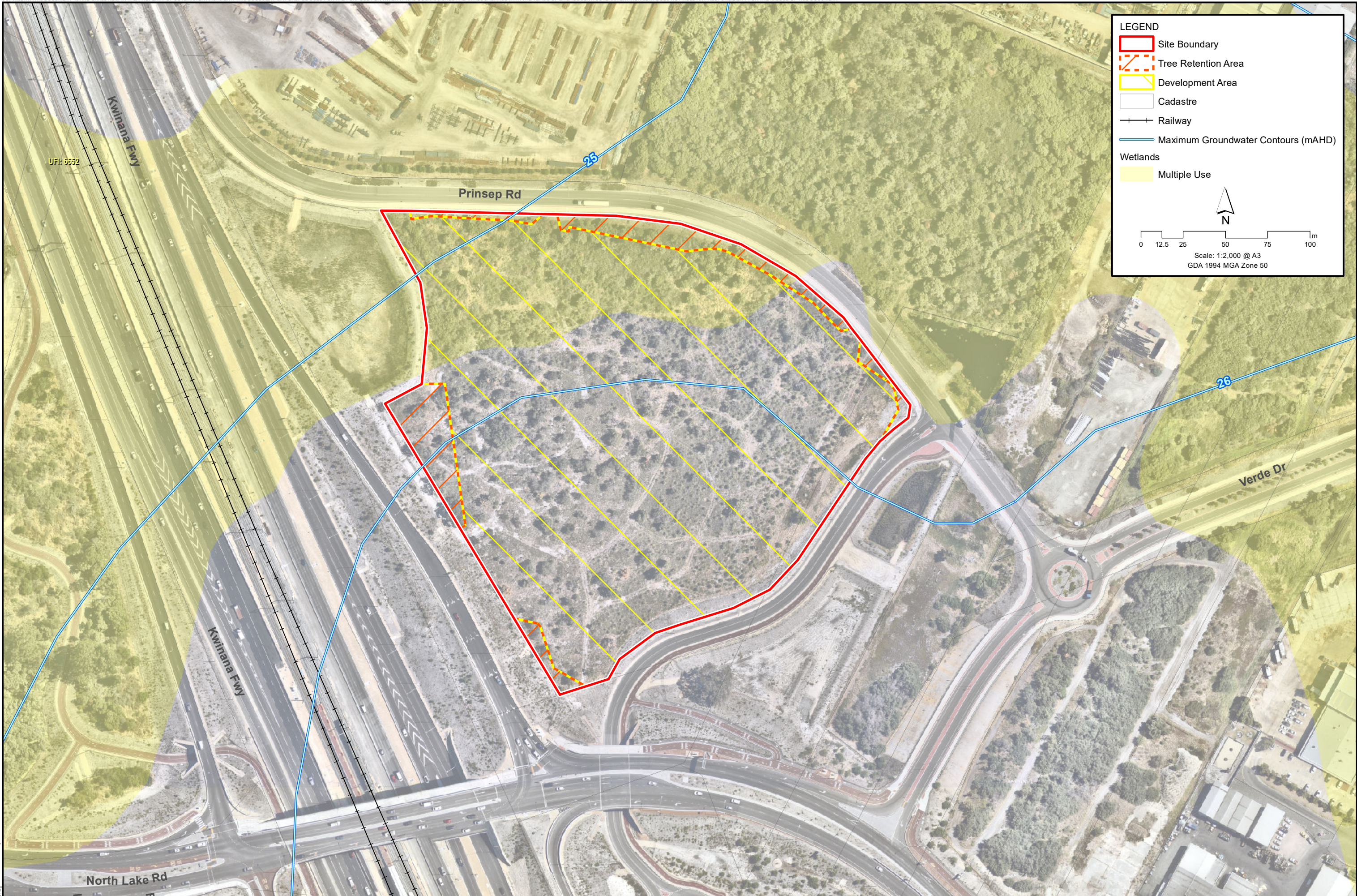


N



0 12.5 25 50 75 100 m

Scale: 1:2,000 @ A3
GDA 1994 MGA Zone 50



LEGEND

- Site Boundary
- Tree Retention Area
- Development Area
- Cadastre
- Railway
- Maximum Groundwater Contours (mAHD)

Wetlands

- Multiple Use

N

0 12.5 25 50 75 100 m

Scale: 1:2,000 @ A3
GDA 1994 MGA Zone 50

ENVIRONMAPS | 0406 590 006
Environmental Mapping Solutions | www.environmaps.com.au

Source: GW Contours - DWER
Wetlands - DBCA, 2023
Cadastre - Landgate, 2022
Orthophoto - NearMaps, 11.12.22

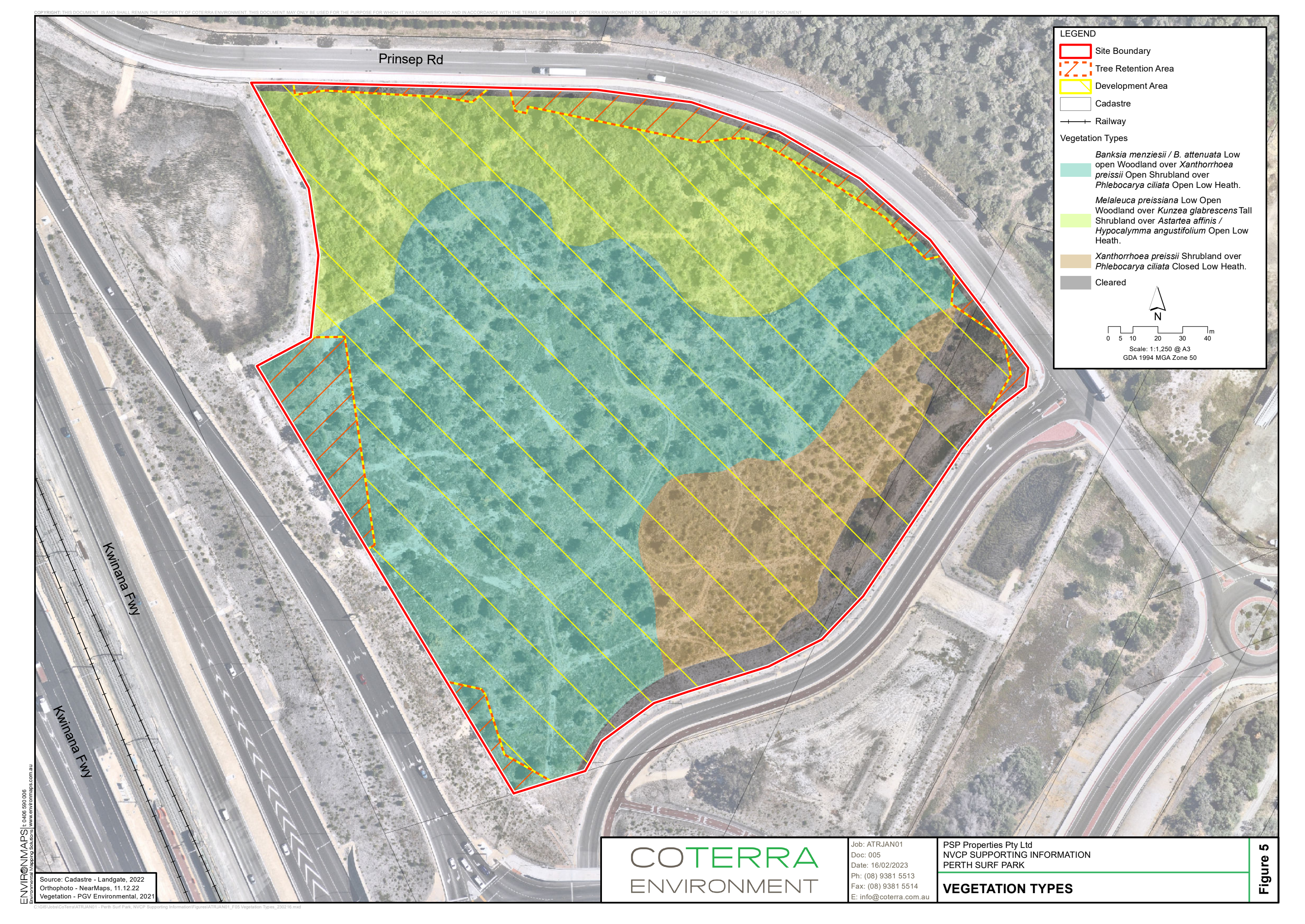
COTERRA
ENVIRONMENT

Job: ATRJAN01
Doc: 004
Date: 15/02/2023
Ph: (08) 9381 5513
Fax: (08) 9381 5514
E: info@coterra.com.au

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PERTH SURF PARK

HYDROLOGY

Figure 4




LEGEND

- Site Boundary
- Tree Retention Area
- Development Area
- Cadastre
- Railway

Vegetation Types

- Banksia menziesii* / *B. attenuata* Low open Woodland over *Xanthorrhoea preissii* Open Shrubland over *Phlebocarya ciliata* Open Low Heath.
- Melaleuca preissiana* Low Open Woodland over *Kunzea glabrescens* Tall Shrubland over *Astartea affinis* / *Hypocalymma angustifolium* Open Low Heath.
- Xanthorrhoea preissii* Shrubland over *Phlebocarya ciliata* Closed Low Heath.
- Cleared



Scale: 1:1,250 @ A3
GDA 1994 MGA Zone 50

Prinsep Rd

Kwinana Fwy

Kwinana Fwy

ENVIRONMAPS | 0406 590 006
 Environmental Mapping Solutions | www.environmaps.com.au

Source: Cadastre - Landgate, 2022
 Orthophoto - NearMaps, 11.12.22
 Vegetation - PGV Environmental, 2021

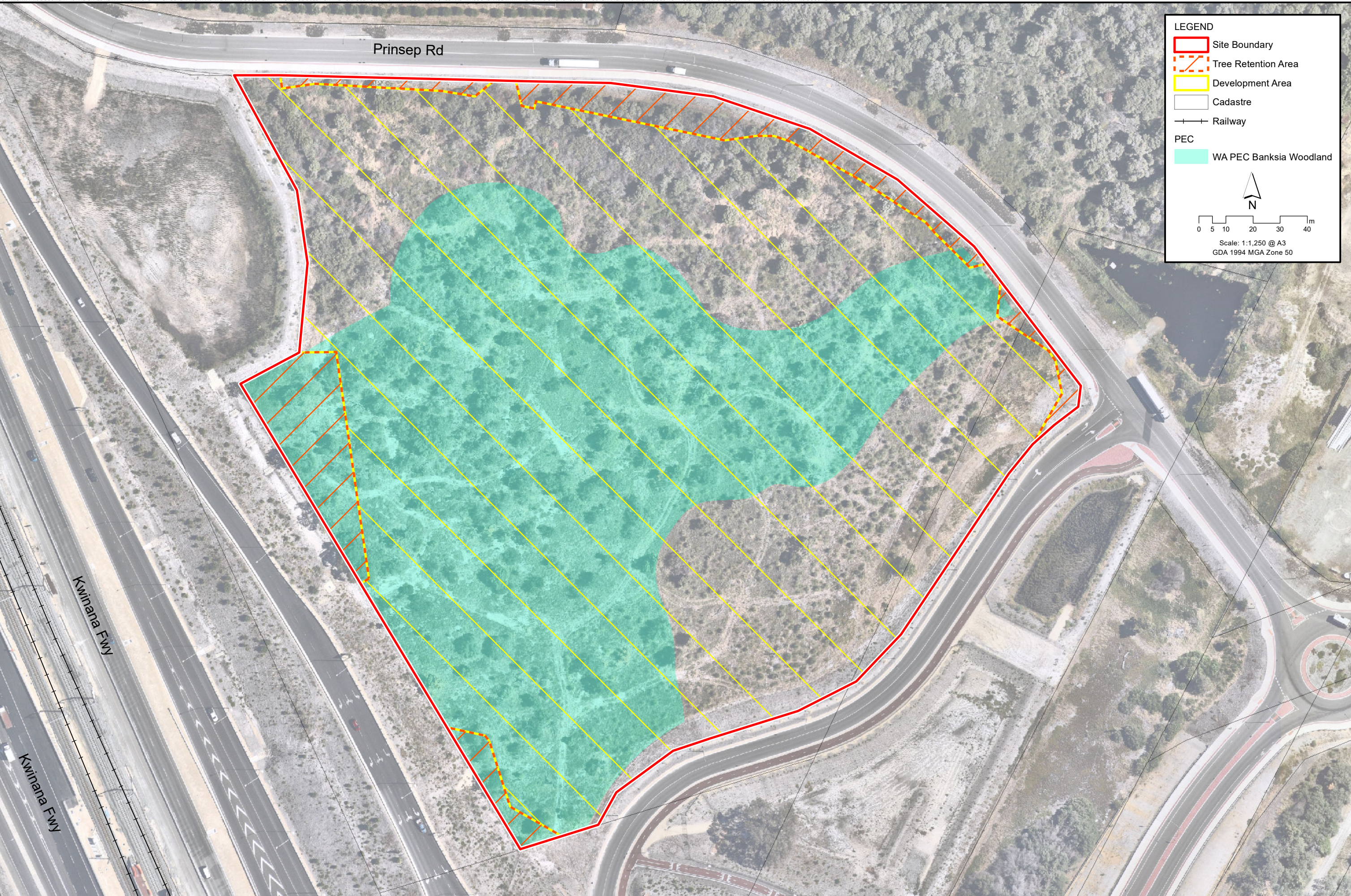
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VEGETATION TYPES

Figure 5



LEGEND

- Site Boundary
- Tree Retention Area
- Development Area
- Cadastre
- Railway

PEC

- WA PEC Banksia Woodland

N

0 5 10 20 30 40 m

Scale: 1:1,250 @ A3
GDA 1994 MGA Zone 50

ENVIRONMAPS | 0406 590 006
Environmental Mapping Solutions | www.environmaps.com.au

Source: Cadastre - Landgate, 2022
Orthophoto - NearMaps, 11.12.22
Vegetation - PGV Environmental, 2021

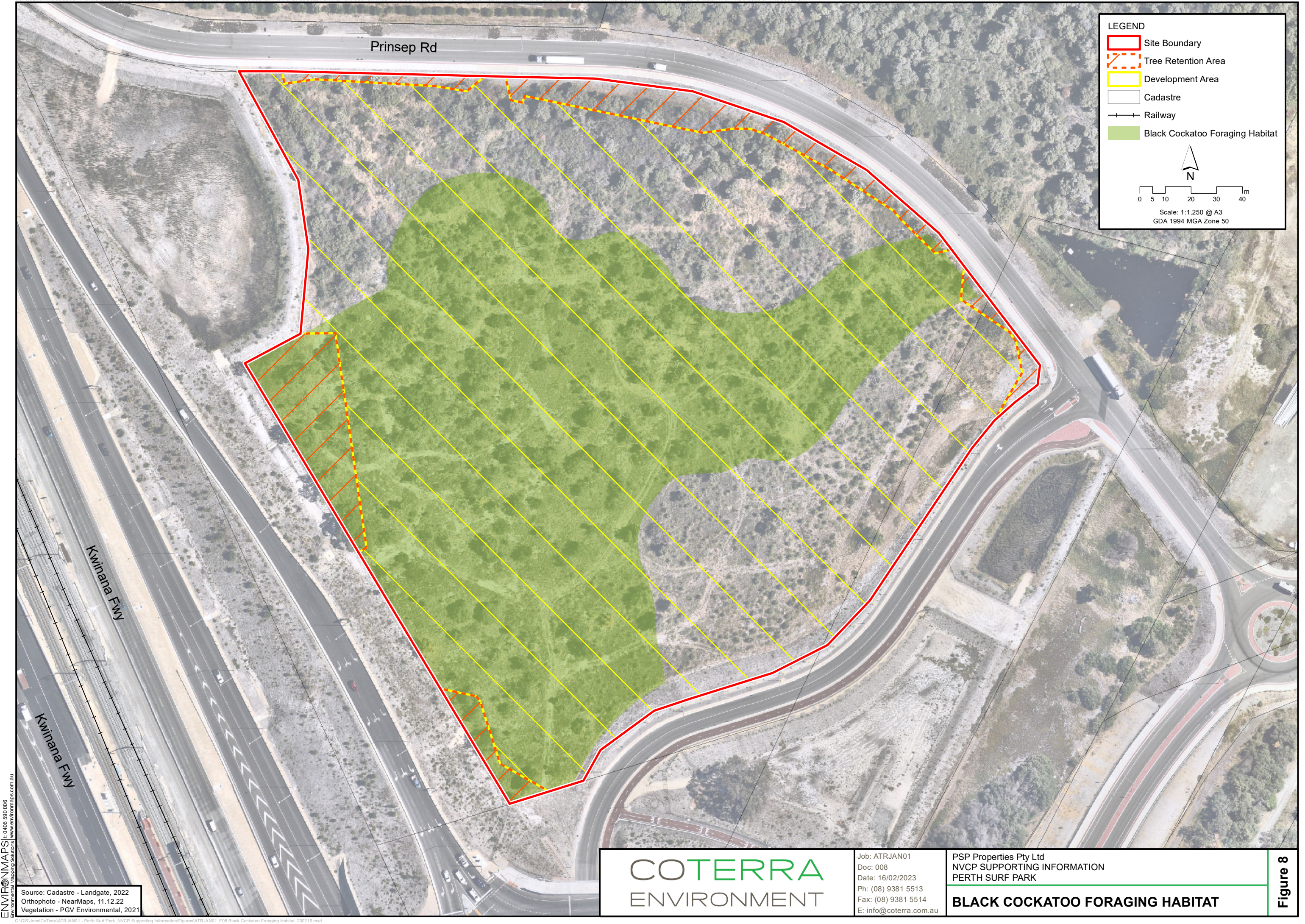
COTERRA
ENVIRONMENT

Job: ATRJAN01
Doc: 007
Date: 16/02/2023
Ph: (08) 9381 5513
Fax: (08) 9381 5514
E: info@coterra.com.au

PSP Properties Pty Ltd
NVCP SUPPORTING INFORMATION
PERTH SURF PARK

**BANKSIA WOODLAND OF THE SWAN COASTAL
PLAIN ECOLOGICAL COMMUNITY (PEC)**

Figure 7



LEGEND

- Site Boundary
- Tree Retention Area
- Development Area
- Cadastre
- Railway
- Black Cockatoo Foraging Habitat

N

0 5 10 20 30 40 m

Scale: 1:1,250 @ A3
GDA 1994 MGA Zone 50

ENVIRONMAPS | t: 0406 590 006
 Environmental Mapping Solutions | www.environmaps.com.au

Source: Cadastre - Landgate, 2022
 Orthophoto - NearMaps, 11.12.22
 Vegetation - PGV Environmental, 2021

COTERRA

ENVIRONMENT

Job: ATRJAN01
 Doc: 008
 Date: 16/02/2023
 Ph: (08) 9381 5513
 Fax: (08) 9381 5514
 E: info@coterra.com.au








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 PERTH SURF PARK


BLACK COCKATOO FORAGING HABITAT

Figure 8

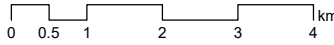
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LEGEND

-  Site Boundary
-  12 km Site Boundary Buffer
-  Railway
-  Bush Forever Area 2000
-  Carnaby Cockatoo Foraging Habitat
-  Carnaby Cockatoo Confirmed Breeding Area
-  Black Cockatoo Roosting Site (buffer)

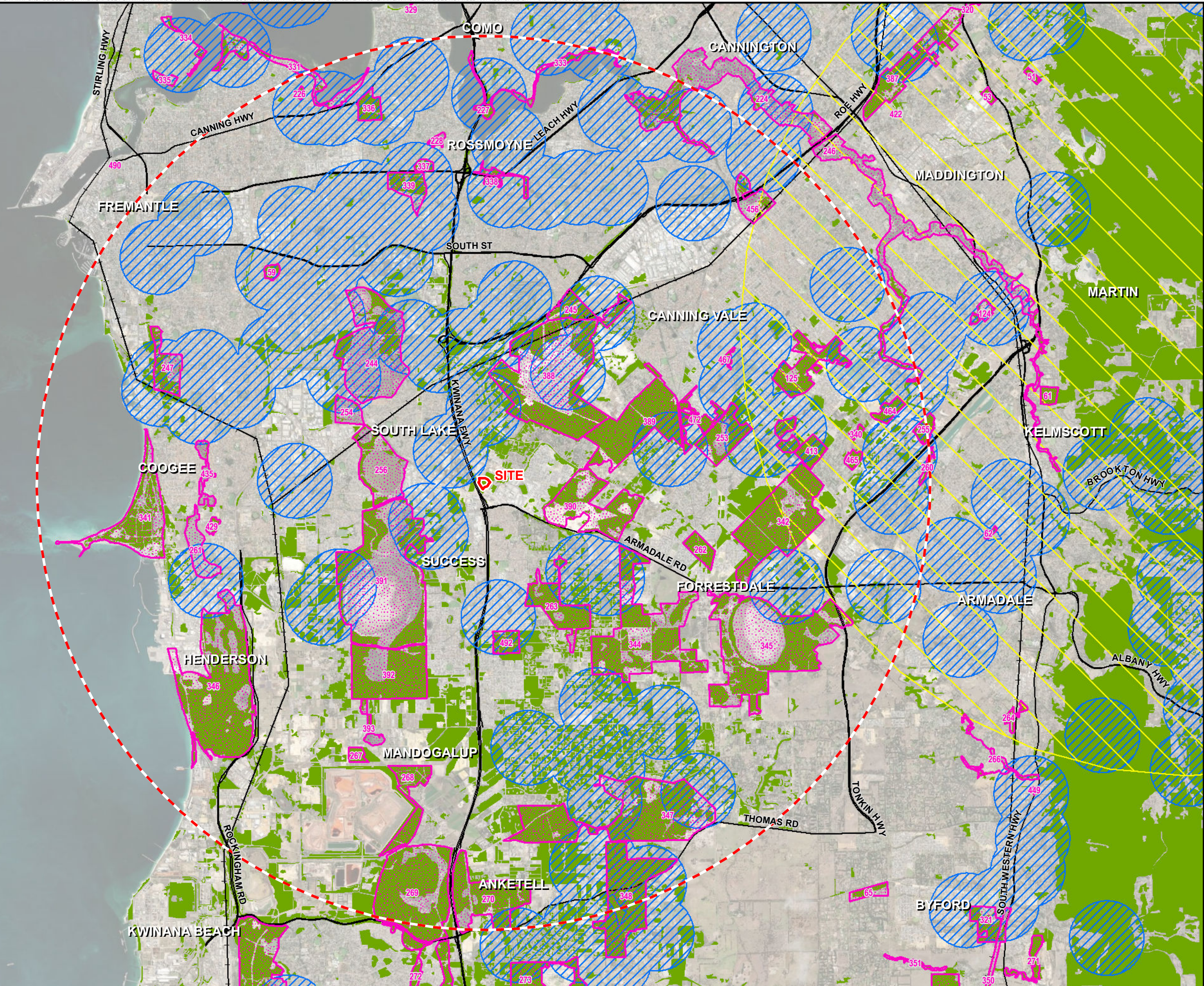


N



0 0.5 1 2 3 4 km

Scale: 1:100,000 @ A3
GDA 1994 MGA Zone 50



ENVIRONMAPS | 0406 590 006
Environmental Mapping Solutions | www.environmaps.com.au

Source: Orthophoto - Open Source
Cockatoo Data - DBCA, 2023
Bush Forever Areas 2000 - DPLH

	<p>Job: ATRJAN01 Doc: 008 Date: 30/01/2023 Ph: (08) 9381 5513 Fax: (08) 9381 5514 E: info@coterra.com.au</p>	<p>PSP Properties Pty Ltd NVCP SUPPORTING INFORMATION PERTH SURF PARK</p> <p>BLACK COCKATOO FORAGING HABITAT</p>	<p>Figure 8</p>
---	--	---	------------------------

Appendix 1 Draft Deposited Plan

Plan Information

Tenure Type	Freehold
Plan Type	Deposited Plan
Plan Purpose	Subdivision

Plan Heading

LOT 9502

Locality and Local Government

Locality	JANDAKOT
Local Government	CITY OF COCKBURN

Examination

Examined	Date
----------	------

Planning Approval

Planning Authority	Exempt from WAPC Approval
Reference	

Delegated under S. 16 P&D Act 2005	Date
------------------------------------	------

In Order For Dealings

Subject To	
------------	--

For Registrar of Titles	Date
-------------------------	------

Plan Approved

Inspector of Plans and Surveys	Date
--------------------------------	------

Survey Details

Compiled From	DP425621 & DP425622
Declared as Special Survey Area	No

Survey Certificate - Regulation 4 Compiled Plan

I, C.J. VAN DER PLAS
 hereby certify that this plan is accurate and is a correct representation of the -
 (a) is a correct and accurate representation of the survey(s) of the subject land ; and
 (b) is in accordance with the relevant law in relation to which it is lodged.

Licensed Surveyor	Date
-------------------	------

Survey Organisation

Name	HARLEY DYKSTRA PTY LTD (BUNBURY)
Address	BUNBURY 6230
Phone	97926000
Email	lodgements@harleydykstra.com.au
Reference	23332

Former Tenure

New Lot / Land	Parent Plan Number	Parent Lot Number	Title Reference	Subject Land Description
9502	DP425621 DP425622	LOT 9500 LOT 9501		

This is a copy of an unregistered plan. This plan was prepared to be registered by the Registrar of Titles following sealing/endorsement by the Local Authority. As alterations beyond the control of the surveyor may be required by the Local Authority or the Registrar of Titles when the original is finally presented for registration, Harley Dykstra Pty Ltd + accepts no liability for any loss or damage whatsoever or howsoever incurred arising out of reliance placed upon this plan by any party for any purpose. The original of this plan remains the property of Harley Dykstra Pty Ltd and copies of such plans made prior to registration must not be reproduced without this note which is an integral part of this plan prior to registration.



Lvl 1, 252 Fitzgerald Street PERTH WA 6000
 15/2 Hensbrook Loop FORRESTDALE WA 6112
 PO BOX 316 KELMSCOTT WA 6991
 T: 08 9495 1947
 W: www.harleydykstra.com.au
 E: Drafting@harleydykstra.com.au

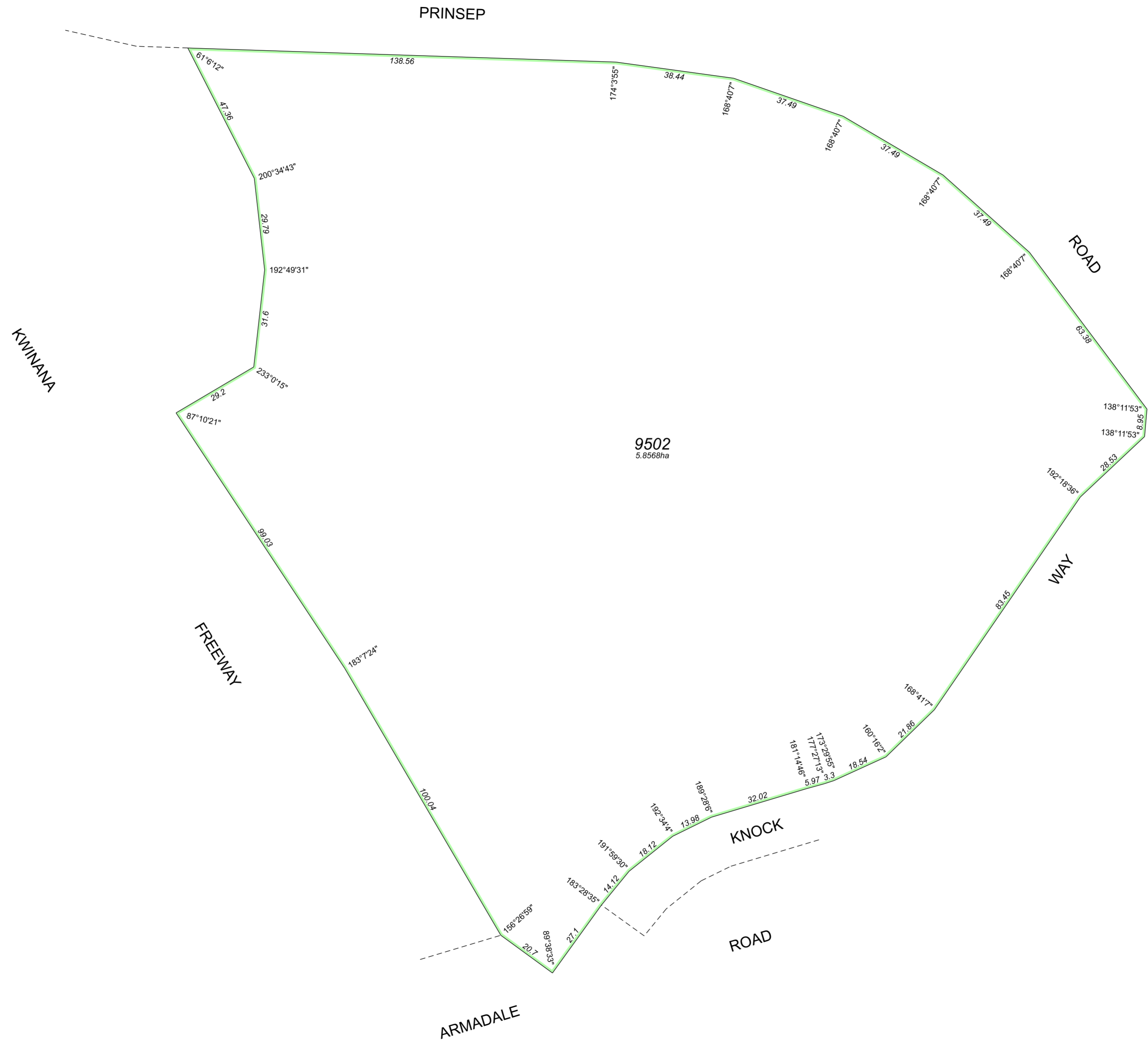
HD Ref
 23332_DP425623_A
 Bdr 06/01/23

ADDITIONAL SHEETS

SHEET SHEETS
 1 OF 2

VERSION NUMBER
 1

DEPOSITED PLAN
425623



9502
5.8568ha



SCALE 1:1000 @ A2
0 10m 20m 30m 40m 50m
ALL DISTANCES ARE IN METRES

This is a copy of an unregistered plan. This plan was prepared to be registered by the Registrar of Titles following sealing/endorsement by the Local Authority. As alterations beyond the control of the surveyor may be required by the Local Authority or the Registrar of Titles when the original is finally presented for registration, Harley Dykstra Pty Ltd accepts no liability for any loss or damage whatsoever or howsoever incurred arising out of reliance placed upon this plan by any party for any purpose. The original of this plan remains the property of Harley Dykstra Pty Ltd and copies of such plans made prior to registration must not be reproduced without this note which is an integral part of this plan prior to registration.

Plan Information

Tenure Type	Freehold
Plan Type	Deposited Plan
Plan Purpose	Subdivision

Plan Heading

LOT 9502

Locality and Local Government

Locality	JANDAKOT
Local Government	CITY OF COCKBURN

Examination

Examined	Date
----------	------

Planning Approval

Planning Authority	Exempt from WAPC Approval
Reference	

Delegated under S. 16 P&D Act 2005	Date
------------------------------------	------

In Order For Dealings

Subject To	
------------	--

For Registrar of Titles	Date
-------------------------	------

Plan Approved

Inspector of Plans and Surveys	Date
--------------------------------	------

Survey Details

Compiled From	DP425621 & DP425622
Declared as Special Survey Area	No

Survey Certificate - Regulation 4 Compiled Plan

I, C.J. VAN DER PLAS
 hereby certify that this plan is accurate and is a correct representation of the -
 (a) is a correct and accurate representation of the survey(s) of the subject land ; and
 (b) is in accordance with the relevant law in relation to which it is lodged.

Licensed Surveyor	Date
-------------------	------

Survey Organisation

Name	HARLEY DYKSTRA PTY LTD (BUNBURY)
Address	BUNBURY 6230
Phone	97926000
Email	lodgements@harleydykstra.com.au
Reference	23332

Former Tenure

New Lot / Land	Parent Plan Number	Parent Lot Number	Title Reference	Subject Land Description
9502	DP425621 DP425622	LOT 9500 LOT 9501		



Lvl 1, 252 Fitzgerald Street PERTH WA 6000
 15/2 Hensbrook Loop FORRESTDALE WA 6112
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 T: 08 9495 1947
 W: www.harleydykstra.com.au
 E: Drafting@harleydykstra.com.au

HD Ref
 23332_DP425623_A
 Bdr 06/01/23

ADDITIONAL SHEETS

SHEET SHEETS

1 OF 2

VERSION NUMBER

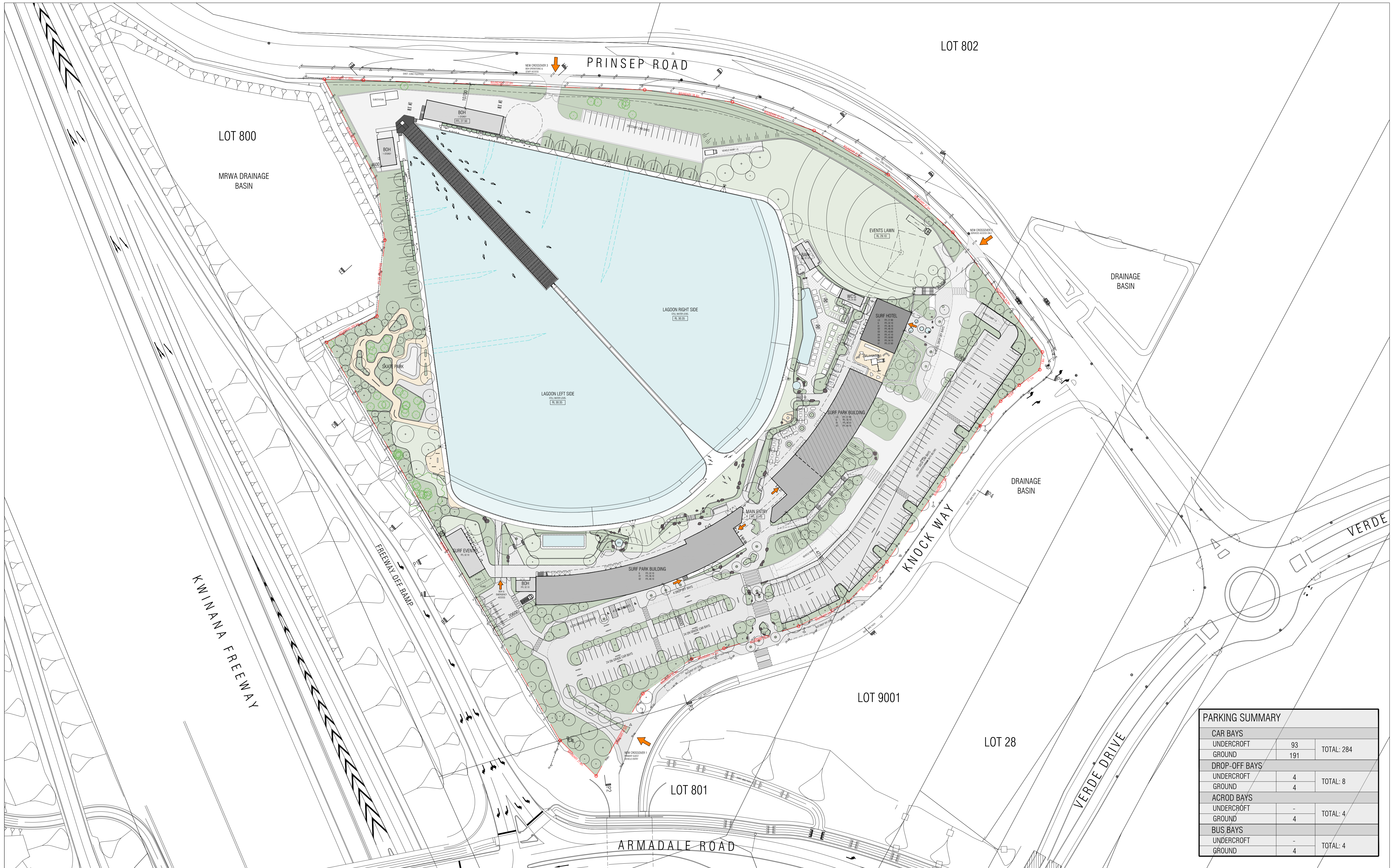
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DEPOSITED PLAN

425623



Appendix 2 Development Plan



PARKING SUMMARY			
CAR BAYS			
UNDERCROFT	93		TOTAL: 284
GROUND	191		
DROP-OFF BAYS			
UNDERCROFT	4		TOTAL: 8
GROUND	4		
ACROD BAYS			
UNDERCROFT	-		TOTAL: 4
GROUND	4		
BUS BAYS			
UNDERCROFT	-		TOTAL: 4
GROUND	4		



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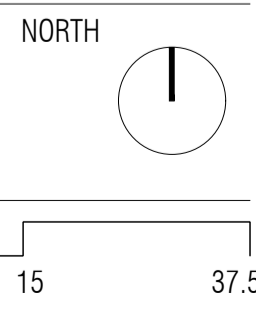
REV.	DATE	AMENDMENT
A	17.08.22	ISSUE FOR CONSULTANTS
B	19.08.22	ISSUE FOR DA

DEVELOPMENT MANAGERS: PLACE DEVELOPMENT
 PLANNING: LATERAL PLANNING
 LANDSCAPE: SEEDSIGN
 CULTURAL: SOFT EARTH
 BUSHFIRE: ECO-LOGICAL
 CIVIL: BG&E
 WASTE: TALIS
 SUSTAINABILITY: CUNDALL
 ACOUSTIC: HERRING STORER
 TRAFFIC: STANTEC
 GEOTECHNICAL: GALT
 ENVIRO & ARCHEOLOGY: GALT

CLIENT
äventuur
 PROJECT
 PERTH SURF PARK

PROJECT ADDRESS
 LOT 800 PRINSEP RD &
 KNOCK WAY, JANDAKOT WA
 PROJECT STATUS
 DEVELOPMENT APPLICATION

PROJECT NUMBER
 21012
 SCALE
 1:750 @ A1 / 1:1500 @ A3



DRAWING
SITE PLAN
 DRAWING NO. DA1.04
 DRAFTER HBW
 CHECKED MM
 REV. B

Appendix 3 EPBC 2022/09267 – Referral Decision Notice (July 2022)



Notification of Referral Decision – not controlled action

Cockburn Surf Park, Lot 800 Prinsep Road, Cockburn, WA (EPBC 2022/09267)

This decision is made under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Proposed action

person proposing to take the action	Aventuur Pty Ltd ABN: 24643061250
--	--------------------------------------

proposed action	To construct and operate a surf sports, recreation and leisure facility on Lot 800 Prinsep Road in the City of Cockburn, approximately 18km south of the Perth Central Business District, Western Australia; as described in the referral received by the department on 20 June 2022 [see EPBC referral 2022/09267]
------------------------	---

Referral decision: Not a controlled action

status of proposed action	The proposed action is not a controlled action.
----------------------------------	---

Person authorised to make decision

name and position	Andrew McNee Assistant Secretary Environment Assessments Queensland and Sea Dumping Branch
--------------------------	--

signature

date of decision	18 July 2022
-------------------------	--------------

Appendix 4 Galt Groundwater Monitoring Memo

TECHNICAL MEMORANDUM



J2101043 003 TM Rev2

09 December 2022

To: David Sorgiovanni

e-mail: david@aventuur.com

Cc: Andrew Ross

Cc email: aross@waveparkgroup.com

From: Brad Palmer

Sender's email: brad.palmer@galtenv.com.au

GROUNDWATER MONITORING PROGRAM PROPOSED PERTH SURF PARK LOT 800 PRINSEP ROAD, JANDAKOT

Dear David,

1. INTRODUCTION

This technical memorandum presents the findings of Galt Environmental Pty Ltd's (Galt's) groundwater monitoring program undertaken for the proposed Perth Surf Park located at Lot 800 Prinsep Road, Jandakot (the site).

The work was undertaken to establish groundwater elevations at the site between May and November 2022. Additionally, selected groundwater samples were analysed to evaluate the suitability of the unconfined aquifer as a water source to fill and maintain water levels in the lagoon.

2. GROUNDWATER MONITORING WELL CONSTRUCTION

Groundwater elevations were recorded at 6 monitoring wells installed across the site. The monitoring wells were installed using a Geoprobe 6620T direct push drill rig supplied and operated by Direct Push Probing.

Each well was constructed using 50 mm, class 18 flush-threaded PVC. The screened interval was installed so that a minimum of 2 m of screen is below the water table. Gravel pack was placed in the annulus around the screened portion of the standpipe with a minimum 0.5 m (thickness) bentonite plug placed above the gravel pack. Each groundwater monitoring well was developed to remove fine sediment from the well and gravel pack.

The locations of the groundwater monitoring wells are shown on Figure 1.

Monitoring well construction logs are presented in Attachment A.

3. SITE-SPECIFIC GROUNDWATER ELEVATIONS

Groundwater elevations were recorded on eight occasions between 6 May 2022 and 8 November 2022. Groundwater elevations recorded during each monitoring event are shown on Table 1 below.

The green shading indicates the maximum groundwater elevation measured at each location during the monitoring program.

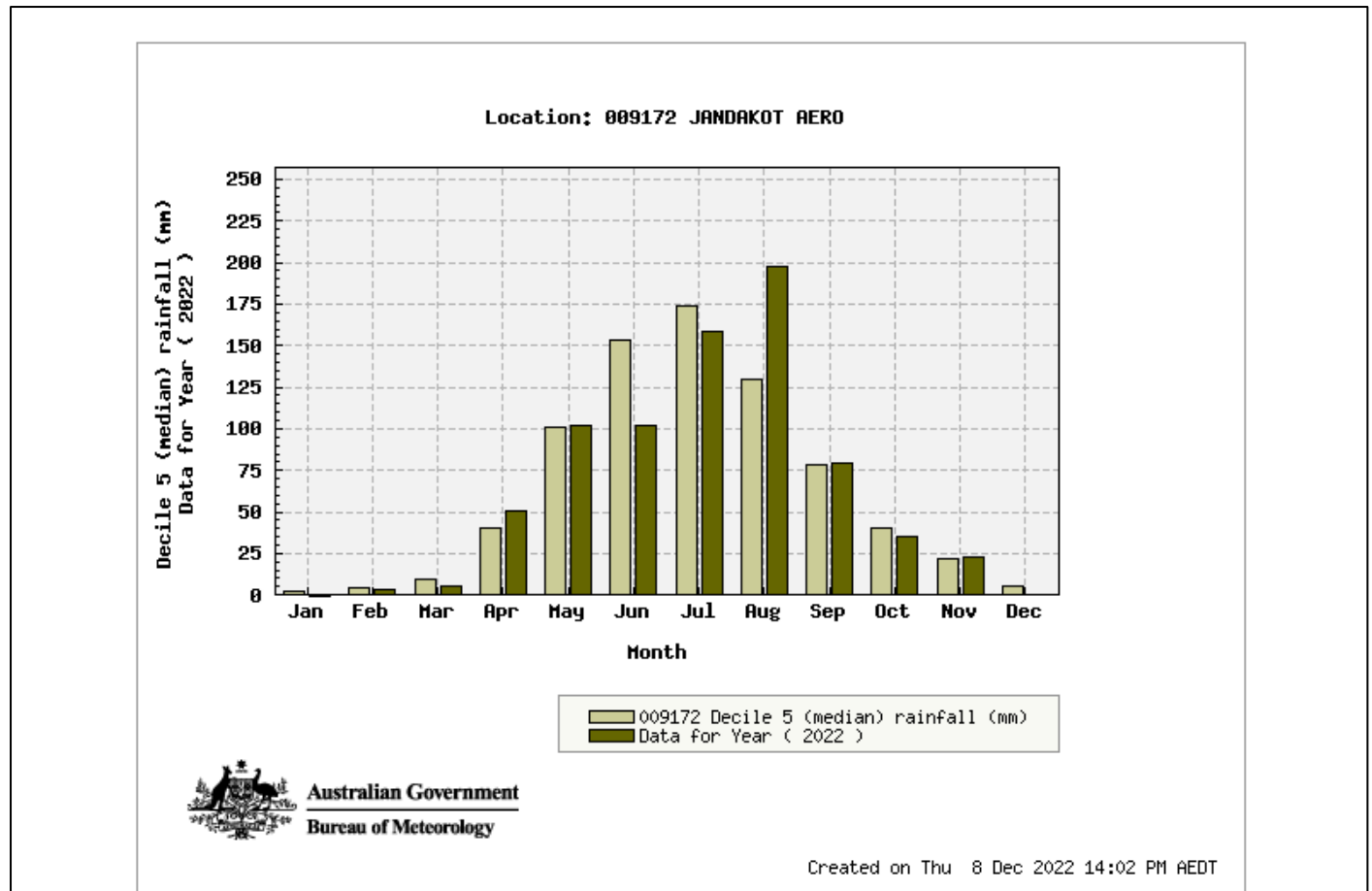
Table 1: Groundwater Elevations

Monitoring Well	Easting	Northing	Surface Elevation (m AHD)	Date of Gauging	Groundwater Depth (m TOC)	Groundwater Depth (m BGL)	Groundwater Elevation (m AHD)
MW01	53920.52	244771.3	25.96	6/05/2022	2.01	1.43	24.53
				11/05/2022	1.87	1.29	24.67
				18/05/2022	1.91	1.33	24.63
				6/07/2022	1.56	0.98	24.98
				23/08/2022	0.69	0.11	25.85
				7/09/2022	0.62	0.04	25.92
				7/10/2022	0.73	0.15	25.81
MW02	53917.07	244665.4	28.91	6/05/2022	4.67	4.04	24.87
				11/05/2022	4.53	3.90	25.01
				18/05/2022	4.45	3.82	25.09
				6/07/2022	4.22	3.59	25.32
				23/08/2022	3.35	2.72	26.19
				7/09/2022	3.34	2.71	26.20
				7/10/2022	3.02	2.39	26.52
MW03	53991.11	244575.2	28.86	6/05/2022	4.59	3.87	24.99
				11/05/2022	4.45	3.73	25.13
				18/05/2022	4.02	3.30	25.56
				6/07/2022	4.15	3.43	25.43
				23/08/2022	3.28	2.56	26.30
				7/09/2022	3.26	2.54	26.32
				7/10/2022	3.2	2.48	26.38
MW04	54028.71	244686.5	27.22	6/05/2022	2.8	2.44	24.78
				11/05/2022	2.8	2.44	24.78
				18/05/2022	1.9	1.54	25.68
				6/07/2022	2.36	2.00	25.22
				23/08/2022	1.62	1.26	25.96
				7/09/2022	1.58	1.23	25.99
				7/10/2022	1.89	1.53	25.69
MW05	54071.3	244756.3	26.16	6/05/2022	1.86	1.21	24.95
				11/05/2022	1.86	1.21	24.95
				18/05/2022	14.9	14.25	11.91
				6/07/2022	1.53	0.88	25.28
				23/08/2022	0.64	-0.01	26.17
				7/09/2022	0.63	-0.02	26.18
				7/10/2022	0.69	0.04	26.12
MW06	54138.82	244673.4	26.85	6/05/2022	2.37	1.86	24.99
				11/05/2022	2.37	1.86	24.99
				18/05/2022	2.35	1.84	25.01
				6/07/2022	2.04	1.53	25.32
				23/08/2022	1.165	0.66	26.20
				7/09/2022	1.13	0.62	26.23
				7/10/2022	0.89	0.38	26.47
				8/11/2022	1.34	0.83	26.02

The maximum groundwater elevation recorded at the site during the monitoring period was RL 26.52 m AHD.

4. RAINFALL

Rainfall data provided by the Bureau of Meteorology (BoM) for Jandakot Airport, indicates that rainfall for August 2022 was well above the 30-year median value. Rainfall in September and October 2022 was broadly similar to the median values.

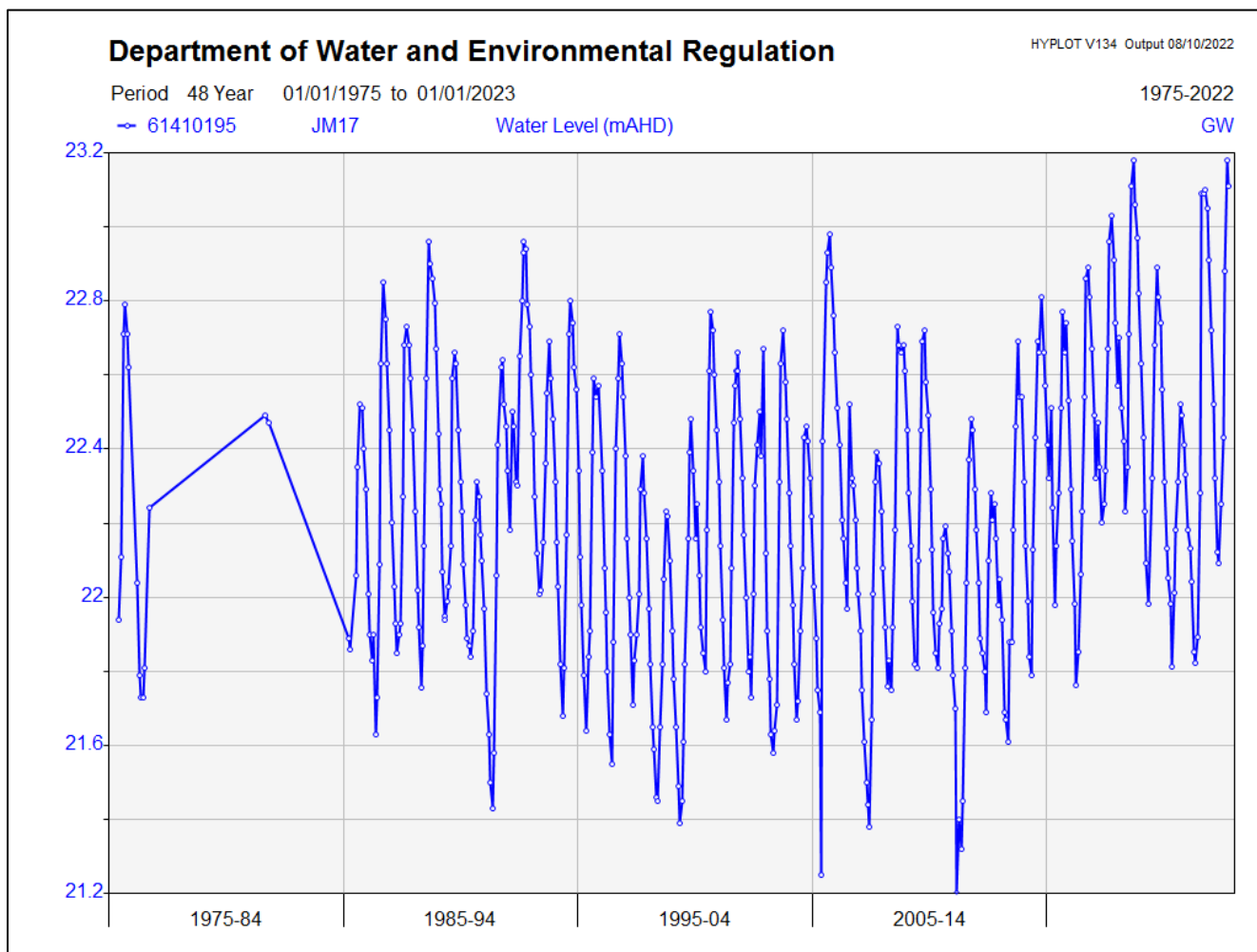


Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Decile 5 (median) monthly rainfall (mm) for years 1972 to 2022	1.9	4.0	9.0	40.0	101.2	153.2	173.7	130.0	78.4	40.1	21.8	5.7	816.8	48
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Monthly rainfall (mm) for year 2022	0.0	2.8	5.6	50.4	101.8	102.4	159.0	197.6	79.0	35.6	22.8			

5. LONG-TERM GROUNDWATER ELEVATIONS

Long-term groundwater elevation data for monitoring bore ID: 61410195 was obtained from Department of Water and Environmental Regulation (DWER). The DWER bore is located approximately 1 km to the west of the site. Records date back to 1975. We note that the records are likely to be somewhat unreliable between 1975 until about 1985. After 1985, groundwater levels appear to have been measured at least annually.

The groundwater elevations as recorded at DWER bore ID: 61410195 are shown in Inline Image 1 below.



Inline Image 1: Long-term groundwater elevations as measured at DWER bore ID: 61410195

The DWER bore has a 47-year record, from which we estimate the average annual maximum groundwater level (AAMGL) to be about RL 22.6 m AHD however we note that there is an upward trend in the dataset. This may be due to alteration of the local aquifer as a result of road and drainage infrastructure upgrades in the vicinity of the bore. The maximum groundwater elevation ever recorded at the bore was in October 2022 with the elevation being RL 23.18 m AHD. We note that the 2022 elevation is 0.58 m above the AAMGL which is consistent with August to October 2022 receiving above average rainfall. However, we note that there appears to be an upward trend in the groundwater elevations in this area over the last 15 years.

Based on the information above, we consider the highest groundwater elevation of RL 26.52 m AHD recorded during the monitoring period (6 May to 8 November 2022) is a plausible estimate for the maximum groundwater level at the site. A hydrogeologist should review data and provide a design groundwater elevation, taking into account the trends and changes to the local groundwater regime.

Note: Galt takes no responsibility for any design decisions based on these values as they are an estimation only based on site-specific measurements and inferences based on long-term climatic trends. We recommend that a suitable safety factor is applied when determining the design groundwater elevations for the site.

6. GROUNDWATER QUALITY

6.1 Groundwater Sampling

Groundwater samples were collected from 3 monitoring wells on 11 November 2022. Samples were collected from in accordance with the following Australian Standards:

- AS 5667.1:1998 *Water Quality Sampling. Part I – Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples*;
- AS 5667.11:1998 *Water Quality Sampling. Part II – Guidance on the Sampling of Groundwater*

Groundwater samples were recovered utilising low-flow methods. The pump was set at the centre of the screened interval and drawdown measured concurrently whilst pumping to ensure the pump flow rates were less than the recharge capacity of the well. An initial flow rate in the order of 0.1 – 0.5 L/min was used and adjusted as appropriate to ensure negligible drawdown during pumping. We note that while drawdown was not recorded on groundwater monitoring logs, an electronic water dipper was used to determine the water depth at each well during monitoring/sampling. We further note that the hydraulic conductivity of the sand encountered in the superficial aquifer is relatively high. Based on our experience with sites with similar geology, groundwater recharge during low flow pumping is generally quite high and, as such, minimal to no groundwater drawdown is often noted.

Measurements of groundwater field parameters, including temperature, pH, electrical conductivity, redox potential and dissolved oxygen, were logged every three to five minutes using appropriately calibrated equipment until stabilisation occurred (stabilisation is considered to be achieved when there is less than 10% variation in physiochemical parameters between three successive readings). Groundwater field parameters were automatically logged using YSI software. The output spreadsheet also records physical observations such as colour and turbidity of the purged water, any indications of the presence of contamination, including odour and sheen, the presence of any foreign material or objects, any QA/QC sampling and the unique sample identifier.

6.2 Laboratory Analysis

Samples were analysed by Eurofins NATA accredited laboratory for a range of parameters as requested by the client. Groundwater test results are summarised in Attachment B. Laboratory certificates of analysis are presented in Attachment C.

6.3 Assessment Criteria

Groundwater results were compared to criteria outlined in the following documents:

- Department of Health (DoH) (2014) *Contaminated Sites Ground and Surface Water Chemical Screening Guidelines*; and
- Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Specifically, groundwater results were assessed against the following:

- Recreational water quality and aesthetics (RWQA); and
- Non-potable use of groundwater (NPUG).

These assessment criteria are considered appropriate for the project given beneficial use of the groundwater is for filling and maintenance of water levels in the surf lagoon.

6.4 Results

The laboratory testing indicates that the concentrations of all parameters were either below the laboratory limit of reporting (LOR) and/or conformed to the adopted assessment criteria. As such, we consider that groundwater at the site is suitable for the proposed use. We note that some level of treatment (i.e. chlorination or similar) will likely be required to comply with DoH guidelines for swimming water.

7. LIMITATIONS

We draw your attention to Attachment D of this report, "Understanding Your Report". The information provided within is intended to inform you as to what your realistic expectations of this report should be. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

Yours Faithfully,

GALT ENVIRONMENTAL PTY LTD



Brad Palmer

Environmental Scientist

Attachments: Figure 1: Site and Location Plan
 A – Groundwater Monitoring Well Construction Logs
 B – Groundwater Quality Test Results
 C – Laboratory Certificates of Analysis
 D – Understanding Your Report

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ATTACHMENT A

Groundwater Monitoring Well Construction Logs

METHOD OF SOIL DESCRIPTION BOREHOLE AND TEST PIT REPORTS



GRAPHIC LOG & SOIL CLASSIFICATION SYMBOLS

Graphic	USCS	Soil Name
		FILL (various types)
		COBBLES / BOULDERS
	GP	GRAVEL (poorly graded)
	GW	GRAVEL (well graded)
	GC	Clayey GRAVEL
	GM	Silty GRAVEL
	SP	SAND (poorly graded)
	SW	SAND (well graded)
	SC	Clayey SAND

Graphic	USCS	Soil Name
	SM	Silty SAND
	ML	SILT (low liquid limit)
	MH	SILT (high liquid limit)
	CL	CLAY (low plasticity)
	CI	CLAY (medium plasticity)
	CH	CLAY (high plasticity)
	OL	Organic SILT (low liquid limit)
	OH	Organic SILT (high liquid limit)
	Pt	PEAT

NOTE: Dual classification given for soils with a fines content between 5% and 12%.

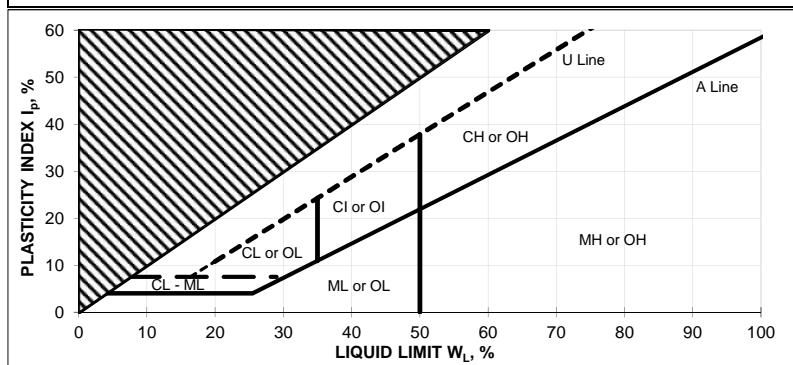
SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-2017. Material properties are assessed in the field by visual/tactile methods in combination with field and laboratory testing techniques (where used).

NOTE: AS 1726-2017 defines a fine grained soil where the total dry mass of fine fractions (<0.075 mm particle size) exceeds 35%.

PARTICLE SIZE		
Soil Name	Particle Size (mm)	
BOULDERS	>200	
COBBLES	63 to 200	
GRAVEL	Coarse	19 to 63
	Medium	6.7 to 19
	Fine	2.3 to 6.7
SAND	Coarse	0.6 to 2.36
	Medium	0.21 to 0.6
	Fine	0.075 to 0.21
FINES	SILT	0.002 to 0.075
	CLAY	<0.002

PLASTICITY - MODIFIED CASAGRANDE CHART - AS1726-2017



RESISTANCE TO EXCAVATION		
Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

MOISTURE CONDITION	
Symbol	Term
D	Dry
M	Moist
W	Wet

CEMENTATION	
Cementation	Description
Weakly cemented	Soil may be easily disaggregated by hand in air or water
Moderately cemented	Effort is required to disaggregate the soil by hand in air or water

CONSISTENCY		
Symbol	Term	Undrained Shear Strength (kPa)
VS	Very Soft	0 to 12
S	Soft	12 to 25
F	Firm	25 to 50
St	Stiff	50 to 100
VSt	Very Stiff	100 to 200
H	Hard	>200

ORGANIC SOILS	
Material	Organic Content % of dry mass
Inorganic soil	<2%
Organic soil	2% to 25%
Peat	>25%

DENSITY		
Symbol	Term	Density Index (%)
VL	Very Loose	<15
L	Loose	15 to 35
MD	Medium Dense	35 to 65
D	Dense	65 to 85
VD	Very Dense	>85

EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS



METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HMLC	HMLC Core Barrel	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

SUPPORT

T Timbering

PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

WATER

▶	Water Inflow	▼	Water Level
◀	Water Loss (complete)		
◁	Water Loss (partial)		

SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

ROCK CORE RECOVERY

$$TCR = \text{Total Core Recovery (\%)} = \frac{CRL}{TCL} \times 100$$

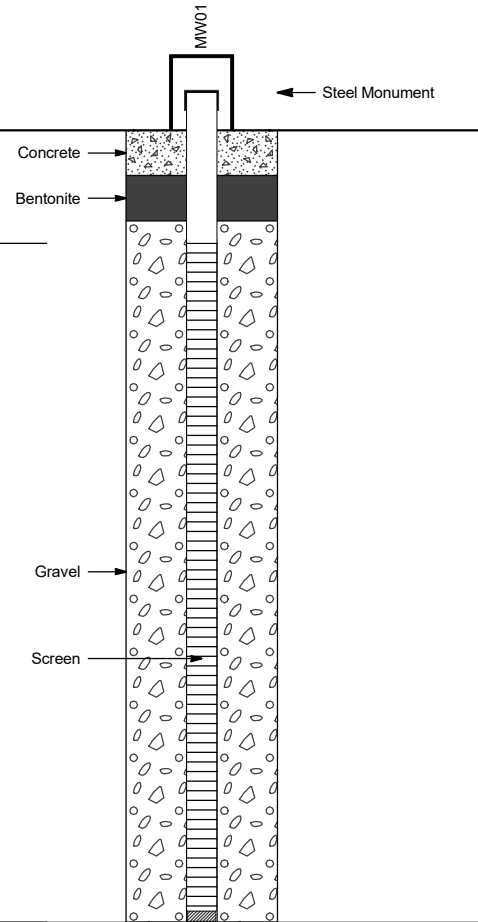
$$RQD = \text{Rock Quality Designation (\%)} = \frac{ALC > 100}{TCL} \times 100$$

TCL Length of Core Run

CRL Length of Core Recovered

ALC>100 Total Length of Axial Lengths of Core Greater than 100 mm Long


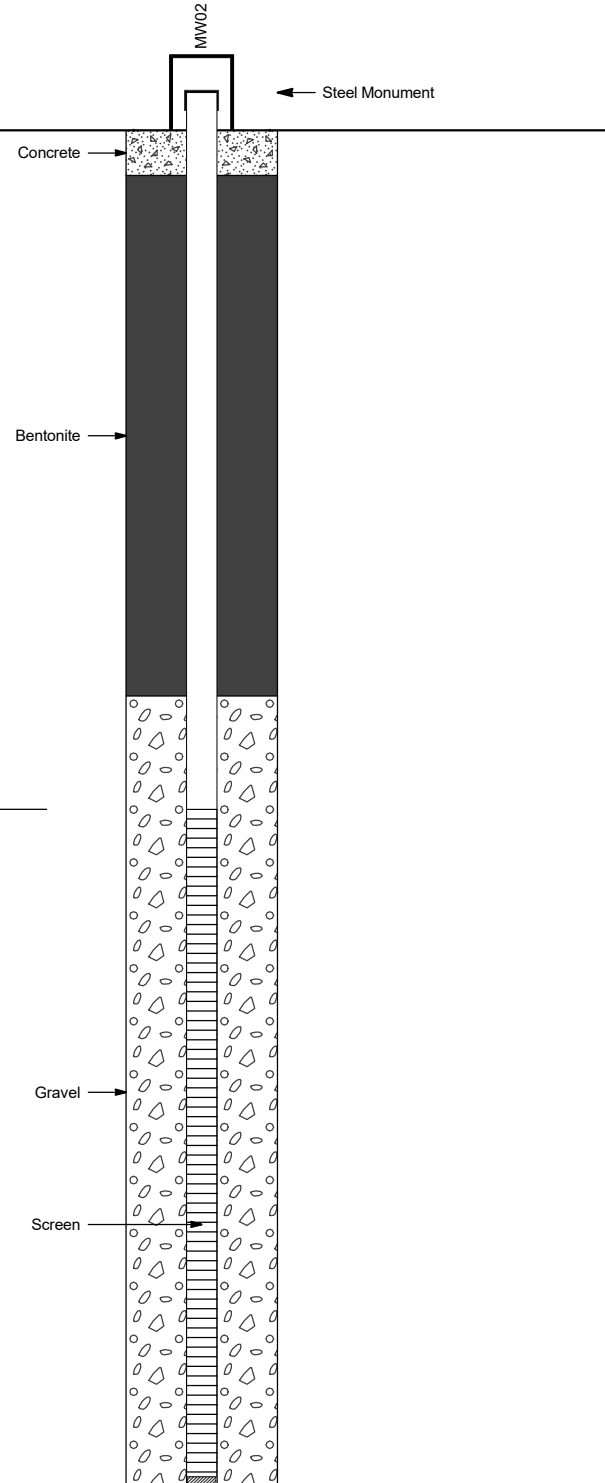






Job Number: J2101043	Easting: 53920.52 m	Contractor: DPP	Date: 28/04/2022
Client: Aventuur Inc	Northing: 244771.27 m	Drill Rig: Geoprobe 6620	Logged: MC
Project: Proposed Perth Surf Park	Datum: PCG94	Inclination: -90°	Checked Date: 05/05/2022
Location: Lot 800 Prinsep Road, Jandakot	Surface RL: 25.962 m AHD		Checked By: BP

Method	Ground Water	Depth (m)	Elevation (m AHD)	Graphic Log	Soil / Rock Description	WELL INSTALLATION DETAILS	
						ID: MW01 Type: Standpipe Installation Date: 28/04/2022	Stick Up & RL: 0.61 m 26.57 m AHD Tip Depth & RL: 3.50 m 22.46 m AHD Static Water Level: NA
		0	26		TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, dark brown, with organics, trace fines		
		1	25		SAND: fine to medium grained, sub-angular to sub-rounded, grey-brown, trace fines		
		2	24		Fine to coarse grained, pale brown to brown, trace rootlets		
		3	23		Pale grey to pale brown		
		4	22		Brown to dark brown, weakly to moderately cemented, trace to with fines	3.50 m	
		5	21				
		6	20				
Hole terminated at 3.50 m Target depth Groundwater encountered at 1.2 m							

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Comments: See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

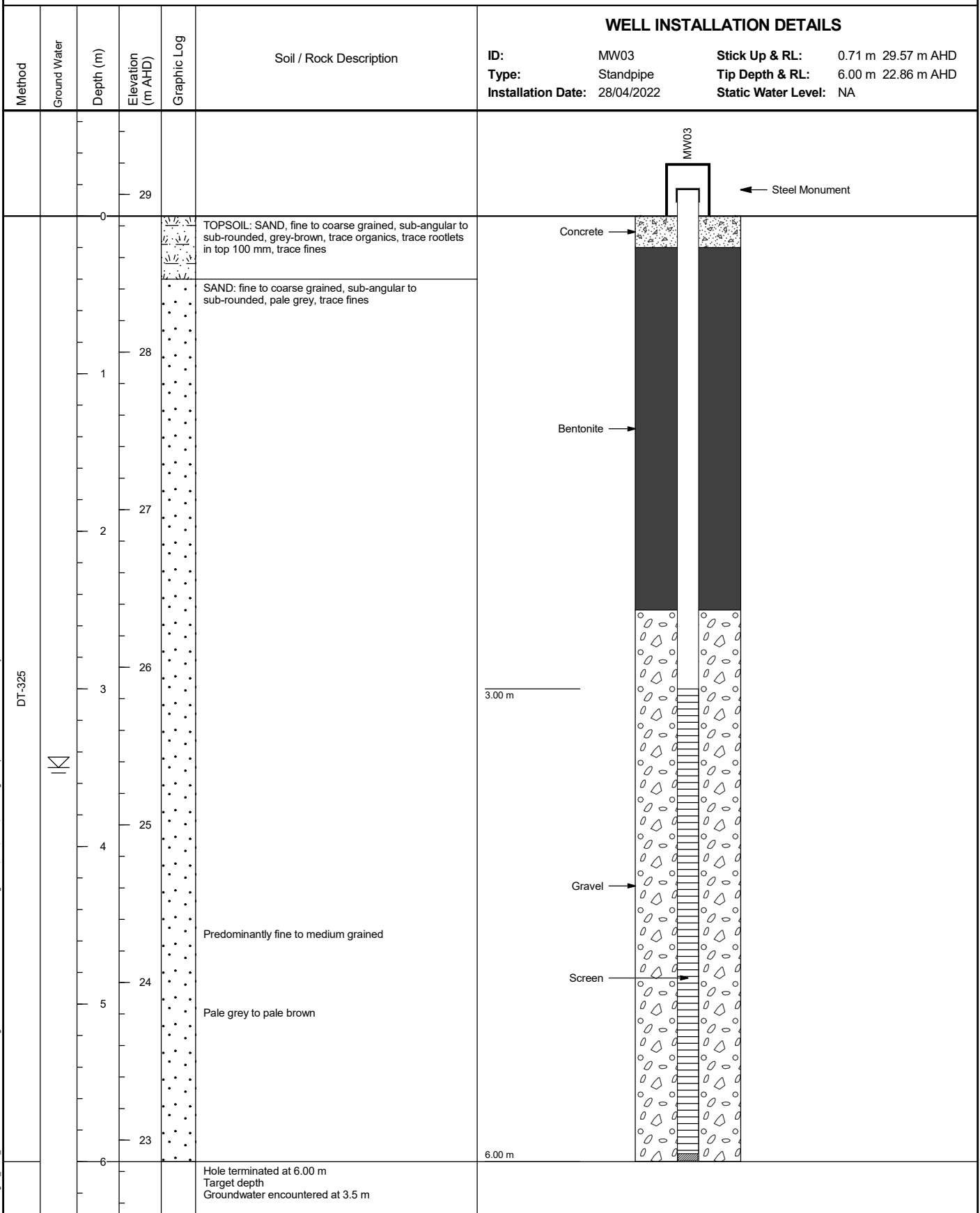
Job Number: J2101043	Easting: 53917.07 m	Contractor: DPP	Date: 28/04/2022
Client: Aventuur Inc	Northing: 244665.38 m	Drill Rig: Geoprobe 6620	Logged: MC
Project: Proposed Perth Surf Park	Datum: PCG94	Inclination: -90°	Checked Date: 05/05/2022
Location: Lot 800 Prinsep Road, Jandakot	Surface RL: 28.914 m AHD		Checked By: BP

Method	Ground Water	Depth (m)	Elevation (m AHD)	Graphic Log	Soil / Rock Description	WELL INSTALLATION DETAILS
			29			ID: MW02 Stick Up & RL: 0.65 m 29.56 m AHD Type: Standpipe Tip Depth & RL: 6.00 m 22.91 m AHD Installation Date: 28/04/2022 Static Water Level: NA
		0			TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, grey-brown, trace organics, trace rootlets in top 100 mm, trace fines	
		1			SAND: fine to medium grained, sub-angular to sub-rounded, pale grey to pale brown, trace fines	
		2			Fine to coarse grained, pale grey	
		3			Brown	
		4			Pale grey	
		5			Pale grey	
		6			Hole terminated at 6.00 m Target depth Groundwater encountered at 3.5 m	6.00 m

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Comments: See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

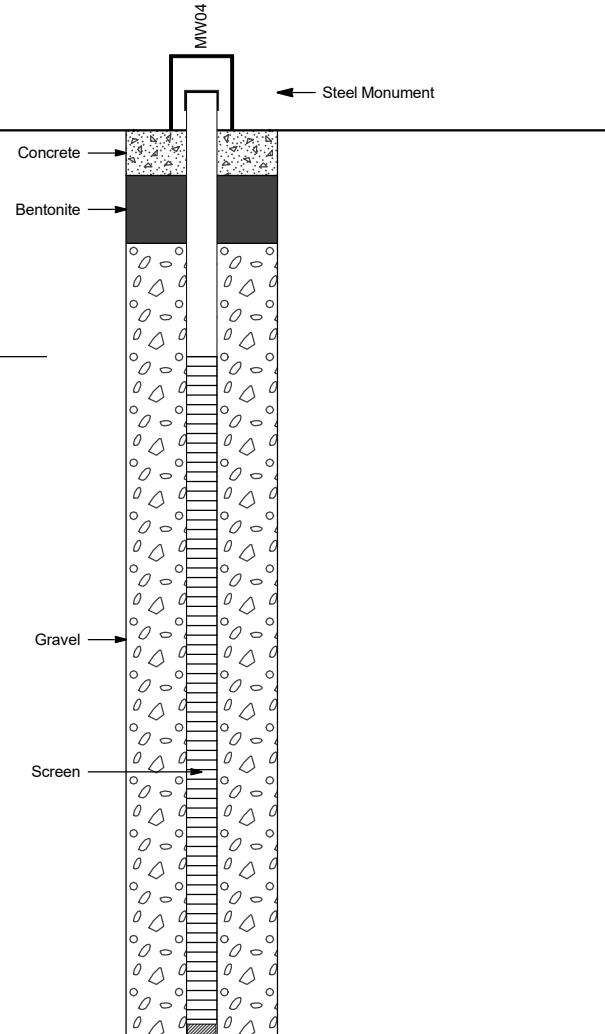
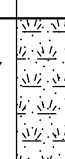


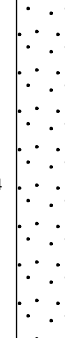
Job Number: J2101043	Easting: 53991.11 m	Contractor: DPP	Date: 28/04/2022
Client: Aventuur Inc	Northing: 244575.22 m	Drill Rig: Geoprobe 6620	Logged: MC
Project: Proposed Perth Surf Park	Datum: PCG94	Inclination: -90°	Checked Date: 05/05/2022
Location: Lot 800 Prinsep Road, Jandakot	Surface RL: 28.863 m AHD		Checked By: BP



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Comments: See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

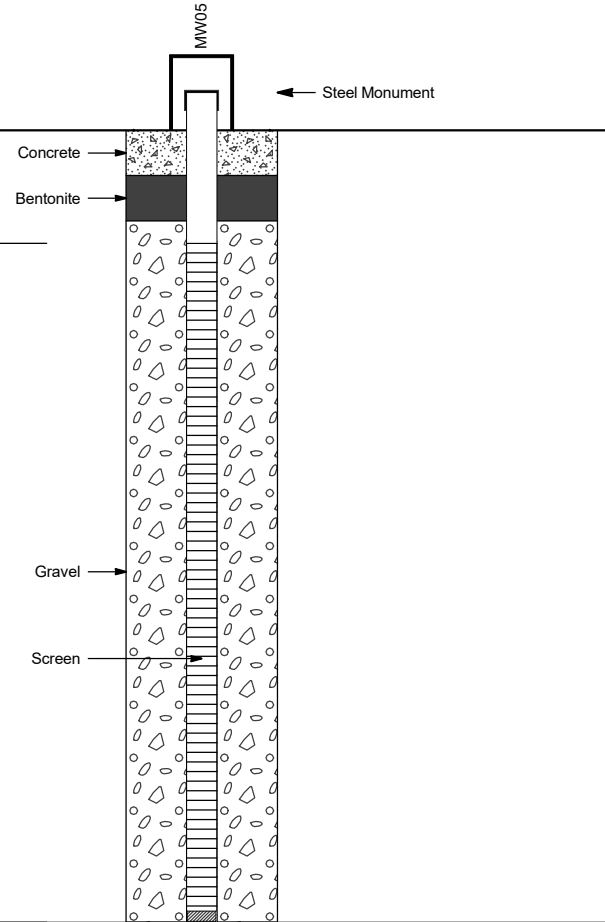
Job Number: J2101043	Easting: 54028.71 m	Contractor: DPP	Date: 28/04/2022
Client: Aventuur Inc	Northing: 244686.48 m	Drill Rig: Geoprobe 6620	Logged: MC
Project: Proposed Perth Surf Park	Datum: PCG94	Inclination: -90°	Checked Date: 05/05/2022
Location: Lot 800 Prinsep Road, Jandakot	Surface RL: 27.216 m AHD		Checked By: BP

Method	Ground Water	Depth (m)	Elevation (m AHD)	Graphic Log	Soil / Rock Description	WELL INSTALLATION DETAILS	
						ID: MW04 Type: Standpipe Installation Date: 28/04/2022	Stick Up & RL: 0.63 m 27.85 m AHD Tip Depth & RL: 4.00 m 23.22 m AHD Static Water Level: NA
		0				 <p>The diagram shows a cross-section of the well MW04. At the surface, there is a 'Steel Monument' with a cap labeled 'MW04'. Below the surface, the well casing consists of several layers: a top layer of 'Concrete', followed by a 'Bentonite' seal. The well is filled with 'Gravel' and has a 'Screen' at the bottom. A scale bar indicates 1.00 m. The hole is shown terminating at 4.00 m depth.</p>	
		0	27		TOPSOIL: SAND, fine to coarse grained, sub-angular to sub-rounded, brown to dark brown, with organics, trace fines		
		1	26		SAND: fine to medium grained, sub-angular to sub-rounded, grey to pale brown, trace to with organics, trace fines		
		2	25		As above, no organics Brown, trace rootlets		
		3	24		Pale grey to grey		
		4	23		Hole terminated at 4.00 m Target depth Groundwater encountered at 2 m		
		5	22				
		6	21				

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Comments: See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions



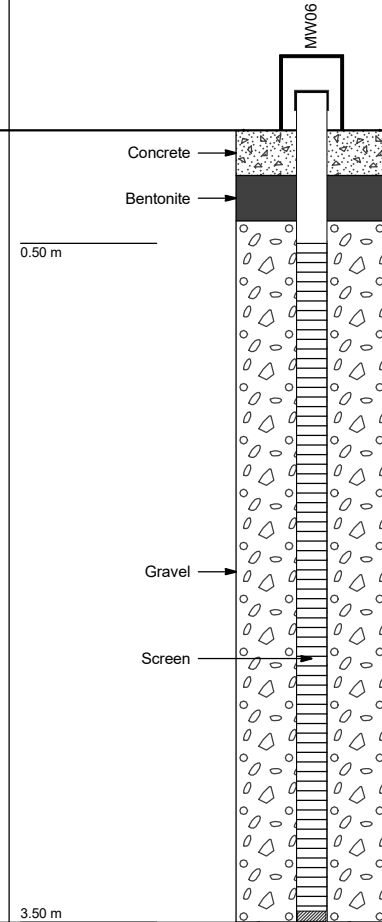



Job Number: J2101043	Easting: 54071.3 m	Contractor: DPP	Date: 28/04/2022
Client: Aventuur Inc	Northing: 244756.31 m	Drill Rig: Geoprobe 6620	Logged: MC
Project: Proposed Perth Surf Park	Datum: PCG94	Inclination: -90°	Checked Date: 05/05/2022
Location: Lot 800 Prinsep Road, Jandakot	Surface RL: 26.155 m AHD		Checked By: BP

Method	Ground Water	Depth (m)	Elevation (m AHD)	Graphic Log	Soil / Rock Description	WELL INSTALLATION DETAILS
						ID: MW05 Stick Up & RL: 0.63 m 26.79 m AHD Type: Standpipe Tip Depth & RL: 3.50 m 22.66 m AHD Installation Date: 28/04/2022 Static Water Level: NA
		0				
			26	TOPSOIL	TOPSOIL: SAND, fine to coarse grained, sub-angular to sub-rounded, dark brown to black, with organics	
				SAND	SAND: fine to medium grained, sub-angular to sub-rounded, pale grey to grey, trace fines, trace rootlets	
		1	25		Brown to dark brown, possibly very weakly cemented, trace rootlets, trace to with fines	
		2	24		Grey-brown Pale grey	
		3	23		Brown to dark brown, weakly to moderately cemented	
					Very weakly to weakly cemented	3.50 m
		4	22		Hole terminated at 3.50 m Target depth Groundwater encountered at 1.2 m	
		5	21			
		6	20			

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Comments: See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2101043	Easting: 54138.82 m	Contractor: DPP	Date: 28/04/2022
Client: Aventuur Inc	Northing: 244673.44 m	Drill Rig: Geoprobe 6620	Logged: MC
Project: Proposed Perth Surf Park	Datum: PCG94	Inclination: -90°	Checked Date: 05/05/2022
Location: Lot 800 Prinsep Road, Jandakot	Surface RL: 26.854 m AHD		Checked By: BP

Method	Ground Water	Depth (m)	Elevation (m AHD)	Graphic Log	Soil / Rock Description	WELL INSTALLATION DETAILS
			27			ID: MW06 Stick Up & RL: 0.51 m 27.36 m AHD Type: Standpipe Tip Depth & RL: 3.50 m 23.35 m AHD Installation Date: 28/04/2022 Static Water Level: NA
DT-325		0	27		SAND: fine to medium grained, sub-angular to sub-rounded, pale grey to grey, trace organics and rootlets in top 100 mm, trace fines	
		1	26		Grey-brown	
		2	25		Pale grey	
		3	24			
		4	23		Hole terminated at 3.50 m Target depth Groundwater encountered at 1.6 m	
		5	22			
		6	21			

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Comments: See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions



ATTACHMENT B

Groundwater Test Results

	Unit	EQL	Non-potable use of groundwater	ANZECC 2000 Recreational water quality and aesthetics	Field ID	MW03	MW04	MW06
					Date	11 Nov 2022	11 Nov 2022	11 Nov 2022
Biological								
Heterotrophic Plate Count (37°C)	CFU/ML					860	560	12,000
Total Coliforms	cfu/100mL	1				>2,400	150	>2,400
E. Coli	cfu/100 ml	1	0			<1	<1	<1
Inorganics								
Cyanide Total	mg/L	0.005	0.8	0.1		<0.005	<0.005	0.023
Electrical Conductivity (Lab)	µS/cm	10				1,000	800	1,200
Fluoride	mg/L	0.1	15			1.5	1.4	1.1
Nitrate (as N)	mg/L	0.01	113	10		<0.01	<0.01	3.7
Nitrite (as N)	mg/L	0.01	9.135	1		<0.01	0.02	0.39
Total Dissolved Solids (Lab)	mg/L	5		1,000		770	910	890
Hardness as CaCO3	mg/L	5		500		22	110	480
Metals filtered								
Arsenic	mg/L	0.001	0.1	0.05		<0.01	0.001	0.002
Cadmium	mg/L	0.0001	0.02	0.005		<0.002	<0.0001	<0.0001
Calcium	mg/L	0.5				6.7	8.8	160
Chromium (III+VI)	mg/L	0.001		0.05		<0.01	0.002	0.002
Copper	mg/L	0.001	20	1		<0.01	0.001	0.035
Lead	mg/L	0.001	0.1	0.05		<0.01	0.001	0.002
Magnesium	mg/L	0.5				1.4	21	20
Mercury	mg/L	0.0001	0.01	0.001		<0.001	<0.0001	<0.0001
Nickel	mg/L	0.001	0.2	0.1		<0.01	0.004	0.002
Zinc	mg/L	0.005		5		<0.05	0.007	0.057

Environmental Standards

Department of Health, 2014, Non-potable use of groundwater

DoE, 2000, ANZECC 2000 Recreational water quality and aesthetics



ATTACHMENT C

Laboratory Certificates of Analysis

Galt Environment P/L
50 Edward Street
Osborne Park
WA 6017



NATA Accredited
Accreditation Number 2377
Site Number 2370

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition
Arrangement for the mutual recognition of the
equivalence of testing, medical testing, calibration,
inspection, proficiency testing scheme providers and
reference materials producers reports and certificates.

Attention: Sarah Carter

Report 940247-W
Project name COCKBURN
Project ID J2101043
Received Date Nov 11, 2022

Client Sample ID			MW03	MW06	MW04	QC01
Sample Matrix			Water	Water	Water	Water
Eurofins Sample No.			L22- No0027971	L22- No0027972	L22- No0027973	L22- No0027974
Date Sampled			Nov 11, 2022	Nov 11, 2022	Nov 11, 2022	Nov 11, 2022
Test/Reference	LOR	Unit				
Conductivity	10	uS/cm	1000	1200	800	1200
Cyanide - Total	0.005	mg/L	< 0.005	0.023	< 0.005	0.020
Fluoride	0.1	mg/L	1.5	1.1	1.4	1.0
Nitrate-N	0.01	mg/L	< 0.01	3.7	< 0.01	3.5
Nitrite-N	0.01	mg/L	< 0.01	0.39	0.02	0.45
pH	0.1	pH Units	6.7	7.5	4.5	7.5
Total Dissolved Solids	5	mg/L	770	890	910	930
Calcium	0.5	mg/L	6.7	160	8.8	160
Hardness mg equivalent CaCO3/L	5	mg/L	22	480	110	480
Heavy Metals						
Magnesium	0.5	mg/L	1.4	20	21	20
Heavy Metals						
Arsenic	0.001	mg/L	< 0.01	0.002	0.001	0.002
Cadmium	0.0001	mg/L	< 0.002	< 0.0001	< 0.0001	< 0.0001
Chromium	0.001	mg/L	< 0.01	0.002	0.002	< 0.001
Copper	0.001	mg/L	< 0.01	0.035	0.001	0.005
Lead	0.001	mg/L	< 0.01	0.002	0.001	< 0.001
Mercury	0.0001	mg/L	< 0.001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	mg/L	< 0.01	0.002	0.004	0.001
Zinc	0.005	mg/L	< 0.05	0.057	0.007	0.015
Microbiology						
Heterotrophic Plate Count 37°C ^{N19}	1	CFU/mL	860	12000	560	2100
Total Coliforms ^{N19}	1	CFU/100mL	> 2400	> 2400	150	520
E. Coli ^{N19}	1	CFU/100mL	< 1	< 1	< 1	< 1

Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Conductivity - Method: ARL019 - Conductivity and Salinity in Water	Welshpool	Nov 11, 2022	28 Days
Total Dissolved Solids - Method: ARL No. 017 - Total Dissolved Solids	Welshpool	Nov 11, 2022	7 Days
Cyanide - Total - Method: ARL No. 317 - Total Cyanide by Microdistillation	Welshpool	Nov 16, 2022	14 Day
Fluoride - Method: ARL321 - Fluoride in Water by Discrete Analyser	Welshpool	Nov 16, 2022	28 Days
Nitrate-N - Method: ARL313/319 - NOx in Water by Discrete Analyser	Welshpool	Nov 11, 2022	28 Days
Nitrite-N - Method: ARL311 - Nitrite in Water by Discrete Analyser	Welshpool	Nov 11, 2022	2 Days
pH - Method: ARL014 - pH in Water	Welshpool	Nov 11, 2022	1 Day
Metals M8 - Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS	Welshpool	Nov 11, 2022	28 Days
Calcium - Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS	Welshpool	Nov 16, 2022	6 Months
Hardness mg equivalent CaCO3/L - Method: APHA 2340B Hardness by Calculation	Welshpool	Nov 16, 2022	28 Months
Heavy Metals - Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS	Welshpool	Nov 16, 2022	28 Days

Company Name: Galt Environment P/L
Address: 50 Edward Street
 Osborne Park
 WA 6017

Project Name: COCKBURN
Project ID: J2101043

Order No.:
Report #: 940247
Phone: 08 6272 0200
Fax: 08 9285 8444

Received: Nov 11, 2022 10:45 AM
Due: Nov 18, 2022
Priority: 5 Day
Contact Name: Sarah Carter

Eurofins Analytical Services Manager : Andrew Harvey

Sample Detail						Cyanide - Total	E-Coil	Fluoride	Heterotrophic Plate Count 37°C	Nitrate-N	Nitrite-N	pH	Total Organic Carbon	Metals M8	Hardness Set	Nutrients in water	Total Dissolved Solids (TDS)
Perth Laboratory - NATA # 2377 Site # 2370						X		X		X	X	X		X	X	X	X
Melbourne Laboratory - NATA # 1261 Site # 1254														X	X		
External Laboratory							X		X				X				
No	Sample ID	Sample Date	Sampling Time	Matrix	LAB ID												
1	MW03	Nov 11, 2022		Water	L22-No0027971	X	X	X	X	X	X	X		X	X		X
2	MW06	Nov 11, 2022		Water	L22-No0027972		X		X			X	X	X		X	X
3	MW04	Nov 11, 2022		Water	L22-No0027973		X		X			X	X	X		X	X
4	QC01	Nov 11, 2022		Water	L22-No0027974		X		X			X	X	X		X	X
Test Counts						1	4	1	4	1	1	4	3	4	1	3	4

Internal Quality Control Review and Glossary

General

- Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
- All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
- All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
- Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
- Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
- SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
- Samples were analysed on an 'as received' basis.
- Information identified on this report with blue colour, indicates data provided by customer that may have an impact on the results.
- This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

Units

mg/kg: milligrams per kilogram	mg/L: milligrams per litre	µg/L: micrograms per litre
ppm: parts per million	ppb: parts per billion	%: Percentage
org/100 mL: Organisms per 100 millilitres	NTU: Nephelometric Turbidity Units	MPN/100 mL: Most Probable Number of organisms per 100 millilitres

Terms

APHA	American Public Health Association
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
TBTO	Tributyltin oxide (<i>bis</i> -tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment however free tributyltin was measured and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 5.4
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should be used as a guide only and may be different when site specific Sampling Analysis and Quality Plan (SAQP) have been implemented

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR: No Limit

Results between 10-20 times the LOR: RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.4 where no positive PFAS results have been reported have been reviewed and no data was affected.

QC Data General Comments

- Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
- Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
- pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
- Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
- For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
- Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test			Units	Result 1		Acceptance Limits	Pass Limits	Qualifying Code
Method Blank								
Conductivity			uS/cm	10		10	Pass	
Cyanide - Total			mg/L	< 0.005		0.005	Pass	
Fluoride			mg/L	< 0.1		0.1	Pass	
Nitrate-N			mg/L	< 0.01		0.01	Pass	
Nitrite-N			mg/L	< 0.01		0.01	Pass	
Total Dissolved Solids			mg/L	< 5		5	Pass	
Calcium			mg/L	< 0.5		0.5	Pass	
Hardness mg equivalent CaCO3/L			mg/L	< 5		5	Pass	
Method Blank								
Heavy Metals								
Magnesium			mg/L	< 0.5		0.5	Pass	
Method Blank								
Heavy Metals								
Arsenic			mg/L	< 0.001		0.001	Pass	
Cadmium			mg/L	< 0.0001		0.0001	Pass	
Chromium			mg/L	< 0.001		0.001	Pass	
Copper			mg/L	< 0.001		0.001	Pass	
Lead			mg/L	< 0.001		0.001	Pass	
Mercury			mg/L	< 0.0001		0.0001	Pass	
Nickel			mg/L	< 0.001		0.001	Pass	
Zinc			mg/L	< 0.005		0.005	Pass	
LCS - % Recovery								
Conductivity			%	102		80-120	Pass	
Calcium			%	99		80-120	Pass	
LCS - % Recovery								
Heavy Metals								
Magnesium			%	102		80-120	Pass	
LCS - % Recovery								
Heavy Metals								
Arsenic			%	100		80-120	Pass	
Cadmium			%	102		80-120	Pass	
Chromium			%	99		80-120	Pass	
Copper			%	99		80-120	Pass	
Lead			%	105		80-120	Pass	
Mercury			%	114		80-120	Pass	
Nickel			%	99		80-120	Pass	
Zinc			%	101		80-120	Pass	
CRM - % Recovery								
Cyanide - Total			%	96		80-120	Pass	
Test	Lab Sample ID	QA Source	Units	Result 1		Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery								
				Result 1				
Cyanide - Total	L22-No0027971	CP	%	84		80-120	Pass	
Fluoride	L22-No0027803	NCP	%	116		80-120	Pass	
Nitrite-N	L22-No0023222	NCP	%	100		80-120	Pass	
Calcium	L22-No0027347	NCP	%	126		75-125	Fail	Q08
Spike - % Recovery								
				Result 1				
Magnesium	L22-No0027347	NCP	%	62		75-125	Fail	Q08
Spike - % Recovery								

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Heavy Metals				Result 1					
Arsenic	L22-No0027347	NCP	%	102			75-125	Pass	
Cadmium	L22-No0027347	NCP	%	103			75-125	Pass	
Chromium	L22-No0027347	NCP	%	98			75-125	Pass	
Copper	L22-No0027347	NCP	%	97			75-125	Pass	
Lead	L22-No0027347	NCP	%	99			75-125	Pass	
Mercury	L22-No0027347	NCP	%	101			75-125	Pass	
Nickel	L22-No0027347	NCP	%	97			75-125	Pass	
Zinc	L22-No0027347	NCP	%	101			75-125	Pass	
Spike - % Recovery				Result 1					
Cyanide - Total	L22-No0027972	CP	%	80			80-120	Pass	
Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate				Result 1	Result 2	RPD			
Conductivity	L22-No0027788	NCP	uS/cm	150000	150000	<1	20%	Pass	
Cyanide - Total	L22-No0023589	NCP	mg/L	< 0.005	< 0.005	<1	20%	Pass	
pH	L22-No0027788	NCP	pH Units	6.9	7.0	<1	30%	Pass	
Total Dissolved Solids	L22-Fe45091	NCP	mg/L	3500	3600	3.0	30%	Pass	
Calcium	L22-No0027346	NCP	mg/L	50	47	6.9	30%	Pass	
Duplicate				Result 1	Result 2	RPD			
Heavy Metals				Result 1	Result 2	RPD			
Magnesium	L22-No0027346	NCP	mg/L	38	36	6.1	30%	Pass	
Duplicate				Result 1	Result 2	RPD			
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	L22-No0027346	NCP	mg/L	0.002	0.002	7.3	30%	Pass	
Cadmium	L22-No0027346	NCP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Chromium	L22-No0027346	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Copper	L22-No0027346	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Lead	L22-No0027346	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Mercury	L22-No0027346	NCP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Nickel	L22-No0027346	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Zinc	L22-No0027346	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Duplicate				Result 1	Result 2	RPD			
Fluoride	L22-No0027974	CP	mg/L	1.0	1.1	3.5	20%	Pass	
Nitrate-N	L22-No0027974	CP	mg/L	3.5	3.4	2.8	30%	Pass	
Nitrite-N	L22-No0027974	CP	mg/L	0.45	0.45	<1	20%	Pass	

Comments

Microbiological analysis has been completed by Eurofins Promicro, NATA Accreditation Number 2561, report reference 22-11103

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	N/A
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
N19	Analysis performed by Eurofins Promicro Pty Ltd under NATA Accreditation No. 2561
Q08	The matrix spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference.

Authorised by:

Andrew Harvey	Analytical Services Manager
Kim Rodgers	Senior Analyst-Metal
Lauren Killin	Senior Analyst-Inorganic
Sam Becker	Senior Analyst-Inorganic



Kim Rodgers
Business Unit Manager

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request

Eurofins shall not be liable for loss, cost, damages or expenses incurred by the client, or any other person or company, resulting from the use of any information or interpretation given in this report. In no case shall Eurofins be liable for consequential damages including, but not limited to, lost profits, damages for failure to meet deadlines and lost production arising from this report. This document shall not be reproduced except in full and relates only to the items tested. Unless indicated otherwise, the tests were performed on the samples as received.



ATTACHMENT D

Understanding Your Report

UNDERSTANDING YOUR REPORT

GALT FORM PMP29 Rev3

1. EXPECTATIONS OF THE REPORT

This document has been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- ✦ the project objectives as we understood them and as described in this report;
- ✦ the specific site mentioned in this report; and
- ✦ the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- ✦ the report was not written for you;
- ✦ the report was not written for the site specific to your development;
- ✦ the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- ✦ the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

3. SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

6. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

7. ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

Geotechnical advice presented in a Galt Environmental report has been provided by Galt Geotechnics under a sub-contract agreement. Similarly, environmental advice presented in a Galt Geotechnics report has been provided by Galt Environmental under a sub-contract agreement.

Unless specifically noted otherwise, no parties shall draw any inferences about the applicability of the Western Australian state government landfill levy from the contents of this document.

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Appendix 5 Water Management Plan (Urbaqua 2022)

Perth Surf Park

Water management plan

Prepared for Aventuur

By Urbaqua

August 2022

Disclaimer and Limitation

This document is published in accordance with and subject to an agreement between Urbaqua and the Client, Aventura, for who it has been prepared for their exclusive use. It has been prepared using the standard of skill and care ordinarily exercised by environmental professionals in the preparation of such Documents.

This report is a qualitative assessment only, based on the scope of services defined by the Client, budgetary and time constraints imposed by the Client, the information supplied by the Client (and its agents), and the method consistent with the preceding. Urbaqua has not attempted to verify the accuracy or completeness of the information supplied.

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1 INTRODUCTION AND BACKGROUND

PSP Properties Pty Ltd as trustee for the Perth Surf Park Property Trust (Developer) is a wholly owned subsidiary of Aventuur, Inc., a global surf park developer and operator. The Developer is proposing to construct and operate Perth Surf Park; a world-class sport, recreation, leisure, tourism and event facility featuring a Wavegarden™ surfing lagoon to be sited close to Cockburn Central Station.

1.1 Purpose

This Water Management Plan (WMP) has been prepared in support of a Development Application for the Perth Surf Park surfing facility which is proposed to be constructed and operated by the Developer.

1.2 Site description

Perth Surf Park is proposed to be located at Lot 800 Prinsep Road, Cockburn (the Study Area). It is bordered by Prinsep Road to the north, Knock Place to the south-west and the Kwinana Freeway to the west. The site layout for the proposed development includes a large open water body and associated infrastructure, car parking, customer facilities and other amenities. A site plan is provided in Figure 1.

1.3 Proposed development

The proposal includes construction of a single lagoon which will be fitted with an electro-mechanical wave generation system to enable surfers of varying ability to participate in year-round surfing. Supporting infrastructure to be constructed includes carparks, showering and changing facilities, retail outlets and café selling equipment and refreshments, surf rental outlets and surf academy. The layout of the proposed facility is illustrated in Appendix 1.

1.4 Report scope and structure

This WMP has been prepared consistent with the requirements of draft *Planning for Water Guidelines* (WAPC, 2021) and *Guidelines for managing risks in recreational water* (NHMRC, 2008). It outlines the proposed approach to water related issues and identifies ongoing actions that will be required to implement the proposal, including:

- Water management objectives for the site (Section 2)
- A description of the Site characteristics (Section 3)
- The proposed strategy for recreational water quality management (Section 4)
- The proposed water source strategy (Section 5)
- The proposed strategy for stormwater management (Section 6)
- Design assumptions used to size water sensitive design elements (Section 6)
- A site layout plan showing post development catchments and stormwater management system details (Figure 6)
- The proposed strategy for groundwater management (Section 7)
- Strategies for management of nuisance insects and landscape (Section 8)
- Construction management plan (Section 8)
- Monitoring and maintenance plan (Section 8).

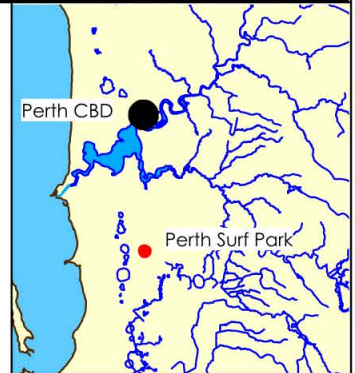
Aventuur - Perth Surf Park

Figure 1 - Study area

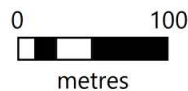


LEGEND:

-  Cadastre
-  Study area



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2 DESIGN OBJECTIVES

Table 1 summarises the design objectives to be achieved for the proposed development of the site, consistent with the draft *Planning for Water Guidelines* (WAPC, 2021) and *Guidelines for managing risks in recreational water* (NHMRC, 2008).

Table 1: Design Objectives

Design Objective

Recreational water quality management

- Manage recreational water quality risks in accordance with *Guidelines for managing risks in recreational water* (NHMRC, 2008) with consideration of applicable requirements from the *Health (Aquatic Facility) Regulations 2020* and the associated Code of Practice.
-

Stormwater management

- Assist in maintaining natural water cycles by retention of rain events within the site.
 - Reduce risks to downstream water quality by managing small (up to 15 mm) rainfall events within the site, using vegetated systems where possible.
-

Groundwater management

- Maintain pre-development groundwater conditions within the Study Area.
 - Contribute to the sustainability of local groundwater resources by maximising infiltration of stormwater on site.
 - Reduce risks to downstream water quality by providing for treatment of water before it enters the local groundwater system.
-

Water sustainability

- Provide alternative water sources for non-drinking water demands.
 - Minimise water demand through waterwise landscaping and promotion of passive irrigation with stormwater runoff wherever possible.
-

Green infrastructure

- Retain existing trees where possible and salvage as many existing native plants (especially grass trees) to re-plant within the landscaping of the site.
 - Use endemic, drought tolerant, native species as part of the landscape design.
 - Provide for passive watering of trees and green spaces by directing small rainfall events towards landscaping and trees.
-

3 SITE CONDITIONS

Perth Surf Park is proposed to be located at Lot 800 Prinsep Road, Cockburn (the Study Area). It is bordered by Prinsep Road to the north, Knock Place to the south-west and the Kwinana Freeway to the west. The site layout for the proposed development includes a large open water body and associated infrastructure, car parking, customer facilities and other amenities. A site plan is provided in Figure 1.

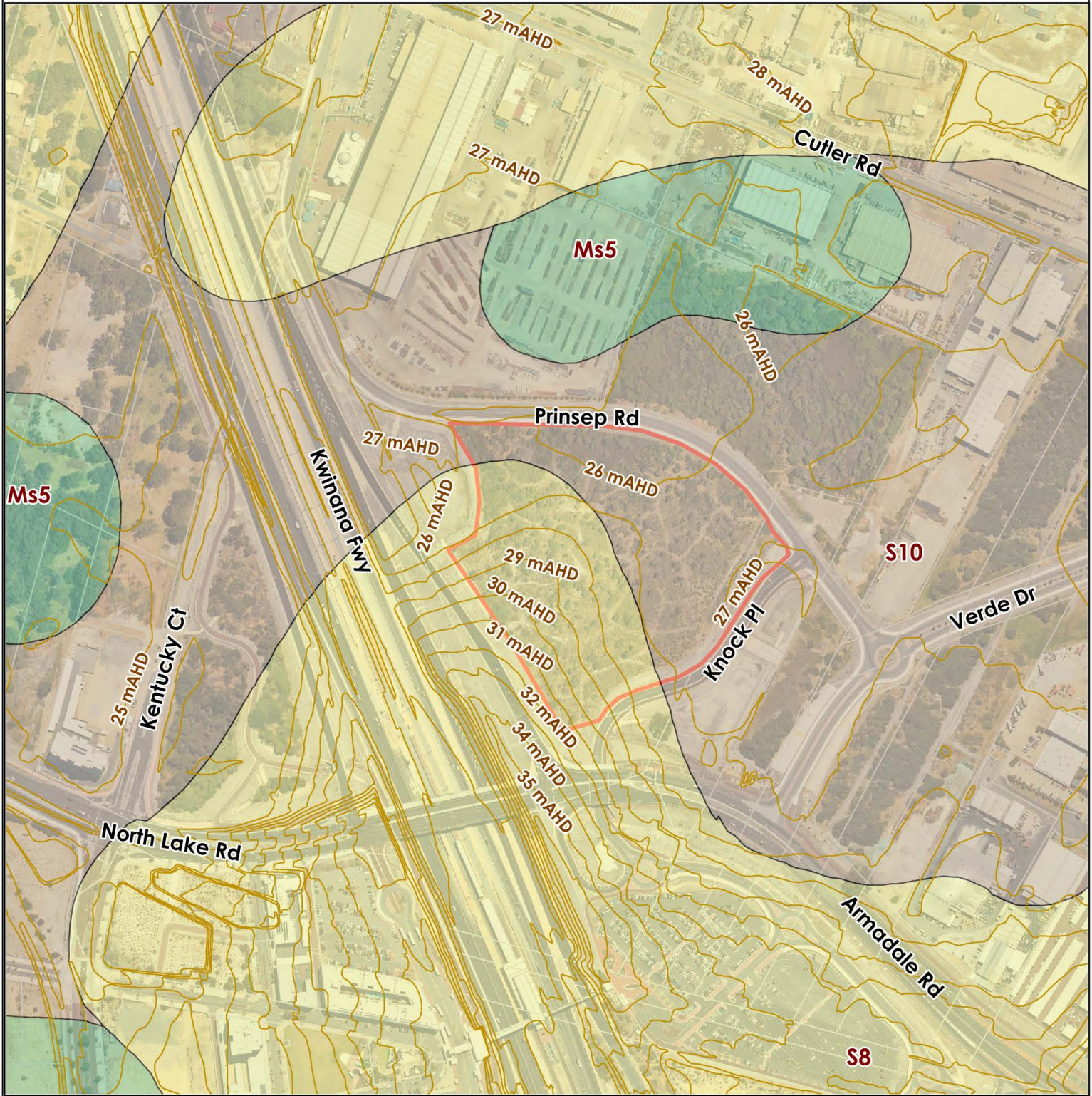
The following environmental characterisation is based on a desktop assessment of regional and local data sets. The site conditions are summarised in Table 2 below.

Table 2: Site Conditions





Category	Site Characteristic
Land Use (Figure 1)	<ul style="list-style-type: none"> The site is undeveloped and partially covered with remnant native vegetation.
Topography (Figure 2)	<ul style="list-style-type: none"> The topography ranges between 26 mAHD and 33 mAHD and generally slopes down towards the north.
Geotechnical (Figure 2)	<ul style="list-style-type: none"> Regional soil mapping indicates that the site is mainly underlain with Bassendean sand (S8). Bassendean sand typically features good infiltration conditions. Geotechnical investigations undertaken by Galt in October 2021 indicate that the site is predominantly underlain by fine to medium grained sand.
General Environment (Figure 3)	<ul style="list-style-type: none"> Acid Sulfate Soil risk mapping (DWER, 2019) indicates moderate to low risk of ASS within 3 m of the surface across the Site (Figure 3). ASS investigations undertaken by Galt in October 2021 concluded that soil from the surface to a depth of approximately 3m are not acid sulfate soils (NASS) and that excavations extending to a depth of 3m will not require further investigation or remedial works. A search of the DWER Contaminated Sites Database (DWER, 2019) indicates that there is one contaminated site located approximately 350m to the north-east of the Study Area. The site is an existing industrial yard/facility and is classified as <i>remediated for restricted use</i>. Aside from this, there are no other contaminated sites noted within 1.5kms of the site.
Surface Water and wetlands (Figure 4)	<ul style="list-style-type: none"> Approximately 1.1 ha (18%) of the site is classified as multiple use wetland. The adjacent uncleared property which is also part of this mapped wetland has been assessed as containing very good condition vegetation and it is noted that this part of the wetland may have values more closely aligned to a conservation category wetland. The site contains an existing drainage basin but otherwise contains no surface water features.

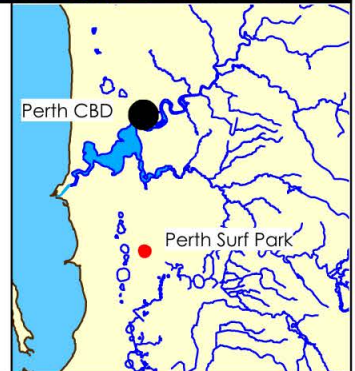
Category	Site Characteristic
Groundwater (Figure 5)	<ul style="list-style-type: none"> • DWER regional groundwater mapping (DWER, 2019) indicates that the 2003 maximum groundwater level varies between approximately 25 m AHD and 26.5 m AHD across the site which translates to depth to groundwater ranging from approximately 1 m to 5 m. • Groundwater flows generally from southeast to northwest. • An assessment undertaken by GHD in 2018 for MRWA to determine design groundwater levels for Armadale Road reported the groundwater elevation adjacent to the site on 20th September 2018 was >26.16 m AHD. However, it was noted that the actual maximum may have occurred earlier and so this level was adjusted upwards by 0.1m to give an estimated 2018 seasonal maximum of 26.26 m AHD. The assessment then derived design groundwater elevations by increasing the 2018 seasonal maximum by 0.75m based on analysis of nearby long-term DWER monitoring bores. This assessment indicates that maximum groundwater level varies between approximately 25.6 m AHD and 27.1 m AHD across the site which translates to depth to groundwater ranging from approximately 0.5 m to 2 m. • The Developer has installed six ground water monitoring bores with down hole piezometers to establish more precise ground water levels and to test the quality of the ground water across the site.
Water Resources	<ul style="list-style-type: none"> • The site is located within the South Lakes subarea of the Jandakot groundwater management area. • All groundwater aquifers present at the site are identified as fully allocated. However, 252,000 kL of groundwater previously allocated to BG&E and Lang O'Rourke under a temporary license has been recently returned and is understood to be available for reallocation. The abstraction well for this previous license is located within the site. • A groundwater license application for 75,000 kL of this groundwater has been lodged with DWER and is currently under assessment.

Aventuur - Perth Surf Park
 Figure 2 - Topography and surface geology

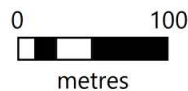


LEGEND:

-  Cadastre
-  Study area
-  1m elevation contours
- Surface geology**
-  Swamp deposits (sandy silt)
-  S10 - Thin Bassendean Sand over Guildford Formation
-  S8 - Bassendean Sand



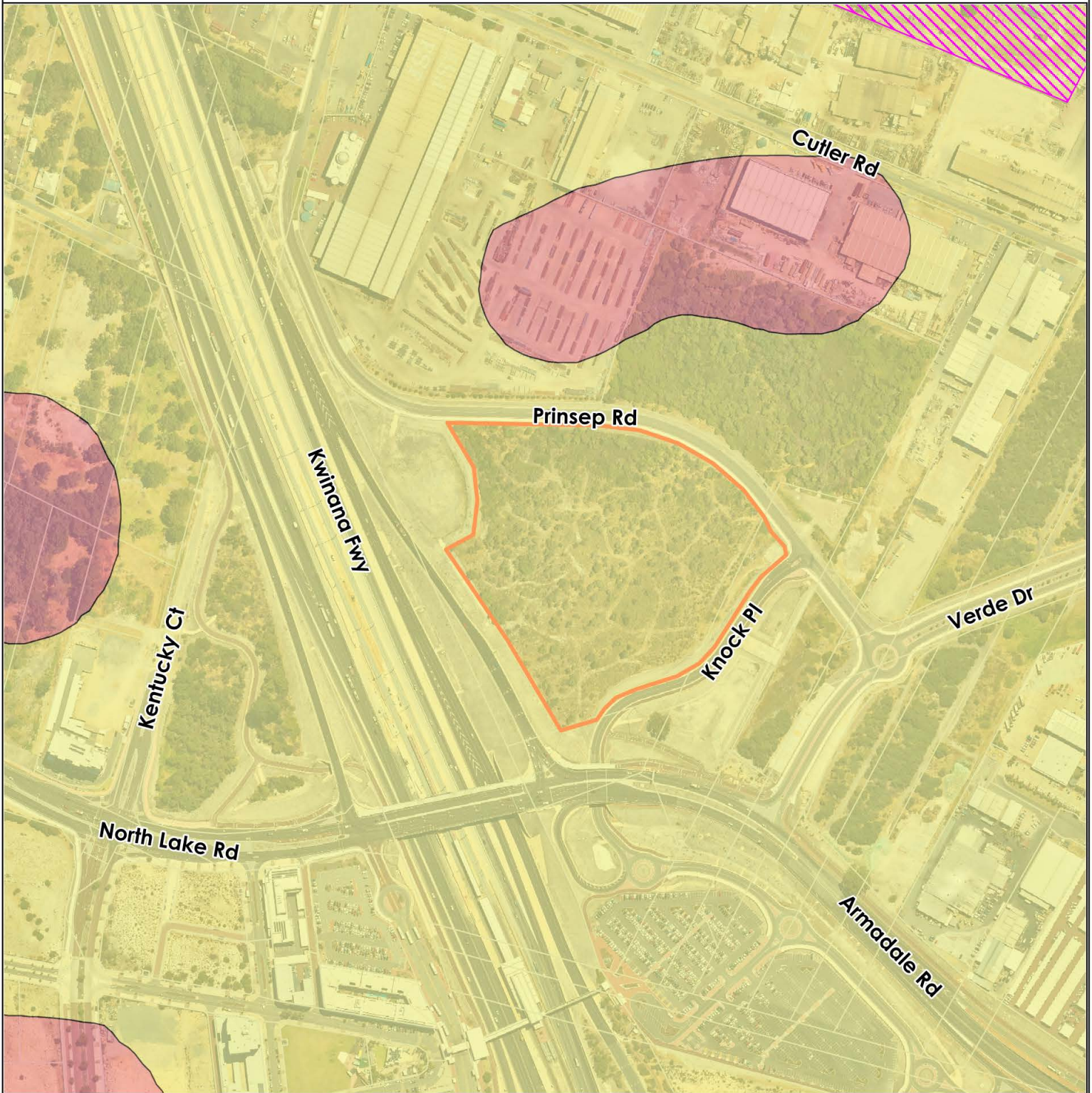
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
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Aventuur - Perth Surf Park

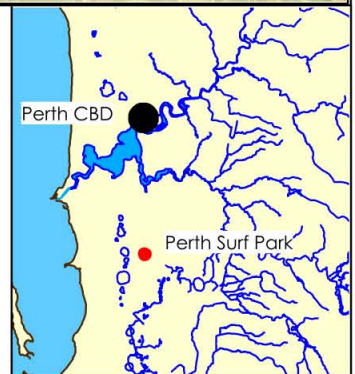
Figure 3 - Acid sulfate soil risk and registered contaminated sites



LEGEND:

-  Cadastre
-  Study area
- Acid sulfate soil risk**
-  High to moderate risk
-  Moderate to low risk

- Contaminated sites database*
-  Contaminated - remediation required
 -  Contaminated - restricted use
 -  Remediated for restricted use



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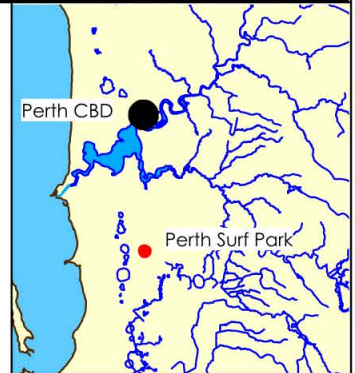
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Aventuur - Perth Surf Park
 Figure 4 - Geomorphic wetlands

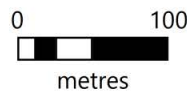


LEGEND:

- Cadastre
- Study area
- Geomorphic wetlands**
- Conservation
- Resource Enhancement
- Multiple Use



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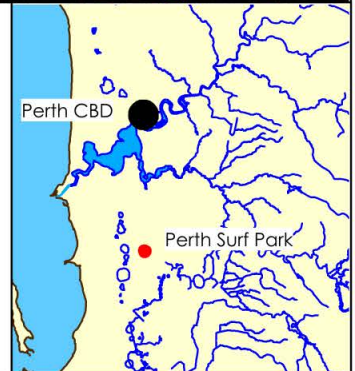
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Aventuur - Perth Surf Park
 Figure 5 - Groundwater level

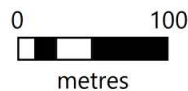


LEGEND:

-  Cadastre
-  Study area
-  Maximum groundwater level (DWER, 2004)



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4 WATER QUALITY MANAGEMENT BASIS OF DESIGN

This section summarises the management of water quality in the Lagoon. For stormwater quality management please refer to section 6.1.3.

4.1 Policy objectives

The Australian Government provides *Guidelines for managing risks in recreational water* (NHMRC, 2008) which are relevant to the proposed facility. The guidelines set out the recommended approach to managing hazards to users.

Hazard groups relevant to this site that are identified by the guidelines are:

1. Physical Hazards; water depth, submerged hazards.
2. Sun, Heat and Cold; including UV radiation, water temperature, air temperature.
3. Microbial quality; waterborne pathogens, bacteria etc.
4. Cyanobacterial quality; cyanobacteria and algae.
5. Chemical quality; natural occurring water quality and pollution.
6. Aesthetic Quality; transparency, colour, oil, litter.

Key risks for water quality in the surf lagoon from the public health perspective are microbial pathogens and algae.

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2018) (ANZG 2018) provide authoritative guidance on fresh and marine water quality management issues in both New Zealand and Australia.

ANZG 2018 is a part of Australia's National Water Quality Management Strategy (NWQMS) which provides a national approach for achieving sustainable use of Australia's water resources by protecting and enhancing water quality while maintaining economic and social development.

ANZG 2018 includes default guideline values (DGVs) for a broad range of water quality parameters including biological indicators, physical and chemical stressors and toxicants.

4.2 Treatment system specification

The water treatment system that processes abstracted groundwater used for the surf lagoon is a purpose-built system that both improves the water quality and protects human health of users. The proposed water treatment system for the lagoon is designed to comply with required public health criteria in accordance with *Guidelines for managing risks in recreational water* (NHMRC, 2008) and applicable requirements of the *Health (Aquatic Facilities) Regulations 2020* and the associated Code of Practice as well as to meet ANZG 2018 DGV's for freshwater ecosystems. The proposed treatment system includes the following key elements:

- **Bulk Screening** - for removal of gross pollutants
- **Filtration** - for removal of suspended solids. These include settled solids extracted from the lagoon floor during routine nightly vacuuming.
- **Primary Disinfection** – chlorine dosing which is designed to kill pathogens and other oxidisable compounds (like organic matter or chloramines). The potential destruction of algae is a useful secondary benefit.

- **UV treatment** – a medium pressure UV system offers secondary disinfection by removing some pathogens that are not removed by other methods (e.g. chlorine resistant Giardia) and is also efficient in removing possible chloramine compounds.
- **Ultrasonics** - strategically distributed ultrasonic probes prevent the growth of algae and also biofilm formation.
- **Mechanical cleaning** - specially designed shore, wall and floor aquatic sweeper vacuum systems provide gross solids removal and the cleaning of lagoon surfaces

Continuous mixing caused by the wave generation system will provide secondary water treatment via permanent oxygenation. It will also provide dispersion which will limit the colonisation or clumping behaviour of algae and some pathogen species.

Filtered backwash from the treatment system (approximately 1m³ per day) will be stored in a tank and further treated. The water will be recycled and used for irrigation and the sediment remaining is in the form of a spadeable waste which will be disposed of offsite to a suitable waste treatment facility.

4.3 Water monitoring program

The NHMRC Guidelines suggest that water quality of the recreational water should be initially compared against the Australian drinking water guidelines to identify the chemicals which are present in concentrations that present sufficient concern to warrant further risk assessment and/or ongoing monitoring. Further, as noted in the NHMRC Guidelines, many of the guideline values for drinking water quality are based on an assumed daily intake (ingestion) of 2L which is not representative of exposure in a recreational environment. It is therefore expected for contaminants to be significantly greater than the concentration that would be acceptable in drinking water sources.

The NHMRC guidelines and ANZG 2018 DGV's have been considered in developing the proposed requirements for water quality assessment and remedial actions for specific hazards related to lagoon water quality which are summarised in Table 3.

Table 3: Proposed lagoon water quality monitoring program

Issue	Assessment	Remedial actions
Waterborne infection	Laboratory monitoring for enteric viruses and protozoa	Close lagoon and treat to remove. re-test and when clear, re-open the lagoon.
Algal toxicoses	Visual monitoring for blue-green Cyanobacteria. Independent laboratory confirmation.	Close lagoon and treat to remove. re-test and when clear, re-open the lagoon.
Mosquito	Visual monitoring	Health warning signage. Personal protection for non-surfers. Chemical treatment if infestation is severe.
Turbidity	Field monitoring supported by laboratory calibration.	Review coagulation strategy. Install additional filtration capacity.
Water chemistry	Online analysis supported by laboratory calibration.	Consider addition of chemicals to attain the trigger values.

The water in the lagoon is proposed to be sourced from groundwater and will be subject to the following treatments:

- Primary Treatment: Sedimentation to remove solids from water.
- Secondary Treatment: removal of more than 85% BOD and suspended solids using a chemical or biological process.
- Tertiary Treatment: removal of high percentage of BOD and suspended solids and disinfection of water.

5 WATER SOURCE STRATEGY

The water source strategy presented below is preliminary, pending confirmation of groundwater availability for non-drinking water use.

5.1 Water demands assessment

Water balance modelling has been undertaken for the site with three major components:

- Water demands assessment for the Lagoon accounting for top-up requirements to replace evaporative and other water losses.
- Water demands assessment for other facilities including toilets, showers, wetsuit washing facilities, hospitalities, and irrigation.
- Initial fill rate assessment for the Lagoon.

5.1.1 Lagoon

Water demand modelling for the lagoon has been developed on a daily timestep over a 10-year duration including rainfall inputs, evaporative losses and leakage, which is effectively nil. The modelling duration selected was 2012 to 2021 which is the most recent available decade on record with an average annual total rainfall for the decade of 760.94 mm/year as compares to 818 mm/year which is the long-term average (1972-2021). The Lagoon is approximately 2 ha in size and 2.75m deep at its deepest points. The model incorporates as-designed stage areas and has been set with a tolerance for depth variation of 100mm consistent with the design requirements for the Wavegarden technology. Other modelling assumptions include:

- Base and walls of the lagoon are finished with a 2mm thick HDPE geomembrane with an effective hydraulic conductivity of 10^{-14} m/s (approx. 8.6×10^{-10} m/day).
- Evaporation has been modelled applying a derivation of the mass transfer equation that applies an expression for the mass transfer coefficient that is a function of wind-speed, water body surface area and includes consideration of the level of disturbance from patronage and wave generation.

A summary of the lagoon modelling results is provided in Table 4 and a more detailed output from the model is provided in Appendix 2.

Table 4: Lagoon water balance modelling results

Flux	Average annual volume	%	10-year peak
In			
Rainfall	15.40 ML/year	28 %	18.41 ML/year
Runoff (from immediate surrounds)	4.03 ML/year	7 %	1.17 ML/year
Top-up	35.7 ML/year	65 %	53.93 ML/year
Out			
Evaporation	53.38 ML/year	97 %	53.65 ML/year
Leakage	0.0 ML/year	0 %	0.0 ML/year
Overflow	1.75 ML/year	3 %	4.01 ML/year
Total	55.1 ML/year	100%	

5.1.2 Facilities and irrigation

Water demand modelling for other facilities and landscape irrigation has been undertaken based on predicted visitor numbers and including the following assumptions:

- 40% of visitors will use shower facilities
- 90% of female visitors and 40% of male visitors will use toilet and hand washing facilities
- 90% of male visitors will use urinal and hand washing facilities
- 70% of visitors will use wetsuit washing facilities
- The Site will include 0.47ha of irrigated turf, 0.92ha of irrigated native planting and 0.31ha of un-irrigated native planting
- Buildings will be provided with VRV reverse cycle air conditioning
- A small allowance for leaks has been included

A summary of the modelling results is provided in Table 5.

Table 5: Facility and irrigation water demand modelling results (ML/year) (excludes lagoon)

Flux	Drinking water	NDW (Groundwater)
In		
Scheme	6.94	
NDW (Groundwater)		9.09
Use on site		
Wave Park facilities	3.80	
Hotel/glamping	2.00	
Hospitality	1.14	
Irrigation		9.09
Out		
Wastewater	5.94	
Evapotranspiration	0.17	8.18
Recharge	0.83	0.91
Total	9.64	8.12

5.1.3 Initial fill methodology

The proposed Wave Park lagoon will require approximately 26,000 m³ water to be filled initially followed by occasional top-ups and less frequent refills following maintenance activities.

At a pumping rate of 50 L/s the lagoon would therefore take approximately 6 days to fill, whilst at a pumping rate of 5 L/s it would take 60 days to fill. It is likely that a fill duration more than around 10 days would be considered not viable therefore the desired pumping rate would be approximately 25-30 L/s.

5.2 Water source options

The following water source options were reviewed to determine an optimal water source strategy for the Site:

- Groundwater (new license application)
- Trades/transfers of existing licensed groundwater entitlements
- Scheme water
- Stormwater harvesting from roofed areas

Consideration was given to the quality of the source, the available volumes and sustainability of the source as well as other considerations such as approvals required and the economic sustainability of the facility.

A summary of the outcomes of this assessment is presented in Table 6 below.

Table 6: Summary of potential water sources

Source	Quality	Quantity	Further Actions
Groundwater (new license application) – Leederville Aquifer	Likely to meet requirements for use with minimal treatment for Lagoon use.	Likely to meet requirements. Aquifer is fully allocated in the management subarea with only one license held by the Water Corporation in the general component and the remainder held in reserve for public drinking water supply.	Consultation with DWER and Water Corporation to determine if an application for access to this resource is likely to be considered. Initiation of a groundwater license application.
Groundwater (new license application) – Superficial Aquifer	Likely to meet requirements for use with some treatment required for Lagoon use.	Likely to meet requirements although yield will be limited to prevent drawdown impacts to the environment. Aquifer is fully allocated in the management subarea although water allocated on the site, under a previously held temporary license is expected to be available for reallocation.	A groundwater license application has been initiated.
Trades/transfers of existing licensed groundwater entitlements	Likely to meet requirements for use with some treatment required for Lagoon use.	A review of potential water trades/transfers has been undertaken. The only resources considered likely to be tradable were two temporary licenses held by BG&E Pty Limited & Lang O'Rourke Australia Construction Pty Ltd (for a total of 297,000 kL per annum). These licenses expired early in 2022.	A groundwater license application has been initiated to secure access to groundwater returned to the consumptive pool following expiry of temporary licenses.

Source	Quality	Quantity	Further Actions
Scheme Water	Likely to meet requirements (potable)	No issue (just sustainability and cost)	None. Satisfactory quality and yield. Scheme water will be used for all drinking water purposes within the site and as a contingency option for Lagoon filling and topping up if required.
Stormwater harvesting from carparks	Likely to meet requirements for use with treatment required for Lagoon use (incl. removal of hydrocarbons and sediment)	Unlikely to fully meet requirements. Seasonal variability in supply and mismatch with periods of peak demand, would require substantial storage which could not be feasibly accommodated within the site. However, clean rainwater harvested from building roofs and the immediate surround of the Lagoon is an important contribution to reduce demand.	Clean rainwater harvested from building roofs and the immediate surround of the Lagoon will be directed into the Lagoon. Runoff from carparks and other hardstand areas will be directed into onsite infiltration systems to contribute to groundwater recharge.
Stormwater harvesting from roofs	Likely to meet requirements for use with minimal treatment required for Lagoon use.	Unlikely to meet requirements. Roof areas not extensive so yield would not be sufficient. Also, seasonal variability in supply would require substantial storage which could not be feasibly accommodated within the site.	None. Stormwater will be directed to infiltration systems to maximise groundwater recharge.

5.3 Selected water sources

5.3.1 Groundwater

It is proposed to source the water in the lagoon (both initial filling and periodic topping-up) from groundwater.

The Leederville Aquifer is preferred due to better water quality, reducing treatment plant processing, a higher water temperature assisting to maintain a more comfortable water temperature in the lagoon for guests, and higher potential yield rates that could be achieved. However, it is noted that this aquifer is predominantly used for public drinking water supply in this location and therefore further consultation with DWER and the Water Corporation is required to determine the potential accessibility of this resource.

Assuming that groundwater will be sourced from the Superficial Aquifer, an application for a license to take water to draw 75,000 kilolitres per annum from the Jandakot, South Lakes, Perth – Superficial Swan resource has been initiated. Whilst it is recognised that this aquifer is currently identified as fully allocated, the recent expiry of two licenses held by BG&E Pty Limited & Lang O'Rourke Australia Construction Pty Ltd (for a total of 297,000 kL per annum) and past discussions with the Department of Water and Environmental Regulation indicates that there may be some limited availability remaining.

5.3.2 *Scheme water*

Scheme water will be used for all drinking water demands at the facility. The Site will be connected to the existing water main. This water meets all the requirements either for potable and surf Lagoon water but is not currently the preferred source for supply to the Lagoon due to cost and sustainability concerns. Scheme water remains under consideration as a contingency option for the Lagoon.

5.4 **Water conservation measures**

The Site has been designed to maximise the efficiency of water use and reuse through the specification of water efficient fixtures and fittings and landscaping using low or zero irrigation demand species wherever possible. Additionally, the site maximises the use of rainwater for passive irrigation and Lagoon top-up to minimise scheme water demand. Clean rainwater harvested from building roofs and the immediate surround of the Lagoon is proposed to be directed into the Lagoon. Runoff from carparks and other hardstand areas will be directed into onsite infiltration systems to contribute to groundwater recharge.

5.5 **Wastewater treatment and disposal**

Operation of machinery in the water treatment process and housekeeping of the plant area will generate some wastewater. Wastewater will also be generated by daily cleaning of the surf lagoon surrounds.

These wastewaters will pass through a gravity-settling tank to concentrate a pumpable sludge, thus recovering as much clarified water as practical. The sludge will be discharged to sewer in accordance with Water Corporation requirements.

5.5.1 *Chemical storage and management*

Any chemical or product required to be stored or handled on the Site is understood to be under the threshold criteria for licensing under the Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007. Any minor quantities of chemicals will be appropriately stored under cover on sealed and bunded surfaces.

5.6 **Water sustainability initiatives**

Scheme water use within the site will be minimised through the use of water efficient fixtures and systems. Alternative water sources, such as rainwater and groundwater, will be used wherever possible to provide for non-drinking water demands such as irrigation of open spaces and top-up of the lagoon.

Although there is likely to be sufficient groundwater available to maintain lagoon water levels and for irrigation of public realm areas at the site, groundwater availability is limited, and future reductions to licensed allocations are anticipated throughout Perth in response to the drying climate. Waterwise landscaping practices will therefore be applied to minimise the irrigation demand and all stormwater from the site will be infiltrated into the groundwater system to support ongoing sustain use of this resource.

5.7 Water balance

Table 7 presents a consolidated water balance for the site including the lagoon and providing a direct comparison with the pre-development site water balance. A more detailed output from each element of the model is provided in Appendix 2.

Table 7: Broadscale comparison of pre and post development water balance (incl. Lagoon)

Flux	Pre-development	Post development	change
In			
Rainfall	56.39 ML/year	56.39 ML/year	-
Scheme		6.94 ML/year	-
Groundwater (taken for use on site)		44.79 ML/year	-
Out			
EVT	26.19 ML/year	16.96 ML/year	-35 %
Evaporation (lagoon)		53.65 ML/year	
Recharge (gross)	30.20 ML/year	31.60 ML/year	+5 %
Runoff (leaving site)	0.0 ML/year	0.0 ML/year	-
Wastewater		5.94 ML/year	-
Total	56.39 ML/year	108.15 ML/year	

Note: Groundwater used on site is proposed to be extracted locally, either from Superficial or Leederville Aquifer.

6 STORMWATER MANAGEMENT PLAN

There is currently no formal drainage system within the Site and stormwater is generally infiltrated through the vegetated surfaces and sandy soil to ultimately end up in the superficial groundwater system. The proposed post development stormwater management system will include vegetated swales and soakage systems to maintain predevelopment rates of groundwater recharge and prevent runoff.

Details of the stormwater system for frequent, minor and major storm events is presented below. Figure 6 presents the drainage design for the site and a full set of detailed engineering drawings (including drainage design) are provided in Appendix 3.

6.1 Stormwater system design

6.1.1 Frequent storm events – 1 exceedance per year (1EY)

Landscaping will provide for the use of stormwater for passive watering of trees and vegetation as a way to enhance the liveability and functionality of public areas. An added benefit of this approach will be to assist with reducing the risk of exporting nutrients to the downstream environment via the local groundwater system.

Runoff from roofs, car parks and paved areas are designed to runoff into vegetated swales which also incorporate underground infiltration cells to provide for management of larger rainfall events within the site (see plate 1).

The vegetated bioretention swale system will provide water quality treatment for frequent events and attenuation of discharge offsite for larger events. The swales will feature nutrient retentive vegetation and a layer of filter media designed to remove nutrients. The construction of the swales will be in accordance with recommendations of the CRC for Water Sensitive Cities. Appropriate plant species will be selected from the *Vegetation Guidelines for Stormwater Bio-filters in South-west of Western Australia* (Monash, 2014).

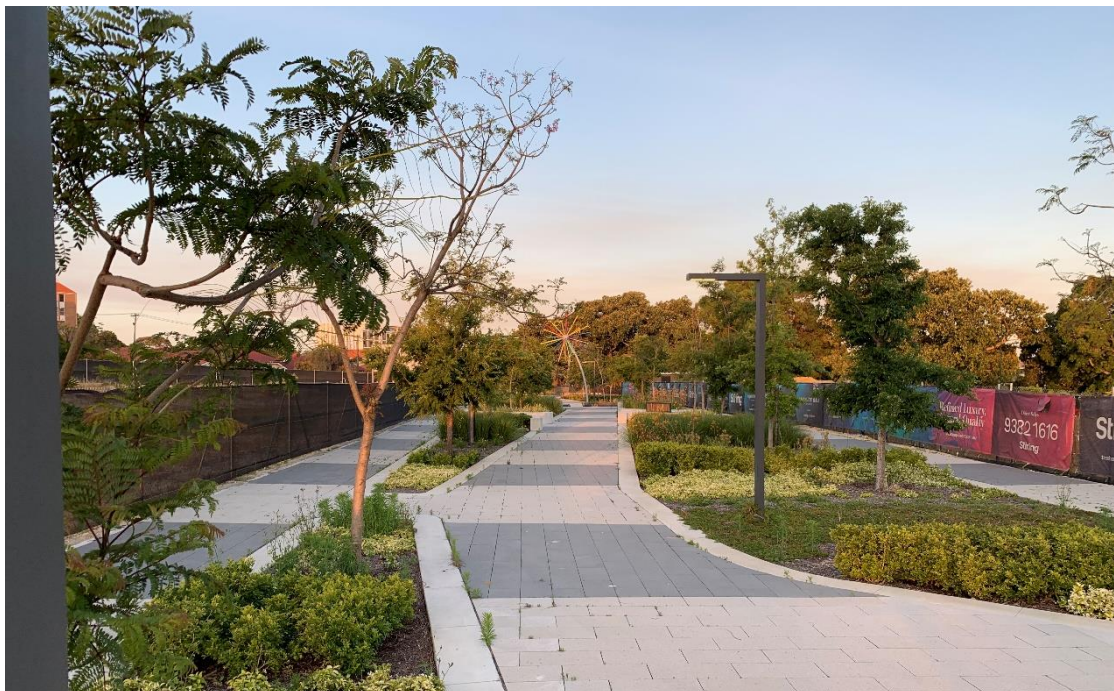


Plate 1: Example of public realm allowing runoff to passively irrigate vegetation

6.1.2 Minor storm events – 20% AEP and Major storm events – 1% AEP

Runoff from roofs, car parks and paved areas that exceeds the capacity of vegetated swales will be directed to underground infiltration cells.

6.1.3 Stormwater quality management

The water quality of stormwater discharges from the developed site will be managed through retention on-site of all frequent event runoff in a vegetated bioretention swale system.

6.2 Drainage modelling

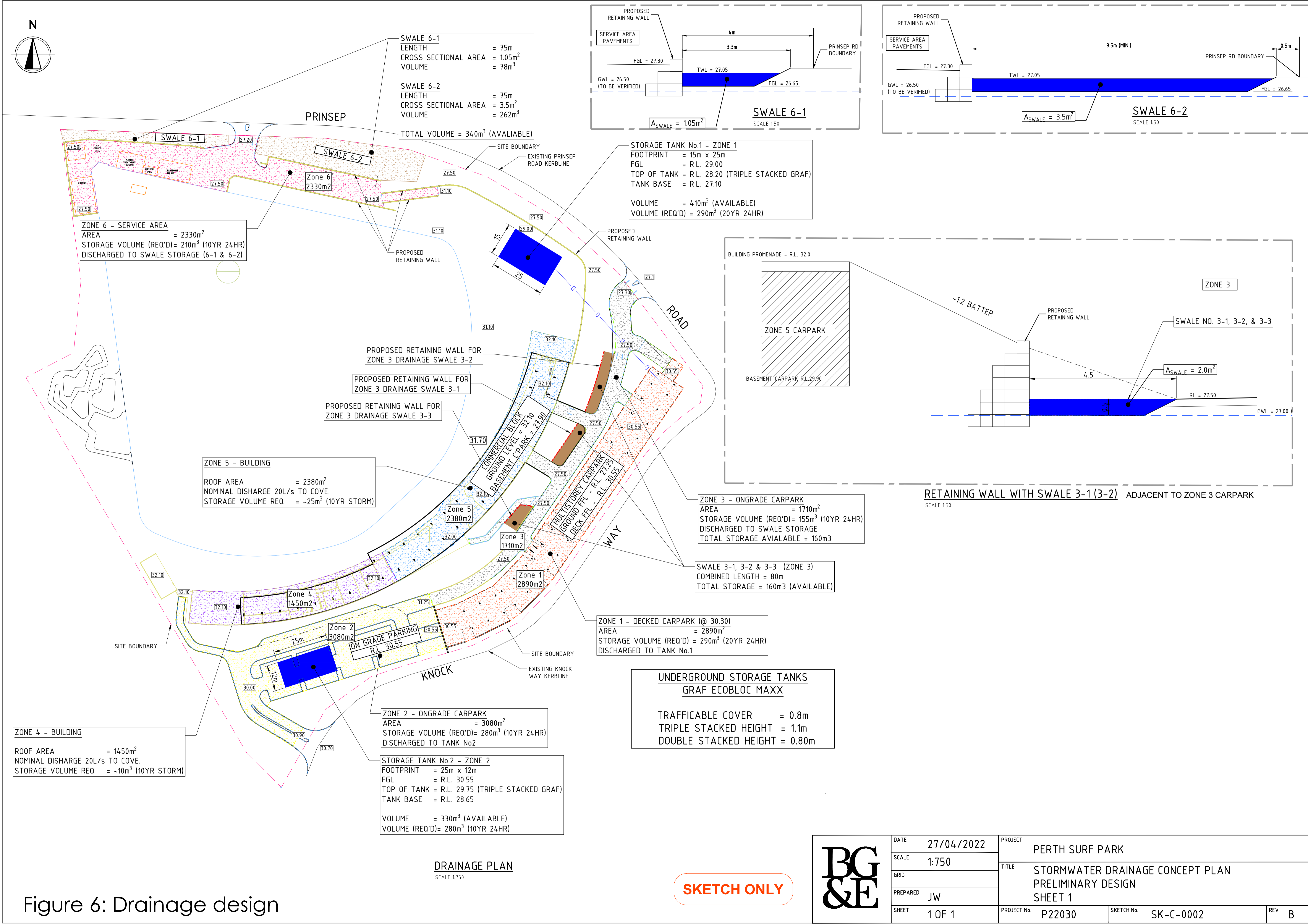
Hydrological and hydraulic modelling has been undertaken to confirm sizing for retention and infiltration up the 1% AEP event onsite. The hydrological and hydraulic modelling package InfoWorks ICM was used for this assessment with the following parameters applied in the modelling:

- A full range of ARR 2019 ensemble design rainfall events were simulated including:
 - 1%, 10% and 20% AEP with durations ranging from 10 minutes to 6 hours.
- An initial loss of 2 mm was applied to impervious portions of the site, accounting for loss of small rainfall in roof and road material.
- An infiltration rate of 5m/day from swales and infiltration systems was assumed.

Peak post-development storage volumes are summarised in Table 8.

Table 8: Peak post-development stormwater storage volumes (m³)

Location	Storage required (m ³)				Storage provided (m ³)
	15mm rainfall	20% AEP	10% AEP	1% AEP	
Tank 1	1.0	32.7	62	224.5	410
Tank 2	8.6	28.8	54.6	166.2	330
Swale 3.1	0.8	7.7	21.0	79.0	160
Swale 6.1	5.6	6.1	6.4	10.4	70
Swale 6.2	4.3	36	54.8	143.9	260
Lagoon (runoff from building roofs, lagoon surrounds & direct rainfall to lagoon surface)	1086	1960.9	2500.1	4722.7	



DRAINAGE PLAN
 SCALE 1:750

SKETCH ONLY

BG & E	DATE	27/04/2022	PROJECT	PERTH SURF PARK	
	SCALE	1:750	TITLE	STORMWATER DRAINAGE CONCEPT PLAN PRELIMINARY DESIGN	
	GRID			SHEET 1	
	PREPARED	JW	PROJECT No.	P22030	SKETCH No.
	SHEET	1 OF 1		REV	B

Figure 6: Drainage design

7 GROUNDWATER MANAGEMENT PLAN

Development of the site will include management of groundwater resources by utilising local infiltration and providing for appropriate management of water quality prior to water entering the groundwater system. A summary of approaches to total water cycle management that will be implemented on the site are provided below.

7.1 Groundwater recharge and water quality management

To contribute to the long-term sustainability of local groundwater resources, stormwater management systems that provide for maximised harvesting and infiltration on-site will be utilised.

In order to reduce the risk of increasing nutrients entering the groundwater system, on site stormwater management (infiltration) systems will incorporate vegetation and soils with high phosphorous retention capacity.

7.2 Groundwater use

As noted in section 5, groundwater from the Superficial Aquifer is proposed to be utilised on the site for filling and maintaining lagoon water levels as well as for irrigation of landscaping within the site. When water is pumped from a bore out of the shallow Superficial Aquifer the surrounding groundwater level will be lowered in a cone shaped depression surrounding the bore. This has the potential to impact groundwater dependent vegetation by drawing the groundwater level beyond the reach of root systems.

Therefore, to provide for the protection of wetland vegetation adjacent to the site an estimate of drawdown has been determined for potential groundwater bore locations at the site, the Cooper-Jacob approximation has been used.

Cooper and Jacob (1946) developed an approximation for the Theis equation and a data analysis method which does not require type-curve matching. The Cooper-Jacob approximation is given by:

$$s = \frac{Q}{4\pi T} \ln \left[2.2459 \frac{Tt}{r^2 S} \right]$$

where:

s = drawdown

Q = pumping rate

T = transmissivity

t = time

r = radial distance from pumping well

S = storage coefficient

Investigations undertaken by Groundwater Development Services for the Armadale Access Alliance and provided in *Armadale Road to North Road Bridge Project – H2 Assessment* (GDS, 2020) resulted in derivation of transmissivities that ranged from 416m²/day to 646m²/day and an adopted transmissivity for use in drawdown modelling of 575 m²/day. The investigations also

identified a local specific yield of 0.1. These values have been adopted for this study and are summarised in Table 9.

Table 9: Input parameters for Superficial Aquifer groundwater drawdown estimation

Input parameters	units	values
Transmissivity	M ² /day	575
Specific yield	m ⁻¹	0.1
Pumping rates:	L/s	5
	L/s	10
	L/s	25

The proposed Perth Surf Park lagoon will require approximately 26,000 m³ water to be filled initially followed by occasional top-ups and less frequent refills following maintenance activities (if required).

At a pumping rate of 25 L/s the lagoon would therefore take approximately 12 days to fill, whilst at a pumping rate of 5 L/s it would take 60 days to fill. It is likely that a fill duration more than around 12 days would be considered not viable therefore the desired pumping rate for the initial fill would be around 25 L/s. For topping-up, the maximum daily requirement is 260 m³ which could be applied over 8 hours while the park is closed for the night. This would require a fill rate between 5 L/s and 10 L/s.

Based on these requirements and input parameters, the Cooper-Jacob approximation returned the results presented in Table 10. A more complete record of results is provided in Appendix 2.

Table 10: Superficial Aquifer groundwater drawdown estimation results

Scenario details (T = 575, Sy=0.1)		values			units
Pumping rate		5	10	25	L/s
Drawdown after 8 hours	5 m from well	0.31	0.62	1.54	m
	50m from well	0.03	0.07	0.16	m
	100m from well	-	-	-	m
	150m from well	-	-	-	m
	250m from well	-	-	-	m
Drawdown after 12 days	5 m from well	0.52	1.04	2.61	M
	50m from well	0.25	0.49	1.23	m
	100m from well	0.16	0.33	0.82	m
	150m from well	0.12	0.23	0.58	m
	250m from well	0.05	0.11	0.27	m

Figure 7 presents a range of radial distances from two possible groundwater bore locations to assist in the interpretation of drawdown estimates presented in Table 10.

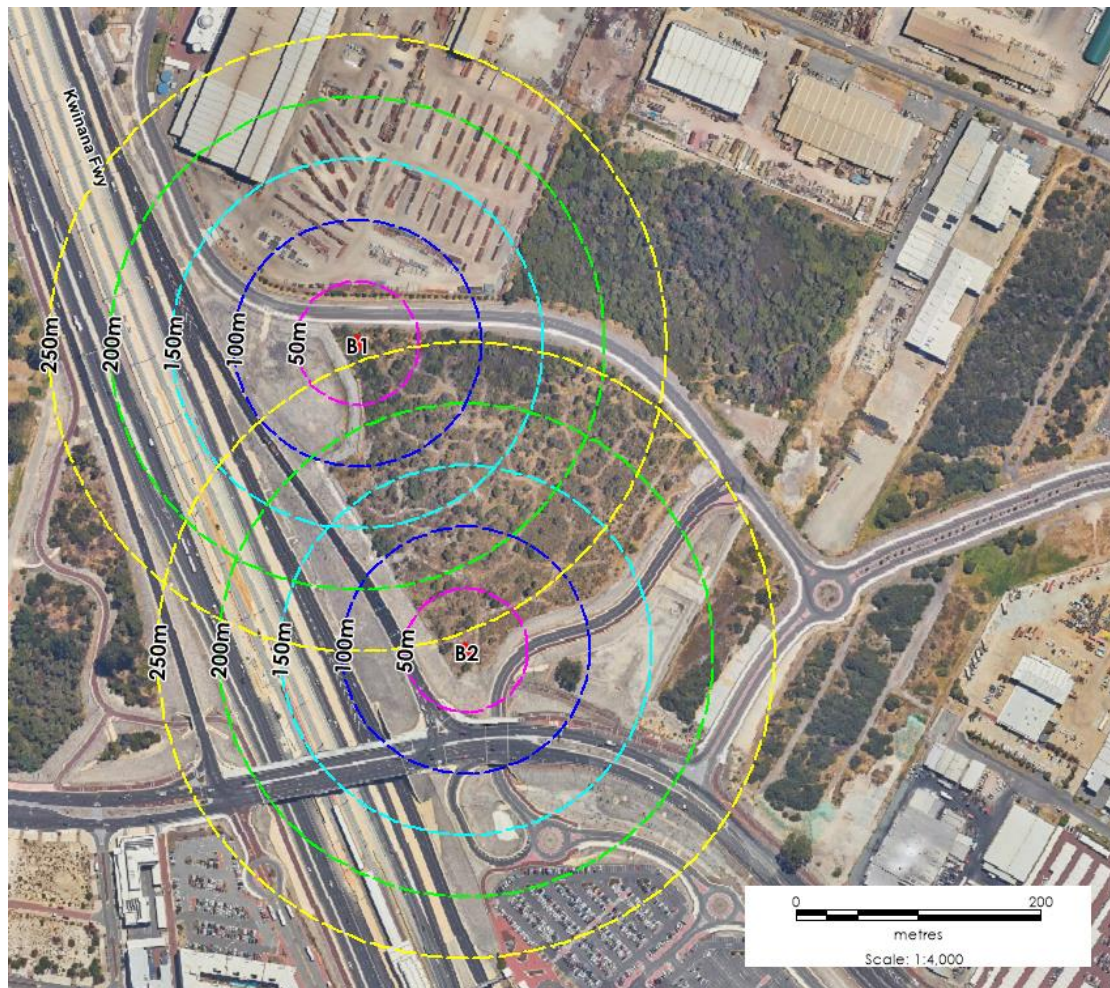


Figure 7: Surf Park site – Potential groundwater bore locations and radial distances

As shown in Figure 7, the drawdown estimates at 150m radial distance would be relevant for consideration of impacts to wetland vegetation in the adjacent lot at location B1 whilst drawdown estimates at 250m would be relevant at location B2.

From the results highlighted in Table 10, pumping at the preferred initial fill rate (25 L/s) for 12 days results in 0.27m drawdown at 250m from the bore. Pumping at the top-up rate (10 L/s) for 8 hours results in zero drawdown at 150m from the bore.

7.2.1 Impact assessment

The tolerance of wetland plants to groundwater drawdown depends on a number of factors, including the depth of drawdown, the length of time the drawdown is occurring and the time of year that it is happening. The wetland is a partial sumpland (above ground water in winter/spring) and a dampland (waterlogged in winter/spring). The wetland has evolved with varying weather patterns and can tolerate lower groundwater levels in dry seasons and higher ones in wet seasons.

Groundwater levels in the vicinity of the site vary seasonally by around 1m and inter-annually by up to 2 m, as observed at long-term DWER monitoring bore reference 61410239 (Figure 8) which is located approximately 800m east of the site, and bore reference 61410232 (Figure 9) which is located approximately 500m north of the site. This suggests that wetland vegetation could be reasonably expected to tolerate short periods of drawdown within the range of this natural variability.

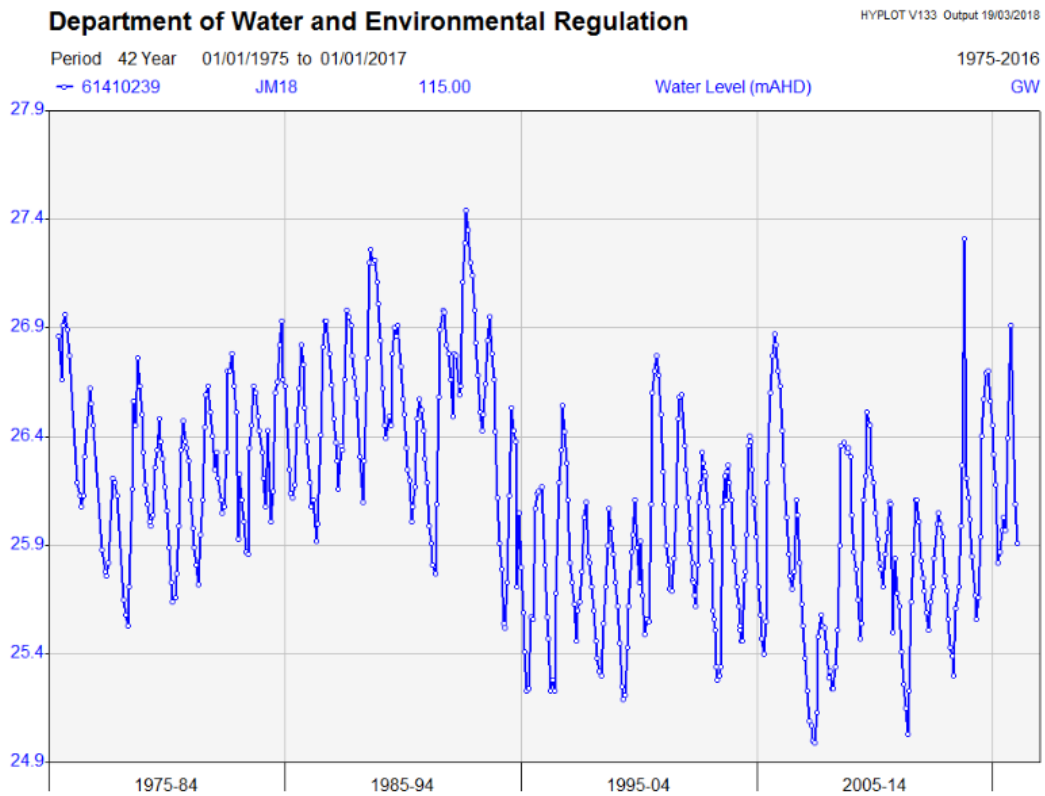


Figure 8: Long-term groundwater level record close to the site (ref: 61410239)

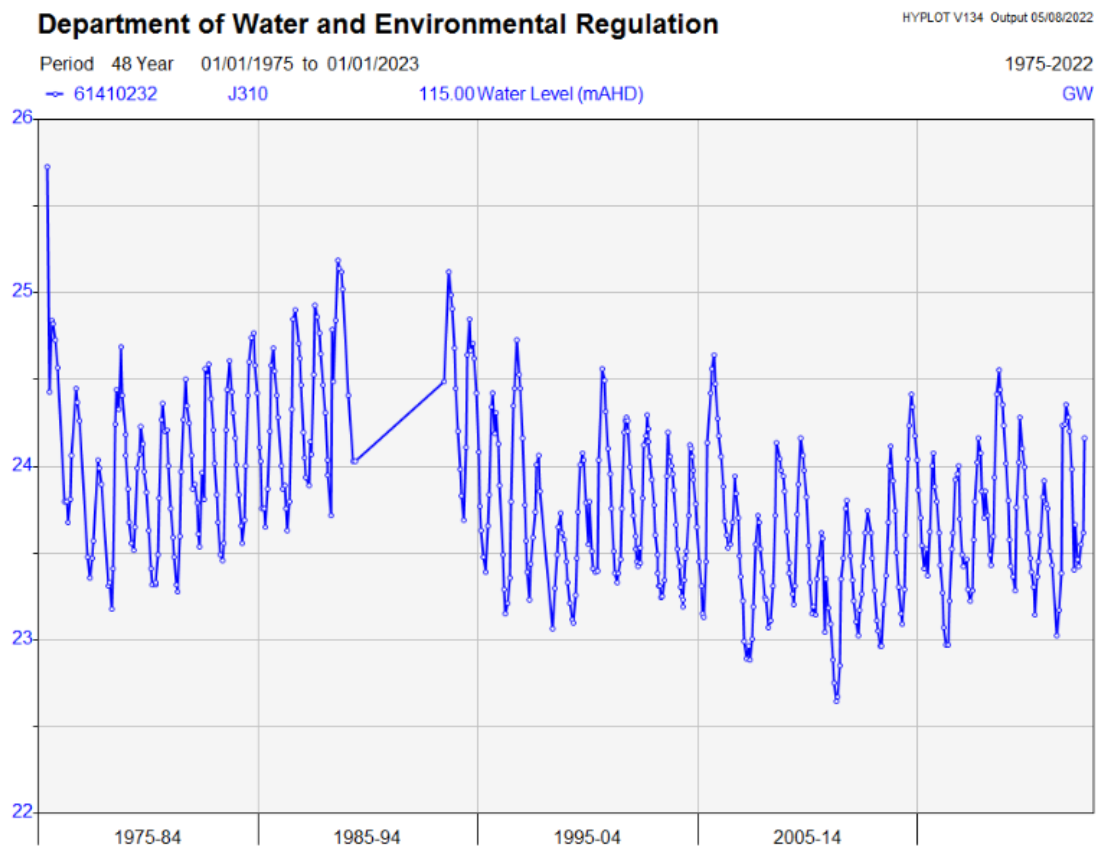


Figure 9: Long-term groundwater level record close to the site (ref: 61410232)

The criteria by which risk is assigned to impacts on groundwater dependent ecosystems has been defined by Froend et al (2004) and considers water levels, the duration of required water levels, and the rate of water level rise or decline. Table 11 and Table 12 identify risk ratings for changes in depth to groundwater and groundwater decline rates respectively.

Table 11: Risk of impact level and magnitude of permissible change (m) for phreatophytic vegetation

Phreatophytic category	Low	Moderate	High	Severe
0-3m (wetland)	0-0.25	0.25-0.5	0.5-0.75	>0.75
0-3m (terrestrial)	0-0.75	0.75-1.25	1.25-1.75	>1.75
3-6m	0-1.0	1.0-1.5	1.5-2.25	>2.25
6-10m	0-1.25	1.25-2.0	2.0-2.25	>2.75

Table 12: Risk of impact level and rate of permissible change (m/yr) for phreatophytic vegetation

Phreatophytic category	Low	Moderate	High	Severe
0-3m (wetland)	0-0.1	0.1-0.2	0.2-0.3	>0.3
0-3m (terrestrial)	0-0.1	0.1-0.25	0.25-0.5	>0.3
3-6m	0-0.1	0.1-0.25	0.25-0.5	>0.5
6-10m	0-0.1	0.1-0.25	0.25-0.5	>0.5

The maximum permissible change in water level in wetland vegetation for a low risk rating is 0.25m and the maximum rate of permissible change is 0.1m/year.

The area rate of change in groundwater level at the edge of the wetland based on long-term DWER monitoring bore records (61410239, Figure 8, and 61410232, Figure 9) was estimated as 0.1m/year by Groundwater Development Services for the Armadale Access Alliance and provided in *Armadale Road to North Road Bridge Project – H2 Assessment* (GDS, 2020). This indicates a low risk rating.

The modelled change in water level at the edge of the wetland based on pumping from bore location B2 at the preferred initial fill rate (25 L/s) for 12 days is 0.27m which would indicate a moderate risk rating for this activity. At bore location B1, pumping at the preferred initial fill rate (25 L/s) for 12 days is 0.58m which would indicate a high risk rating for this activity.

The modelled change in water level at the edge of the wetland based on pumping from either bore location at the top-up rate (10 L/s) for 8 hours is 0m which would indicate a low risk rating for this activity.

As shown in Figure 7, the drawdown estimates at 150m radial distance would be relevant for consideration of impacts to wetland vegetation in the adjacent lot at location B1 whilst drawdown estimates at 250m would be relevant at location B2.

From the results highlighted in Table 10, pumping at the preferred initial fill rate (25 L/s) for 12 days results in 0.27m drawdown at 250m from the bore. Pumping at the top-up rate (10 L/s) for 8 hours results in zero drawdown at 150m from the bore.

Based on this assessment of potential drawdown from groundwater abstraction, a pumping rate of 25 L/s for 12 days would be considered unacceptable at bore location B1 but could be considered acceptable, with monitoring, at bore location B2.

At a pumping rate of 10 L/s for 8 hours it is likely that either of the bore locations could be considered acceptable.

7.2.2 *Management actions*

Pump testing at the site will be completed to determine achievable pumping rates and confirm aquifer parameters. Bores will be located, and pumping rates established to prevent impacts to wetland vegetation.

Initial filling of the lagoon will be undertaken during winter months to minimise the potential impact of drawdown and ensure that aquifer recovery is as fast as possible, assisted by winter recharge.

Initial filling of the lagoon may include up to 50% scheme water to reduce the potential drawdown if required.

Topping up will be limited to up to 8 hours at a pumping rate of 10L/s, or 3 hours at up to 25L/s.

It is recommended that observation bores at the northern boundary of the site are established for the monitoring of potential impacts during the initial fill and for ongoing groundwater level and quality monitoring.

8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 Management of nuisance insects

Construction of artificial waterbodies can provide new chironomid midge and mosquito habitats. The risk of nuisance insects can be minimised through good design and is expected to be minimised by the following design specifications:

- Minimal water level fluctuation (<100 mm)
- Regular shape with steep even sides
- Regular aeration (created by wave action)
- No aquatic vegetation
- Water quality treatment for recirculated inflows (insects and insect larvae will be filtered if they enter the Lagoon treatment process)

In regard to nuisance insect management, the site management plan may include an ongoing program of midge and mosquito control including treatment options.

8.2 Landscape design and management

Landscape designs for the site will be developed with consideration of species selection to minimise water demand and includes the preferential use of locally endemic species in stormwater management systems and other vegetated areas.

The use of turf will be minimised and limited to specific functional areas of the site. Verge areas and batters will be vegetated with locally endemic species selected for minimal water demand, to provide suitable visual buffering for the site and to provide habitat for and facilitate the movement of local fauna (if any). A suitable weed removal and revegetation methodology will be developed by a suitably licenced and experienced ecologist to minimise potential impacts.

8.3 Circumstantial discharge from the lagoon

It is necessary to have the ability to discharge from the lagoon if significant repairs are required. However, it should be noted that there are no circumstances when an uncontrolled discharge will occur. The flow rate for discharge will be controlled to prevent downstream issues and the discharge can be terminated immediately in the event of significant rainfall or other unforeseen issue.

Circumstantial lagoon discharge may be undertaken via the following methods:

- Discharge to sewer
- Discharge to the underground infiltration system designed as part of the stormwater management system
- Discharge by injection into the superficial aquifer

None of these strategies are likely to result in adverse water quality impacts, given the lagoon water quality will be required to meet the Australian Government National Health and Medical Research Council (NHMRC) *Guidelines for Managing Risks in Recreational Water (2008)*, which are generally more prescriptive and sensitive than the applicable ANZG DGV's. Notwithstanding, testing of the discharged water will occur prior to discharge into the

environment by any pathway and certain water quality analytes (e.g. pH, alkalinity, chlorine (to ensure there is none), turbidity etc) will be continuously tested during discharge.

The residual chlorine level that will be maintained in the lagoon is 0.5mg/L. The Australian Drinking Water Guidelines, specify that a drinking water distribution system should maintain a free chlorine residual of between 0.2 and 0.5mg/L. The ADWG specify health and aesthetic quality guideline values for chlorine in drinking water of between 0.6mg/L and 5.0mg/L. The lagoon will meet the guideline values for the other physical properties specified in the ADWG (e.g. pH, hardness, turbidity, TDS).

In the event of a requirement to drain down the lagoon and chlorine levels are considered too high for acceptable discharge, there are two options to reduce chlorine levels prior to discharge. These are:

1. Planned Drain Down
 - a. Cease chlorine dosing
 - b. Maintain circulation and filtration through WTP
 - c. Maintain wave action in lagoon
 - d. The residual chlorine level in the lagoon will rapidly volatilise off through both UV radiation from the sun, and also through wave action
 - e. It will take 24-48 hours before no chlorine would be detectable in the lagoon
 - f. At this point, undertake a controlled drain down of the lagoon water body to the sewer
2. Unplanned / Emergency Drain Down
 - a. Cease chlorine dosing
 - b. Maintain circulation and filtration through WTP
 - c. Add sodium thiosulphate to the lagoon to rapidly neutralise residual chlorine (~100kg in volume)
 - d. 100% mixing of sodium thiosulphate within water body with wave action and WTP circulation ~6 minutes
 - e. 100% mixing with WTP circulation, but without wave action ~45minutes
 - f. Residual chlorine instantly deactivated by sodium thiosulphate
 - g. Once no detectable residual chlorine in water body, undertake managed drain down of the lagoon to the sewer

8.3.1 Discharge to sewer

Any circumstantial discharge via this pathway will be managed within the distribution capacity of the sewerage system in consultation with the Water Corporation.

8.3.2 Discharge to the stormwater system

The proposed stormwater management system is estimated to be capable of distributing water at a rate somewhat over 150 L/s. Any circumstantial discharge via this pathway will be managed within the distribution capacity of the existing stormwater management system.

8.3.3 Discharge by injection into the Superficial Aquifer

If required, discharge of water by injection into the superficial aquifer may be considered as part of the detailed design of the site, subject to managed aquifer recharge approvals.

8.4 Construction management

Construction activities have the potential to impact water quality and generate or transport contaminants and pollutants. It is necessary to ensure that the design, operation and management of all site erosion, sedimentation and water quality controls are integrated during construction or remediation activities and that operational impacts on the environment are minimised.

8.4.1 Sediment control

During the development works there is potential for sediment to be blown or washed off the construction site. The contractor will be required to provide a construction management plan or construction specification, for approval by the Local Government with advice from DWER, that identifies appropriate management practices and controls to prevent transport of sediment off site during subdivision works. As a minimum, the following measures will be undertaken:

- Minimising the area of the site which is disturbed.
- Install sediment fencing near areas of concentrated flow.
- Reinststate and/or stabilise completed parts of the sites in a timely manner.
- Ensure the site is stabilised prior to forecasted rainfall events.
- Establish dust management procedures to limit the transport of wind-blown sediment from the site including the use of water carts, installation of wind fencing and application of spray-on stabilisation products.
- Control of vehicle access to the site using a limited number of stabilised access points to limit tracking of soil into sealed roads by vehicles (use of vehicle rumble grids to be considered).

Following construction of drainage infrastructure, temporary sediment traps may also be required to prevent sedimentations and blockage prior to building construction on individual lots. Vegetated areas should also be inspected to remove any sediment build up or weeds.

8.4.2 Dewatering

Earthworks plans indicate that there will be no reduction in the existing clearance to groundwater and therefore it is unlikely that there will be a need for dewatering during the earthworks phase of the works. As the civil works progress, there may be a need for dewatering to enable construction of drainage and sewerage infrastructure though this is considered unlikely. Any dewatering will be managed in accordance with licensing requirements through a separate Dewatering Management Plan to be approved by the DWER (if required).

8.4.3 Acid sulfate soils

DWER acid sulfate soil risk mapping indicates that Study Area has moderate to low risk of ASS within 3 m of the natural surface (Figure 3). Further, ASS investigations undertaken by Galf in October 2021 concluded that soil from the surface to a depth of approximately 3m are not acid sulfate soils (NASS) and that excavations extending to a depth of 3m will not require further investigation or remedial works. However, in accordance *the Identification and investigation of acid sulfate soils and acidic landscapes* (DWER, 2015) (the ASS guidelines), where excavation of the natural surface will be undertaken, for example installation of drainage and sewer infrastructure, further testing may be required to determine the local presence of acid sulfate soils if deeper excavations are proposed.

8.5 Monitoring and maintenance

A monitoring program based on the water quality criteria discussed in section 4, will be followed for the lagoon (Table 3).

In addition to this, there is a need for ongoing environmental monitoring and management including regular inspection and remedial actions where necessary. The preliminary monitoring and maintenance plan proposed for the Site are provided in Table 13.

The full scope of onsite monitoring and reporting will be developed once more details including specification and design are completed and available for review.

Table 13: Proposed monitoring program

Element	Inspection/monitoring frequency	Remedial actions
Vegetated swales and biofilters	Twice per year in Spring and Autumn	Sediment and dead plant removal Structural repairs Weed removal Replanting
Mosquito	Twice per year in Spring and Autumn	Health warning signage. Chemical treatment if infestation is severe.
Groundwater quality including: <ul style="list-style-type: none"> pH Total suspended solids (TSS) Total nitrogen (TN) and total dissolved nitrogen (TDN) Ammonium (NH₄) Nitrate and nitrite (NO_x-N) Total phosphorus (TP) Filterable reactive phosphorus (FRP) Chlorine 	Quarterly sampling for first 12 months Frequency may be reduced thereafter following review of data.	Samples will be compared to ANZG 2018 DGV's and typical stormwater discharge quality. Consider system and/or site management modifications where performance is found to be inadequate.
Groundwater levels	Continuous monitoring during initial fill. Monthly for first 12 months Frequency may be reduced thereafter following review of data	Groundwater bore operating requirement modifications where issues are identified. Drainage system modifications where issues are identified.

8.5.1 Risk management

All water treatment plants face some risk of unexpected plumbing or machinery water leakages. The water treatment plant's designer will be commissioned to identify all points of potential, but unpredictable, water leakage. The designer will also perform a risk likelihood and consequence assessment to identify the potential leakage points.

Points identified as having an uncomfortable adverse impact and significant potential, will have leak-detecting sensors installed and will be housed within an appropriately sized bund. Digital leak detection sensors will communicate continuously with the computerised water treatment plant control system.

In the event of a sensor signalling a leak, the responsible employees will be immediately notified by a text message alert. Repeated signalling from a sensor will result in an alarm status and immediate shutdown of the surfing lagoon for immediate repairs. In addition to the leak detection capability, the water treatment plant computer control system will also continuously monitor pipeline pressures. Detection of any unexpected high or low pipeline pressures will result in activation of a similar alert and alarm protocol.

The lagoon comprises of reinforced concrete walls and footings, together with a wide concrete plinth and dividing wall that runs up the central axis of the lagoon.

An admixture is used in the concrete mix for the walls, footings and plinth which bridges any fine cracks that might develop, thus maintaining the waterproofing integrity of the walls, footings and plinth. An aliphatic polyurethane surface coating is also applied to the walls and footings. The possibility of a leak occurring through these structures (other than as a result of a major seismic event, criminal act or major accident) is very remote.

A 3.0mm thick HDPE plastic membrane is used to line the floor of the lagoon. The liner is mechanically anchored with a proprietary stainless steel clamping system and bolted to the footings of the concrete walls and the plinth which comprise the main structural elements of the lagoon. The sealing system between the HDPE membrane and reinforced concrete perimeter (walls, footings and slabs) provide a very high degree of water tightness.

A leak detection system is also installed below the plastic liner. This comprises a series of pipes and electrically actuated sensors. Where a leak occurs beneath the liner, an alert is triggered. The leak detection system identifies the specific area of the lagoon floor where a leak is present. To repair a leak, a dive team is deployed to visually inspect the liner, identify the issue, and then use underwater adhesives to patch and repair the liner membrane. These types of repairs are uncommon, but if they occur, they can typically be undertaken overnight, with the lagoon fully operational the following day.

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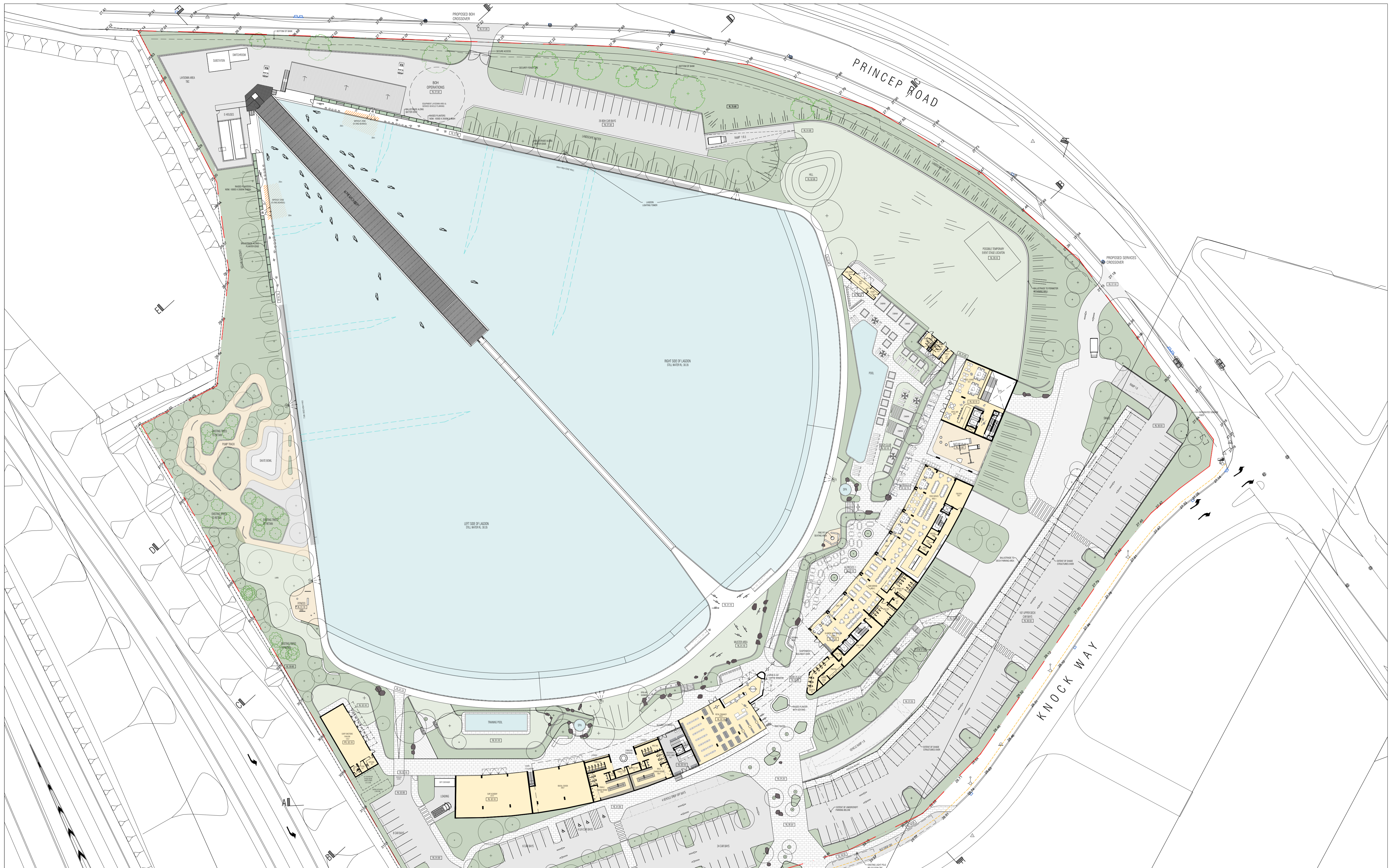
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APPENDIX 1: PROPOSED LAYOUT



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REV.	DATE	AMENDMENT
A	07.07.22	CLIENT REVIEW
B	11.07.22	WIP FOR CONSULTANTS
C	19.07.22	CONSULTANT UPDATE

DEVELOPMENT MANAGERS: PLACE DEVELOPMENT
 PLANNING: LATERAL PLANNING
 LANDSCAPE: SEEDSIGN
 CULTURAL: SOFT EARTH
 BUSHFIRE: ECO-LOGICAL
 CIVIL: BG&E
 WASTE: TALIS
 SUSTAINABILITY: CUNDALL
 ACOUSTIC: HERRING STORER
 TRAFFIC: STANTEC
 GEOTECHNICAL: GALT
 ENVIRO & ARCHEOLOGY: GALT

CLIENT
äventuur
 PROJECT
 PERTH SURF PARK

PROJECT ADDRESS
 LOT 800 PRINCEP RD &
 KNOCK WAY, JANDAKOT WA
 PROJECT STATUS
 DEVELOPMENT APPLICAITON

PROJECT NUMBER
 21012
 SCALE
 1:500 @ A1 / 1:1000 @ A3

DRAWING
OVERVIEW
GROUND FLOOR PLAN
 DRAWING NO. DA2.01
 DRAFTER HBW
 CHECKED MM
 REV. C

APPENDIX 2: WATER BALANCE AND DRAWDOWN MODELLING OUTPUTS

Site Water Balance
Aventuur: Cockburn Wave Park
Sheet 1: Water Demands and Waste Generation



Domestic Uses																
Dwelling Type		Wave Park facilities			Hotel			Glamping								
No. households		1			48			20								
Population / household		818			2			2			1.765			1.552		
Occupancy %		100			80			80			100			100		
Effective Population		818			76.8			32			0			0		
Use	Base Rate	Rate	Source	Waste	Rate	Source	Waste	Rate	Source	Waste	Rate	Source	Waste	Rate	Source	Waste
Domestic Individual Usage																
kl/pp/day																
Shower	0.009	0.0036	DW	BW	0.009	DW	BW	0.009	DW	BW	0.009	DW	GW1	0.009	DW	GW1
Kitchen sink	0.001	0	DW	BW	0.001	DW	BW	0.001	DW	BW	0.001	DW	GW2	0.001	DW	GW2
Bathroom basin	0.002	0.0018	DW	BW	0.002	DW	BW	0.002	DW	BW	0.002	DW	GW1	0.002	DW	GW1
Dishwasher	0.003	0	DW	BW	0.003	DW	BW	0.003	DW	BW	0.003	DW	GW2	0.003	DW	GW2
Bath	0.001	0	DW	BW	0.001	DW	BW	0.001	DW	BW	0.001	DW	GW1	0.001	DW	GW1
Laundry trough	0.004	0	DW	BW	0.004	DW	BW	0.004	DW	BW	0.004	DW	GW1	0.004	DW	GW1
Toilet	0.005	0.0033	DW	BW	0.005	DW	BW	0.005	DW	BW	0.005	NDW	BW	0.005	NDW	BW
Urinals	0.001	0.0005	DW	BW	0.001	DW	BW	0.001	DW	BW	0.001	NDW	GW1	0.001	NDW	GW1
Household Usage																
kl/household/day																
Leaks	0.029	0.029	DW	N/A	0.029	DW	N/A	0.029	DW	N/A	0.029	DW	N/A	0.029	DW	N/A
Wetsuit washing	0.005	2.863	DW	BW	0	DW	BW	0	DW	BW	0	DW	N/A	0	DW	N/A
Evaporative cooling	0.006	0.06	DW	N/A	0.006	DW	N/A	0.006	DW	N/A	0.006	DW	N/A	0.006	DW	N/A
Other	0.004	0	DW	N/A	0.004	DW	N/A	0.004	DW	N/A	0.004	DW	N/A	0.004	DW	N/A
Other																
kl/each/year																
Household / Communal Pools	90	0	DW	N/A	0	DW	N/A	0	DW	N/A	0	DW	N/A	0	DW	N/A
Domestic Irrigation																
Number Lots																
Average Lot Area	m2															
Irrigated area	%	100			75			0			25			22		
Irrigation event depth	mm	10			10			10			10			10		
Frequency (days/week)	days	2			2			2			2			2		
Season length	months	9			9			9			9			9		
Source		GNDW			GNDW			GNDW			GNDW			GNDW		
No. Irrigation Events		79.0			79.0			79.0			79.0			79.0		
Irrigation Demand	kl/year	0.0			0.0			0.0			0.0			0.0		
Domestic Waste Streams																
kl/year																
Greywater Type 1 (GW1)		0			0			0			0			0		
Greywater Type 2 (GW2)		0			0			0			0			0		
Black Water (BW)		3765			729			304			0			0		
Lost (N/A)		33			684			285			0			0		
Irrigation (IRR)		0			0			0			0			0		
Overall Domestic Demand																
kl/year																
Drinking Water (DW)		3797			1413			589			0			0		
Non-Drinking Water (NDW)		0			0			0			0			0		
Rain Water (RW)		0			0			0			0			0		
Groundwater (GND)		0			0			0			0			0		
Total Demand		3797			1413			589			0			0		
Total per capita demand	kl/pp/yr	5			18			18			#####			#####		
Per capita DW demand		5			18			18			#####			#####		
Public Irrigation																
Irrigated turf																
Total Area	m2	4725			9171			3057			0			0		
Irrigation coverage	%	100			90			0			100			25		
Irrigation event depth	mm	10			10			10			10			10		
Frequency (days/week)	days	2			2			2			2			2		
Season length	months	8			8			8			8			8		
Source		GNDW			GNDW			GNDW			NDW			NDW		
No. Irrigation Events		70.0			70.0			70.0			70.0			70.0		
Irrigation Demand	kl/year	3307.5			5777.7			0.0			0.0			0.0		
Commercial Uses																
Base rate																
kl/year																
Hospitality		570	Qty	Rate	Source	Waste	Total	Comment								
		1	2	570	DW	BW	1140									
			1		DW	N/A	0									

Site Water Balance
Aventuur: Cockburn Wave Park
Sheet 1: Water Demands and Waste Generation



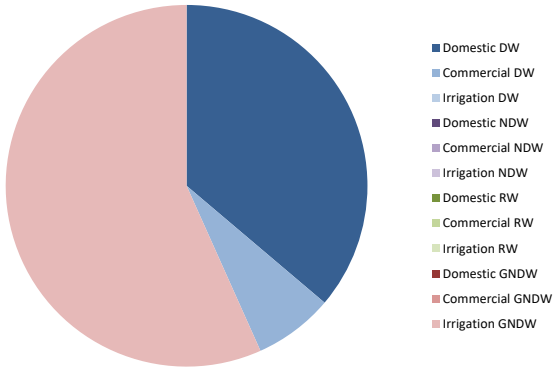
Demand Based Water Balance (kL/year)

	Domestic kL / year	Commercial kL / year	Public Irr' kL / year	Total kL / year	%	
Total Water Use	5799	1140	9085	16025	100.0%	16.025
Source Demand						
Drinking Water (DW)	5799	1140	0	6939	43.3%	6.9393
Non-Drinking Water (NDW)	0	0	0	0	0.0%	0
Rain Water (RW)	0	0	0	0	0.0%	0
Groundwater (GND)	0	0	9085	9085	56.7%	9.0852
					100.0%	
Waste						
Greywater Type 1 (GW1)	0	0		0	0.0%	0
Greywater Type 2 (GW2)	0	0		0	0.0%	0
Black Water (BW)	4798	1140		5938	37.1%	5.9381
Lost (N/A)	1001	0		1001	6.2%	1.0012
Irrigation (IRR)	0	0	9085	9085	56.7%	9.0852
					100.0%	

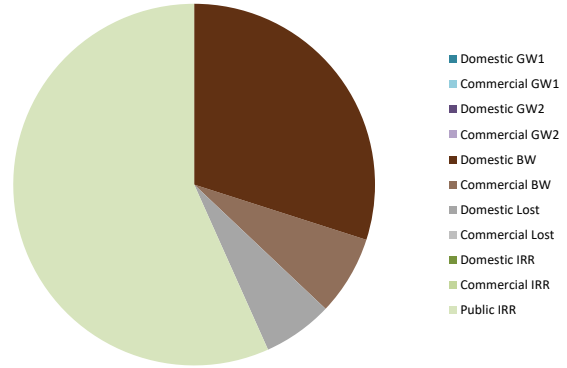
Performance

Population	927	people
POS Area	1.70	ha
Total Irrigated POS	1.39	ha
Per Capita Domestic Total Water	17	kL/person/year
Per Capita Domestic Drinking Water	6	kL/person/year
POS Irrigation Rate	5359	kL/ha/year
POS Irrigation Rate (excl unirrigated POS)	6538	kL/ha/year

Sources Demand



Waste Streams



WATER BALANCE CALCULATIONS
Lagoon Water Balance - Options Analysis



Calculation Sheet 1

Scenario HDPE Liner
Inf Model Liner
Rainfall Data
Source JANDAKOT AERO
Reference 9172
Climate Data Perth Metro

Total lagoon catchment 4.861 ha
 External to lagoon 2.697 ha

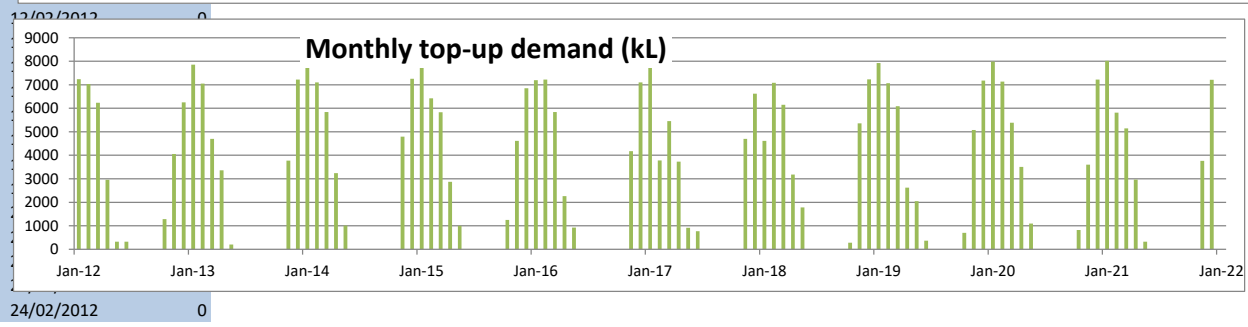
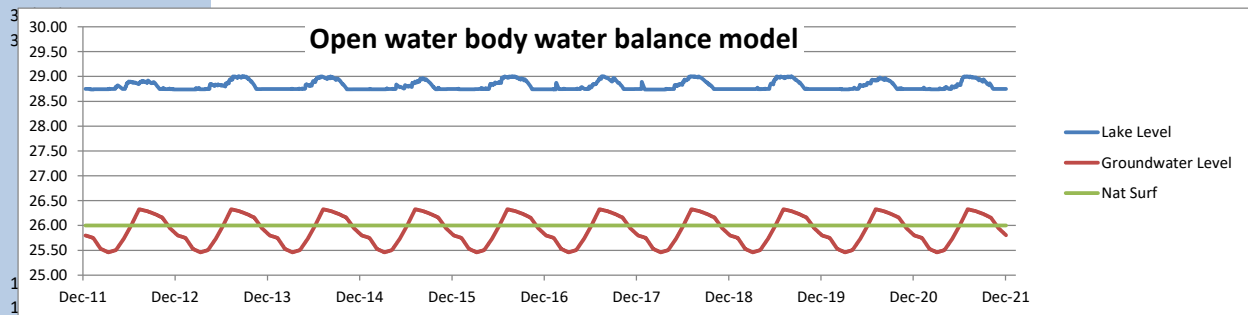
Date	Rainfall mm	Month	Evap mm/month	mm/day	Surr GWL m AHD
1/01/2012	0	Jan	406	13.1	25.800
2/01/2012	0	Feb	358	12.8	25.750
3/01/2012	0	Mar	312	10.1	25.532
4/01/2012	0	Apr	185	6.2	25.459
5/01/2012	0	May	127	4.1	25.505
6/01/2012	0.4	Jun	86	2.9	25.734
7/01/2012	0.4	Jul	83	2.7	26.007
8/01/2012	0	Aug	102	3.3	26.328
9/01/2012	0	Sep	140	4.7	26.290
10/01/2012	0	Oct	219	7.1	26.234
11/01/2012	0	Nov	287	9.6	26.159
12/01/2012	0	Dec	369	11.9	25.947
13/01/2012	0	Jan	405.540914	13.1	25.8

Level	Area (m2)	Storage
26	1836	0
26.6	4639	1942
27.2	6066	5154
27.8	10559	10141
28.4	17768	18639
28.75	19841	25221
29	20740	30293
29.2	21640	34531

Model Results	Total (ML)
Change in Storage	-0.02
INPUTS	
Direct Rainfall	154.0
Catchment Runoff	40.33
top-up	357.0
OUTPUTS	
Evaporation	533.8
Net seepage to GW	0.0
Overflow as Stormwater	17.5

Model Inputs	Value	Unit
initial water level	28.75	mAD
pan evaporation factor	1.00	El/Ep
liner conductivity - 10^	-14	m/s
liner conductivity	8.64E-10	m/day
liner thickness	0.002	m
seepage through base	Y	(Y/N)
base of lake	26	m AD
depression storage	2	mm
natural surface level	26	mAD
site area draining to lake	2.70	ha
overflow level	29	m
max volume	30293.4503	m3
maintained lake level	28.75	m

Annual Demand	ML
Maximum	39.1
Minimum	33.2
Average	35.7



24/02/2012 0

Site Water Balance
Urbsurf: Perth
Sheet 1: Broadscale water balance



Inf Model

Rainfall Data

Source	JANDAKOT AERO
Reference	9172

Pan Evap Data

Source	Armadale
Reference	

EVT Data

Source	JANDAKOT AERO	Vegetated
Reference	BoM (2017)	Hardstand

Initial loss

	32
	2

Runoff coeff

	0
	0

Date	Rainfall mm
1/01/2012	0
2/01/2012	0
3/01/2012	0
4/01/2012	0
5/01/2012	0
6/01/2012	0.4
7/01/2012	0.4
8/01/2012	0
9/01/2012	0
10/01/2012	0
11/01/2012	0
12/01/2012	0
13/01/2012	0
14/01/2012	0
15/01/2012	0
16/01/2012	0
17/01/2012	0
18/01/2012	0
19/01/2012	0
20/01/2012	10.4
21/01/2012	1.6
22/01/2012	0
23/01/2012	0
24/01/2012	0
25/01/2012	0
26/01/2012	0
27/01/2012	0
28/01/2012	0
29/01/2012	0
30/01/2012	0
31/01/2012	0
1/02/2012	0
2/02/2012	1.8
3/02/2012	13.6
4/02/2012	0
5/02/2012	0
6/02/2012	0
7/02/2012	0
8/02/2012	0
9/02/2012	0
10/02/2012	0.2
11/02/2012	0
12/02/2012	0
13/02/2012	0
14/02/2012	0
15/02/2012	0
16/02/2012	0
17/02/2012	0
18/02/2012	0
19/02/2012	0
20/02/2012	0
21/02/2012	0
22/02/2012	0
23/02/2012	0
24/02/2012	0
25/02/2012	0
26/02/2012	1
27/02/2012	0
28/02/2012	0

Month	Pan Evap mm/day	Evap factor Wetland	Reference EVT		Deep rooted veg EVT Factors	
			mm/month	mm/day	Native	Non-native
Jan	9.6	1.00	244	7.9	0.10	0.20
Feb	8.9	1.00	184	6.3	0.10	0.20
Mar	7.2	0.70	164	5.3	1.00	1.10
Apr	4.1	0.70	128	4.3	1.00	1.10
May	2.8	0.70	85	2.7	1.00	1.10
Jun	2.0	0.70	63	2.1	1.00	1.10
Jul	1.9	0.70	67	2.2	1.00	1.10
Aug	2.2	0.70	76	2.5	1.00	1.10
Sep	3.5	0.70	103	3.4	1.00	1.10
Oct	5.0	0.70	148	4.8	1.00	1.10
Nov	6.8	0.70	218	7.3	1.00	1.10
Dec	8.4	1.00	194	6.2	0.10	0.20
Jan	9.580645161		244	7.9		

Model Inputs

	Scenario 1	Scenario 2
Note:	Predevelopment	Postdevelopment
Total site area (ha)	7.41	4.71 (excludes Lagoon)
% shallow rooted veg		10.03%
% deep rooted veg (non-native)		
% deep rooted veg (native)	100.00%	25.95%
% Wetland/drainage		
% Hardstand/roof	0.00%	64.03%
	100%	100%

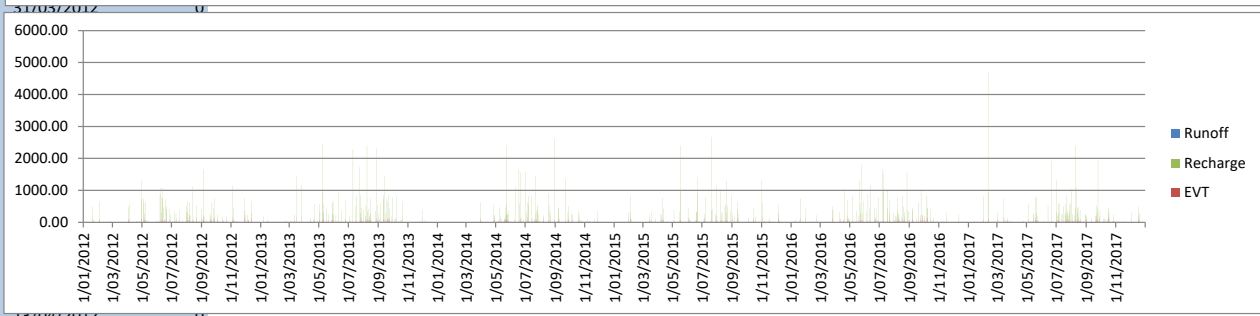
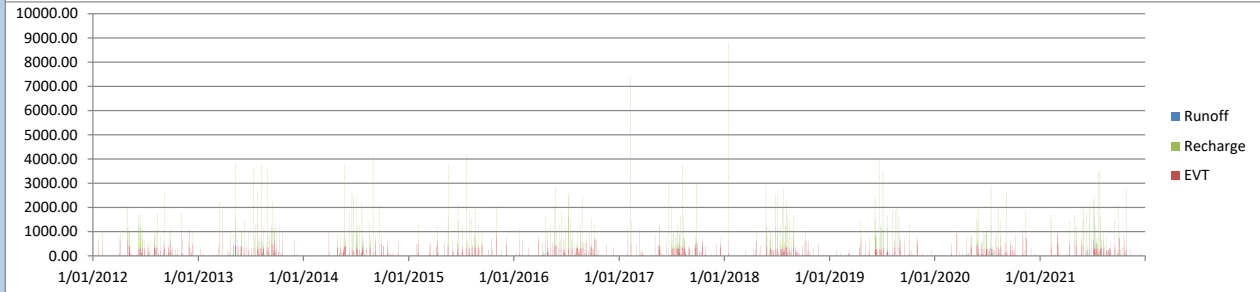
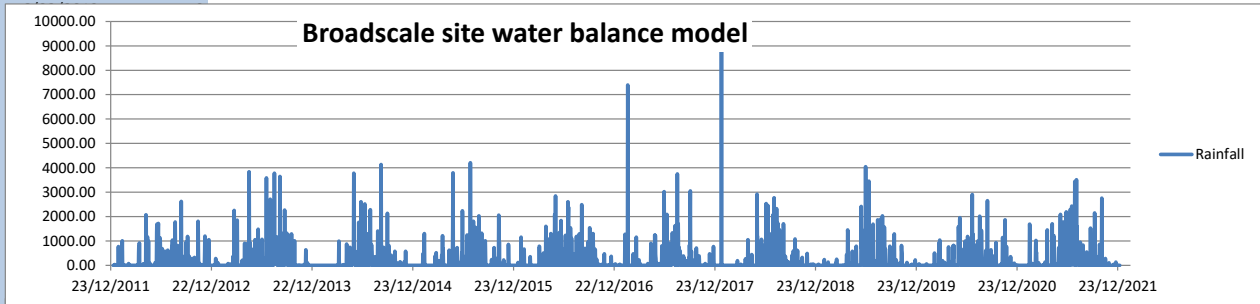
Average annual results

	Scenario 1	Scenario 2	
Rainfall (10y ave)	56.386	35.863	ML
NDW (Irrigation + leaks + overflows etc)		12.667	
EVT (10y ave)	26.188	16.962	Natural & irrigation ML
% EVT	46%	35%	
Recharge (10y ave)	30.198	31.569	Incl. 10% irrigation rtn ML
% Recharge	54%	65%	
Runoff (10y ave)	0.000	0.000	100% infiltrated on site ML
% Runoff	0%	0%	
	100%	100%	

Average monthly results - Recharge

Month	Average rainfall	
Jan	1.482	0.941
Feb	1.700	1.111
Mar	1.697	0.276
Apr	2.638	0.859
May	7.283	4.205
Jun	8.167	5.540
Jul	11.961	8.052
Aug	9.993	5.972
Sep	5.602	2.158
Oct	3.434	0.788
Nov	1.732	0.186
Dec	0.697	0.111

29/02/2012	0
1/03/2012	0
2/03/2012	0
3/03/2012	0
4/03/2012	0
5/03/2012	0



15/04/2012	0
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DRAWDOWN CALCULATION
Aventuur: Perth Surf Park
Cooper-Jacob Estimation



Scenario 1 - Parameters from Armadale Road H2 Assessment

Aquifer parameters:

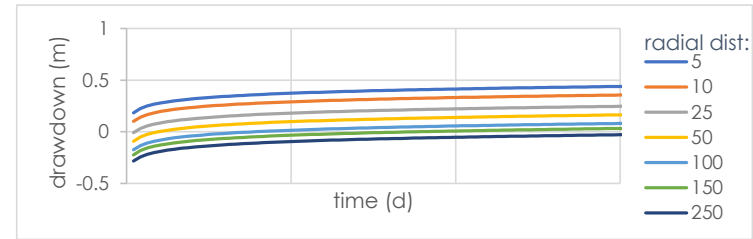
T	0.0067	m ² /s	Transmissivity	Timestep	3600	seconds
S	0.10	m ⁻¹	Specific yield	Total run time	181	days

Typical ranges (Davidson, 1995)	Transmissivity	Specific storage
Bassendean Sand	200 to 1000 m ² /day	1x10 ⁻⁶ m ⁻¹
Guildford Formation	100 m ² /day	5x10 ⁻⁵ m ⁻¹

Option 1

Pumping rate: Q 0.005 m³/s

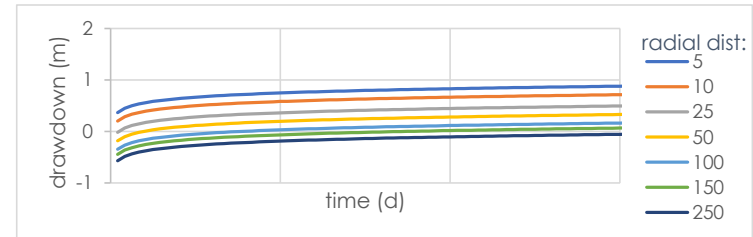
Drawdown at time:	Radial distance (r) from pumping well (m)						
	5	10	25	50	100	150	250
1 hours	0.183	0.101	-0.009	-0.092	-0.175	-0.223	-0.284
5 hours	0.280	0.197	0.087	0.004	-0.078	-0.127	-0.188
8 hours	0.308	0.225	0.115	0.032	-0.050	-0.099	-0.160
288 hours	0.522	0.439	0.330	0.247	0.164	0.115	0.054



Option 2

Pumping rate: Q 0.010 m³/s

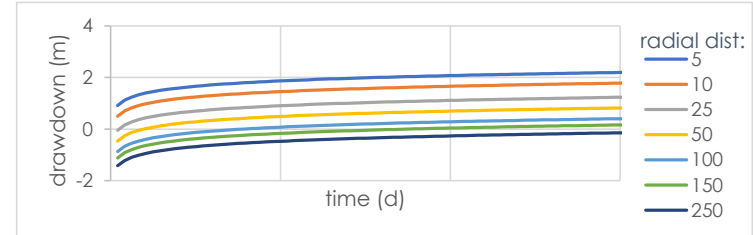
Drawdown at time:	Radial distance (r) from pumping well (m)						
	5	10	25	50	100	150	250
1 hours	0.367	0.201	-0.018	-0.184	-0.349	-0.446	-0.569
5 hours	0.559	0.394	0.175	0.009	-0.157	-0.254	-0.376
8 hours	0.616	0.450	0.231	0.065	-0.101	-0.198	-0.320
288 hours	1.044	0.878	0.659	0.493	0.328	0.231	0.109



Option 3

Pumping rate: Q 0.025 m³/s

Drawdown at time:	Radial distance (r) from pumping well (m)						
	5	10	25	50	100	150	250
1 hours	0.917	0.503	-0.045	-0.459	-0.874	-1.116	-1.421
5 hours	1.399	0.984	0.436	0.022	-0.392	-0.635	-0.940
8 hours	1.539	1.125	0.577	0.162	-0.252	-0.494	-0.800
288 hours	2.610	2.196	1.648	1.234	0.819	0.577	0.271



APPENDIX 3: ENGINEERING DETAILS



Client: Aventura Pty Ltd

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Draft report	V1	HBr	SSh	Electronic	May 2022
Final report	V2	HBr	SSh	Electronic	July 2022
Revised final report	V3	HBr	SSh	Electronic	August 2022
Revised final report	V4	HBr	SSh	Electronic	Sept 2022

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**Appendix 6 Cockburn Central East Local Structure Plan Area,
Level 1 Flora and Fauna Assessment and Addendum –
Targeted Caladenia huegelii survey (FVC 2019)**



**COCKBURN CENTRAL EAST LOCAL STRUCTURE PLAN (CCE LSP)
AREA, LEVEL 1 FLORA AND FAUNA ASSESSMENT
NOVEMBER 2016
AND
ADDENDUM - TARGETED CALADENIA HUEGELII SURVEY
JANUARY 2018**

CITY OF COCKBURN



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EXECUTIVE SUMMARY

Focused Vision Consulting Pty Ltd (FVC) was commissioned during September 2016 by the City of Cockburn (the City) to undertake a Level 1 flora, vegetation and fauna assessment of the Cockburn Central East Local Structure Plan (CCE LSP) area. The survey results are required in order to address the requirements of the Western Australian Planning Commission (WAPC) structure plan framework (WAPC 2015) for the preparation and implementation of the CCE LSP. A total of 31.21 hectares, encompassing a number of lots within the LSP were assessed for flora, vegetation and fauna values.

The biological assessment incorporated both desktop and field assessments of flora, vegetation, fauna and habitat values associated with the CCE LSP area. A single-phase Level 1 flora, vegetation, terrestrial vertebrate fauna and habitat assessment was carried out Kellie Bauer–Simpson (Principal Ecologist) and Greg Harewood (Senior Zoologist) and this report presents the findings of the assessment.

The key ecological values associated with the study area are summarised as follows:

- Several Threatened and Priority flora species were identified during the desktop review as potentially occurring at the site, although none were recorded during the assessment.
- None of the flora species recorded are of any conservation significance.
- Five intact vegetation communities and three degraded vegetation communities were described and mapped within the study area, consisting of four woodlands, two woodland/wetland vegetation types, one heath and one degraded community.
- Areas of Banksia woodland (vegetation communities BaEt and BaXp) are likely to be representative of the newly listed Commonwealth TEC; *Banksia woodlands of the Swan Coastal Plain*.
- Five fauna habitats, consisting of woodlands and woodland/wetlands, one open heath/scrub and degraded areas were described and mapped across the study area.
- Evidence of Threatened Black-cockatoos (Carnaby's Black-cockatoo and Forest Red-tailed Black-cockatoo) was recorded during the site survey, including a direct sighting of Forest Red-tailed Black-cockatoos overflying the site and evidence of both species feeding on native tree fruits.
- Evidence of the Priority 4 species, Southern Brown Bandicoot/Quenda was observed in the form of diggings and this species is likely to inhabit the areas of dense understorey within the Paperbark Woodland/Swamp habitat, as well as probably the Banksia Woodland habitat.
- Rainbow Bee-eater (*Merops ornatus*) was determined to have a moderate likelihood of occurrence in the study area, based on recorded sightings by GHD (2015) and the presence of potentially suitable habitat.
- The site supports a dampland classified as a Multiple Use wetland (UFI 5562).

Below is a summary of the outcomes of the assessment against the ten clearing principles and impact mitigation/management and/or further study recommendations and comments:

- The proposed clearing is at variance with principle 2 (b), due to the presence of suitable foraging habitat and potential breeding habitat for Threatened Black-cockatoos, and likely habitat for the migratory bird species, Rainbow Bee-eater.
 - Impact mitigating recommendations:
 - Avoid or minimise clearing areas of the Banksia Woodland habitat
 - Avoid clearing the habitat tree located at 392497 mE, 6445689 mN

- Limit ground disturbing activities (clearing and earthworks) to between February and July, which is outside the breeding season for Rainbow Bee-eater.
- The proposed clearing is at variance with principle 6 (f), due to the presence of a wetland at the site.
 - Recommendations:
 - Obtain advice from the Department of Water once concept plans are drafted, in order to achieve environmentally sensitive development in association with the wetland.
- The proposed clearing is likely to be at variance with principle 4 (d), due to the likely presence of the Banksia Woodlands TEC at the site.
 - Recommendations:
 - Undertake a follow-up assessment to confirm the presence and extent of the Banksia Woodland TEC at the site, which will also better inform potential offset requirements.
- The proposed clearing is likely to be at variance with principle 7 (g), due to the likelihood that it will cause appreciable land degradation.
 - Recommendations:
 - Consider options to offset impacts of further degradation by enhancement of areas that are currently degraded and may be retained.
- The proposed clearing may be at variance with principle 9 (i), due to the potential impacts on surface water and groundwater.
 - Impact mitigating recommendations:
 - Minimise the areas of clearing of riparian/wetland vegetation where possible.
 - Ensure suitable drainage features are incorporated into developments to avoid potential adverse impacts from run-off, and on surface and groundwater quality.
- The proposed clearing is unlikely to be, but may be at variance with principle 3 (c), due to the potential (although unlikely) presence of Threatened orchid, *Caladenia huegelii*.
 - Recommendation:
 - Consider a follow-up flora survey during early to mid-September 2017, targeting *Caladenia huegelii*, to further confirm the absence of this species. This assessment could also target other potentially occurring conservation significant flora, in order to ascertain their absence at the site.
- The proposed clearing is unlikely to be, but may be at variance with principle 10 (j), due to the potential (although unlikely) to cause flooding.
 - Recommendation:
 - Ensure suitable drainage features are incorporated into developments to avoid potential flooding.

Avoidance of the majority of the Banksia woodland area, likely to represent the TEC could be achieved by realigning the proposed North Lake Road to Beelihar Drive road alignment. Other currently proposed road alignments are considered well-placed to minimise impacts on areas of best quality vegetation and habitat within the study area.

The DotEE has advised that development of the LSP itself would not require referral, but that any impacts to identified MNES (Banksia Woodland TEC or Black-Cockatoo foraging habitat) by the City of by third parties when developing the site would require referral to the Commonwealth DotEE.

1 INTRODUCTION

1.1 BACKGROUND

Focused Vision Consulting Pty Ltd (FVC) was commissioned during September 2016 by the City of Cockburn (the City) to undertake a Level 1 flora, vegetation and fauna assessment of the Cockburn Central East Local Structure Plan (CCE LSP) area. The survey results are required in order to address the requirements of the Western Australian Planning Commission (WAPC) structure plan framework (WAPC 2015) for the preparation and implementation of the CCE LSP. A total of 31.21 hectares, encompassing a number of lots within the LSP were assessed for flora, vegetation and fauna values, as shown in **Figure 1**.

1.2 LOCATION

The study area is located approximately 20 km south of the Perth CBD, directly adjacent to the Kwinana Freeway on both the western and eastern sides. On the western side of the Freeway, the area is bounded by Kentucky Court and North Lake Road. To the east of the Freeway, the study area is comprised of numerous lots between Cutler Road and Knock Place, Cockburn Central (**Figure 1**).

1.3 SCOPE OF WORK

The scope of work included:

- a desktop study to gather relevant background and biological information on the site
- a field assessment to determine the flora (both native and weeds), vegetation (including condition), vertebrate fauna and habitat values (including habitat trees) associated with the lots
- preparation of a report that summarises the results and includes:
 - a discussion on the results, including records of listed and conservation significant flora, fauna and communities
 - consideration of the findings of the *Wetland Management and Rehabilitation Strategy for Solomon Road Wetland* (Env Australia 2007)
 - incorporation of the findings of the *City of Cockburn North Lake Road Extension Ecological Assessment* (GHD 2015)
 - a discussion on the relevant considerations, including mitigations of the road layout and relevant lot location, considering of the draft concept identified within **Figure 2**.

The scope includes a Level 1 flora, vegetation and fauna assessment, carried out in accordance with:

- EPA (2014a) Guidance Statement 51, *Guidance for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*
- EPA & DPaW (2015) *Technical Guide for Flora and Vegetation Surveys for Environmental Impact Assessment*
- EPA (2014b) Guidance Statement 56, *Guidance for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*
- EPA & DEC (2010) *Technical Guide for Terrestrial Vertebrate Fauna Surveys*
- DSEWPaC (2012) *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris; Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii; Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso.*



Legend
Survey Areas

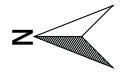


Figure 1 - Survey Area



Figure 2 CCE LSP Draft Concept

2 EXISTING ENVIRONMENT

2.1 CLIMATE

The Swan Coastal Plain has a warm Mediterranean climate which is characterised by hot dry summers and cool to mild wet winters (Mitchell *et al.*, 2002). Jandakot Airport (009172) is the closest meteorological recording station to Cockburn Central and has recorded an average annual rainfall of 824 mm (BoM, 2016).

2.2 IBRA REGION

There are 89 recognised Interim Biogeographic Regionalisation for Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (Commonwealth of Australia 2013). The study area lies within the Swan Coastal Plain IBRA region and, at a finer scale, within the Perth subregion (Mitchell *et al.* 2002).

2.3 GEOLOGY AND SOILS

The study area lies within the Bassendean Dune System which consists of very old leached sands to various depths (GHD 2015) and are the oldest of the three dunes systems occurring on the Swan Coastal Plain. Sands within this system contain very little silt or clay and very low levels of nutrient elements (ESWA 2016).

Soils within the study area are mapped as three sub units of the Bassendean System (Schoknecht *et al.* 2004). They are described as:

- 212Bs_B1 - Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands with pale yellow B horizon
- 212Bs_B2 – Flat to very gently undulating sandplain with well to moderate well drained deep bleached grey sands with a pale yellow B horizon or weak iron organic hardpan
- 212Bs_B4 – Broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depth generally greater than 1.5 m by clay or less frequently a strong iron organic hardpan.

2.4 VEGETATION

The study area is located on the Swan Coastal Plain and has been broadly characterised by Beard (1990) as “e2Mb cbLi - Medium very sparse woodland; jarrah, with low woodland; Banksia and Casuarina (Association 1001)”.

Vegetation of the Perth subregion comprises heath and/or Tuart (*Eucalyptus gomphocephala*) woodlands on limestone, Jarrah (*Eucalyptus marginata*) and *Banksia* woodlands on Quaternary marine dunes and Marri (*Corymbia calophylla*) on colluvial and alluvial sands (Mitchell *et al.* 2002).

Vegetation complexes within the study area have been defined by Heddle *et al.* (1980) and are based on vegetation in association with landforms and underlying geology. One vegetation complex Bassendean complex – central and south as described by Heddle *et al.* (1980) occurs within the study area. This complex ranges from woodlands of *Eucalyptus marginata*, *Allocasuarina* and *Banksia* on sand dunes to a low woodland of *Melaleuca* species, and sedge lands on the low-lying depressions and swamps.

3 METHODOLOGY

The biological assessment incorporated both desktop and field assessments of flora, vegetation, fauna and habitat values associated with the CCE LSP area (**Figure 1**). A single-phase Level 1 flora, vegetation, terrestrial vertebrate fauna and habitat assessment was carried out Kellie Bauer–Simpson (Principal Ecologist) and Greg Harewood (Senior Zoologist) on 27 September, with a follow-up visit on 29 September 2016.

The assessments were carried out in accordance with all relevant legislation, including EPA policies, guidance statements and regulations relating to flora and fauna assessments in Western Australia, including:

- EPA (2002) Position Statement 3: *Terrestrial Biological Surveys as an Element of Biodiversity*
- EPA (2014a) Guidance Statement 51, *Guidance for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*
- EPA & DPaW (2015) *Technical Guide for Flora and Vegetation Surveys for Environmental Impact Assessment*
- EPA (2014b) Guidance Statement 56, *Guidance for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*
- EPA & DEC (2010) *Technical Guide for Terrestrial Vertebrate Fauna Surveys*.
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Wildlife Conservation Act 1950* (WC Act).

3.1 DESKTOP REVIEW

A review of publicly available information and site-specific information provided by the City was undertaken. The information reviewed included:

- DPaW NatureMap Species Report (**Appendix A**); generated on 26 September 2016, providing:
 - flora and fauna species listed as rare (Threatened (T)) or likely to become extinct
 - flora and fauna species protected under international agreements (IA)
 - other specially protected fauna (Scheduled)
 - flora and fauna species listed as Priority 1 to 5 (P1, P2, P3, P4, P5)
 - other non-conservation taxa recorded or know to the area.
- EPBC Act Protected Matters (Matters of National Environmental Significance (MNES)) (**Appendix B**); search for the project area; generated on 26 September 2016, providing results relevant to:
 - the following MNES:
 - World Heritage Properties
 - National Heritage Places
 - Wetlands of International Importance
 - Great Barrier Reef Marine Park
 - Commonwealth Marine Areas
 - Listed Threatened Ecological Communities (TECs)
 - Listed Threatened Species (flora and fauna)
 - Listed Migratory Species
 - the following other matters protected by the EPBC Act:
 - Commonwealth Land
 - Commonwealth Heritage Places
 - Listed Marine Species
 - Whales and other Cetaceans

- Critical Habitats
 - Commonwealth Reserves (Terrestrial)
 - Commonwealth Reserves (Marine).
- spatial data provided the City of Cockburn for:
 - known or previously recorded occurrences of Threatened flora across the entire City
 - regional data for geomorphic wetlands
- DPaW database search results for:
 - Threatened and Priority flora, searched for within a 5 km buffer of the study area
 - Threatened, Priority and conservation significant vertebrate fauna, searched for within a 3 km buffer of the study area
 - Threatened and Priority Ecological Communities, searched for within a 5 km buffer of the study area (*results not yet received at time of issue of this draft report*)
- relevant technical reports:
 - GHD (2015) North Lake Road Extension Ecological Assessment. Unpublished report for the City of Cockburn.
 - ENV Australia (2007) Wetland Management and Rehabilitation Strategy – Solomon Road Wetland. Unpublished report for the City of Cockburn.
 - 360 Environmental (2012). Lots 124 and 125 Frankland Avenue Hammond Park: Graceful Sun Moth Survey & Site Based (Lomandra) Habitat Assessment. Report prepared for WorldStyle Furniture Wholesaler, Perth.
 - Bamford Consulting Ecologists (2011). Threatened Fauna Assessment: Lots 42-44 Frankland Road, Hammond Park. Report prepared for Bayley Environmental Services.
 - Bamford Consulting Ecologists (2012). Lot 123 Wattleup Road, Hammond Park. Significant Fauna Assessment. Report prepared for Bayley Environmental Services.
 - Ecoscape (2009). Fauna Survey for Lots 13, 14 and 18 Barfield Road and Lots 48-51 Rowley Road, Hammond Park. Unpublished report for Gold Estates and the Department of Housing.
 - Emerge Associates (Emerge) (2011). Level 1 Fauna Survey and Habitat Assessment - Various Allotments, Mandogalup. Unpublished report prepared for Qube Mandogalup Land Development Company.
 - ENV (2009). Jandakot Airport Fauna Survey. Unpublished report for Jandakot Airport Holdings Pty Ltd.
 - GHD (2012). Report for Hammond Park Primary School. Flora and Fauna Assessment. Unpublished report for the Department of Education.
 - Harewood, G. (2005). Fauna Assessment, Mandogalup. Unpublished report for Cardno BSD.
 - Harewood, G. (2006). Fauna Assessment, Lot 121 Wattleup Road, Wattleup. Unpublished report for Cardno BSD.
 - Harewood, G. (2009). Fauna Survey (Level 2) East Rockingham WWTP Site & Pipeline Corridors. Unpublished report for ERM.
 - Harewood, G. (2011a). Fauna Assessment Lot 9001 and Lot 35 Barfield Road, Hammond Park. Unpublished report for Mainlake Holdings Pty Ltd.
 - Harewood, G. (2011b). Fauna Underpass Monitoring Spring 2010 – Perth Mandurah Rail Line. Unpublished report for the Public Transport Authority of Western Australia.
 - Harewood, G. (2014a). Fauna Assessment of Lot 33 Barfield Road, Hammond Park. Unpublished report for West Coast Plan (on behalf of the Passione Family).
 - Harewood, G. (2014b). Fauna Assessment of Lots 109 and 110 Wattleup Road, Hammond Park. Unpublished report for Emerge Associates.

- o Harewood, G. (2014c). Fauna Assessment of Lots 1, 111 & 810 Wattleup Road, Hammond Park. Unpublished report for Emerge Associates.
- o Phoenix Environmental Sciences (2011). Vertebrate Fauna Survey for the Roe Highway Extension Project. Unpublished report for South Metro Connect.
- o Strategen (2013). Mandogalup Black Cockatoo Habitat Survey. Unpublished Report for Satterley Property Group.
- o Terrestrial Ecosystems (2012). Level 1 Fauna Assessment for Hammond Park Primary School. Unpublished report for Taylor Robinson.

Species lists produced from the abovementioned literature reviews contain observations/inferred distributions from a broader area than the subject site and therefore may include fauna species that would only ever occur as vagrants. The databases also often include or are based on very old records and in some cases, certain flora and fauna species have become locally or regionally extinct. Database errors and anomalies exist also, for example, results returned from DPaW for the Threatened and Priority Flora database search included a result for a Threatened species that occurs at Mt Success on the south coast of Western Australia, which has been confused with the locality of Success, within which some of the study area occurs.

Information from these sources is therefore only taken as indicative and local knowledge and information is taken into consideration when determining what actual species may be present within the specific area being investigated. Species considered errors or unlikely to be present even if resulting from database searches are not shown in the potential species lists or results.

The review of the above information provided guidance for field preparations and has assisted in the preparation of this report.

3.2 FIELD ASSESSMENT

3.2.1 Flora and Vegetation Assessment

The single-phase Level 1 field flora and vegetation assessment was undertaken by Principal Ecologist, Kellie Bauer-Simpson on 27 and 29 September 2016, utilising non-permanent quadrats to characterise vegetation where it was determined to be in good or better condition. Observations and opportunistic data collection was also carried out continuously within and throughout the study area with a particular focus on Threatened and Priority flora and ecological communities, potentially supported by the sites.

Field data was collected from five quadrats, representing of each of the intact vegetation communities present. Each quadrat was recorded in accordance with Guidance Statement 51 to collect information to define the vegetation communities and the floristic diversity. Site-specific data was also collected from relevés in areas in poorer condition than good, to define the degraded vegetation types present.

The vegetation communities present within the study area was described to National Vegetation Information System (NVIS) Level 5, in accordance with the applicable methodologies (DEH 2003) in combination with the Muir (1977) Structural Vegetation Classifications (**Appendix C**).

The condition of the vegetation was documented at each quadrat and relevé and at appropriate locations between, in accordance with the Vegetation Condition Scale adapted from Keighery (1994) and Trudgen (1988), and as per the Technical Guide for Flora and Vegetation Assessments (EPA & DPaW 2015) (**Table 1**).

Table 1: Vegetation Condition Scale (adapted from Keighery (1994) and Trudgen (1988))

Vegetation Condition Rating	Description (for South West and Interzone Botanical Provinces)	Former Rating Category (Keighery 1994)
1	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.	Pristine
2	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.	Excellent
3	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Very Good
4	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	Good
5	<i>NA for South West and Interzone Botanical Provinces</i>	NA
6	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.	Degraded
7	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 and shrubs.	Completely Degraded

Flora identifications were undertaken by specialist taxonomist, Udani Sirisena. Plant group specialist taxonomists may be consulted if required for challenging identifications. Taxonomy and nomenclature will follow current protocols of the WA Herbarium. The data processing task allows for the preparation of species lists, including those for collected flora specimens, once identified.

The spatial extent of each of the observed vegetation communities, varying vegetation condition within the site were mapped using an electronic tablet equipped with the mobile mapping software, MAPPT™, using a customised data collection form, digitising spatial extents onto georeferenced aerial imagery and recording other information including geo-tagged photographs.

3.2.2 Fauna Assessment

A day time Level 1 fauna assessment was conducted by Senior Zoologist Greg Harewood, on 27 September 2016, in accordance with EPA (2014b) and EPA & DEC (2010), incorporating results of the desktop assessment in accordance with the guidelines, plus a field assessment addressing habitat mapping, targeted survey for relevant fauna species of conservation significance, and collection of a terrestrial vertebrate fauna species list, from all opportunistic observations made on site. The site was also visited at dusk on the same day to observe potential night roosting activities on Black-cockatoos.

Fauna species and direct evidence of fauna activity was observed and recorded continuously whilst on site. Secondary evidence of a species presence such as tracks, scats, skeletal remains, foraging evidence or calls were also noted if observed/heard.

The fauna habitats present within the study area were described based on site observations and detailed vegetation community data, and taking into account aspects important to fauna such as soil, rocks, bare ground, leaf litter, wood (woody debris, logs, etc.), lower and ground strata density (cover), canopy height/cover/density and presence of or proximity to surface water.

3.2.2.1 Targeted Black-cockatoo Assessment

Particular attention was focused on Black-cockatoos and their suitable habitat within the study area. A targeted survey for Black-cockatoos was conducted utilising *Referral guidelines for three threatened black cockatoo species* (DSEWPaC 2012), as endorsed by the Commonwealth Department of the Environment and Energy (DotEE), and as such required that the survey:

- be carried out by a suitably qualified person with experience in vegetation or cockatoo surveys, depending on the type of survey being undertaken
- maximise the chance of detecting the species' habitat and/or signs of use
- determine the context of the site within the broader landscape; for example, the amount and quality of habitat nearby and in the local region (for example, within 10 km)
- account for uncertainty and error (false presence and absences)
- include collation of existing data on known locations of breeding and feeding birds and night roost locations.

The targeted survey for Black-cockatoos aimed to record any observed individuals either at the site or as an overfly observation, any evidence of their activity (e.g. chewed Marri nuts or Banksia cones), as well as habitat suitable for nesting/breeding, roosting or foraging. Such suitable habitat was mapped, with areas quantified.

The various habitats suitable for Black-cockatoos were identified in accordance with the categories outlined in **Table 2**.

Table 2: Black-cockatoo Habitats Surveyed

Habitat	Examples
Foraging habitat	Food source plants for Black-cockatoos include Jarrah (<i>Eucalyptus marginata</i>), Marri (<i>Corymbia calophylla</i>), Proteaceous species such as <i>Banksia</i> , <i>Hakea</i> and <i>Grevillea</i> , <i>Allocasuarina</i> , and <i>Anigozanthos</i> and introduced species such as Pines (<i>Pinus</i> spp.) and Cape Lilac (<i>Melia azedarach</i>), but also <i>Erodium</i> spp. and various species grown for fruit, nuts and seeds which grow in native shrubland, heathland, woodland or forest and agricultural areas.
Night roosting habitat	These habitats include suitable trees (<i>Eucalyptus</i> or <i>Corymbia</i>) within or near riparian environments or natural or artificial water sources.
Breeding/nesting habitat	Any patch of woodland or forest that contains <i>Eucalyptus</i> or <i>Corymbia</i> trees with either a diameter at breast height of greater than 500 mm or with suitable nest hollows. More specifically, all individual trees observed to support suitable hollows within the study area.

A tree habitat survey was also included to specifically observe suitable trees within the study area to assess their status as a breeding/nesting tree, with or without hollows, or as potential future nesting trees (with a diameter at breast height (DBH) of 500 mm or greater).

Target tree species included Tuart, Jarrah and Flooded Gum, or any other *Corymbia*/*Eucalyptus* species of a suitable size that may have been present. *Banksia*, Sheoak and *Melaleuca* tree species were not assessed as they typically do not develop suitably large hollows that are used by Black-cockatoos.

The location of each tree identified as being over the threshold DBH was recorded with a GPS and details on tree species, number and size of hollows (if any) were noted. Trees observed to contain hollows (of any size/type) were marked with "H" using spray paint for easy future reference.

Based on this assessment, trees present within the subject site have been placed into one of four categories:

- Tree <50cm DBH or an unsuitable species (not recorded)
- Tree >50cm DBH, a habitat tree, but with no hollows observed
- Tree >50cm DBH, one or more hollows observed, none of which were considered suitable for Black-cockatoos to utilise for nesting
- Tree >50cm DBH, one or more hollows observed, with at least one hollow considered suitable for Black-cockatoos to utilise for nesting.

For the purposes of this assessment a tree containing a potential cockatoo nest hollow was defined as:

Generally, any tree which is alive or dead that contains one or more visible hollows (cavities within the trunk or branches) suitable for occupation by a black cockatoo for the purpose of nesting/breeding. Hollows that had an entrance greater than about 10cm in diameter and would allow the entry of a black cockatoo into a suitably orientated and sized branch/trunk were recorded as a "potential black cockatoo nest hollow".

Identified hollows were examined using binoculars for evidence of actual use by Black-cockatoos (e.g. chewing around hollow entrance, scarring and scratch marks on trunks and branches). Trees with possible nest hollows were also scratched and raked with a large stick/pole in attempt to flush any sitting birds from hollows and calls of chicks were also listened for.

The location and nature of Black-cockatoo foraging evidence (e.g. chewed fruits around base of trees) observed during the reconnaissance survey was recorded. The nature and extent of potential foraging habitat

present was also documented irrespective of the presence of any actual foraging evidence, based on the broader habitat mapping.

Direct and indirect evidence of Black-cockatoos roosting within trees within the study area was noted if observed (e.g. branch clippings, droppings or moulted feathers). A visit to the site at dusk was also carried out to make relevant observations of night roosting activity.

4 RESULTS

4.1 DESKTOP REVIEW

4.1.1 Significant Species

The DPaW database search results, NatureMap Species Report and the MNES Report all returned results for the potential presence of conservation significant flora and fauna in the region of the study area. Of particular importance were the results for the potential occurrence of the following Threatened and Commonwealth listed species:

- flora:
 - *Andersonia gracilis*
 - *Caladenia huegelii*
 - *Diuris micrantha*
 - *Diuris purdiei*
 - *Drakaea elastica*
 - *Drakaea micrantha*
 - *Lepidosperma rostratum*
- fauna:
 - Australasian Bittern (*Botaurus poiciloptilus*)
 - Curlew Sandpiper (*Calidris ferruginea*) (also migratory)
 - Forest Red-tailed Black-cockatoo (*Calyptorhynchus banksii naso*)
 - Carnaby's Black-cockatoo (*Calyptorhynchus latirostris*)
 - Malleefowl (*Leipoa ocellata*)
 - Numbat (*Myrmecobius fasciatus*)
 - Eastern Curlew (*Numenius madagascariensis*)
 - Australian Painted Snipe (*Rostratula australis*)
 - Chuditch (*Dasyurus geoffroi*)
 - Western Ringtail Possum (*Pseudocheirus occidentalis*)
- migratory birds:
 - Fork-tailed Swift (*Apus pacificus*)
 - Grey Wagtail (*Motacilla cinerea*)
 - Osprey (*Pandion haliaetus*)
 - Common Greenshank (*Tringa nebularia*)
 - Wood Sandpiper (*Tringa glareola*)
 - Marsh Sandpiper (*Tringa stagnatilis*)
 - Rainbow Bee-eater (*Merops ornatus*)
 - Eastern Curlew (*Numenius madagascariensis*)
 - Great Egret (*Ardea alba*)
 - Cattle Egret (*Ardea ibis*)
 - White-bellied Sea-Eagle (*Haliaeetus leucogaster*)
 - Sharp-tailed Sandpiper (*Calidris acuminata*)
 - Pectoral Sandpiper (*Calidris melanotos*)
 - Red-necked Stint (*Calidris ruficollis*)
 - Long-toed Stint (*Calidris subminuta*)
 - Little-ringed Plover (*Charadrius dubius curonicus*)
 - Black-tailed Godwit (*Limosa limosa*)
 - Glossy Ibis (*Plegadis falcinellus*)
 - Pacific Golden Plover (*Pluvialis fulva*)
 - Grey Plover (*Pluvialis squatarola*)

- Peregrine Falcon (*Falco peregrinus*).

The following Priority listed species also returned results:

- flora:
 - *Acacia lasiocarpa* var. *bracteolate* - long peduncle variant (G.J. Keighery 5026) (P1)
 - *Thelymitra variegata* (P2)
 - *Amanita drummondii* (P3)
 - *Amanita fibrilloses* (P3)
 - *Byblis gigantea* (P3)
 - *Cyathochaeta teretifolia* (P3)
 - *Dampiera triloba* (P3)
 - *Dodonaea hackettiana* (P3)
 - *Eryngium pinnatifidum* subsp. *palustre* (G.J. Keighery 13459) (P3)
 - *Jacksonia gracillima* (P3)
 - *Phlebocarya pilosissima* subsp. *pilosissima* (P3)
 - *Stylidium paludicola* (P3)
 - *Microtis quadrata* (P4)
 - *Ornduffia submerse* (P4)
 - *Stylidium longitubum* (P4)
 - *Thysanotus glaucus* (P4)
 - *Tripterococcus* sp. *Brachylobus* (A.S. George 14234) (P4)
 - *Verticordia lindleyi* subsp. *lindleyi* (P4).
- fauna:
 - Cricket (*Throscodectes xiphos*) (P1)
 - Lined Skink (*Lerista lineata*) (P3)
 - Western Brush Wallaby (*Macropus irma*) (P4)
 - Blue-billed Duck (*Oxyura australis*) (P4)
 - Graceful Sunmoth (*Synemon gratiosa*) (P4)
 - Southern Brown Bandicoot (*Isodon obesulus fusciventer*) (P4).

Spatial data for Threatened flora in the region provided by the City of Cockburn also shows previously recorded occurrences of *Caladenia huegelii* and an unnamed species (likely also *Caladenia huegelii*) in areas from 1.7 km to the east of the study area. The distance between these populations and the study area is such that any proposed development or clearing would have no impact, including indirect impacts, on these populations.

4.1.1.1 Fauna Literature Review Results

Given the mobile nature of fauna, greater efforts in building potential species lists are warranted. Therefore, a review of several relevant reports as listed in Section 3.1 was also carried out. The compiled list, which also incorporates observed and recorded species from the field assessment is presented in **Appendix D**.

The list of potential fauna presented in **Appendix D** assumes that each species listed is not known to be locally extinct and that suitable habitat for each species, as identified during the habitat assessment, is present within the study area. However, the list presented is likely to be an overestimation of the fauna species that actually use the site for some purpose.

With respect to native vertebrate fauna, 11 mammals (including eight bat species), 97 bird, 26 reptile and 10 frog species have previously been recorded in the general vicinity of the CCE LSP study area, some of which

have the potential to occur in or utilise sections of the study area at times. Twelve species of introduced animals could also frequent the area.

Of the 143 native animals that are listed as potentially occurring in the area, three are considered to be endangered/vulnerable or in need of special protection under State and/or Commonwealth legislation. In addition, two migratory and two DPaW priority species are also listed as potentially present (some likely only on a seasonal basis).

4.1.2 Threatened and Priority Ecological Communities

A DPaW database search for Threatened and Priority Ecological Communities within a 5 km buffer of the study area was requested on 20 September 2016. Results of search 15-01216EC showed that the recently listed Endangered ecological community of Commonwealth significance, *Banksia Woodlands of the Swan Coastal Plain* occurs within the study area. At a State level, various sub-types of this community type are also listed as Priority Ecological Communities (PECs). No other TECs or PECs are known to be supported by the study area, based on the database search results.

The MNES Report (**Appendix B**) identified the potential presence of one Threatened Ecological Community (TEC) within the study area. The Endangered TEC – *Banksia Woodlands of the Swan Coastal Plain*, is typically described as having a prominent tree layer of Banksias with scattered Eucalypts and a species rich understorey of sclerophyllous shrubs, graminoids and forbs (DotEE, 2016a).

4.1.3 Wetlands

The study area supports one geomorphic “Multiple Use” Dampland across approximately one third of the site, in the northern sections. This area is characterised by the damper vegetation types supporting *Melaleuca* and a higher density of *Xathorrhoea preissii*. No other water waterways or wetlands are present within the immediately adjacent areas or are linked to the study area through surface drainage (GHD, 2015).

The MNES report also included reference to the occurrence of Ramsar wetlands, Forrestdale and Thomsons Lakes, within 10 km. However, these results are not of significance as any proposed clearing or development would be unlikely to impact either of these Ramsar sites.

4.2 FIELD ASSESSMENTS

4.2.1 Flora

A total of 107 flora species from 90 genera and 44 families were recorded during the field survey. The total includes 62 (57.9%) native species and 45 (42.1%) introduced (weed) species. The most dominant families recorded were Fabaceae and Myrtaceae. The full list of vascular flora species recorded and representative communities in which they occur are detailed in **Appendix E**.

None of the recorded flora species are listed as Threatened under the WC Act or under the EPBC Act, nor are any listed as Priority Flora under the WC Act.

Four of the introduced (weed) species recorded are listed as Declared Pest plants under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). These are:

- **Asparagus asparagoides* (Bridal Creeper)
- **Echium plantagineum* (Paterson's Curse)
- **Zantedeschia aethiopica* (Arum Lily)
- **Gomphocarpus fruticosus* (Narrow-leaf Cotton Bush)

Declared Pest species require management under the BAM Act and are categorised as follows:

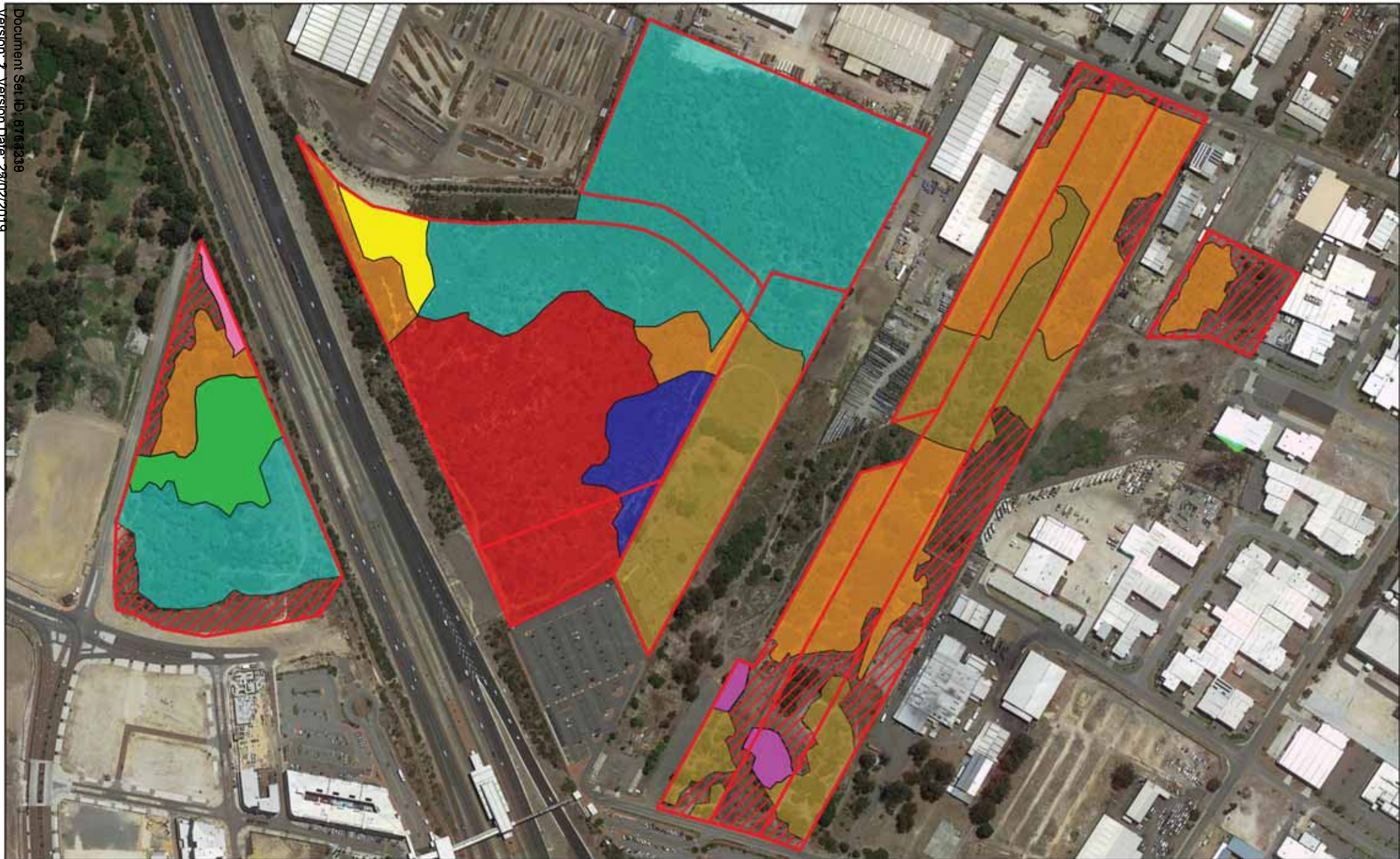
- C1 – Exclusion
- C2 – Eradication
- C3 – Management.

**Asparagus asparagoides* and **Zantedeschia aethiopica* require C3 management for the whole of the State. **Echium plantagineum* and **Gomphocarpus fruticosus* require C3 management in a variety of areas around the State but no specific management is required within the study area (DAFWA 2016).

4.2.2 Vegetation

Five intact and three degraded vegetation communities were described and delineated within the study area. This comprised of four woodlands, two woodland/wetland vegetation types, one heath and one degraded community/habitat which is a mosaic of shrublands (mostly introduced/non-endemic shrubs) and grasslands (introduced grasses/weeds). Each community is described in **Appendix F** and spatially mapped in **Figure 3**.

The condition of the vegetation was found to range from rating 3- 4 (Good to Very Good) to rating 7 (Completely Degraded). The majority of the study area is considered to be in Degraded to Good condition. The varying vegetation condition across the study area is presented in **Figure 4**.



0 50 100 150 200 m



Figure 3 - Vegetation Communities

Legend

- | | | | |
|--------------|----------|--------|---------|
| Survey Areas | Eg (d) | Mp (d) | i |
| BeEt | ErAl (d) | MpAl | Cleared |
| BaXp | Mp | Xp | |



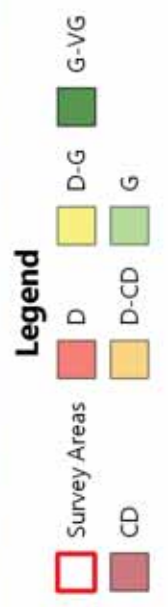


Figure 4 - Vegetation Condition

4.2.3 Fauna

Opportunistic fauna observations made during the September 2016 field survey are listed in **Appendix D**. A total of 25 native fauna species were observed (or positively identified from foraging evidence, scats, tracks, skeletons or calls) within the study area during the one day survey period. The use of the study area by five introduced species was also confirmed.

Evidence of three fauna species of conservation significance was observed during the field assessment. Carnaby's Black-cockatoo, listed as Endangered under the EPBC Act and as Schedule 2 under the WC Act was observed from evidence of chewed Banksia cones. The Forest Red-tailed Black-cockatoo, listed as Vulnerable under the EPBC Act and as Schedule 3 under the WC Act was observed flying overhead during the field survey and GHD also recorded this species flying over the area in 2015 (GHD 2015). Further evidence of this species' use of the site was evidenced from chewed Coastal Blackbutt (*Eucalyptus todtiana*) fruits. Diggings attributed to the Southern Brown Bandicoot/Quenda, a DPaW-listed Priority 4 species, were also found at several locations.

A fauna assessment of some areas of the currently defined study area was carried out by GHD in October 2015. During this assessment, which included a single day survey by a zoologist, in addition to several days by ornithologists from Birdlife Australia, 34 native fauna species were recorded. Eight introduced species were also observed.

GHD reported both Carnaby's and Forest Red-tailed Black-cockatoos as flying over the area, and the Rainbow Bee-eater (listed migratory species) was observed nesting in a sand embankment along North Lake Road. Evidence of the Southern Brown Bandicoot was also observed and the Perth Lined Lerista (skink; DPaW Priority 3 species) was also recorded.

Combining the results of the September 2016 field assessment and those of the GHD (2015) field assessment, a total of 47 fauna species have been recorded within the study area (as summarised in **Table 3**), these being comprised of:

- 34 birds (including four introduced species)
- five reptiles
- six mammals (including four introduced species)
- two frogs.

Table 3: Summary of Potential Vertebrate Fauna Species

Group	Total No. Potential Species	Potential No. Specially Protected Species	Potential No. Migratory Species	Potential No. Migratory Species	No. Species Recorded in Study Area During Survey
Amphibians	10	0	0	0	2
Reptiles	26	0	0	1	5
Birds	103 ⁶	3	2	0	34 ⁴
Non-Volant Mammals	9 ⁶	0	0	1	6 ⁴
Volant Mammals (Bats)	8	0	0	0	0
Total	155¹²	3	2	2	47⁸

NB: Detailed results presented in Appendix D

Superscript = No. of introduced species included in total

4.2.4 Fauna Habitats

Despite significant disturbance in some areas from past and current land uses, some sections of the study area are in relatively good condition and provide value as habitat to native fauna.

The study site was found to support five habitat types, consisting of woodlands and woodland/wetlands, one open heath/scrub and degraded areas. The five fauna habitats recorded are described below and their spatial extent across the study area is presented in **Figure 5**.

4.2.4.1 *Banksia Woodland*

The Banksia Woodland habitat consists of an overstorey of Banksia species (*Banksia attenuata*, *Banksia menziesii* and *Banksia ilicifolia*), occasionally with Coastal Blackbutt (*Eucalyptus todtiana*), over native shrubs and herbs, as well as grassy weeds in more degraded areas. The soils are deep, loose sands, mostly pale grey, but also light brown with some more loamy constituents in lower lying areas. The overstorey layer is up to 7 m tall and sparse in some areas, but denser in areas of better condition. The native understorey is degraded in some areas, but annually (during late winter and spring) is quite densely covered in weeds, and provides a moderate leaf litter cover. Many of the mid-strata shrubs, such as Grasstrees which dominate throughout the habitat, have foliage mostly down to the ground, providing good coverage for ground dwelling mammals and reptiles and with spacing suitable to enable easy movement. The open sand lenses are known to provide suitable habitat for the Perth Lined Lerista (Priority 4). The composition of Proteaceous species and other food source plants (e.g. *Eucalyptus todtiana*) for Threatened Black-cockatoos is quite abundant and varied, including most significantly, the presence of consistent Banksia stands. This habitat type does not support large trees suitable for nesting or night roosting habitat for Black-cockatoos.

4.2.4.2 *Paperbark Woodland/Swamp*

The Paperbark Woodland/Swamp habitat occurs in lower lying areas of the study site and is dominated by *Melaleuca preissiana*, which occurs occasionally with the introduced shrub, **Acacia longifolia* and mostly occurs over native shrubs such as *Hypocalymma angustifolium* or over dense stands of weeds, commonly **Fumaria capreolata*. The understorey density is similar across the habitat during late winter and spring, regardless of whether it consists of native species or weeds, and in such densities, provides ideal habitat for small ground-dwelling mammals and reptiles, including Southern Brown Bandicoots, for which evidence was apparent during the field assessment. Soils in the Paperbark Woodland/Swamp habitat type range from grey sands to brown loamy sands in the lower lying and wetter areas in the centre of the section west of the freeway, and in the northern-most sections north of the train station carpark. Soils are heavier and more compact than in the Banksia Woodland habitat. The overstorey is up to 9 m tall, with some very old and tall *Melaleuca preissiana* specimens present. There are few species present that provide foraging habitat for Threatened Black-cockatoos and large trees suitable for nesting or night roosting habitat for Black-cockatoos are largely absent. However, a single stag (historic death) Flooded Gum (*Eucalyptus rudis*) tree with a hollow considered potentially suitable for Black-cockatoo nesting is present (**Figure 6**).

4.2.4.3 *Tall Open Woodland*

The Tall Open Woodland habitat consists of an overstorey of tall (to over 15 m) Eucalypts, over little or no native understorey, ranging from sparse stands of the introduced **Acacia longifolia* to areas of little more than introduced grasses and other weeds. In this habitat, the trees are mature and most present are habitat trees with a DBH greater than 500 mm (**Figure 6**). Although areas of this habitat type interface closely with infrastructure and human activity (train station carparks and the Kwinana Freeway), which limits habitat potential at a ground-level, the height of the canopy provides excellent habitat for birds, including potential

nesting and night-roosting opportunities for Black-cockatoos; although no evidence of either activity was observed during the field assessment, nor is considered likely. No Black-cockatoo foraging habitat is present within this habitat type.

4.2.4.4 Open Heath

The Open Heath habitat is represented in a small section of the study area and consists of Grasstrees over an understorey of native shrubs, sedges and rushes, predominantly *Dasypogon bromeliifolius* and *Phlebocarya ciliata*, also with a relatively high abundance of introduced grasses. There are very few trees present, consisting mostly of sparse Banksias. The bare ground proportion in this habitat type is low, providing excellent coverage for reptiles and to a lesser degree, small mammals. The substrate is relatively soft, loose grey sands, well-suited to burrowing fauna. There is a lack of suitable foraging, nesting and night-roosting habitat for Threatened Black-cockatoos in the Open Heath habitat.

4.2.4.5 Degraded Open Areas

The Degraded Open Areas provide very little habitat for native fauna, with a high potential for vulnerability to native and introduced predators in most areas. This habitat type consists of mostly cleared areas supporting dense areas of weeds. A section in the north, immediately east of the Freeway includes rehabilitation which is sparse and appears to be regeneration of the Paperbark Woodland/Wetland habitat. Some areas of the study area, in the east and north-eastern sections support this habitat type in the form of mostly introduced and disturbance shrubs; mostly *Leptospermum laevigatum* (Victorian Teatree) and *Adenanthos cygnorum*, a native disturbance opportunist. In such areas, although not naturally occurring nor endemic, better coverage, food sources and therefore habitat is provided, which is more akin to that of the intact woodland habitats. There is a lack of suitable foraging, nesting and night-roosting habitat for Threatened Black-cockatoos in the Open Degraded Areas.



- Legend**
- Degraded open areas
 - Paperback Woodland/Swamp
 - Banksia Woodland
 - Open Heath
 - Tall open woodland
 - Survey Areas



Figure 5 - Fauna Habitats



- Legend**
- Survey Areas
 - Jarrah (Hollow/s)
 - Flooded Gum (Potential Black-cockatoo nest)
 - Tuart
 - Eucalyptus sp.
 - Flooded Gum (Hollow/s)
 - Tuart (Hollow/s)

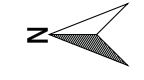


Figure 6 - Habitat Trees

4.2.5 Black-cockatoo Habitat Assessment

4.2.5.1 Breeding Habitat

The trees of the study area were assessed for their suitability in providing nesting habitat for Black-cockatoos, in accordance with DotEE criteria (DSEWPaC 2012). A number of trees were found to represent habitat trees, with a DBH of 500 mm or greater, consisting of representatives from the following suite of species, the locations of which are shown in **Figure 6**, with a summary provided in **Table 4**:

- Tuart - *Eucalyptus gomphocephala*
- Jarrah – *Eucalyptus marginata*
- Flooded Gum – *Eucalyptus rudis*
- planted, non-endemic *Eucalyptus* species.

One occurrence of a Flooded Gum which is an historic death (stag tree) provides a hollow considered suitably to potentially provide nesting/breeding habitat for Black-cockatoos (**Figure 6**).

Table 4: Summary of Potential Black-cockatoo Habitat Trees (DBH ≥ 500 mm) Recorded

Lot No.	Total No. Habitat Trees	No. Trees with no Hollows Observed	No. Trees with Hollows Considered Unsuitable for BC Nesting	No. Trees with Hollows Considered <u>Possibly</u> Suitable for BC Nesting	Tree Species			
					Tuart	Jarrah	Flooded Gum	Euc. sp. (non-endemic)
33	8	6	2	0	8	0	0	0
36	4	4	0	0	4	0	0	0
801	1	0	1	0	0	0	1	0
802	1	0	0	1	0	0	1	0
9500	4	2	2	0	0	2	0	2
Total	18	12	5	1	12	2	2	2

The field assessment identified 18 habitat trees (trees with a DBH of >500 mm) (**Figure 6**). Most trees (12) appeared not to contain hollows of any size. Five trees appeared to contain small hollows or possible small hollows, considered by unlikely to be suitable for Black-cockatoos to use for nesting purposes. One of these hollows appeared to be in use by Galahs.

One tree was identified as containing a hollow that appeared possibly big enough to allow the entry of a Black-cockatoo into a suitably sized and orientated trunk, but no evidence of actual use was observed. The probability of this actually representing a hollow that would be used by black cockatoos can be regarded as being very low.

Additional details on each habitat tree observed can be found in **Appendix G**.

4.2.5.2 Foraging Habitat

Following is a list of the key flora species recorded within the study area during the fauna assessment that are known to be used as a direct food source (i.e. fruits or flowers) by one or more species of Black-cockatoo:

- Jarrah - *Eucalyptus marginata*
- Coastal Blackbutt - *Eucalyptus todtiana*
- Sheoak - *Allocasuarina fraseriana*
- Candlestick Banksia - *Banksia attenuata*
- Firewood Banksia - *Banksia menziesii*
- Holly-leaved Banksia - *Banksia ilicifolia*
- Grass Tree - *Xanthorrhoea preissii*.

A number of other tree/shrub species present (e.g. Tuart, Flooded Gum and Acacia species) are also utilised as a food source by Black-cockatoos, but to a much lesser degree than those listed.

Some evidence of Black-cockatoos foraging onsite was observed during the field assessment, in the form of chewed Banksia cones (*Banksia attenuata* and *Banksia menziesii*) and Coastal Blackbutt (*Eucalyptus todtiana*) fruits. This evidence was attributed to Carnaby's Black-cockatoo and the Forest Red-tailed Black-cockatoo, respectively.

Foraging habitat within the subject site is mainly comprised of the Banksia Woodland which occupies approximately 9.5 hectares (~32.4%) of the study area.

4.2.5.3 Roosting Habitat

No existing roosting trees (trees used at night by Black-cockatoos to rest) were positively identified during the field survey, and given the limited number of larger trees present, Black-cockatoos are considered very unlikely to use the study area for this purpose.

5 DISCUSSION

5.1 FLORA

The total of 62 (57.9%) native species and 45 (42.1%) introduced (weed) species recorded within the project area represents a large proportion of weeds. This is expected, due to the close proximity of the study area to infrastructure, and areas of busy human activity, such as major transport arteries and cleared industrial areas.

Of the 107 vascular flora species recorded, only one could not be identified to species level (*Opuntia* sp.; Prickly Pear). This species does not have the potential to be a Threatened or Priority flora, as all *Opuntia* species occurring within Western Australia are introduced (weed) species. *Opuntia* species are not listed by DAFWA as Declared Pest weeds.

Four of the introduced (weed) species recorded are listed as Declared Pest plants under the *Biosecurity and Agriculture Management Act 2007*. **Asparagus asparagoides* (Bridal creeper) and **Zantedeschia aethiopica* (Arum Lily) require C3 management for the whole of the State, including within the project area. **Echium plantagineum* and **Gomphocarpus fruticosus* require C3 management in some areas around the State but not within the study area, where no specific control measures are required (DAFWA, 2016).

Asparagus asparagoides (Bridal Creeper) is regarded as one of Australia's worst weeds due to its invasiveness, potential for spread and economic and environmental impacts (DEE, 2016b). Rare native plants are threatened with extinction by Bridal Creeper. The species forms a thick mat of underground tubers which impedes the root growth of other native plants and often prevents seedling establishment (DEE, 2016b).

Zantedeschia aethiopica (Arum Lily) occurs in pasture and bushland, particularly in damp areas. It is able to form large spreading monocultures that choke native species, reduce biodiversity and decrease habitat and food resources for native animals (Cape to Cape Catchment Group, 2016). The two aforementioned species are listed as Declared Pest plants under the BAM Act and as such, landholders are required to manage and control them to reduce the size of infestations and prevent the spread of these weeds.

None of the recorded flora species are listed as Threatened under the WC Act or under the EPBC Act, nor are any listed as Priority Flora under the WC Act. However, the site is considered to potentially be suitable habitat for a number of Threatened and Priority Flora that have the potential to occur, based on habitat requirements and habitat suitability in the project area as summarised in **Table 5**.

Table 5: Likelihood of Occurrence of Threatened and Priority Flora

Species	Conservation Status	Habitat/Proximity and relevance of records	Likelihood of Occurrence
<i>Andersonia gracilis</i>	T	White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps. Not resulting from DPaW records.	LOW
<i>Caladenia huegelii</i>	T	Grey or brown sand, clay loam. Jarrah, <i>Banksia</i> or (less likely) <i>Mealaleuca</i> woodland. Lower slopes. Recent records nearby.	MODERATE
<i>Diuris micrantha</i>	T	Brown loamy clay. Winter-wet swamps, in shallow water. Not resulting from DPaW records.	LOW
<i>Diuris purdiei</i>	T	Grey-black sand, moist. Winter-wet swamps. Not resulting from DPaW records.	LOW
<i>Drakaea elastica</i>	T	White or grey sand. Low-lying situations adjoining winter-wet swamps. Often with <i>Kunzea</i> spp.. Not resulting from DPaW records.	LOW
<i>Drakaea micrantha</i>	T	White-grey sand. <i>Banksia</i> , Jarrah woodlands. Lower slopes. Not resulting from DPaW records.	LOW
<i>Lepidosperma rostratum</i>	T	Peaty sand, clay. Swamps.	LOW
<i>Acacia lasiocarpa</i> var. <i>bracteolate</i> (long peduncle)	P1	Grey or black sand over clay. Swampy areas, winter wet lowlands. Records in Jandakot.	MODERATE
<i>Thelymitra variegata</i>	P2	Sandy clay, sand, laterite.	LOW
<i>Byblis gigantea</i>	P3	Sandy-peat swamps. Seasonally wet areas. Records in Jandakot.	MODERATE
<i>Cyathochaeta teretifolia</i>	P3	Grey sand, sandy clay. Swamps, creek edges.	MODERATE
<i>Dampiera triloba</i>	P3	No habitat information found. Recorded from North Lake and Roe Highway extension area.	MODERATE
<i>Dodonaea hackettiana</i>	P3	Grey sands, peats, outcropping limestone. Locally recorded amongst weeds. Records in Jandakot.	MODERATE
<i>Eryngium pinnatifidum</i> subsp. <i>palustre</i>	P3	Claypans.	LOW
<i>Jacksonia gracillima</i>	P3	Grey-pale brown sands. Coastal Plain.	MODERATE
<i>Phlebocarya pilosissima</i> subsp. <i>pilosissima</i>	P3	White or grey sand, sand ridges, lateritic gravel. <i>Banksia</i> woodland.	MODERATE
<i>Stylidium paludicola</i>	P3	Peaty sand over clay. Winter wet habitats. Marri and Melaleuca woodland, Melaleuca shrubland.	LOW
<i>Microtis quadrata</i>	P4	Habitat preference not able to be located. Records in Jandakot.	MODERATE
<i>Ornduffia submersa</i>	P4	Aquatic herb.	LOW
<i>Stylidium longitubum</i>	P4	Sandy clay, clay. Seasonal wetlands. Records in Jandakot.	MODERATE
<i>Thysanotus glaucus</i>	P4	White, grey or yellow sand, sandy gravel. Open lenses.	LOW
<i>Tripterococcus</i> sp. <i>Brachylobus</i>	P4	No habitat information found.	MODERATE
<i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>	P4	Sand, sandy clay. Winter-wet depressions.	MODERATE

None of the Threatened or Priority flora species with the potential to occur in the project area are considered to be highly likely to occur. Rather all such species are considered to have a low, or moderate likelihood of occurrence, based on known habitat preferences and the proximity and currency of previous records.

Of the species considered to have a moderate likelihood of occurrence, only one is listed as Threatened, *Caladenia huegelii*. This species is known from several local populations, and the study area provides the preferred habitat for the species. Based on this, it is recommended that follow-up surveys be carried out to target this species during the appropriate season (early September), prior to specific development activities that would require clearing, to ensure avoidance of impacts to populations which may yet to be defined.

The survey was considered to have been conducted during optimal spring flowering period to identified the majority of species occurring within the study area. If possible within the timing constraints of the planning and development aspects of the project, it is recommended that an additional, second phase assessment be conducted during the complimentary season (autumn), to capture alternative-season flowering species and ephemerals, and/or during spring 2017, to compliment the results of the 2016 spring survey, and to best inform planning and development decisions regarding the wider CCE LSP area.

5.2 VEGETATION

The study area supports five intact and three degraded vegetation communities. Areas of the higher quality vegetation are found in the larger pocket of remnant vegetation, adjacent to the east side of the Kwinana Freeway, and this may be attributed to the proximity to the impacts of edge effects from current activities, as well as historic land uses.

All of the intact vegetation communities have been analysed in relation to species presence/absence and landform/soil types, in comparison to the Gibson *et al* (1994) dataset, in order to assign inferred Floristic Community Types (FCTs). A summary of the results of this analysis is presented below in **Table 6**, including the conservation status with regards to current TEC and PEC status, and the Gibson *et al* (1994) reservation and risk of extinction classification.

Table 6: Inferred FCTs of the Intact Vegetation Communities Recorded

Community Code	Brief Community Description	Inferred FCT	FCT Title	Conservation Significance
BaEt	Banksia over <i>Eucalyptus todtiana</i> woodland	23a	Central <i>Banksia attenuata</i> – <i>Banksia menziesii</i> woodlands	Likely a Commonwealth TEC FCT: well reserved; low risk
BaXp	Banksia over <i>Xanthorrhoea preissii</i> woodland	21a	Central <i>Banksia attenuata</i> – <i>Eucalyptus marginata</i> woodlands	Likely a Commonwealth TEC FCT: well reserved; low risk
Xp	<i>Xanthorrhoea preissii</i> heath	23a	Central <i>Banksia attenuata</i> – <i>Banksia menziesii</i> woodlands	Likely a Commonwealth TEC FCT: well reserved; low risk
Mp	<i>Melaleuca preissiana</i> woodland/swamp	4	<i>Melaleuca preissiana</i> damplands	Not a TEC or PEC FCT: well reserved; low risk
MpAI	<i>Melaleuca preissiana</i> over <i>*Acacia longifolia</i> woodland/swamp	4	<i>Melaleuca preissiana</i> damplands	Not a TEC or PEC FCT: well reserved; low risk

All inferred FCTs were documented in Gibson *et al* (1994) as “well reserved” and at “low risk” of extinction, and although none of the community types have been previously listed as a TEC or PEC, the recent Commonwealth listing of the Banksia woodlands of the Swan Coastal Plain TEC (DotEE 2016a) encompasses a number of *Banksia* woodlands, including those equivalent to FCTs 21a and 23a. This community type is typically described as having a prominent tree layer of Banksias with scattered Eucalypts and a species rich understorey. However, diagnosis of the presence of this TEC is more complicated than analysing results of a Level 1 or Level 2 flora and vegetation assessment. Specific information including patch size and regional context requires assessment and analysis, as well as plot-based data, in order to determine the presence of the TEC. However, based on the information collected as part of this study, it is considered highly likely that the areas mapped as *Banksia* woodland (communities BaEt and BaXp) are representative of the Commonwealth listed TEC. Some further assessment on patch size and quality on the vicinity, as well as analysis of replicate plot-based quadrat data within the *Banksia* woodland areas would appropriately confirm this, and would accurately define areas subject to Commonwealth protection.

Avoidance of the majority of the Banksia woodland area, likely to represent the TEC could be achieved by realigning the proposed North Lake Road to Beelihar Drive road alignment, as shown in **Figure 7**. Other currently proposed road alignments are considered well-placed to minimise impacts on areas of best quality vegetation and habitat within the study area.

The condition of the vegetation was found to range from rating 3- 4 (Good – Very Good) to rating 7 (Completely Degraded) in the Keighery (1994) scale. The majority of the study area is considered to be in Degraded to Good condition.

One of the EPA's objectives is to retain at least 10% of the pre-European extent of vegetation types in constrained areas in the Perth and Peel regions (EPA, 2015). The study area supports the Bassendean Complex-Central and South, which, according to the Local Biodiversity Program study (Western Australian Local Government Association 2013), is represented by 27.70% of its pre-European extent. This percentage exceeds the EPA threshold, based on a pre-European extent of 87,392.73 ha and 24,206.24 ha documented by WALGA in 2013 as remaining.

5.3 CONSERVATION SIGNIFICANT FAUNA SPECIES

The desktop review determined that 17 terrestrial fauna species of conservation significance have previously been recorded within the vicinity of the study area. The likelihood of the occurrence of these species in the study areas has been assessed, which is summarised below in **Table 7**.



- Legend**
- Survey Areas
 - Banksia_Woodlands
 - Existing Road Alignment Plans
 - Suggested Alternative Road Alignment



Figure 7 - Suggested Alternative Road Alignment

Table 7: Likelihood of Occurrence of Conservation Significant Fauna in the Study Area

Species	Common Name	Conservation Category			Habitat Preference	Likelihood of Occurrence
		EPBC	WC Act	DPaW		
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	S1	T(EN)	Permanent and seasonal freshwater wetlands, rarely estuarine habitats. Wetlands with tall, dense vegetation, particularly sedges/rushes/reeds.	LOW
<i>Calidris ferruginea</i>	Curlew Sandpiper	EN	S1	T(EN)	Intertidal mudflats, sheltered coastal areas; estuaries, bays, inlets, non-tidal swamps, lakes, lagoons near coast. Less in inland ephemeral/permanent lakes.	LOW
<i>Calyptorhynchus latirostris</i>	Carnaby's Black-cockatoo	EN	S2	T(EN)	Eucalypt woodland; Salmon Gum, Wandoo, Marri, Jarrah. Heath; Kwongan, Banksia/Hakea, other Proteaceous shrubs. Pines, Cape lilac.	MODERATE
<i>Calyptorhynchus banksia naso</i>	Forest Red-tailed Black-cockatoo	EN	S3	T(VU)	Eucalypt woodland; Salmon Gum, Wandoo, Marri, Jarrah. Heath; Kwongan, Banksia/Hakea, other Proteaceous shrubs. Pines, Cape lilac.	MODERATE
<i>Leipoa ocellata</i>	Malleefowl	VU	S1	T(VU)	Dry inland scrub, mallee. Large, contiguous areas of Mallee, woodlands with moderate to high levels of leaf litter.	LOW
<i>Rostratula australis</i>	Australian Painted Snipe	M/VU	S5	IA/T(VU)	Shallow freshwater (occasionally brackish) temporary or permanent wetlands; inundated grassland, dams. Grass, sedges/rushes/reeds, or samphire; Melaleuca.	LOW
<i>Numenius madagascariensis</i>	Eastern Curlew	EN	S1	IA/T(EN)	Sheltered coasts, mangrove swamps, bays, harbours and lagoons that contain mudflats and sandflats.	LOW
<i>Oxyura australis</i>	Blue-billed Duck	-	-	P4	Well vegetated freshwater swamps, large dams and lakes, winters on more open water. Occasionally salt lakes and estuaries freshened by floodwaters.	LOW
<i>Merops ornatus</i>	Rainbow Bee-eater	M	S5	IA	Open country, most vegetation types, dunes, banks; prefer lightly wooded, preferably sandy, country near water.	HIGH
<i>Lerista lineata</i>	Perth Lined Lerista	-	-	P3	White sands under areas of shrubs and heath where it inhabits loose soil and leaf litter particularly in association with Banksias.	HIGH
<i>Macropus irma</i>	Western Brush Wallaby	-	-	P4	Open forest, woodland, favouring open, seasonally wet flats with low grasses and open scrubby thickets. Mallee and heathland, uncommon in karri forest.	LOW
<i>Dasyurus geoffroii</i>	Chuditch	VU	S1	T(VU)	Jarrah (<i>Eucalyptus marginata</i>) forest	LOW
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	VU	S1	T(VU)	Unburnt Peppermint woodland but also Jarrah, Wandoo and Marri forest	LOW
<i>Myrmecobius fasciatus</i>	Numbat	VU	S1	T(VU)	Upland Jarrah forest, open eucalypt woodland, Banksia woodland and tall closed shrublands with termites in the soil, hollow logs and branches for shelter.	LOW
<i>Isodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	-	P4	Scrubby, dense vegetation; forest, woodland. Jarrah and Wandoo forests associated with water or wetlands.	LOW
<i>Throscodectes xiphos</i>	Cricket	EN	-	P1	Not known. Possibly heathlands and woodlands	LOW
<i>Synemon gratiosa</i>	Graceful Sunmoth	-	-	P4	Coastal dunes and woodlands supporting <i>Lomandra maritima</i> or <i>hermaphrodita</i> .	LOW

The results of the likelihood of occurrence analysis determined that all but four of the 17 conservation significant terrestrial fauna species assessed are unlikely to occur within or utilise the study area. A number of the species listed in **Table 7** may however utilise the habitats of the study areas as occasional visitors, but are unlikely to rely on it for their ongoing survival.

Whilst the likelihood of occurrence analysis did not incorporate a detailed literature review to ascertain the location and currency of previously recorded or known populations of each species, this can be applied to the species resulting in moderate or high likelihood scores, to further conclude risk of impact to these species.

5.3.1 Carnaby's Black-cockatoo

Carnaby's Black-cockatoo is listed as Schedule 2 under the WC Act and as Endangered under the EPBC Act. The species is confined to the south-west of Western Australia, north to the lower Murchison River and east to Nabawa, Wilroy, Waddi Forest, Nugadong, Manmanning, Durokoppin, Noongar (Moorine Rock), Lake Cronin, Ravensthorpe Range, head of Oldfield River, 20 km east south-east of Condingup and Cape Arid; also casual on Rottnest Island (Johnstone and Storr 1998).

The habitat of Carnaby's Black-cockatoo includes forests, woodlands, heathlands, farms. The species feeds preferentially on Banksia, Hakeas and Marri, but also other Proteaceous species and fruits from introduced trees such as Pines and Cape Lilac.

Carnaby's Black-cockatoo has specific nesting site requirements, with nests mostly in smoothed-barked eucalypts and in hollows ranging from 2.5 to 12 m above the ground, an entrance from 23 to 30 cm in diameter and a depth of 0.1 to 2.5 m (Johnstone and Storr, 1998).

Breeding occurs in winter/spring mainly in eastern forest and wheatbelt where they can find mature hollow bearing trees to nest in (Morcombe, 2003). Judging from records in the Storr-Johnstone Bird Data Bank, this species is currently expanding its breeding range westward and south into the Jarrah – Marri forest of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain, including the region between Mandurah and Bunbury. Carnaby's Black-cockatoo has been known to breed close to the town of Mandurah, as well as at Dawesville, Lake Clifton and Baldivis (Ron Johnstone *pers. comm.*) and there are small resident populations on the southern Swan Coastal Plain near Mandurah, Lake Clifton and near Bunbury. At each of these sites the birds forage in remnant vegetation and adjacent pine plantations (Johnstone 2008).

Carnaby's Black-cockatoo lays eggs from July or August to October or November, with most clutches being laid in August and September (Saunders 1986). Birds in inland regions may begin laying up to three weeks earlier than those in coastal areas (Saunders 1977). The female incubates the eggs over a period of 28 to 29 days. The young depart the nest 10 to 12 weeks after hatching (Saunders 1977; Smith & Saunders 1986).

Evidence of foraging activity was observed at the study site during the September 2016 field assessment in the form of chewed banksia cones. Most of the remnant vegetation containing banksia and jarrah within the site represents potential foraging habitat. Carnaby's Black-cockatoo was also recorded flying over the study area by GHD in 2015 (GHD 2015), and overfly activity of the species is regularly observed in the Cockburn region (Kellie Bauer-Simpson, *pers. comm.*).

All of the 18 large trees (>500 mm DBH) recorded during the field survey would be considered by the DotEE as potential Black-cockatoo breeding habitat, though only one appears to possibly contain a hollow of a size potentially suitable for this purpose. The possibility of this tree or any others being used for breeding proposes now or in the future would be considered to be extremely low.

No evidence of Black-cockatoo night roosting on site was observed during a dusk observation on 27 September 2016.

The potential impact of future development at the site on Carnaby's Black-cockatoo would be loss and/or modification of some areas of foraging and potential (unlikely) breeding habitat.

5.3.2 Forest Red-tailed Black-cockatoo

The Forest Red-Tailed Black-cockatoo is listed as Schedule 3 under the WC Act and as Vulnerable under the EPBC Act. The species is found in the humid and subhumid south west, mainly hilly interior, north to Gingin and east to Mt Helena, Christmas Tree Well, North Bannister, Mt Saddleback, Rock Gully and the upper King River (Johnstone and Storr 1998).

Preferred habitat for Forest Red-Tailed Black-cockatoos is Eucalypt forests. The species feeds on Marri, Jarrah, Blackbutt, Karri, Sheoak and Snottygobble and nests in the large hollows of Marri, Jarrah and Karri (Johnstone and Kirkby 1999). In Marri, the nest hollows of the Forest Red-tailed Black-cockatoo range from 8 to 14 m above ground, the entrance 12 to 41 cm in diameter and the depth is one to five metres (Johnstone and Storr 1998).

Breeding for the species commences in winter/spring. There are few records of breeding in the Forest Red-tailed Black-cockatoo (Johnstone and Storr 1998), but eggs are known to be laid in October and November (Johnstone 1997; Johnstone and Storr 1998). Recent data however indicates that breeding in all months of the year occurs with peaks in spring and autumn–winter (Ron Johnstone *pers. comm.*). The incubation period is 29 to 31 days and young fledged at eight to nine weeks (Simpson and Day 2010).

Individuals of this species were observed flying overhead during the field survey and GHD also recorded this species flying over the area in 2015 (GHD 2015). Some foraging evidence (chewed Coastal Blackbutt fruits) was also attributed to this species, though Carnaby's Black-cockatoos also utilise this food source. All areas of remnant vegetation containing Jarrah, Coastal Blackbutt and Sheoak (The Banksia Woodland habitat) within the site represent potential foraging habitat.

The potential impact of future development at the site on the Forest Red-tailed Black-cockatoo would be loss and/or modification of some areas of foraging and potential (unlikely) breeding habitat.

5.3.3 Rainbow Bee-eater

One species, Rainbow Bee-eater (*Merops ornatus*) was determined to have a high likelihood of occurrence, based on the presence of suitable habitat, and as it was recorded by GHD (2015) breeding in a sand embankment along North Lake Road in 2015. The Rainbow Bee-eater is likely to utilise the study area in small numbers during the summer migratory period. This species is a common seasonal visitor to south west. Population numbers at any one location would however never be significant as the species usually breeds in pairs and only rarely in small colonies (Johnstone and Storr 1998). This species is a migratory bird, protected under international agreements (Japan-Australia Migratory Bird Agreement (JAMBA) and China-Australia Migratory Bird Agreement (CAMBA)).

The Rainbow Bee-eater is not considered globally threatened. There are no published estimates of the global population size, but it is assumed to be quite large as the Rainbow Bee-eater is widely distributed throughout all of Australia (except Tasmania) and eastern Indonesia, including Bali, the Lesser Sundas and Sulawesi, and east to Papua New Guinea, the Bismarck Archipelago and, rarely, the Solomon Islands. It is a vagrant visitor to locations further north including Palau, south-western Micronesia, Saipan, the northern Mariana Islands, and Miyako Island and the southern Ryuku Islands in Japan (del Hoyo *et al.* 2001; Higgins 1999). The species breeds mostly in Australia, which occurs between August to January, at which time the birds will be found mostly in their subterranean nests. The chosen habitats of the species are widely varied and versatile, and

include mainly open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (Higgins 1999). Thus, utilisation of the habitats of the study area, including open sandy ground, is possible. However, no nests were observed during the field survey. Minimisation of impacts could be achieved by limiting ground disturbing activities to February to July, outside the breeding season.

5.3.4 Perth Lined Lerista

Lerista lineata is listed as Priority 3 by DPaW and is found along the lower west coast from north of Perth and south to Leschenault Peninsula/Kemerton. It has also been found at Rottne Island and Garden Island (Storr *et al.* 1999), but is most typically found in the southern suburbs of Perth (Bush *et al.* 2002).

Habitat: This small species of skink inhabits white sands (Storr *et al.* 1999) under areas of shrubs and heath where it inhabits loose soil and leaf litter (Nevill 2005) particularly in association with banksias (Bush *et al.* 2002).

Lerista lineata was recorded within the study area by GHD (2015) and has been recorded in other nearby bush remnants (ENV 2009, Phoenix 2010). Most of the Banksia dominated habitat appears to be suitable for this species to persist. This species is also known to inhabit gardens (Nevill 2005, Bush *et al.* 2010) so may persist in degraded areas and subsequent to development.

The potential impact of future development at the site on *Lerista lineata* would be loss and/or modification of some areas of habitat.

5.4 FAUNA HABITATS

The five habitat types defined and mapped for the study area vary in quality and value in terms of providing for native fauna, including species of conservation significance.

The Open Degraded Areas habitat provides very little value for native fauna, whilst the Heath habitat provides some, but less than the woodland habitats. The Tall Open Woodland habitats are also of lesser value, given their typically degraded nature, although given the mature trees, are an important resource for birds.

The Paperbark Woodland/Swamp habitat provides for a number of native birds, small mammals and reptiles, in particular in better quality sections east of the Kwinana Freeway. This habitat type is likely to support populations of the Priority 4 species, Southern Brown Bandicoot/Quenda. Additionally, within this habitat is a single Flooded Gum stag which supports a hollow potentially suitable for Threatened Black-cockatoo nesting.

Of greatest significance with regards to habitat is the Banksia Woodland habitat which occupies a total of 9.5 hectares of the study area. This habitat type includes some of the best quality vegetation in the study area and is suitable foraging habitat for Threatened Black-cockatoos. Clearing of areas greater than one hectare of this habitat would require referral to the Commonwealth DoTEE.

5.5 WETLANDS

The study area supports one geomorphic "Multiple Use" Wetland, (Unique Feature Identifier UFI) 6652) which has been classified as a dampland (WA Atlas, 2016). Multiple Use (M category) wetlands have been evaluated to be poor in natural and human attribute. As such the key management objective for Multiple Use wetlands is to use, develop and manage the wetland in the context of water, town and environmental planning. Some of the revegetation recommendations provided in ENV (2008) for the rehabilitation of the Solomon Road Wetland could be considered as part of the CCE LSP, in order to enhance the natural and aesthetic value of areas retained as part of the ultimate development of the site. Such actions could include appropriate management of drainage and stormwater, suitable fire risk management and rehabilitation/landscaping treatments in the form of weed management and revegetation with locally endemic species.

The MNES report also included reference to the occurrence of Ramsar wetlands, Forrestdale and Thomsons Lakes, within 10 km. However, these results are not of significance as the proposed clearing will not impact either of these Ramsar sites.

5.6 ASSESSMENT AGAINST THE TEN CLEARING PRINCIPLES

The project has been broadly assessed against the Department of Environment Regulation (DER) ten clearing principles, based on information collected during the assessment. A summary of this assessment (assuming the entire study site would be cleared) and recommendations for impact avoidance are provided below in **Table 8**.

Table 8: Summary of the Assessment against the Ten Clearing Principles

Principle	Assessment	Outcome	Avoidance or Mitigation Recommendation/ Comment
1 (a) Native vegetation should not be cleared if it comprises a high level of biological diversity.	A total five intact vegetation communities and three degraded vegetation communities in varying condition, comprising 107 vascular flora species (57.9% native) were recorded. Five different vertebrate fauna habitats were found to be supported by the site, with 47 vertebrate fauna species recorded during the field assessment. This diversity is considered moderately low. No species of Priority flora were recorded during the field survey conducted in September 2016. The vegetation communities present at the site are not equivalent to any listed Priority Ecological Communities.	Proposed clearing is not at variance with this principle.	Follow-up flora survey during complimentary season (autumn) or during spring 2017 to further confirm the native flora species which indicates that no Priority Flora are present.
2 (b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a significant habitat for fauna indigenous to Western Australia.	Five fauna habitats were defined and mapped across the study site, which includes the Banksia Woodland habitat. This habitat occupies 9.5 hectares of the study site and is suitable for foraging by Threatened Black-cockatoos. A number of potential habitat trees were also recorded across the study site, with one located at 392497 mE, 6445689 mN supporting a hollow that could potentially be suitable for Black-cockatoo nesting.	Proposed clearing is at variance with this principle.	Avoid clearing areas of the Banksia Woodland habitat and avoid clearing the habitat tree located at 392497 mE, 6445689 mN.
3 (c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of rare flora	A number of Threatened flora species were determined to potentially be supported by the study area, based on the results of the desktop review. The site is considered suitable habitat for the Threatened orchid, <i>Caladenia huegelii</i> . However, no rare (Threatened) flora were recorded during the field assessment.	Proposed clearing is not likely to be at variance with this principle.	Follow-up flora survey during early to mid-September 2017, targeting <i>Caladenia huegelii</i> , to further confirm the absence of this species.
4 (d) Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of a Threatened Ecological Community (TEC).	Previous assessments have not determined the presence of TECs within a 5km radius of the study area (GHD, 2015). However, the recent listing of the Banksia Woodlands TEC by the Commonwealth DoEE is likely to apply to the entire extent of Banksia woodland (communities BaEt and BaXp) within the study area. Further qualitative assessment would be required to confirm the presence of this TEC.	Proposed clearing is likely to be at variance with this principle.	Undertake a follow-up assessment to diagnose the Banksia Woodland with regards to equivalence to the TEC.

Principle	Assessment	Outcome	Avoidance or Mitigation Recommendation/ Comment
<p>5 (e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in areas that have been extensively cleared.</p>	<p>The study area supports the Bassendean Complex-Central and South, which, according to the Local Biodiversity Program study (Western Australian Local Government Association 2013), is represented by 27.70% of its pre-European extent. This percentage exceeds the 10% EPA threshold for constrained areas of the Perth and Peel regions ((EPA, 2015), based on a pre-European extent of 87,392.73 ha and 24,206.24 ha documented by WALGA in 2013 as remaining.</p>	<p>Proposed clearing is not at variance with this principle.</p>	<p>NA</p>
<p>6 (f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland</p>	<p>The study area traverses one geomorphic "Multiple Use" Wetland, which has been classified as a dampland (WA Atlas, 2016). No other water waterways or wetlands are present within the immediately adjacent areas or are linked to the study area through surface drainage (GHD, 2015). Multiple Use (M category) allow for development in conjunction with and management of wetland values, in the context of water, town and environmental planning.</p>	<p>Proposed clearing is at variance with this principle.</p>	<p>Although the site supports a wetland, the classification of that wetland should allow for development in conjunction with suitable management. Obtaining further advice from the Department of Water once concept plans are drafted is recommended.</p>
<p>7 (g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.</p>	<p>The extent of existing clearing in the region of the study area is significant, comprising adjacent infrastructure and light commercial developments. The remnant vegetation present within the study area is mostly very degraded, although some better quality areas exist. Proposed clearing would result in further land degradation, although in the context of existing degradation, this is not considered significantly appreciable.</p>	<p>Proposed clearing is likely to be at variance with this principle.</p>	<p>Further degradation from clearing could be offset by enhancement of areas that are currently degraded, via appropriate management of weeds, bush fire risk, drainage and storm water, and by implementation of an appropriate rehabilitation/revegetation plan for any natural areas retained.</p>
<p>8 (h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.</p>	<p>The nearest conservation reserve to the study area is Thomsons Lake Nature Reserve, located approximately 3 km to the south-west of the study site. Any proposed clearing would not impact on this conservation area.</p>	<p>Proposed clearing is not at variance with this principle.</p>	<p>NA</p>

Principle	Assessment	Outcome	Avoidance or Mitigation Recommendation/ Comment
<p>9 (i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.</p>	<p>Data relating to groundwater (depth to) in the study area has not been made available and an analysis of surface water and groundwater has not been carried out as part of the flora and fauna assessment. However, generally, clearing of riparian and wetland vegetation that interacts with groundwater may have impacts on groundwater levels and potentially quality. Some areas of vegetation in the study area are specifically growing in association with surface or groundwater features, particularly the Mp and MpAl vegetation communities. Clearing vegetation can have impacts on surface water flows from rainfall run-off and this could impact the quality of surface water. However, there are no apparent areas of surface water in the study area, and the free draining sands present would be expected to result in negligible effects on surface run-off.</p>	<p>Proposed clearing may be at variance with this principle.</p>	<p>Minimise the areas of clearing of riparian/wetland vegetation where possible. Ensure suitable drainage features are incorporated into developments to avoid potential adverse impacts from run-off, and on surface and groundwater quality.</p>
<p>10 (j) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate the incidence or intensity of flooding.</p>	<p>Proposed clearing has the potential to cause flooding within and around the proposed development area, however, the free draining sands of the study area are likely to limit this. Furthermore, any proposed development would incorporate suitable drainage features that would suitably direct surface water and avoid any flooding in adjacent natural areas, if retained.</p>	<p>Proposed clearing is unlikely to be at variance with this principle.</p>	<p>Ensure suitable drainage features are incorporated into developments to avoid potential flooding.</p>

6 CONCLUSION AND RECOMMENDATIONS

The key ecological values associated with the study area are summarised as follows:

- Several Threatened and Priority flora species were identified during the desktop review as potentially occurring at the site, although none were recorded during the assessment.
- None of the flora species recorded are of any conservation significance.
- Five intact vegetation communities and three degraded vegetation communities were described and mapped within the study area, consisting of four woodlands, two woodland/wetland vegetation types, one heath and one degraded community.
- Areas of Banksia woodland (vegetation communities BaEt and BaXp) are likely to be representative of the newly listed Commonwealth TEC; *Banksia woodlands of the Swan Coastal Plain*.
- Five fauna habitats, consisting of woodlands and woodland/wetlands, one open heath/scrub and degraded areas were described and mapped across the study area.
- Evidence of Threatened Black-cockatoos (Carnaby's Black-cockatoo and Forest Red-tailed Black-cockatoo) was recorded during the site survey, including a direct sighting of Forest Red-tailed Black-cockatoos overflying the site and evidence of both species feeding on native tree fruits.
- Evidence of the Priority 4 species, Southern Brown Bandicoot/Quenda was observed in the form of diggings and this species is likely to inhabit the areas of dense understorey within the Paperbark Woodland/Swamp habitat, as well as probably the Banksia Woodland habitat.
- Rainbow Bee-eater (*Merops ornatus*) was determined to have a moderate likelihood of occurrence in the study area, based on recorded sightings by GHD (2015) and the presence of potentially suitable habitat.
- The site supports a dampland classified as a Multiple Use wetland (UFI 5562).

Below is a summary of the outcomes of the assessment against the ten clearing principles and impact mitigation/management and/or further study recommendations and comments:

- The proposed clearing is at variance with principle 2 (b), due to the presence of suitable foraging habitat and potential breeding habitat for Threatened Black-cockatoos, and likely habitat for the migratory bird species, Rainbow Bee-eater.
 - Impact mitigating recommendations:
 - Avoid or minimise clearing areas of the Banksia Woodland habitat
 - Avoid clearing the habitat tree located at 392497 mE, 6445689 mN
 - Limit ground disturbing activities (clearing and earthworks) to between February and July, which is outside the breeding season for Rainbow Bee-eater.
- The proposed clearing is at variance with principle 6 (f), due to the presence of a wetland at the site.
 - Recommendations:
 - Obtain advice from the Department of Water once concept plans are drafted, in order to achieve environmentally sensitive development in association with the wetland.
- The proposed clearing is likely to be at variance with principle 4 (d), due to the likely presence of the Banksia Woodlands TEC at the site.
 - Recommendations:
 - Undertake a follow-up assessment to confirm the presence and extent of the Banksia Woodland TEC at the site, which will also better inform potential offset requirements.

- The proposed clearing is likely to be at variance with principle 7 (g), due to the likelihood that it will cause appreciable land degradation.
 - Recommendations:
 - Consider options to offset impacts of further degradation by enhancement of areas that are currently degraded and may be retained.
- The proposed clearing may be at variance with principle 9 (i), due to the potential impacts on surface water and groundwater.
 - Impact mitigating recommendations:
 - Minimise the areas of clearing of riparian/wetland vegetation where possible.
 - Ensure suitable drainage features are incorporated into developments to avoid potential adverse impacts from run-off, and on surface and groundwater quality.
- The proposed clearing is unlikely to be, but may be at variance with principle 3 (c), due to the potential (although unlikely) presence of Threatened orchid, *Caladenia huegelii*.
 - Recommendation:
 - Consider a follow-up flora survey during early to mid-September 2017, targeting *Caladenia huegelii*, to further confirm the absence of this species. This assessment could also target other potentially occurring conservation significant flora, in order to ascertain their absence at the site.
- The proposed clearing is unlikely to be, but may be at variance with principle 10 (j), due to the potential (although unlikely) to cause flooding.
 - Recommendation:
 - Ensure suitable drainage features are incorporated into developments to avoid potential flooding.

Avoidance of the majority of the Banksia woodland area, likely to represent the TEC could be achieved by realigning the proposed North Lake Road to Beelihar Drive road alignment, as shown in **Figure 7**. Other currently proposed road alignments are considered well-placed to minimise impacts on areas of best quality vegetation and habitat within the study area.

The findings of the study suggest that any impacts to areas of the Banksia Woodland TEC or Black-Cockatoo foraging habitat would require referral to the Commonwealth DotEE. The DotEE has advised that development of the LSP itself would not require referral and that the City would only be required to refer for impacts to such areas that would result from road developments. Third parties who may develop the land within the LSP area would be required to refer the project under the EPBC Act where those developments may impact on the identified MNES (Small 2016 *pers. comm.*).

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APPENDIX A: NATUREMAP SPECIES REPORT

NatureMap Species Report

Created By Guest user on 26/09/2016

Current Names Only Yes
 Core Datasets Only Yes
 Method 'By Polygon'
 Vertices 32° 07' 45" S,115° 50' 59" E 32° 07' 45" S,115° 50' 60" E 32° 07' 18" S,115° 51' 03" E 32° 06' 42" S,115° 51' 09" E 32° 06' 47" S,115° 51' 28" E 32° 07' 11" S,115° 52' 36" E 32° 07' 42" S,115° 52' 13" E 32° 07' 36" S,115° 51' 56" E 32° 07' 40" S,115° 51' 32" E 32° 07' 45" S,115° 50' 59" E
 Conservation Status

Conservation Status	Species	Records
Non-conservation taxon	89	137
Priority 1	1	3
Priority 5	2	9
Protected under international agreement	1	1
Rare or likely to become extinct	2	2
TOTAL	95	152

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
Rare or likely to become extinct				
1.	1596 <i>Caladenia huegelii</i> (Grand Spider Orchid)		T	
2.	24146 <i>Myrmecobius fasciatus</i> (Numbat, Walpurti)		T	
Protected under international agreement				
3.	24598 <i>Merops ornatus</i> (Rainbow Bee-eater)		IA	
Priority 1				
4.	33994 <i>Throscodectes xiphos</i> (cricket)		P1	
Priority 5				
5.	25478 <i>Isoodon obesulus</i> (Southern Brown Bandicoot)		P5	
6.	24153 <i>Isoodon obesulus</i> subsp. <i>fusciventer</i> (Quenda, Southern Brown Bandicoot)		P5	
Non-conservation taxon				
7.	24560 <i>Acanthorhynchus superciliosus</i> (Western Spinebill)			
8.	25536 <i>Accipiter fasciatus</i> (Brown Goshawk)			
9.	42368 <i>Acritoscincus trilineatus</i> (Western Three-lined Skink)			
10.	44629 <i>Anilius australis</i>			
11.	24561 <i>Anthochaera carunculata</i> (Red Wattlebird)			
12.	24562 <i>Anthochaera lunulata</i> (Western Little Wattlebird)			
13.	17737 <i>Azolla pinnata</i>			
14.	<i>Barnardius zonarius</i>			
15.	741 <i>Baumea articulata</i> (Jointed Rush)			
16.	744 <i>Baumea laxa</i>			
17.	16636 <i>Boronia crenulata</i> subsp. <i>viminea</i>			
18.	5458 <i>Calytrix flavescens</i> (Summer Starflower)			
19.	5460 <i>Calytrix fraseri</i> (Pink Summer Calytrix)			
20.	<i>Calytrix</i> sp.			
21.	2794 <i>Carpobrotus aequilaterus</i> (Angular Pigface)	Y		
22.	6214 <i>Centella asiatica</i>			
23.	43380 <i>Chelodina collieii</i> (Oblong Turtle)			
24.	24980 <i>Christinus marmoratus</i> (Marbled Gecko)			
25.	25568 <i>Coracina novaehollandiae</i> (Black-faced Cuckoo-shrike)			
26.	25592 <i>Corvus coronoides</i> (Australian Raven)			
27.	25595 <i>Cracticus tibicen</i> (Australian Magpie)			
28.	25399 <i>Crinia glauerti</i> (Clicking Frog)			
29.	25400 <i>Crinia insignifera</i> (Squelching Froglet)			
30.	30899 <i>Ctenophorus adelaidensis</i> (Southern Heath Dragon, Western Heath Dragon)			
31.	25027 <i>Ctenotus australis</i>			
32.	25040 <i>Ctenotus gemmula</i> (Jewelled South-west Ctenotus (Swan Coastal Plain pop P3), skink)			
33.	40660 <i>Cycnogeton huegelii</i>			

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
34.	24322 <i>Cygnus atratus</i> (Black Swan)			
35.	30901 <i>Dacelo novaeguineae</i> (Laughing Kookaburra)	Y		
36.	<i>Descolea maculata</i>			
37.	25607 <i>Dicaeum hirundinaceum</i> (Mistletoebird)			
38.	11105 <i>Echinochloa crus-galli</i>	Y		
39.	<i>Eolophus roseicapillus</i>			
40.	20483 <i>Gastrolobium linearifolium</i>			
41.	3921 <i>Gastrolobium reticulatum</i>			
42.	6161 <i>Gonocarpus pithyoides</i>			
43.	24443 <i>Grallina cyanoleuca</i> (Magpie-lark)			
44.	25410 <i>Heleioporus eyrei</i> (Moaning Frog)			
45.	25119 <i>Hemiergis quadrilineata</i>			
46.	5173 <i>Hibbertia subvaginata</i>			
47.	24491 <i>Hirundo neoxena</i> (Welcome Swallow)			
48.	921 <i>Isolepis producta</i>			
49.	1188 <i>Juncus pallidus</i> (Pale Rush)			
50.	15498 <i>Kunzea glabrescens</i> (Spearwood)			
51.	<i>Latrodectus hasseltii</i>			
52.	8099 <i>Leontodon saxatilis</i> (Hairy Hawkbit)	Y		
53.	25661 <i>Lichmera indistincta</i> (Brown Honeyeater)			
54.	25415 <i>Limnodynastes dorsalis</i> (Western Banjo Frog)			
55.	25378 <i>Litoria adelaidensis</i> (Slender Tree Frog)			
56.	25388 <i>Litoria moorei</i> (Motorbike Frog)			
57.	7408 <i>Lobelia tenuior</i> (Slender Lobelia)			
58.	6458 <i>Lysinema elegans</i>			
59.	25654 <i>Malurus splendens</i> (Splendid Fairy-wren)			
60.	25758 <i>Megalurus gramineus</i> (Little Grassbird)			
61.	34676 <i>Meionectes brownii</i> (Swamp Raspwort)			
62.	<i>Metaballus litus</i>			
63.	15419 <i>Microtis media</i> subsp. <i>media</i>			
64.	25192 <i>Morethia obscura</i>			
65.	24223 <i>Mus musculus</i> (House Mouse)	Y		
66.	25252 <i>Notechis scutatus</i> (Tiger Snake)			
67.	14293 <i>Oenothera indecora</i> subsp. <i>bonariensis</i>	Y		
68.	16347 <i>Oenothera laciniata</i>	Y		
69.	24409 <i>Phaps chalcoptera</i> (Common Bronzewing)			
70.	1478 <i>Phlebocarya ciliata</i>			
71.	1479 <i>Phlebocarya filifolia</i>			
72.	24596 <i>Phylidonyris novaehollandiae</i> (New Holland Honeyeater)			
73.	4141 <i>Phyllota gracilis</i>			
74.	<i>Phytophthora cinnamomi</i>			
75.	4524 <i>Platytheca galioides</i>			
76.	25722 <i>Polytelis anthopeplus</i> (Regent Parrot)			
77.	25731 <i>Porphyrio porphyrio</i> (Purple Swamphen)			
78.	25732 <i>Porzana pusilla</i> (Baillon's Crake)			
79.	24771 <i>Porzana tabuensis</i> (Spotless Crake)			
80.	25511 <i>Pseudonaja affinis</i> (Dugite)			
81.	25259 <i>Pseudonaja affinis</i> subsp. <i>affinis</i> (Dugite)			
82.	25433 <i>Pseudophryne guentheri</i> (Crawling Toadlet)			
83.	4181 <i>Pultenaea reticulata</i>			
84.	<i>Purpureicephalus spurius</i>			
85.	24245 <i>Rattus rattus</i> (Black Rat)	Y		
86.	25534 <i>Sericornis frontalis</i> (White-browed Scrubwren)			
87.	25590 <i>Streptopelia senegalensis</i> (Laughing Turtle-Dove)	Y		
88.	24844 <i>Threskiornis molucca</i> (Australian White Ibis)			
89.	25519 <i>Tiliqua rugosa</i>			
90.	25207 <i>Tiliqua rugosa</i> subsp. <i>rugosa</i>			
91.	4383 <i>Tribulus terrestris</i> (Caltrop)	Y		
92.	25723 <i>Trichoglossus haematodus</i> (Rainbow Lorikeet)			
93.	150 <i>Triglochin stowardii</i>			
94.	98 <i>Typha domingensis</i> (Bulrush, Djandjidd)			
95.	25765 <i>Zosterops lateralis</i> (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

Name ID Species Name

Naturalised

Conservation Code

¹Endemic To Query
Area

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly 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.

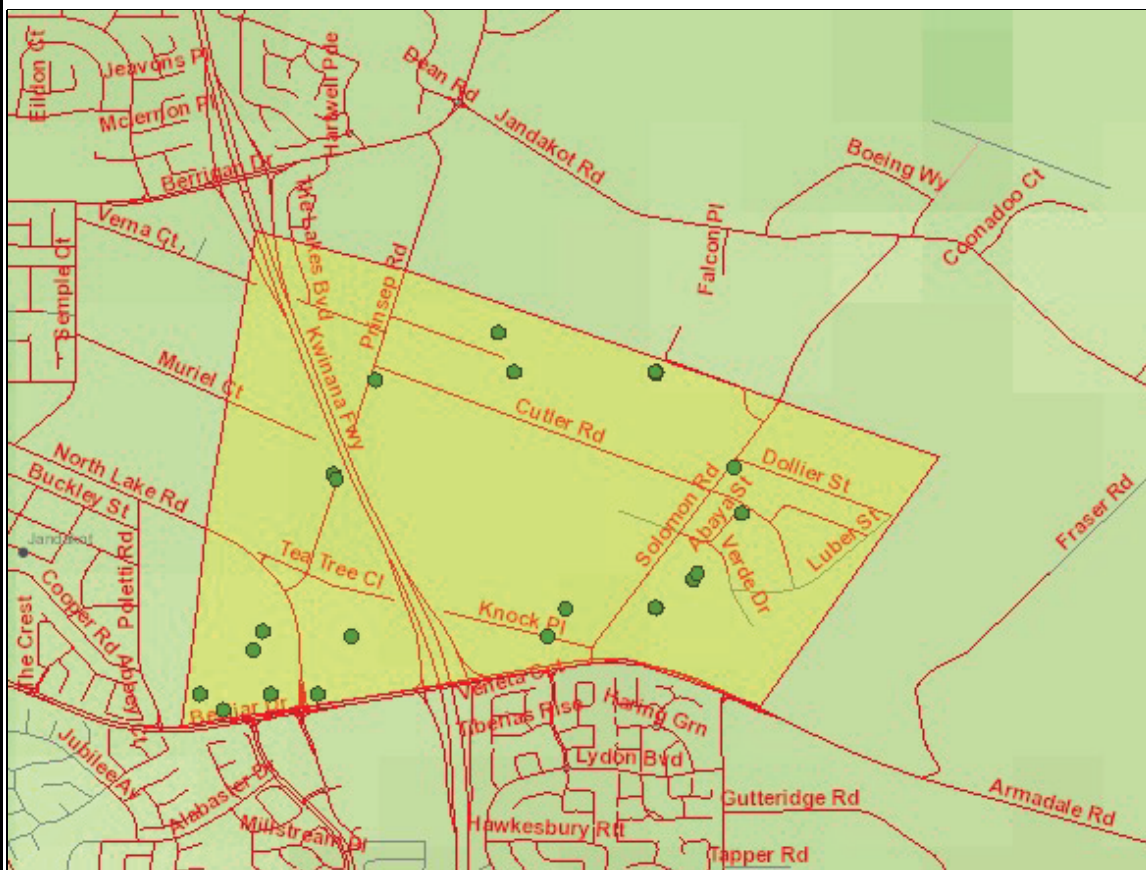
NatureMap

Mapping Western Australia's biodiversity

CCE LSP Project Area

Printed by Guest user on 26/9/2016

Query details : Current Names Only=Yes; Core Datasets Only=Yes; Method='By Polygon'; Vertices=32° 07' 45" S,115° 50' 59" E 32° 07' 45" S,115° 50' 60" E 32° 07' 18" S,115° 51' 03" E 32° 06' 42" S,115° 51' 09" E 32° 06' 47" S,115° 51' 28" E 32° 07' 11" S,115° 52' 36" E 32° 07' 42" S,115° 52' 13" E 32° 07' 36" S,115° 51' 56" E 32° 07' 40" S,115° 51' 32" E 32° 07' 45" S,115° 50' 59" E ;



Search Results

- Selected
- Selected Species
- All Results
- Non-conservation taxon
 - Priority 1
 - Priority 5
 - Protected under international agreement
 - Rare or likely to become extinct

Reference Layers

- Major WA Towns
- Major WA Towns
- Major WA Towns
- Roads
 - Sealed
 - Unsealed
 - Track
- State Borders
- Australian Continent



NatureMap is a collaborative project of the Department of Parks and Wildlife, Western Australia, and the Western Australian Museum.

APPENDIX B: EPBC ACT PROTECTED MATTERS (MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE (MNES))



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: 26/09/16 19:59:27

[Summary](#)

[Details](#)

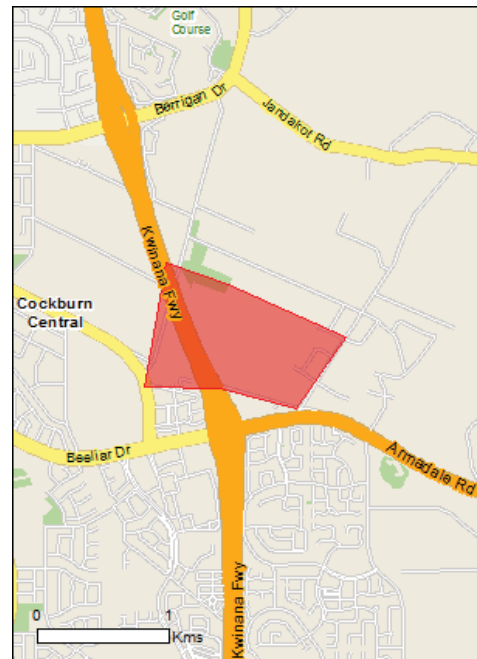
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

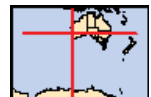
[Acknowledgements](#)



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

[Coordinates](#)

Buffer: 0.0Km



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:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	16
Listed Migratory Species:	6

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:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	11
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	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:	None
Regional Forest Agreements:	None
Invasive Species:	40
Nationally Important Wetlands:	None
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 10km of Ramsar

Listed Threatened Species	[Resource Information]	
Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	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
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Vulnerable	Species or species habitat may occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species

Name	Status	Type of Presence
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	habitat likely to occur within area Species or species habitat likely to occur within area
Drakaea elastica Glossy-leafed Hammer-orchid, Praying Virgin [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely 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
---	--	--

Migratory Terrestrial Species

Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
---	--	--

Migratory Wetlands Species

Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	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
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

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

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

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to 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
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

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 Resources 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

Name	Status	Type of Presence
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 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
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
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 Asparagus [22473]		Species or species habitat likely to occur

Name	Status	Type of Presence
Asparagus plumosus Climbing Asparagus-fern [48993]		within area Species or species 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 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
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Protasparagus densiflorus Asparagus Fern, Plume Asparagus [5015]		Species or species habitat likely to occur within area
Protasparagus plumosus Climbing Asparagus-fern, Ferny Asparagus [11747]		Species or species habitat likely to 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
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

Name

Status

Type of Presence
habitat likely to occur within
area

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.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

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

-32.125249 115.858998,-32.125268 115.858998,-32.125122 115.853741,-32.117944 115.855308,-32.119216 115.859492,-32.122269 115.867603,-32.126431 115.864213,-32.125249 115.858998

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](#)
- [Parks and Wildlife Commission NT, Northern Territory Government](#)
- [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, Atherton and Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [Geoscience Australia](#)
- [CSIRO](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

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APPENDIX C: MUIR STRUCTURAL VEGETATION CLASSIFICATIONS

Life Form/Height Class	Canopy Cover			
	Dense 70-100%	Mid-dense 30-70%	Sparse 10-30%	Very sparse 2-10%
Trees >30m Trees 15-30m Trees 5-15m Trees <5m	Dense tall forest Dense forest Dense low forest A Dense low forest B	Tall forest Forest Low forest A Low forest B	Tall woodland Woodland Low woodland A Low woodland B	Open tall woodland Open woodland Open low woodland A Open low woodland B
Mallee Tree Form Mallee Shrub form	Dense tree mallee Dense shrub mallee	Tree mallee Shrub mallee	Open tree mallee Open shrub mallee	Very open tree mallee Very open shrub mallee
Shrubs >2m Shrubs 1.5-2m Shrubs 1-1.5m Shrubs 0.5-1m Shrubs <0.5m	Dense thicket Dense heath A Dense heath B Dense low heath C Dense low heath D	Thicket Heath A Heath B Low heath C Low heath D	Scrub Low scrub A Low scrub B Dwarf scrub C Dwarf scrub D	Open scrub Open low scrub A Open low scrub B Open dwarf scrub C Open dwarf scrub D
Mat plants Hummock grass Bunch grass >0.5m Bunch grass <0.5m Herbaceous spp.	Dense mat plants Dense hummock grass Dense tall grass Dense low grass Dense herbs	Mat plants Mid-dense hummock grass Tall grass Low grass Herbs	Open mat plants Hummock grass Open tall grass Open low grass Open herbs	Very open mat plants Open hummock grass Very open tall grass Very open low grass Very open herbs
Sedges >0.5m Sedges <0.5m	Dense tall sedges Dense low sedges	Tall sedges Low sedges	Open tall sedges Open low sedges	Very open tall sedges Very open low sedges
Ferns Mosses, Liverwort	Dense ferns Dense mosses	Ferns Mosses	Open ferns Open mosses	Very open ferns Very open mosses

Source: (Muir 1977)

APPENDIX D: OBSERVED AND POTENTIAL FAUNA SPECIES LIST

Observed and Potential Vertebrate Fauna List

Cockburn Central East - Local Structure Plan Area

Compiled by Greg Harewood - November 2016
 Approximate centroid = 32.21492°S and 115.85916°E
 Recorded (Sighted/Heard/Signs/Captured) = X

A = Harewood, G. (2016). Fauna Assessment of Cockburn Central East - Local Structure Plan Area. Unpublished report for Focused Vision Consulting.

B = GHD (2015). North Lake Road Extension Ecological Assessment. Unpublished report for the City of Cockburn

C = ENV (2009). Jandakot Airport Fauna Survey. Unpublished report for Jandakot Airport Holdings Pty Ltd.

D = Phoenix Environmental Sciences (2011). Vertebrate Fauna Survey for the Roe Highway Extension Project. Unpublished report for South Metro Connect.

E = Harewood, G. (2009) Fauna Survey (Level 2) East Rockingham WWTP Site and Pipeline Corridors. Unpublished report for ERM.

F = DPaW (2016). NatureMap Database search. "By Circle" 115° 51' 36" E, 32° 07' 18" S – Study area (plus 8km buffer), 06/0102016.

Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Amphibia								
Myobatrachidae								
Ground or Burrowing Frogs								
<i>Crinia georgiana</i>	Quacking Frog	LC			X	X		X
<i>Crinia glauerti</i>	Clicking Frog	LC				X		X
<i>Crinia insignifera</i>	Squelching Froglet	LC				X		X
<i>Geocrinia leai</i>	Ticking Frog	LC						
<i>Heleioporus eyrei</i>	Moaning Frog	LC		X		X		X
<i>Limnodynastes dorsalis</i>	Western Banjo Frog	LC		X	X	X		X
<i>Myobatrachus gouldii</i>	Turtle Frog	LC				X		X

WC Act Status - S1 to S7, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, DPaW Priority Status - P1 to P4, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, Bush Forever Decreaser Species - Bh = habitat specialists, Bp = wide ranging species, Be = extinct in Perth Coastal Plain Region. IUCN Red List Category Definitions LC = Least Concern - see Appendix A and <http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria> for others.

Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
<i>Pseudophryne guentheri</i>	Crawling Toadlet	LC						X
Hylidae Tree or Water-Holding Frogs								
<i>Litoria adelaidensis</i>	Slender Tree Frog	LC			X	X		X
<i>Litoria moorei</i>	Motorbike Frog	LC				X		X

Reptilia

Diplodactylidae

Geckoes

<i>Strophurus spinigerus</i>	Soft Spiny-tailed Gecko						X	X
------------------------------	-------------------------	--	--	--	--	--	---	---

Gekkonidae

Geckoes

<i>Christinus marmoratus</i>	Marbled Gecko					X	X	X
------------------------------	---------------	--	--	--	--	---	---	---

Pygopodidae

Legless Lizards

<i>Aprasia repens</i>	Sandplain Worm Lizard					X		X
-----------------------	-----------------------	--	--	--	--	---	--	---

<i>Delma fraseri</i>	Fraser's Legless Lizard			X			X	X
----------------------	-------------------------	--	--	---	--	--	---	---

<i>Lialis burtonis</i>	Burton's Legless Lizard					X	X	X
------------------------	-------------------------	--	--	--	--	---	---	---

<i>Pygopus lepidopodus</i>	Common Scaly Foot			X		X		X
----------------------------	-------------------	--	--	---	--	---	--	---

WC Act Status - S1 to S7, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, DPaW Priority Status - P1 to P4, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, Bush Forever Decreaser Species - Bh = habitat specialists, Bp = wide ranging species, Be = extinct in Perth Coastal Plain Region. IUCN Red List Category Definitions LC = Least Concern - see Appendix A and <http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria> for others.

Class	Common Name	Conservation Status	A	B	C	D	E	F
Family <i>Species</i>								
Agamidae								
Dragon Lizards								
<i>Ctenophorus adelaidensis</i>	Southern Heath Dragon							X
<i>Pogona minor</i>	Western Bearded Dragon			X	X	X	X	X
Varanidae								
Monitor's or Goanna's								
<i>Varanus gouldii</i>	Gould's Sand Monitor			X				X
<i>Varanus tristis</i>	Racehorse Monitor						X	

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Scincidae								
Skinks								
<i>Acritoscincus trilineatum</i>	Southwestern Cool Skink				X	X		
<i>Cryptoblepharus buchananii</i>	Fence Skink				X	X	X	X
<i>Ctenotus australis</i>	Western Ctenotus					X	X	X
<i>Ctenotus fallens</i>	West Coast Ctenotus					X	X	X
<i>Ctenotus impar</i>	Odd-striped Ctenotus							X
<i>Egernia napoleonis</i>	Salmon-bellied Skink					X		X
<i>Hemiergis quadrilineata</i>	Two-toed Mulch Skink				X	X	X	X
<i>Lerista elegans</i>	West Coast Four-toed Lerista				X	X	X	X
<i>Lerista lineata</i>	Perth Lined Lerista	P3		X		X		X
<i>Menetia greyii</i>	Dwarf Skink				X	X	X	X
<i>Morethia lineocellata</i>	West Coast Pale-flecked Morethia					X	X	X
<i>Morethia obscura</i>	Shrubland Pale-flecked Morethia					X	X	X
<i>Tiliqua rugosa</i>	Bobtail		X		X	X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Elapidae								
Elapid Snakes								
<i>Notechis scutatus</i>	Tiger Snake					X		X
<i>Pseudonaja affinis</i>	Dugite			X	X	X	X	X
<i>Simoselaps bertholdi</i>	Jan's Banded Snake							X

Aves

Phasianidae

Quails, Pheasants

<i>Coturnix pectoralis</i>	Stubble Quail	LC						X
<i>Coturnix ypsilophora</i>	Brown Quail	LC			X			X

Anatidae

Geese, Swans, Ducks

<i>Anas gracilis</i>	Grey Teal	LC				X		X
<i>Anas superciliosa</i>	Pacific Black Duck	LC			X	X		X
<i>Chenonetta jubata</i>	Australian Wood Duck	LC						X
<i>Tadorna tadornoides</i>	Australian Shelduck	LC				X		X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Ardeidae								
Heron, Egrets, Bitterns								
<i>Ardea alba</i>	Great Egret	S5 Mig CA JA				X		X
<i>Ardea novaehollandiae</i>	White-faced Heron	LC				X		X
<i>Ardea pacifica</i>	White-necked Heron	LC						X
Threskiornithidae								
Ibises, Spoonbills								
<i>Platalea flavipes</i>	Yellow-billed Spoonbill	LC				X		X
<i>Threskiornis molucca</i>	Australian White Ibis	LC	X	X	X	X		X
<i>Threskiornis spinicollis</i>	Straw-necked Ibis	LC	X		X	X		X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Accipitridae								
Kites, Goshawks, Eagles, Harriers								
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk	Bp LC			X		X	X
<i>Accipiter fasciatus</i>	Brown Goshawk	Bp LC		X		X	X	X
<i>Aquila audax</i>	Wedge-tailed Eagle	Bp LC				X		X
<i>Aquila morphnoides</i>	Little Eagle	Bp LC			X		X	X
<i>Circus approximans</i>	Swamp Harrier	LC				X		X
<i>Circus assimilis</i>	Spotted Harrier	LC						X
<i>Elanus caeruleus</i>	Black-shouldered Kite	LC			X	X	X	X
<i>Haliastur sphenurus</i>	Whistling Kite	Bp LC				X	X	X
<i>Hamirostra isura</i>	Square-tailed Kite	Bp LC						

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Falconidae								
Falcon								
<i>Falco berigora</i>	Brown Falcon	Bp LC						X
<i>Falco cenchroides</i>	Australian Kestrel	LC	X	X	X	X	X	X
<i>Falco longipennis</i>	Australian Hobby	LC			X	X	X	X
<i>Falco peregrinus</i>	Peregrine Falcon	S7 Bp LC					X	X
Rallidae								
Rails, Crakes, Swamphens, Coots								
<i>Fulica atra</i>	Eurasian Coot	LC				X		X
<i>Gallinula tenebrosa</i>	Dusky Moorhen	Bh LC				X		X
<i>Gallinula ventralis</i>	Black-tailed Native-hen	LC				X		X
<i>Gallirallus philippensis</i>	Buff-banded Rail	LC						X
<i>Porphyrio porphyrio</i>	Purple Swamphen	LC				X		X
<i>Porzana fluminea</i>	Australian Spotted Crake	LC						X
<i>Porzana pusilla</i>	Baillon's Crake	LC						X
<i>Porzana tabuensis</i>	Spotless Crake	LC						X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Turnicidae								
Button-quails								
<i>Turnix varia</i>	Painted Button-quail	Bp LC						X
Columbidae								
Pigeons, Doves								
<i>Columba livia</i>	Domestic Pigeon	Introduced				X		X
<i>Ocyphaps lophotes</i>	Crested Pigeon	LC			X	X		X
<i>Phaps chalcoptera</i>	Common Bronzewing	Bh LC			X		X	X
<i>Streptopelia chinensis</i>	Spotted Turtle-Dove	Introduced		X	X	X		X
<i>Streptopelia senegalensis</i>	Laughing Turtle-Dove	Introduced		X	X	X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Psittacidae								
Parrots								
<i>Cacatua roseicapilla</i>	Galah	LC	X	X	X	X	X	X
<i>Cacatua sanguinea</i>	Little Corella	LC			X	X		X
<i>Cacatua tenuirostris</i>	Eastern Long-billed Corella	Introduced						X
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black-Cockatoo	S3 VU Bp VU A2c+3c+4c	X	X	X	X		X
<i>Calyptorhynchus latirostris</i>	Carnaby's Black-Cockatoo	S2 EN Bp EN A2bcde+3bcde+4bcde	X	X	X	X	X	X
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet	LC						X
<i>Neophema elegans</i>	Elegant Parrot	LC				X		X
<i>Platycercus icterotis icterotis</i>	Western Rosella (western ssp)	Bp LC						
<i>Platycercus spurius</i>	Red-capped Parrot	LC	X	X	X	X	X	X
<i>Platycercus zonarius</i>	Australian Ringneck Parrot	LC	X	X	X	X	X	X
<i>Polytelis anthopeplus</i>	Regent Parrot	LC						X
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	Introduced	X	X	X	X		X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Cuculidae Parasitic Cuckoos								
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	LC		X	X			X
<i>Chrysococcyx basalis</i>	Horsfield's Bronze Cuckoo	LC			X		X	
<i>Chrysococcyx lucidus</i>	Shining Bronze Cuckoo	LC	X		X	X		X
<i>Cuculus pallidus</i>	Pallid Cuckoo	LC						
Strigidae Hawk Owls								
<i>Ninox novaeseelandiae</i>	Boobook Owl	LC				X		X
Tytonidae Barn Owls								
<i>Tyto alba</i>	Barn Owl	LC					X	X
Podargidae Frogmouths								
<i>Podargus strigoides</i>	Tawny Frogmouth	LC						X
Caprimulgidae Nightjars								
<i>Eurostopodus argus</i>	Spotted Nightjar	LC						X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Aegothelidae Owlet-nightjars								
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	LC				X		X
Halcyonidae Tree Kingfishers								
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	Introduced	X	X		X	X	X
<i>Todiramphus sanctus</i>	Sacred Kingfisher	LC				X		X
Meropidae Bee-eaters								
<i>Merops ornatus</i>	Rainbow Bee-eater	S5 Mig JA LC		X		X	X	X
Maluridae Fairy Wrens, GrassWrens								
<i>Malurus splendens</i>	Splendid Fairy-wren	Bh LC	X	X	X	X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Acanthizidae								
Thornbills, Geryones, Fieldwrens & Whitefaces								
<i>Acanthiza apicalis</i>	Broad-tailed Thornbill	Bh LC				X	X	X
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	Bh LC			X	X		X
<i>Acanthiza inornata</i>	Western Thornbill	Bh LC				X	X	X
<i>Gerygone fusca</i>	Western Gerygone	LC	X	X	X	X	X	X
<i>Sericornis frontalis</i>	White-browed Scrubwren	Bh LC				X	X	X
<i>Smicromnis brevirostris</i>	Weebill	Bh LC				X	X	X
Pardalotidae								
Pardalotes								
<i>Pardalotus punctatus</i>	Spotted Pardalote	LC				X		X
<i>Pardalotus striatus</i>	Striated Pardalote	LC		X	X	X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Meliphagidae Honeyeaters, Chats								
<i>Acanthorhynchus superciliosus</i>	Western Spinebill	LC			X	X		X
<i>Anthochaera carunculata</i>	Red Wattlebird	LC	X	X	X	X	X	X
<i>Anthochaera lunulata</i>	Western Little Wattlebird	Bp LC		X	X	X		X
<i>Epthianura albifrons</i>	White-fronted Chat	LC			X			X
<i>Lichenostomus virescens</i>	Singing Honeyeater	LC	X	X	X	X	X	
<i>Lichmera indistincta</i>	Brown Honeyeater	LC	X	X	X	X	X	X
<i>Phylidonyris melanops</i>	Tawny-crowned Honeyeater	Bp LC						X
<i>Phylidonyris nigra</i>	White-cheeked Honeyeater	Bp LC			X	X		X
<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	Bp LC	X	X	X	X	X	X
Petroicidae Australian Robins								
<i>Petroica multicolor</i>	Scarlet Robin	Bh LC					X	X
Neosittidae Sitellas								
<i>Daphoenositta chrysoptera</i>	Varied Sittella	Bh LC				X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Pachycephalidae								
Crested Shrike-tit, Crested Bellbird, Shrike Thrushes, Whistlers								
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	Bh LC			X	X	X	X
<i>Pachycephala pectoralis</i>	Golden Whistler	Bh LC			X			X
<i>Pachycephala rufiventris</i>	Rufous Whistler	LC	X	X	X	X	X	X
Dicruridae								
Monarchs, Magpie Lark, Flycatchers, Fantails, Drongo								
<i>Grallina cyanoleuca</i>	Magpie-lark	LC		X	X	X	X	X
<i>Rhipidura fuliginosa</i>	Grey Fantail	LC	X			X	X	X
<i>Rhipidura leucophrys</i>	Willie Wagtail	LC	X	X	X	X	X	X
Campephagidae								
Cuckoo-shrikes, Trillers								
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	LC	X	X	X	X	X	X
<i>Lalage tricolor</i>	White-winged Triller	LC						

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Artamidae Woodswallows, Butcherbirds, Currawongs								
<i>Artamus cinereus</i>	Black-faced Woodswallow	Bp LC						X
<i>Artamus cyanopterus</i>	Dusky Woodswallow	Bp LC				X		X
Cracticidae Currawongs, Magpies & Butcherbirds								
<i>Cracticus tibicen</i>	Australian Magpie	LC	X	X	X	X	X	X
<i>Cracticus torquatus</i>	Grey Butcherbird	LC	X	X	X	X	X	X
Corvidae Ravens, Crows								
<i>Corvus coronoides</i>	Australian Raven	LC	X	X	X	X	X	X
Motacillidae Old World Pipits, Wagtails								
<i>Anthus australis</i>	Australian Pipit	LC					X	
Dicaeidae Flowerpeckers								
<i>Dicaeum hirundinaceum</i>	Mistletoebird	LC						X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Hirundinidae Swallows, Martins								
<i>Hirundo neoxena</i>	Welcome Swallow	LC				X	X	X
<i>Hirundo nigricans</i>	Tree Martin	LC		X	X	X	X	X
Sylviidae Old World Warblers								
<i>Cincloramphus cruralis</i>	Brown Songlark	LC						X
<i>Cincloramphus mathewsi</i>	Rufous Songlark	LC						X
Zosteropidae White-eyes								
<i>Zosterops lateralis</i>	Silvereye	LC	X	X	X	X	X	X
Mammalia								
Peramelidae Bandicoots								
<i>Isodon obesulus fusciventer</i>	Southern Brown Bandicoot	P4 LC	X	X	X	X	X	
Phalangeridae Brush-tail Possums, Cuscuses								
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	LC				X		X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Molossidae								
Freetail Bats								
<i>Austronomus australis</i>	White-striped Freetail-bat	LC			X	X		X
<i>Ozimops kitcheneri</i>	Southern Freetail-bat	LC				X	X	
Vespertilionidae								
Ordinary Bats								
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	LC			X	X	X	X
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	LC						
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	LC				X		X
<i>Nyctophilus gouldi</i>	Gould's Long-eared Bat	LC						
<i>Nyctophilus major</i>	Western Long-eared Bat	LC					X	
<i>Vespadelus regulus</i>	Southern Forest Bat	LC			X	X	X	X
Muridae								
Rats, Mice								
<i>Mus musculus</i>	House Mouse	Introduced		X	X	X	X	X
<i>Rattus rattus</i>	Black Rat	Introduced			X	X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Canidae								
Dogs, Foxes								
<i>Canis lupus familiaris</i>	Dog	Introduced	X	X			X	
<i>Vulpes vulpes</i>	Red Fox	Introduced	X		X	X	X	X
Felidae								
Cats								
<i>Felis catus</i>	Cat	Introduced		X	X	X	X	X
Leporidae								
Rabbits, Hares								
<i>Oryctolagus cuniculus</i>	Rabbit	Introduced	X	X	X	X	X	X

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APPENDIX E: FLORA SPECIES LIST (BY COMMUNITY)

* denotes introduced (weed) species
 DP denotes Declared Pest plants

Family	Species	N/I	Vegetation Community							
			BaEt	BaXp	Xp	Mp	MpAI	ErAI (d)	Eg (d)	i
Aizoaceae	<i>Carpobrotus edulis</i>	*	+	+	+					+
Apiaceae	<i>Daucus glochidiatus</i>	*	+	+						
Apocynaceae	<i>Gomphocarpus fruticosus</i>	DP		+						
Araceae	<i>Zantedeschia aethiopica</i>	DP				+				
Asparagaceae	<i>Asparagus asparagoides</i>	DP	+				+			
Asphodelaceae	<i>Trachyandra divaricata</i>	*								+
Asteraceae	<i>Arctotheca calendula</i>	*			+	+	+	+	+	+
	<i>Hypochaeris glabra</i>	*	+	+	+	+	+	+	+	+
	<i>Osteospermum ecklonis</i>	*								+
	<i>Sonchus oleraceus</i>	*		+						+
	<i>Ursinia anthemoides</i>	*	+	+						+
Boraginaceae	<i>Echium plantagineum</i>	DP		+						
Brassicaceae	<i>Brassica tournefortii</i>	*	+							+
Cactaceae	<i>Opuntia</i> sp.	*								+
Campanulaceae	<i>Wahlenbergia capensis</i>	*	+							
Caryophyllaceae	<i>Petrorhagia dubia</i>	*			+					
	<i>Allocauarina fraseri</i>			+	+					
Casuarinaceae	<i>Allocauarina humilis</i>		+							
	<i>Burchardia congesta</i>		+							
Colchicaceae	<i>Burchardia congesta</i>		+							
Crassulaceae	<i>Crassula colorata</i>		+		+					+
Cyperaceae	<i>Isolepis marginata</i>			+						+
	<i>Lepidosperma longitudinale</i>					+				
Dasygogonaceae	<i>Dasygogon bromeliifolius</i>			+	+					
Dilleniaceae	<i>Hibbertia hypericoides</i>		+							
	<i>Hibbertia subvaginata</i>		+			+	+			
Ecdeiocoleaceae	<i>Ecdeiocolea monostachya</i>									+
Elaeocarpaceae	<i>Tetratheca hirsuta</i>					+				
Ericaceae	<i>Conostephium minus</i>				+					
	<i>Leucopogon australis</i>					+				
	<i>Leucopogon conostephioides</i>		+							
Euphorbiaceae	<i>Euphorbia terracina</i>	*			+					+
	<i>Ricinus communis</i>	*		+					+	
Fabaceae	<i>Acacia longifolia</i>	*	+					+	+	+
	<i>Acacia pulchella</i>					+	+	+		
	<i>Acacia saligna</i>			+						
	<i>Bossiaea eriocarpa</i>		+							
	<i>Chamaecytisus palmensis</i>	*		+						+
	<i>Daviesia triflora</i>		+							
	<i>Gastrolobium capitatum</i>		+							
	<i>Gompholobium tomentosum</i>		+							
	<i>Hovea pungens</i>		+							
	<i>Jacksonia furcellata</i>		+	+						
	<i>Lupinus cosentinii</i>	*								+
	<i>Medicago polymorpha</i>	*				+		+	+	
	<i>Trifolium campestre</i>	*		+						+
<i>Vicia hirsuta</i>	*								+	
<i>Vicia sativa</i> subsp. <i>nigra</i>	*		+						+	
Geraniaceae	<i>Erodium botrys</i>	*		+						
	<i>Pelargonium capitatum</i>	*		+						+
Goodeniaceae	<i>Dampiera linearis</i>		+							

* denotes introduced (weed) species
 DP denotes Declared Pest plants

Family	Species	N/I	Vegetation Community							
			BaEt	BaXp	Xp	Mp	MpAI	ErAI (d)	Eg (d)	i
Haemodoraceae	<i>Anigozanthos humilis</i>		+							
	<i>Anigozanthos manglesii</i>		+							
	<i>Conostylis aculeata</i> subsp. <i>aculeata</i>		+							
	<i>Phlebocarya ciliata</i>		+		+					
Iridaceae	<i>Freesia alba</i> × <i>leichtlinii</i>	*								+
	<i>Gladiolus caryophyllaceus</i>	*	+	+	+					+
	<i>Patersonia occidentalis</i>	*	+							
	<i>Romulea rosea</i>	*	+							
	<i>Watsonia meriana</i>	*								+
Lauraceae	<i>Cassytha racemosa</i>					+	+			
Loranthaceae	<i>Nuytsia floribunda</i>		+	+						+
Malvaceae	<i>Brachychiton diversifolius</i>									+
Meliaceae	<i>Melia azedarach</i>	*								+
Myrtaceae	<i>Aotus gracillima</i>		+							
	<i>Astartea scoparia</i>					+	+			
	<i>Eremaea pauciflora</i> var. <i>pauciflora</i>		+							
	<i>Eucalyptus gomphocephala</i>								+	+
	<i>Eucalyptus marginata</i>			+						
	<i>Eucalyptus petiolaris</i>									+
	<i>Eucalyptus rudis</i>				+	+		+		
	<i>Eucalyptus todtiana</i>			+						
	<i>Hypocalymma angustifolium</i>		+	+		+	+			
	<i>Hypocalymma robustum</i>		+							
	<i>Kunzea glabrescens</i>					+	+			+
	<i>Leptospermum laevigatum</i>	*				+	+	+	+	+
	<i>Melaleuca preissiana</i>			+			+			+
	<i>Pericalymma ellipticum</i>						+			
	<i>Regelia inops</i>				+					
	<i>Scholtzia involucreta</i>		+		+					
Oleaceae	<i>Olea europaea</i>	*								+
Orchidaceae	<i>Caladenia flava</i>		+							
	<i>Diuris brumalis</i>		+							
	<i>Thelymitra crinita</i>		+			+				
Orobanchaceae	<i>Orobanche minor</i>	*		+						
Oxalidaceae	<i>Oxalis pes-caprae</i>	*		+						+
Papaveraceae	<i>Fumaria capreolata</i>	*	+	+	+	+	+	+	+	+
Poaceae	<i>Briza maxima</i>	*	+	+	+	+	+	+	+	
	<i>Briza minor</i>	*			+	+	+	+	+	
	<i>Bromus arenarius</i>	*		+	+					+
	<i>Cynodon dactylon</i>	*								+
	<i>Ehrharta calycina</i>	*					+	+	+	+
	<i>Ehrharta longiflora</i>	*		+	+	+	+	+	+	+
	<i>Lagurus ovatus</i>	*								+
	<i>Lolium rigidum</i>	*		+	+					+
	<i>Lysimachia arvensis</i>	*		+						
	<i>Stirlingia latifolia</i>	*								
Primulaceae	<i>Lysimachia arvensis</i>	*		+						
Proteaceae	<i>Adenanthos cygnorum</i>		+							+
	<i>Adenanthos obovatus</i>		+	+	+					
	<i>Banksia attenuata</i>				+					+
	<i>Banksia illicifolia</i>		+							
	<i>Banksia menziesii</i>		+	+	+					
	<i>Petrophile linearis</i>		+							
	<i>Stirlingia latifolia</i>		+							

* denotes introduced (weed) species
 DP denotes Declared Pest plants

Family	Species	N/I	Vegetation Community							
			BaEt	BaXp	Xp	Mp	MpAI	ErAI (d)	Eg (d)	i
Restionaceae	<i>Leptocarpus scariosus</i>		+							
	<i>Lyginia imberbis</i>		+							
Solanaceae	<i>Solanum linnaeanum</i>	*								+
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>				+		+			+
Zamiaceae	<i>Macrozamia riedlei</i>		+							
Total		45	48	35	22	22	18	12	11	43

APPENDIX F: SITE DESCRIPTIONS

BaEt

Low Woodland A of *Banksia attenuata* and *Eucalyptus tottiana* over *Xanthorrhoea preissii* over *Dasypogon bromeliifolius* and *Phlebocarya ciliata* in pale grey sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	10 m x 10 m
Habitat	Woodland
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Pale Grey
Soil Texture	Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	3-4 (Good to Very Good)
Disturbance Type	Weeds
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 25%



Species	Dominant Height (m)	Form	% cover
<i>Banksia attenuata</i>	6	Tree	7
<i>Eucalyptus tottiana</i>	5	Tree	5
<i>Banksia ilicifolia</i>		Tree	1
<i>Banksia menziesii</i>		Tree	1
<i>Xanthorrhoea preissii</i>	2	Shrub	3
<i>Acacia longifolia</i>		Shrub	1

Species	Dominant Height (m)	Form	% cover
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>		Shrub	1
<i>Adenanthos obovatus</i>		Shrub	1
<i>Allocasuarina humilis</i>		Shrub	1
<i>Bossiaea eriocarpa</i>		Shrub	1
<i>Eremaea pauciflora</i> var. <i>pauciflora</i>		Shrub	1
<i>Gastrolobium capitatum</i>		Shrub	1
<i>Gompholobium tomentosum</i>		Shrub	1
<i>Hibbertia hypericoides</i>		Shrub	1
<i>Hibbertia subvaginata</i>		Shrub	1
<i>Hovea pungens</i>		Shrub	1
<i>Hypocalymma angustifolium</i>		Shrub	1
<i>Hypocalymma robustum</i>		Shrub	1
<i>Jacksonia furcellata</i>		Shrub	1
<i>Daviesia triflora</i>		Shrub	1
<i>Aotus gracillima</i>		Shrub	1
<i>Leucopogon conostephioides</i>		Shrub	1
<i>Nuytsia floribunda</i>		Shrub	1
<i>Petrophile linearis</i>		Shrub	1
<i>Scholtzia involucrata</i>		Shrub	1
<i>Asparagus asparagoides</i> * (DP)		Climber	1
<i>Fumaria capreolata</i> *		Climber	1
<i>Dasypogon bromeliifolius</i>	0.4	Herb	10
<i>Phlebocarya ciliata</i>	0.3	Herb	10
<i>Anigozanthos humilis</i>		Herb	1
<i>Anigozanthos manglesii</i>		Herb	1
<i>Brassica tournefortii</i> *		Herb	1
<i>Burchardia congesta</i>		Herb	1
<i>Caladenia flava</i>		Herb	1
<i>Carpobrotus edulis</i> *		Herb	1
<i>Conostylis aculeata</i> subsp. <i>aculeata</i>		Herb	1
<i>Crassula colorata</i>		Herb	1
<i>Dampiera linearis</i>		Herb	1
<i>Daucus glochidiatus</i> *		Herb	1
<i>Diuris brumalis</i>		Herb	1
<i>Gladiolus caryophyllaceus</i> *		Herb	1
<i>Hypochaeris glabra</i> *		Herb	1
<i>Leptocarpus scariosus</i>		Herb	1
<i>Macrozamia riedlei</i>		Shrub	1
<i>Patersonia occidentalis</i>		Herb	1
<i>Romulea rosea</i> *		Herb	1

Species	Dominant Height (m)	Form	% cover
<i>Stirlingia latifolia</i>		Herb	1
<i>Thelymitra crinita</i>		Herb	1
<i>Ursinia anthemoides</i> *		Herb	1
<i>Wahlenbergia capensis</i> *		Herb	1
<i>Lyginia imberbis</i>		Sedge	1
<i>Briza maxima</i> *		Grass	1

BaXp

Low Woodland A of *Banksia attenuata* and *Banksia ilicifolia* over occasionally dominant patches of *Kunzea glabrescens*, with *Xanthorrhoea preissii* and **Acacia longifolia*, over mostly weeds, dominated by **Ehrharta calycina* and **Actotheca calendula*, in grey sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	10 m x 10 m
Habitat	Woodland
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Grey
Soil Texture	Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	4 (Good)
Disturbance Type	Weeds; Vehicle tracks
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 25%



Species	Dominant Height (m)	Form	% cover
<i>Banksia attenuata</i>	6	Tree	6
<i>Banksia ilicifolia</i>	7	Tree	3
<i>Allocasuarina fraseriana</i>		Tree	1
<i>Banksia menziesii</i>		Tree	1
<i>Eucalyptus marginata</i>		Tree	1
<i>Eucalyptus tottiana</i>		Tree	1
<i>Melaleuca preissiana</i>		Tree	1

Species	Dominant Height (m)	Form	% cover
<i>Xanthorrhoea preissii</i>	1.5	Shrub	3
<i>Kunzea glabrescens</i>	3	Shrub	2
<i>Acacia longifolia</i> *	3	Shrub	1
<i>Acacia saligna</i>		Shrub	1
<i>Adenanthos obovatus</i>		Shrub	1
<i>Chamaecytisus palmensis</i> *		Shrub	1
<i>Gomphocarpus fruticosus</i> *(DP)		Shrub	1
<i>Hypocalymma angustifolium</i>		Shrub	1
<i>Jacksonia furcellata</i>		Shrub	1
<i>Nuytsia floribunda</i>		Shrub	1
<i>Regelia inops</i>		Shrub	1
<i>Ricinus communis</i> *		Shrub	1
<i>Fumaria capreolata</i> *		Climber	1
<i>Arctotheca calendula</i> *	0.2	Herb	10
<i>Carpobrotus edulis</i> *		Herb	1
<i>Dasypogon bromeliifolius</i>		Herb	1
<i>Daucus glochidiatus</i> *		Herb	1
<i>Echium plantagineum</i> *(DP)		Herb	1
<i>Erodium botrys</i> *		Herb	1
<i>Gladiolus caryophyllaceus</i> *		Herb	1
<i>Hypochaeris glabra</i> *		Herb	1
<i>Lysimachia arvensis</i> *		Herb	1
<i>Orobanche minor</i> *		Herb	1
<i>Oxalis pes-caprae</i> *		Herb	1
<i>Pelargonium capitatum</i> *		Herb	1
<i>Raphanus raphanistrum</i> *		Herb	1
<i>Sonchus oleraceus</i> *		Herb	1
<i>Trifolium campestre</i> *		Herb	1
<i>Ursinia anthemoides</i> *		Herb	1
<i>Vicia sativa</i> subsp. <i>nigra</i> *		Herb	1
<i>Isolepis marginata</i>		Sedge	1
<i>Ehrharta calycina</i> *	1	Grass	40
<i>Briza maxima</i> *		Grass	1
<i>Bromus arenarius</i> *		Grass	1
<i>Ehrharta longiflora</i> *		Grass	1
<i>Lolium rigidum</i> *		Grass	1

Xp

Low Scrub A of *Xanthorrhoea preissii* over *Dasypogon bromeliifolius*, *Phlebocarya ciliata* and **Ehrharta calycina*, in grey sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	10 m x 10 m
Habitat/Waterway	Heath/Scrub
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Grey
Soil Texture	Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	4 (Good)
Disturbance Type	Weeds
Time since fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 20%



Species	Dominant Height (m)	Form	% cover
<i>Allocasuarina fraseriana</i>		Tree	1
<i>Eucalyptus rudis</i>		Tree	1
<i>Xanthorrhoea preissii</i>	2	Shrub	30
<i>Adenanthos obovatus</i>		Shrub	1
<i>Conostephium minus</i>		Shrub	1
<i>Scholtzia involucrata</i>		Shrub	1
<i>Fumaria capreolata*</i>		Climber	1

Species	Dominant Height (m)	Form	% cover
<i>Dasypogon bromeliifolius</i>	0.4	Herb	25
<i>Phlebocarya ciliata</i>	0.3	Herb	7
<i>Arctotheca calendula</i> *		Herb	1
<i>Carpobrotus edulis</i> *		Herb	1
<i>Crassula colorata</i>		Herb	1
<i>Euphorbia terracina</i> *		Herb	1
<i>Gladiolus caryophyllaceus</i> *		Herb	1
<i>Hypochaeris glabra</i> *		Herb	1
<i>Lolium rigidum</i> *		Herb	1
<i>Petrorhagia dubia</i> *		Herb	1
<i>Ehrharta calycina</i> *	1	Grass	50
<i>Briza maxima</i> *		Grass	1
<i>Briza minor</i> *		Grass	1
<i>Bromus arenarius</i> *		Grass	1
<i>Ehrharta longiflora</i> *		Grass	1

Mp

Low Woodland A of occasional *Eucalyptus rudis* over *Melaleuca preissiana* over occasionally dominant patches of *Kunzea glabrescens*, with *Xanthorrhoea preissii* and **Acacia longifolia*, over mostly weeds, dominated by **Ehrharta calycina*, in brown loamy sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	10 m x 10 m
Habitat/Waterway	Woodland/Wetland
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Brown
Soil Texture	Loamy Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	3-4 (Good to Very Good)
Disturbance Type	Weeds
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 40%



Species	Dominant Height (m)	Form	% cover
<i>Melaleuca preissiana</i>	9	Tree	9
<i>Eucalyptus rudis</i>	12	Tree	2
<i>Kunzea glabrescens</i>	3	Shrub	20
<i>Acacia longifolia</i> *	4	Shrub	4
<i>Xanthorrhoea preissii</i>	2	Shrub	3
<i>Acacia pulchella</i>		Shrub	1
<i>Astartea scoparia</i>		Shrub	1

Species	Dominant Height (m)	Form	% cover
<i>Hibbertia subvaginata</i>		Shrub	1
<i>Hypocalymma angustifolium</i>		Shrub	1
<i>Leptospermum laevigatum</i> *		Shrub	1
<i>Leucopogon australis</i>		Shrub	1
<i>Pericalymma ellipticum</i>		Shrub	1
<i>Tetradlea hirsuta</i>		Shrub	1
<i>Asparagus asparagoides</i> * (DP)		Climber	1
<i>Cassytha racemosa</i>		Climber	1
<i>Fumaria capreolata</i> *		Climber	1
<i>Arctotheca calendula</i> *		Herb	1
<i>Hypochaeris glabra</i> *		Herb	1
<i>Medicago polymorpha</i> *		Herb	1
<i>Thelymitra crinita</i>		Herb	1
<i>Zantedeschia aethiopica</i> * (DP)		Herb	1
<i>Lepidosperma longitudinale</i>		Sedge	1
<i>Ehrharta calycina</i> *	1	Grass	50
<i>Briza maxima</i> *		Grass	1
<i>Briza minor</i> *		Grass	1
<i>Ehrharta longiflora</i> *		Grass	1

MpAI

Low Woodland A of *Melaleuca preissiana* over **Acacia longifolia*, over mostly weeds, dominated by **Ehrharta calycina* and **Ehrharta longiflora* in brown loamy sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	10 m x 10 m
Habitat/Waterway	Woodland/Wetland
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Brown
Soil Texture	Loamy Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	4-6 (Degraded to Good)
Disturbance Type	Weeds
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 40%
Picture	

Species	Dominant Height (m)	Form	% cover
<i>Melaleuca preissiana</i>	6	Tree	12
<i>Kunzea glabrescens</i>		Shrub	2
<i>Acacia longifolia</i> *	5	Shrub	10
<i>Xanthorrhoea preissii</i>		Shrub	2
<i>Acacia pulchella</i>		Shrub	1
<i>Astartea scoparia</i>		Shrub	1
<i>Hibbertia subvaginata</i>		Shrub	1
<i>Hypocalymma angustifolium</i>		Shrub	1
<i>Leptospermum laevigatum</i> *		Shrub	1
<i>Asparagus asparagoides</i> * (DP)		Climber	1
<i>Cassytha racemosa</i>		Climber	1
<i>Fumaria capreolata</i> *		Climber	1
<i>Arctotheca calendula</i> *		Herb	1
<i>Hypochaeris glabra</i> *		Herb	1
<i>Medicago polymorpha</i> *		Herb	1
<i>Ehrharta calycina</i> *	1	Grass	50
<i>Ehrharta longiflora</i> *	1	Grass	4
<i>Briza maxima</i> *		Grass	1
<i>Briza minor</i> *		Grass	1

ErAI (d)

Degraded areas of *Eucalyptus rudis* over **Acacia longifolia* over weeds, dominated by **Ehrharta calycina* and **Ehrharta longiflora* in brown loamy sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	Relevé
Habitat/Waterway	Woodland
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Brown
Soil Texture	Loamy Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	6 (Degraded)
Disturbance Type	Weeds
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 40%

Species	Form	% cover
<i>Eucalyptus rudis</i>	Tree	10
<i>Acacia longifolia</i> *	Shrub	10
<i>Acacia pulchella</i>	Shrub	1
<i>Leptospermum laevigatum</i> *	Shrub	1
<i>Fumaria capreolata</i> *	Climber	1
<i>Arctotheca calendula</i> *	Herb	1
<i>Hypochaeris glabra</i> *	Herb	1
<i>Medicago polymorpha</i> *	Herb	1
<i>Ehrharta calycina</i> *	Grass	50
<i>Ehrharta longiflora</i> *	Grass	4
<i>Briza maxima</i> *	Grass	1
<i>Briza minor</i> *	Grass	1

Eg (d)

Degraded areas of *Eucalyptus gomphocephala* over weeds, dominated by **Ehrharta calycina* and **Ehrharta longiflora* in brown loamy sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	Relevé
Habitat/Waterway	Woodland
Slope	Moderate
Surface Layer	Loose Soil
Soil Colour	Grey
Soil Texture	Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	4-6 (Degraded to Completely Degraded)
Disturbance Type	Weeds, tracks
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 40%

Species	Form	% cover
<i>Eucalyptus gomphocephala</i>	Tree	10
<i>Leptospermum laevigatum</i> *	Shrub	1
<i>Ricinnis communis</i> *	Shrub	1
<i>Fumaria capreolata</i> *	Climber	1
<i>Arctotheca calendula</i> *	Herb	1
<i>Hypochaeris glabra</i> *	Herb	1
<i>Medicago polymorpha</i> *	Herb	1
<i>Ehrharta calycina</i> *	Grass	30
<i>Ehrharta longiflora</i> *	Grass	10
<i>Briza maxima</i> *	Grass	1
<i>Briza minor</i> *	Grass	1

i

Completely degraded areas of planted trees and shrubs and weeds, or weeds only, with occasional *Adenanthos cygnorum* subsp. *cygnorum* and *Xanthorrhoea preissii*, in grey or brown sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	Relevé
Habitat/Waterway	Degraded; Shrubland/Grassland Mosaic
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Grey/brown
Soil Texture	Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	6 (Completely Degraded)
Disturbance Type	Weeds; Vehicle tracks
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 5%

Typical Species	Form	% cover
<i>Brachychiton diversifolius</i> *	Tree	1
<i>Eucalyptus petiolaris</i> *	Tree	1
<i>Melia azedarach</i> *	Tree	1
<i>Olea europaea</i> *	Tree	1
<i>Leptospermum laevigatum</i> *	Shrub	15
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	Shrub	10
<i>Acacia longifolia</i> *	Shrub	1
<i>Opuntia</i> sp.*	Shrub	1
<i>Solanum linnaeanum</i> *	Shrub	1
<i>Xanthorrhoea preissii</i>	Shrub	1
<i>Fumaria capreolata</i> *	Climber	1
<i>Arctotheca calendula</i> *	Herb	1
<i>Brassica tournefortii</i> *	Herb	1
<i>Chamaecytisus palmensis</i> *	Herb	1
<i>Euphorbia terracina</i> *	Herb	1
<i>Freesia alba</i> × <i>leichtlinii</i> *	Herb	1
<i>Gladiolus caryophyllaceus</i> *	Herb	1
<i>Hypochaeris glabra</i> *	Herb	1
<i>Lupinus cosentinii</i> *	Herb	1
<i>Osteospermum ecklonis</i> *	Herb	1
<i>Oxalis pes-caprae</i> *	Herb	1
<i>Pelargonium capitatum</i> *	Herb	1
<i>Sonchus oleraceus</i> *	Herb	1
<i>Trachyandra divaricata</i> *	Herb	1
<i>Trifolium campestre</i> *	Herb	1

Typical Species	Form	% cover
<i>Ursinia anthemoides</i> *	Herb	1
<i>Vicia hirsuta</i> *	Herb	1
<i>Vicia sativa</i> subsp. <i>nigra</i> *	Herb	1
<i>Watsonia meriana</i> *	Herb	1
<i>Ecdeiocolea monostachya</i>	Sedge	1
<i>Isolepis marginata</i>	Sedge	1
<i>Ehrharta calycina</i> *	Grass	60
<i>Bromus arenarius</i> *	Grass	1
<i>Carpobrotus edulis</i> *	Grass	1
<i>Cynodon dactylon</i> *	Grass	1
<i>Ehrharta longiflora</i> *	Grass	1
<i>Lagurus ovatus</i> *	Grass	1
<i>Lolium rigidum</i> *	Grass	1

APPENDIX G: HABITAT TREE DATA

mE	mN	Lot No.	Tree Species	Tree Height (m)	No. Hollows	Hollow Type 1	Hollow Size 1 (cm)	Hollow Type 2	Hollow Size 2 (cm)	Occupancy	Chew Marks	Potential Cockatoo Nest Hollow	Comments
392023	6445500	9500	Jarrah	15-20	1	Knot Hole	5-10			No Signs	No Signs	No	Depth of hollows unknown
392058	6445521	9500	Jarrah	15-20	2	Knot Hole	5-10	Spout Branch	5-10	Bees	No Signs	No	Partly dead – Hollow depths unknown
392054	6445367	9500	Non-endemic Eucalypt	20+	0					No Signs	No Signs	No	Planted Non-endemic
392024	6445383	9500	Non-endemic Eucalypt	20+	0					No Signs	No Signs	No	Planted Non-endemic
392547	6445161	33	Dead Tuart	20+	1	Knot Hole	10-20			Galahs	Galahs	No	Galah present - Hollow depth unknown
392552	6445161	33	Tuart	20+	0					No Signs	No Signs	No	
392556	6445152	33	Tuart	20+	0					No Signs	No Signs	No	
392557	6445147	33	Tuart	20+	0					No Signs	No Signs	No	
392614	6445213	33	Tuart	20+	0					No Signs	No Signs	No	
392597	6445225	33	Tuart	20+	0					No Signs	No Signs	No	
392590	6445226	33	Tuart	15-20	1	Spout Branch	5-10			No Signs	No Signs	No	Depth of hollows unknown
392571	6445205	33	Tuart	20+	0					No Signs	No Signs	No	
392571	6445204	36	Tuart	15-20	0					No Signs	No Signs	No	
392515	6445202	36	Tuart	20+	0					No Signs	No Signs	No	
392524	6445224	36	Tuart	20+	0					No Signs	No Signs	No	
392524	6445222	36	Tuart	20+	0					No Signs	No Signs	No	
392436	6445361	801	Flooded Gum	20+	1	Fissure	5-10			No Signs	No Signs	No	Depth of hollows unknown
392497	6445689	802	Dead Flooded Gum	10-15	2	Knot Hole	5-10	Spout Trunk	20+	No Signs	No Signs	Yes	Depth of hollows unknown



**COCKBURN CENTRAL EAST LOCAL STRUCTURE PLAN (CCE LSP)
AREA, TARGETED CALADENIA HUEGELII SURVEY**

JANUARY 2018

CITY OF COCKBURN



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EXECUTIVE SUMMARY

Focused Vision Consulting Pty Ltd (FVC) was commissioned during September 2017 by the City of Cockburn (the City) to undertake a targeted *Caladenia huegelii* survey within the Cockburn Central East Local Structure Plan (CCE LSP) area (study area).

A targeted survey of the study area was conducted by FVC on 27 September 2017. Two experienced botanists, Kellie Bauer-Simpson and Gabriela Martinez with an experienced field assistant, Will Bauer-Simpson, systematically assessed the suitable habitat areas of the study area for *Caladenia huegelii*. The searches were conducted via a series of parallel transects in accordance with the Department of the Environment (2013) Guidelines for Detecting Orchids Listed as 'Threatened'.

The timing of the survey (September) was considered optimal to conduct a targeted flora survey for *Caladenia huegelii*, and other Spider Orchid species such as *Caladenia longicauda* were also observed in flower during the survey.

Although a detailed search was carried out, no *Caladenia huegelii* plants were recorded.

1 INTRODUCTION

1.1 BACKGROUND

Focused Vision Consulting (FVC) was commissioned during September 2017 by the City of Cockburn (the City) to undertake a targeted *Caladenia huegelii* survey within the Cockburn Central East Local Structure Plan (CCE LSP) area (study area). This work is following a spring flora, vegetation, fauna and habitat assessment completed by FVC during 2016. The results of that study identified that the site provides suitable habitat for the species, and therefore *Caladenia huegelii* may be present within the study area. The study area encompasses a number of Lots, totalling 31.21 ha as shown in **Figure 1**, much of which was included in the targeted search, depending on habitat suitability, also shown in **Figure 1**.

This report provides the results of the Targeted *Caladenia huegelii* survey undertaken within the study area during September 2017.

1.2 LOCATION

The study area is located approximately 20 km south of the Perth CBD, directly adjacent to the Kwinana Freeway on both the western and eastern sides. On the western side of the freeway, the area is bounded by Kentucky Court and North Lake Road. To the east of the freeway, the study area is comprised of numerous lots between Cutler Road and Knock Place, Cockburn Central (**Figure 1**).

1.3 SCOPE OF WORK

The scope included a targeted *Caladenia huegelii* survey. The tasks required to be carried out included:

- undertaking systematic traverses of the study area, within suitable habitat, to search for *Caladenia huegelii* plants, where (if) plants were observed, recording the:
 - GPS location of each individual *Caladenia huegelii* allowing an inventory of the number of plants/population size
 - vegetation type and condition at the recorded location
 - condition of plants/populations recorded
- the preparation of a report that summarises results and includes:
 - a discussion on the results, including identification and spatial mapping of all occurrences of *Caladenia huegelii* within the study area
 - identification of any potential environmental impacts and develop management recommendations for the protection of the Threatened flora species.

The survey was carried out in accordance with:

- Department of the Environment (2013) Guidelines for Detecting Orchids Listed as 'Threatened' under the *Environment and Biodiversity Conservation Act 1999* (EPBC Act).



0 50 100 150 200 m

GDA 94 / MGA Zone 50

**Figure 1 - Cockburn Central East
Local Structure Plan Project Area**



Legend

 Project Area



2 EXISTING ENVIRONMENT

2.1 CLIMATE

The Swan Coastal Plain has a warm Mediterranean climate which is characterised by hot dry summers and cool to mild wet winters (Mitchell *et al.* 2002). Jandakot Airport (009172) is the closest meteorological recording station to Cockburn Central and has recorded an average annual rainfall of 823.5 mm (BoM 2017).

2.2 IBRA REGION

There are 89 recognised Interim Biogeographic Regionalisation for Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (Commonwealth of Australia 2013). The study area lies within the Swan Coastal Plain IBRA region and, at a finer scale, within the Perth subregion (Mitchell *et al.* 2002).

2.3 GEOLOGY AND SOILS

The study area lies within the Bassendean Dune System which consists of very old leached sands to various depths (GHD 2015) and are the oldest of the three dunes systems occurring on the Swan Coastal Plain. Sands within this system contain very little silt or clay and very low levels of nutrient elements (ESWA 2016).

Soils within the study area are mapped as three sub units of the Bassendean System (Schoknecht *et al.* 2004). They are described as:

- 212Bs_B1 - Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands with pale yellow B horizon
- 212Bs_B2 – Flat to very gently undulating sandplain with well to moderate well drained deep bleached grey sands with a pale yellow B horizon or weak iron organic hardpan
- 212Bs_B4 – Broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depth generally greater than 1.5 m by clay or less frequently a strong iron organic hardpan.

2.4 VEGETATION

The study area is located on the Swan Coastal Plain and has been broadly characterised by Beard (1990) as “e2Mb cbLi - Medium very sparse woodland; jarrah, with low woodland; Banksia and Casuarina (Association 1001)”.

Vegetation of the Perth subregion comprises heath and/or Tuart (*Eucalyptus gomphocephala*) woodlands on limestone, Jarrah (*Eucalyptus marginata*) and *Banksia* woodlands on Quaternary marine dunes and Marri (*Corymbia calophylla*) on colluvial and alluvial sands (Mitchell *et al.* 2002).

Vegetation complexes within the study area have been defined by Heddle *et al.* (1980) and are based on vegetation in association with landforms and underlying geology. One vegetation complex Bassendean complex – central and south as described by Heddle *et al.* (1980) occurs within the study area. This complex ranges from woodlands of *Eucalyptus marginata*, *Allocasuarina* and *Banksia* on sand dunes to a low woodland of *Melaleuca* species, and sedge lands on the low-lying depressions and swamps.

3 SPECIES PROFILE

3.1 CALADENIA HUEGELII

3.1.1 Conservation Significance

Caladenia huegelii was classified as Threatened (Declared Rare Flora – Extant) in November 1990 under the *Wildlife Conservation Act, 1950* (WC Act) and listed under Schedules 1 to 4 of the Wildlife Conservation (Rare Flora) Notice for Threatened Flora. It is a species of flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F (20) of the WC Act. *Caladenia huegelii* is also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The species is also ranked Critically Endangered (CR) under World Conservation Union (IUCN 2001) criterion B2ab (i, ii, iii, iv) due to the severe fragmentation of populations and the continuing decline in the extent of its occurrence, area of occupancy, quality of habitat and number of locations.

3.1.2 Ecology, Habitat and Distribution

Caladenia huegelii grows up to 60 cm tall with a single erect, pale green, hairy leaf and one or two (rarely three) predominantly pale greenish-cream flowers 7-10 cm across, with variable suffusions, lines and spots of red-maroon. Floral odour is absent. The sepals end in slender light brown to yellow clubs. The large labellum is prominently two coloured with a pale greenish-cream base and a uniformly dark maroon recurved apex. The leaf is densely hirsute to 4 mm long. Leaves are visible from May to November. Flowering occurs from September to October, with not all adult plants producing a flower each year. Some plants have been recorded not to produce a leaf each year and remain as a dormant tuberoid below ground (Hopper and Brown 2001).

Correct identification of *Caladenia huegelii* can only be carried out when it is in flower as a range of *Caladenia* species produce similar leaves (DEC 2009).

The preferred habitat of *Caladenia huegelii* is well drained, deep sandy soils in areas of mixed woodland of Jarrah (*Eucalyptus marginata*), Candlestick Banksia (*Banksia attenuata*), Holly Banksia (*Banksia ilicifolia*) and Firewood Banksia (*Banksia menziesii*) with scattered Sheoak (*Allocasuarina fraseriana*) and Marri (*Corymbia calophylla*) over dense Blueboy (*Stirlingia latifolia*), Swan River Myrtle (*Hypocalymma robustum*), Yellow buttercups (*Hibbertia hypericoides*), Buttercups (*Hibbertia subvaginata*), Balga (*Xanthorrhoea preissii*), coastal jugflower (*Adenanthos cuneatus*) and *Conostylis* species (DEC 2009).

Caladenia huegelii is found in the Jarrah Forest and Swan Coastal Plain Bioregions of Western Australia. A review of available information on populations held by the Department of Biodiversity Conservation and Attractions (DBCA) in 2017 indicated that 41 known records of the species are held at the Western Australian Herbarium (DBCA 2017).

4 METHODOLOGY

The areas of suitable habitat within the CCE LSP study area were determined based on previous vegetation mapping (FVC 2016). Suitable habitat was determined to encompass the two Banksia woodland units (BeEt and BaXp, as mapped by FVC (2016)) in better than degraded condition (Degraded to Good, or better). On a finer scale, some sections of the suitable habitat (Banksia woodland) were found to be either cleared since the 2016 spring survey, or not specifically suitable habitat for *Caladenia huegelii*, due to domination of dense stands of introduced Victorian Tea-tree (*Leptospermum laevigatum*). These areas were therefore not searched in detail (mostly impenetrable) and are presented in **Figure 2**.

A targeted flora survey of the suitable habitat areas within the, study area was carried out on 27 September 2017 during the optimal flowering period for *Caladenia huegelii*. The survey was conducted in accordance with the Department of the Environment (2013) Guidelines for Detecting Orchids Listed as 'Threatened'.

Two experienced FVC botanists, Kellie Bauer-Simpson and Gabriela Martinez and an experienced field assistant, Will Bauer-Simpson, systematically assessed the suitable habitat areas for the presence of *Caladenia huegelii* individuals. A series of parallel transects, spaced approximately 10 m apart were traversed for the search, to ensure all areas of suitable habitat was inspected. Where the habitat is in poorer condition, the spacing of traverses was made broader, as the occurrence of *Caladenia huegelii* was considered much less likely, since native understorey in these locations is greatly reduced, mostly due to weed domination.

Navigation of the sweeps were carried out using a combination of Garmin handheld Global Positioning System (GPS), tablets using the customized software program Mappt™ and magnetic compasses. The traverses made by field personnel for the searches are shown in **Figure 3**.

If individuals or suspected individuals of *Caladenia huegelii* flora were observed, the following data was to be recorded:

- GPS location of each individual plant allowing an inventory of the number of plants/population size
- vegetation type and condition at the recorded location
- condition of plants/populations recorded.



0 50 100 150 200 m


GDA 94 / MGA Zone 50

Figure 2 - Study Areas



Legend

 Project Area

 Unsuitable Habitat

 Mapped Banksia Woodland

 Cleared





0 50 100 150 200 m

GDA 94 / MGA Zone 50

Figure 3 - Search Traverses



Legend

- Project Area
- Search Traverses
- Search Areas



5 RESULTS

No flowering *Caladenia huegelii* individuals were observed or recorded during the survey September 2017 survey conducted within areas of suitable habitat within the CCE LSP study area.

Two *Caladenia* were observed during the survey; *Caladenia flava* and *Caladenia longicauda*. These two species are very common in the south-west of Western Australia and are of no conservation significance.

6 DISCUSSION AND CONCLUSION

A targeted survey of the study area was conducted by FVC on 27 September 2017. Results from previous surveys conducted by FVC in 2016 identified two vegetation types within the study area, BeEt and BaXp, which provided suitable habitat for *Caladenia huegelii* and therefore were included in the targeted search as shown in **Figure 2**.

The timing of the survey (September) was considered optimal to conduct a targeted flora survey for *Caladenia huegelii* as other orchids such as the Spider Orchid species, *Caladenia longicauda* were also observed in flower during the survey.

Although a detailed survey was carried out within suitable habitat within the site, no *Caladenia huegelii* plants were observed or recorded.

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APPENDIX 8

Flora and Fauna Assessment – Focussed Vision



**COCKBURN CENTRAL EAST LOCAL STRUCTURE PLAN (CCE LSP)
AREA, LEVEL 1 FLORA AND FAUNA ASSESSMENT
NOVEMBER 2016
AND
ADDENDUM - TARGETED CALADENIA HUEGELII SURVEY
JANUARY 2018**

CITY OF COCKBURN



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EXECUTIVE SUMMARY

Focused Vision Consulting Pty Ltd (FVC) was commissioned during September 2016 by the City of Cockburn (the City) to undertake a Level 1 flora, vegetation and fauna assessment of the Cockburn Central East Local Structure Plan (CCE LSP) area. The survey results are required in order to address the requirements of the Western Australian Planning Commission (WAPC) structure plan framework (WAPC 2015) for the preparation and implementation of the CCE LSP. A total of 31.21 hectares, encompassing a number of lots within the LSP were assessed for flora, vegetation and fauna values.

The biological assessment incorporated both desktop and field assessments of flora, vegetation, fauna and habitat values associated with the CCE LSP area. A single-phase Level 1 flora, vegetation, terrestrial vertebrate fauna and habitat assessment was carried out Kellie Bauer–Simpson (Principal Ecologist) and Greg Harewood (Senior Zoologist) and this report presents the findings of the assessment.

The key ecological values associated with the study area are summarised as follows:

- Several Threatened and Priority flora species were identified during the desktop review as potentially occurring at the site, although none were recorded during the assessment.
- None of the flora species recorded are of any conservation significance.
- Five intact vegetation communities and three degraded vegetation communities were described and mapped within the study area, consisting of four woodlands, two woodland/wetland vegetation types, one heath and one degraded community.
- Areas of Banksia woodland (vegetation communities BaEt and BaXp) are likely to be representative of the newly listed Commonwealth TEC; *Banksia woodlands of the Swan Coastal Plain*.
- Five fauna habitats, consisting of woodlands and woodland/wetlands, one open heath/scrub and degraded areas were described and mapped across the study area.
- Evidence of Threatened Black-cockatoos (Carnaby's Black-cockatoo and Forest Red-tailed Black-cockatoo) was recorded during the site survey, including a direct sighting of Forest Red-tailed Black-cockatoos overflying the site and evidence of both species feeding on native tree fruits.
- Evidence of the Priority 4 species, Southern Brown Bandicoot/Quenda was observed in the form of diggings and this species is likely to inhabit the areas of dense understorey within the Paperbark Woodland/Swamp habitat, as well as probably the Banksia Woodland habitat.
- Rainbow Bee-eater (*Merops ornatus*) was determined to have a moderate likelihood of occurrence in the study area, based on recorded sightings by GHD (2015) and the presence of potentially suitable habitat.
- The site supports a dampland classified as a Multiple Use wetland (UFI 5562).

Below is a summary of the outcomes of the assessment against the ten clearing principles and impact mitigation/management and/or further study recommendations and comments:

- The proposed clearing is at variance with principle 2 (b), due to the presence of suitable foraging habitat and potential breeding habitat for Threatened Black-cockatoos, and likely habitat for the migratory bird species, Rainbow Bee-eater.
 - Impact mitigating recommendations:
 - Avoid or minimise clearing areas of the Banksia Woodland habitat
 - Avoid clearing the habitat tree located at 392497 mE, 6445689 mN

- Limit ground disturbing activities (clearing and earthworks) to between February and July, which is outside the breeding season for Rainbow Bee-eater.
- The proposed clearing is at variance with principle 6 (f), due to the presence of a wetland at the site.
 - Recommendations:
 - Obtain advice from the Department of Water once concept plans are drafted, in order to achieve environmentally sensitive development in association with the wetland.
- The proposed clearing is likely to be at variance with principle 4 (d), due to the likely presence of the Banksia Woodlands TEC at the site.
 - Recommendations:
 - Undertake a follow-up assessment to confirm the presence and extent of the Banksia Woodland TEC at the site, which will also better inform potential offset requirements.
- The proposed clearing is likely to be at variance with principle 7 (g), due to the likelihood that it will cause appreciable land degradation.
 - Recommendations:
 - Consider options to offset impacts of further degradation by enhancement of areas that are currently degraded and may be retained.
- The proposed clearing may be at variance with principle 9 (i), due to the potential impacts on surface water and groundwater.
 - Impact mitigating recommendations:
 - Minimise the areas of clearing of riparian/wetland vegetation where possible.
 - Ensure suitable drainage features are incorporated into developments to avoid potential adverse impacts from run-off, and on surface and groundwater quality.
- The proposed clearing is unlikely to be, but may be at variance with principle 3 (c), due to the potential (although unlikely) presence of Threatened orchid, *Caladenia huegelii*.
 - Recommendation:
 - Consider a follow-up flora survey during early to mid-September 2017, targeting *Caladenia huegelii*, to further confirm the absence of this species. This assessment could also target other potentially occurring conservation significant flora, in order to ascertain their absence at the site.
- The proposed clearing is unlikely to be, but may be at variance with principle 10 (j), due to the potential (although unlikely) to cause flooding.
 - Recommendation:
 - Ensure suitable drainage features are incorporated into developments to avoid potential flooding.

Avoidance of the majority of the Banksia woodland area, likely to represent the TEC could be achieved by realigning the proposed North Lake Road to Beelihar Drive road alignment. Other currently proposed road alignments are considered well-placed to minimise impacts on areas of best quality vegetation and habitat within the study area.

The DotEE has advised that development of the LSP itself would not require referral, but that any impacts to identified MNES (Banksia Woodland TEC or Black-Cockatoo foraging habitat) by the City of by third parties when developing the site would require referral to the Commonwealth DotEE.

1 INTRODUCTION

1.1 BACKGROUND

Focused Vision Consulting Pty Ltd (FVC) was commissioned during September 2016 by the City of Cockburn (the City) to undertake a Level 1 flora, vegetation and fauna assessment of the Cockburn Central East Local Structure Plan (CCE LSP) area. The survey results are required in order to address the requirements of the Western Australian Planning Commission (WAPC) structure plan framework (WAPC 2015) for the preparation and implementation of the CCE LSP. A total of 31.21 hectares, encompassing a number of lots within the LSP were assessed for flora, vegetation and fauna values, as shown in **Figure 1**.

1.2 LOCATION

The study area is located approximately 20 km south of the Perth CBD, directly adjacent to the Kwinana Freeway on both the western and eastern sides. On the western side of the Freeway, the area is bounded by Kentucky Court and North Lake Road. To the east of the Freeway, the study area is comprised of numerous lots between Cutler Road and Knock Place, Cockburn Central (**Figure 1**).

1.3 SCOPE OF WORK

The scope of work included:

- a desktop study to gather relevant background and biological information on the site
- a field assessment to determine the flora (both native and weeds), vegetation (including condition), vertebrate fauna and habitat values (including habitat trees) associated with the lots
- preparation of a report that summarises the results and includes:
 - a discussion on the results, including records of listed and conservation significant flora, fauna and communities
 - consideration of the findings of the *Wetland Management and Rehabilitation Strategy for Solomon Road Wetland* (Env Australia 2007)
 - incorporation of the findings of the *City of Cockburn North Lake Road Extension Ecological Assessment* (GHD 2015)
 - a discussion on the relevant considerations, including mitigations of the road layout and relevant lot location, considering of the draft concept identified within **Figure 2**.

The scope includes a Level 1 flora, vegetation and fauna assessment, carried out in accordance with:

- EPA (2014a) Guidance Statement 51, *Guidance for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*
- EPA & DPaW (2015) *Technical Guide for Flora and Vegetation Surveys for Environmental Impact Assessment*
- EPA (2014b) Guidance Statement 56, *Guidance for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*
- EPA & DEC (2010) *Technical Guide for Terrestrial Vertebrate Fauna Surveys*
- DSEWPaC (2012) *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris; Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii; Forest red-tailed black cockatoo (vulnerable) Calyptorhynchus banksii naso.*



Legend
Survey Areas

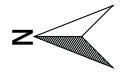


Figure 1 - Survey Area



Figure 2 CCE LSP Draft Concept

2 EXISTING ENVIRONMENT

2.1 CLIMATE

The Swan Coastal Plain has a warm Mediterranean climate which is characterised by hot dry summers and cool to mild wet winters (Mitchell *et al.*, 2002). Jandakot Airport (009172) is the closest meteorological recording station to Cockburn Central and has recorded an average annual rainfall of 824 mm (BoM, 2016).

2.2 IBRA REGION

There are 89 recognised Interim Biogeographic Regionalisation for Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (Commonwealth of Australia 2013). The study area lies within the Swan Coastal Plain IBRA region and, at a finer scale, within the Perth subregion (Mitchell *et al.* 2002).

2.3 GEOLOGY AND SOILS

The study area lies within the Bassendean Dune System which consists of very old leached sands to various depths (GHD 2015) and are the oldest of the three dunes systems occurring on the Swan Coastal Plain. Sands within this system contain very little silt or clay and very low levels of nutrient elements (ESWA 2016).

Soils within the study area are mapped as three sub units of the Bassendean System (Schoknecht *et al.* 2004). They are described as:

- 212Bs_B1 - Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands with pale yellow B horizon
- 212Bs_B2 – Flat to very gently undulating sandplain with well to moderate well drained deep bleached grey sands with a pale yellow B horizon or weak iron organic hardpan
- 212Bs_B4 – Broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depth generally greater than 1.5 m by clay or less frequently a strong iron organic hardpan.

2.4 VEGETATION

The study area is located on the Swan Coastal Plain and has been broadly characterised by Beard (1990) as “e2Mb cbLi - Medium very sparse woodland; jarrah, with low woodland; Banksia and Casuarina (Association 1001)”.

Vegetation of the Perth subregion comprises heath and/or Tuart (*Eucalyptus gomphocephala*) woodlands on limestone, Jarrah (*Eucalyptus marginata*) and *Banksia* woodlands on Quaternary marine dunes and Marri (*Corymbia calophylla*) on colluvial and alluvial sands (Mitchell *et al.* 2002).

Vegetation complexes within the study area have been defined by Heddle *et al.* (1980) and are based on vegetation in association with landforms and underlying geology. One vegetation complex Bassendean complex – central and south as described by Heddle *et al.* (1980) occurs within the study area. This complex ranges from woodlands of *Eucalyptus marginata*, *Allocasuarina* and *Banksia* on sand dunes to a low woodland of *Melaleuca* species, and sedge lands on the low-lying depressions and swamps.

3 METHODOLOGY

The biological assessment incorporated both desktop and field assessments of flora, vegetation, fauna and habitat values associated with the CCE LSP area (**Figure 1**). A single-phase Level 1 flora, vegetation, terrestrial vertebrate fauna and habitat assessment was carried out Kellie Bauer–Simpson (Principal Ecologist) and Greg Harewood (Senior Zoologist) on 27 September, with a follow-up visit on 29 September 2016.

The assessments were carried out in accordance with all relevant legislation, including EPA policies, guidance statements and regulations relating to flora and fauna assessments in Western Australia, including:

- EPA (2002) Position Statement 3: *Terrestrial Biological Surveys as an Element of Biodiversity*
- EPA (2014a) Guidance Statement 51, *Guidance for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*
- EPA & DPaW (2015) *Technical Guide for Flora and Vegetation Surveys for Environmental Impact Assessment*
- EPA (2014b) Guidance Statement 56, *Guidance for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*
- EPA & DEC (2010) *Technical Guide for Terrestrial Vertebrate Fauna Surveys*.
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Wildlife Conservation Act 1950* (WC Act).

3.1 DESKTOP REVIEW

A review of publicly available information and site-specific information provided by the City was undertaken. The information reviewed included:

- DPaW NatureMap Species Report (**Appendix A**); generated on 26 September 2016, providing:
 - flora and fauna species listed as rare (Threatened (T)) or likely to become extinct
 - flora and fauna species protected under international agreements (IA)
 - other specially protected fauna (Scheduled)
 - flora and fauna species listed as Priority 1 to 5 (P1, P2, P3, P4, P5)
 - other non-conservation taxa recorded or know to the area.
- EPBC Act Protected Matters (Matters of National Environmental Significance (MNES)) (**Appendix B**); search for the project area; generated on 26 September 2016, providing results relevant to:
 - the following MNES:
 - World Heritage Properties
 - National Heritage Places
 - Wetlands of International Importance
 - Great Barrier Reef Marine Park
 - Commonwealth Marine Areas
 - Listed Threatened Ecological Communities (TECs)
 - Listed Threatened Species (flora and fauna)
 - Listed Migratory Species
 - the following other matters protected by the EPBC Act:
 - Commonwealth Land
 - Commonwealth Heritage Places
 - Listed Marine Species
 - Whales and other Cetaceans

- Critical Habitats
 - Commonwealth Reserves (Terrestrial)
 - Commonwealth Reserves (Marine).
- spatial data provided the City of Cockburn for:
 - known or previously recorded occurrences of Threatened flora across the entire City
 - regional data for geomorphic wetlands
- DPaW database search results for:
 - Threatened and Priority flora, searched for within a 5 km buffer of the study area
 - Threatened, Priority and conservation significant vertebrate fauna, searched for within a 3 km buffer of the study area
 - Threatened and Priority Ecological Communities, searched for within a 5 km buffer of the study area (*results not yet received at time of issue of this draft report*)
- relevant technical reports:
 - GHD (2015) North Lake Road Extension Ecological Assessment. Unpublished report for the City of Cockburn.
 - ENV Australia (2007) Wetland Management and Rehabilitation Strategy – Solomon Road Wetland. Unpublished report for the City of Cockburn.
 - 360 Environmental (2012). Lots 124 and 125 Frankland Avenue Hammond Park: Graceful Sun Moth Survey & Site Based (Lomandra) Habitat Assessment. Report prepared for WorldStyle Furniture Wholesaler, Perth.
 - Bamford Consulting Ecologists (2011). Threatened Fauna Assessment: Lots 42-44 Frankland Road, Hammond Park. Report prepared for Bayley Environmental Services.
 - Bamford Consulting Ecologists (2012). Lot 123 Wattleup Road, Hammond Park. Significant Fauna Assessment. Report prepared for Bayley Environmental Services.
 - Ecoscape (2009). Fauna Survey for Lots 13, 14 and 18 Barfield Road and Lots 48-51 Rowley Road, Hammond Park. Unpublished report for Gold Estates and the Department of Housing.
 - Emerge Associates (Emerge) (2011). Level 1 Fauna Survey and Habitat Assessment - Various Allotments, Mandogalup. Unpublished report prepared for Qube Mandogalup Land Development Company.
 - ENV (2009). Jandakot Airport Fauna Survey. Unpublished report for Jandakot Airport Holdings Pty Ltd.
 - GHD (2012). Report for Hammond Park Primary School. Flora and Fauna Assessment. Unpublished report for the Department of Education.
 - Harewood, G. (2005). Fauna Assessment, Mandogalup. Unpublished report for Cardno BSD.
 - Harewood, G. (2006). Fauna Assessment, Lot 121 Wattleup Road, Wattleup. Unpublished report for Cardno BSD.
 - Harewood, G. (2009). Fauna Survey (Level 2) East Rockingham WWTP Site & Pipeline Corridors. Unpublished report for ERM.
 - Harewood, G. (2011a). Fauna Assessment Lot 9001 and Lot 35 Barfield Road, Hammond Park. Unpublished report for Mainlake Holdings Pty Ltd.
 - Harewood, G. (2011b). Fauna Underpass Monitoring Spring 2010 – Perth Mandurah Rail Line. Unpublished report for the Public Transport Authority of Western Australia.
 - Harewood, G. (2014a). Fauna Assessment of Lot 33 Barfield Road, Hammond Park. Unpublished report for West Coast Plan (on behalf of the Passione Family).
 - Harewood, G. (2014b). Fauna Assessment of Lots 109 and 110 Wattleup Road, Hammond Park. Unpublished report for Emerge Associates.

- Harewood, G. (2014c). Fauna Assessment of Lots 1, 111 & 810 Wattleup Road, Hammond Park. Unpublished report for Emerge Associates.
- Phoenix Environmental Sciences (2011). Vertebrate Fauna Survey for the Roe Highway Extension Project. Unpublished report for South Metro Connect.
- Strategen (2013). Mandogalup Black Cockatoo Habitat Survey. Unpublished Report for Satterley Property Group.
- Terrestrial Ecosystems (2012). Level 1 Fauna Assessment for Hammond Park Primary School. Unpublished report for Taylor Robinson.

Species lists produced from the abovementioned literature reviews contain observations/inferred distributions from a broader area than the subject site and therefore may include fauna species that would only ever occur as vagrants. The databases also often include or are based on very old records and in some cases, certain flora and fauna species have become locally or regionally extinct. Database errors and anomalies exist also, for example, results returned from DPaW for the Threatened and Priority Flora database search included a result for a Threatened species that occurs at Mt Success on the south coast of Western Australia, which has been confused with the locality of Success, within which some of the study area occurs.

Information from these sources is therefore only taken as indicative and local knowledge and information is taken into consideration when determining what actual species may be present within the specific area being investigated. Species considered errors or unlikely to be present even if resulting from database searches are not shown in the potential species lists or results.

The review of the above information provided guidance for field preparations and has assisted in the preparation of this report.

3.2 FIELD ASSESSMENT

3.2.1 Flora and Vegetation Assessment

The single-phase Level 1 field flora and vegetation assessment was undertaken by Principal Ecologist, Kellie Bauer-Simpson on 27 and 29 September 2016, utilising non-permanent quadrats to characterise vegetation where it was determined to be in good or better condition. Observations and opportunistic data collection was also carried out continuously within and throughout the study area with a particular focus on Threatened and Priority flora and ecological communities, potentially supported by the sites.

Field data was collected from five quadrats, representing of each of the intact vegetation communities present. Each quadrat was recorded in accordance with Guidance Statement 51 to collect information to define the vegetation communities and the floristic diversity. Site-specific data was also collected from relevés in areas in poorer condition than good, to define the degraded vegetation types present.

The vegetation communities present within the study area was described to National Vegetation Information System (NVIS) Level 5, in accordance with the applicable methodologies (DEH 2003) in combination with the Muir (1977) Structural Vegetation Classifications (**Appendix C**).

The condition of the vegetation was documented at each quadrat and relevé and at appropriate locations between, in accordance with the Vegetation Condition Scale adapted from Keighery (1994) and Trudgen (1988), and as per the Technical Guide for Flora and Vegetation Assessments (EPA & DPaW 2015) (**Table 1**).

Table 1: Vegetation Condition Scale (adapted from Keighery (1994) and Trudgen (1988))

Vegetation Condition Rating	Description (for South West and Interzone Botanical Provinces)	Former Rating Category (Keighery 1994)
1	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.	Pristine
2	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.	Excellent
3	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Very Good
4	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	Good
5	<i>NA for South West and Interzone Botanical Provinces</i>	NA
6	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.	Degraded
7	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 and shrubs.	Completely Degraded

Flora identifications were undertaken by specialist taxonomist, Udani Sirisena. Plant group specialist taxonomists may be consulted if required for challenging identifications. Taxonomy and nomenclature will follow current protocols of the WA Herbarium. The data processing task allows for the preparation of species lists, including those for collected flora specimens, once identified.

The spatial extent of each of the observed vegetation communities, varying vegetation condition within the site were mapped using an electronic tablet equipped with the mobile mapping software, MAPPT™, using a customised data collection form, digitising spatial extents onto georeferenced aerial imagery and recording other information including geo-tagged photographs.

3.2.2 Fauna Assessment

A day time Level 1 fauna assessment was conducted by Senior Zoologist Greg Harewood, on 27 September 2016, in accordance with EPA (2014b) and EPA & DEC (2010), incorporating results of the desktop assessment in accordance with the guidelines, plus a field assessment addressing habitat mapping, targeted survey for relevant fauna species of conservation significance, and collection of a terrestrial vertebrate fauna species list, from all opportunistic observations made on site. The site was also visited at dusk on the same day to observe potential night roosting activities on Black-cockatoos.

Fauna species and direct evidence of fauna activity was observed and recorded continuously whilst on site. Secondary evidence of a species presence such as tracks, scats, skeletal remains, foraging evidence or calls were also noted if observed/heard.

The fauna habitats present within the study area were described based on site observations and detailed vegetation community data, and taking into account aspects important to fauna such as soil, rocks, bare ground, leaf litter, wood (woody debris, logs, etc.), lower and ground strata density (cover), canopy height/cover/density and presence of or proximity to surface water.

3.2.2.1 Targeted Black-cockatoo Assessment

Particular attention was focused on Black-cockatoos and their suitable habitat within the study area. A targeted survey for Black-cockatoos was conducted utilising *Referral guidelines for three threatened black cockatoo species* (DSEWPac 2012), as endorsed by the Commonwealth Department of the Environment and Energy (DotEE), and as such required that the survey:

- be carried out by a suitably qualified person with experience in vegetation or cockatoo surveys, depending on the type of survey being undertaken
- maximise the chance of detecting the species' habitat and/or signs of use
- determine the context of the site within the broader landscape; for example, the amount and quality of habitat nearby and in the local region (for example, within 10 km)
- account for uncertainty and error (false presence and absences)
- include collation of existing data on known locations of breeding and feeding birds and night roost locations.

The targeted survey for Black-cockatoos aimed to record any observed individuals either at the site or as an overfly observation, any evidence of their activity (e.g. chewed Marri nuts or Banksia cones), as well as habitat suitable for nesting/breeding, roosting or foraging. Such suitable habitat was mapped, with areas quantified.

The various habitats suitable for Black-cockatoos were identified in accordance with the categories outlined in **Table 2**.

Table 2: Black-cockatoo Habitats Surveyed

Habitat	Examples
Foraging habitat	Food source plants for Black-cockatoos include Jarrah (<i>Eucalyptus marginata</i>), Marri (<i>Corymbia calophylla</i>), Proteaceous species such as <i>Banksia</i> , <i>Hakea</i> and <i>Grevillea</i> , <i>Allocasuarina</i> , and <i>Anigozanthos</i> and introduced species such as Pines (<i>Pinus</i> spp.) and Cape Lilac (<i>Melia azedarach</i>), but also <i>Erodium</i> spp. and various species grown for fruit, nuts and seeds which grow in native shrubland, heathland, woodland or forest and agricultural areas.
Night roosting habitat	These habitats include suitable trees (<i>Eucalyptus</i> or <i>Corymbia</i>) within or near riparian environments or natural or artificial water sources.
Breeding/nesting habitat	Any patch of woodland or forest that contains <i>Eucalyptus</i> or <i>Corymbia</i> trees with either a diameter at breast height of greater than 500 mm or with suitable nest hollows. More specifically, all individual trees observed to support suitable hollows within the study area.

A tree habitat survey was also included to specifically observe suitable trees within the study area to assess their status as a breeding/nesting tree, with or without hollows, or as potential future nesting trees (with a diameter at breast height (DBH) of 500 mm or greater).

Target tree species included Tuart, Jarrah and Flooded Gum, or any other *Corymbia*/*Eucalyptus* species of a suitable size that may have been present. *Banksia*, Sheoak and *Melaleuca* tree species were not assessed as they typically do not develop suitably large hollows that are used by Black-cockatoos.

The location of each tree identified as being over the threshold DBH was recorded with a GPS and details on tree species, number and size of hollows (if any) were noted. Trees observed to contain hollows (of any size/type) were marked with "H" using spray paint for easy future reference.

Based on this assessment, trees present within the subject site have been placed into one of four categories:

- Tree <50cm DBH or an unsuitable species (not recorded)
- Tree >50cm DBH, a habitat tree, but with no hollows observed
- Tree >50cm DBH, one or more hollows observed, none of which were considered suitable for Black-cockatoos to utilise for nesting
- Tree >50cm DBH, one or more hollows observed, with at least one hollow considered suitable for Black-cockatoos to utilise for nesting.

For the purposes of this assessment a tree containing a potential cockatoo nest hollow was defined as:

Generally, any tree which is alive or dead that contains one or more visible hollows (cavities within the trunk or branches) suitable for occupation by a black cockatoo for the purpose of nesting/breeding. Hollows that had an entrance greater than about 10cm in diameter and would allow the entry of a black cockatoo into a suitably orientated and sized branch/trunk were recorded as a "potential black cockatoo nest hollow".

Identified hollows were examined using binoculars for evidence of actual use by Black-cockatoos (e.g. chewing around hollow entrance, scarring and scratch marks on trunks and branches). Trees with possible nest hollows were also scratched and raked with a large stick/pole in attempt to flush any sitting birds from hollows and calls of chicks were also listened for.

The location and nature of Black-cockatoo foraging evidence (e.g. chewed fruits around base of trees) observed during the reconnaissance survey was recorded. The nature and extent of potential foraging habitat

present was also documented irrespective of the presence of any actual foraging evidence, based on the broader habitat mapping.

Direct and indirect evidence of Black-cockatoos roosting within trees within the study area was noted if observed (e.g. branch clippings, droppings or moulted feathers). A visit to the site at dusk was also carried out to make relevant observations of night roosting activity.

4 RESULTS

4.1 DESKTOP REVIEW

4.1.1 Significant Species

The DPaW database search results, NatureMap Species Report and the MNES Report all returned results for the potential presence of conservation significant flora and fauna in the region of the study area. Of particular importance were the results for the potential occurrence of the following Threatened and Commonwealth listed species:

- flora:
 - *Andersonia gracilis*
 - *Caladenia huegelii*
 - *Diuris micrantha*
 - *Diuris purdiei*
 - *Drakaea elastica*
 - *Drakaea micrantha*
 - *Lepidosperma rostratum*
- fauna:
 - Australasian Bittern (*Botaurus poiciloptilus*)
 - Curlew Sandpiper (*Calidris ferruginea*) (also migratory)
 - Forest Red-tailed Black-cockatoo (*Calyptorhynchus banksii naso*)
 - Carnaby's Black-cockatoo (*Calyptorhynchus latirostris*)
 - Malleefowl (*Leipoa ocellata*)
 - Numbat (*Myrmecobius fasciatus*)
 - Eastern Curlew (*Numenius madagascariensis*)
 - Australian Painted Snipe (*Rostratula australis*)
 - Chuditch (*Dasyurus geoffroi*)
 - Western Ringtail Possum (*Pseudocheirus occidentalis*)
- migratory birds:
 - Fork-tailed Swift (*Apus pacificus*)
 - Grey Wagtail (*Motacilla cinerea*)
 - Osprey (*Pandion haliaetus*)
 - Common Greenshank (*Tringa nebularia*)
 - Wood Sandpiper (*Tringa glareola*)
 - Marsh Sandpiper (*Tringa stagnatilis*)
 - Rainbow Bee-eater (*Merops ornatus*)
 - Eastern Curlew (*Numenius madagascariensis*)
 - Great Egret (*Ardea alba*)
 - Cattle Egret (*Ardea ibis*)
 - White-bellied Sea-Eagle (*Haliaeetus leucogaster*)
 - Sharp-tailed Sandpiper (*Calidris acuminata*)
 - Pectoral Sandpiper (*Calidris melanotos*)
 - Red-necked Stint (*Calidris ruficollis*)
 - Long-toed Stint (*Calidris subminuta*)
 - Little-ringed Plover (*Charadrius dubius curonicus*)
 - Black-tailed Godwit (*Limosa limosa*)
 - Glossy Ibis (*Plegadis falcinellus*)
 - Pacific Golden Plover (*Pluvialis fulva*)
 - Grey Plover (*Pluvialis squatarola*)

- Peregrine Falcon (*Falco peregrinus*).

The following Priority listed species also returned results:

- flora:
 - *Acacia lasiocarpa* var. *bracteolate* - long peduncle variant (G.J. Keighery 5026) (P1)
 - *Thelymitra variegata* (P2)
 - *Amanita drummondii* (P3)
 - *Amanita fibrilloses* (P3)
 - *Byblis gigantea* (P3)
 - *Cyathochaeta teretifolia* (P3)
 - *Dampiera triloba* (P3)
 - *Dodonaea hackettiana* (P3)
 - *Eryngium pinnatifidum* subsp. *palustre* (G.J. Keighery 13459) (P3)
 - *Jacksonia gracillima* (P3)
 - *Phlebocarya pilosissima* subsp. *pilosissima* (P3)
 - *Stylidium paludicola* (P3)
 - *Microtis quadrata* (P4)
 - *Ornduffia submerse* (P4)
 - *Stylidium longitubum* (P4)
 - *Thysanotus glaucus* (P4)
 - *Tripterococcus* sp. *Brachylobus* (A.S. George 14234) (P4)
 - *Verticordia lindleyi* subsp. *lindleyi* (P4).
- fauna:
 - Cricket (*Throscodectes xiphos*) (P1)
 - Lined Skink (*Lerista lineata*) (P3)
 - Western Brush Wallaby (*Macropus irma*) (P4)
 - Blue-billed Duck (*Oxyura australis*) (P4)
 - Graceful Sunmoth (*Synemon gratiosa*) (P4)
 - Southern Brown Bandicoot (*Isodon obesulus fusciventer*) (P4).

Spatial data for Threatened flora in the region provided by the City of Cockburn also shows previously recorded occurrences of *Caladenia huegelii* and an unnamed species (likely also *Caladenia huegelii*) in areas from 1.7 km to the east of the study area. The distance between these populations and the study area is such that any proposed development or clearing would have no impact, including indirect impacts, on these populations.

4.1.1.1 Fauna Literature Review Results

Given the mobile nature of fauna, greater efforts in building potential species lists are warranted. Therefore, a review of several relevant reports as listed in Section 3.1 was also carried out. The compiled list, which also incorporates observed and recorded species from the field assessment is presented in **Appendix D**.

The list of potential fauna presented in **Appendix D** assumes that each species listed is not known to be locally extinct and that suitable habitat for each species, as identified during the habitat assessment, is present within the study area. However, the list presented is likely to be an overestimation of the fauna species that actually use the site for some purpose.

With respect to native vertebrate fauna, 11 mammals (including eight bat species), 97 bird, 26 reptile and 10 frog species have previously been recorded in the general vicinity of the CCE LSP study area, some of which

have the potential to occur in or utilise sections of the study area at times. Twelve species of introduced animals could also frequent the area.

Of the 143 native animals that are listed as potentially occurring in the area, three are considered to be endangered/vulnerable or in need of special protection under State and/or Commonwealth legislation. In addition, two migratory and two DPaW priority species are also listed as potentially present (some likely only on a seasonal basis).

4.1.2 Threatened and Priority Ecological Communities

A DPaW database search for Threatened and Priority Ecological Communities within a 5 km buffer of the study area was requested on 20 September 2016. Results of search 15-01216EC showed that the recently listed Endangered ecological community of Commonwealth significance, *Banksia Woodlands of the Swan Coastal Plain* occurs within the study area. At a State level, various sub-types of this community type are also listed as Priority Ecological Communities (PECs). No other TECs or PECs are known to be supported by the study area, based on the database search results.

The MNES Report (**Appendix B**) identified the potential presence of one Threatened Ecological Community (TEC) within the study area. The Endangered TEC – *Banksia Woodlands of the Swan Coastal Plain*, is typically described as having a prominent tree layer of Banksias with scattered Eucalypts and a species rich understorey of sclerophyllous shrubs, graminoids and forbs (DotEE, 2016a).

4.1.3 Wetlands

The study area supports one geomorphic “Multiple Use” Dampland across approximately one third of the site, in the northern sections. This area is characterised by the damper vegetation types supporting *Melaleuca* and a higher density of *Xathorrhoea preissii*. No other water waterways or wetlands are present within the immediately adjacent areas or are linked to the study area through surface drainage (GHD, 2015).

The MNES report also included reference to the occurrence of Ramsar wetlands, Forrestdale and Thomsons Lakes, within 10 km. However, these results are not of significance as any proposed clearing or development would be unlikely to impact either of these Ramsar sites.

4.2 FIELD ASSESSMENTS

4.2.1 Flora

A total of 107 flora species from 90 genera and 44 families were recorded during the field survey. The total includes 62 (57.9%) native species and 45 (42.1%) introduced (weed) species. The most dominant families recorded were Fabaceae and Myrtaceae. The full list of vascular flora species recorded and representative communities in which they occur are detailed in **Appendix E**.

None of the recorded flora species are listed as Threatened under the WC Act or under the EPBC Act, nor are any listed as Priority Flora under the WC Act.

Four of the introduced (weed) species recorded are listed as Declared Pest plants under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). These are:

- **Asparagus asparagoides* (Bridal Creeper)
- **Echium plantagineum* (Paterson's Curse)
- **Zantedeschia aethiopica* (Arum Lily)
- **Gomphocarpus fruticosus* (Narrow-leaf Cotton Bush)

Declared Pest species require management under the BAM Act and are categorised as follows:

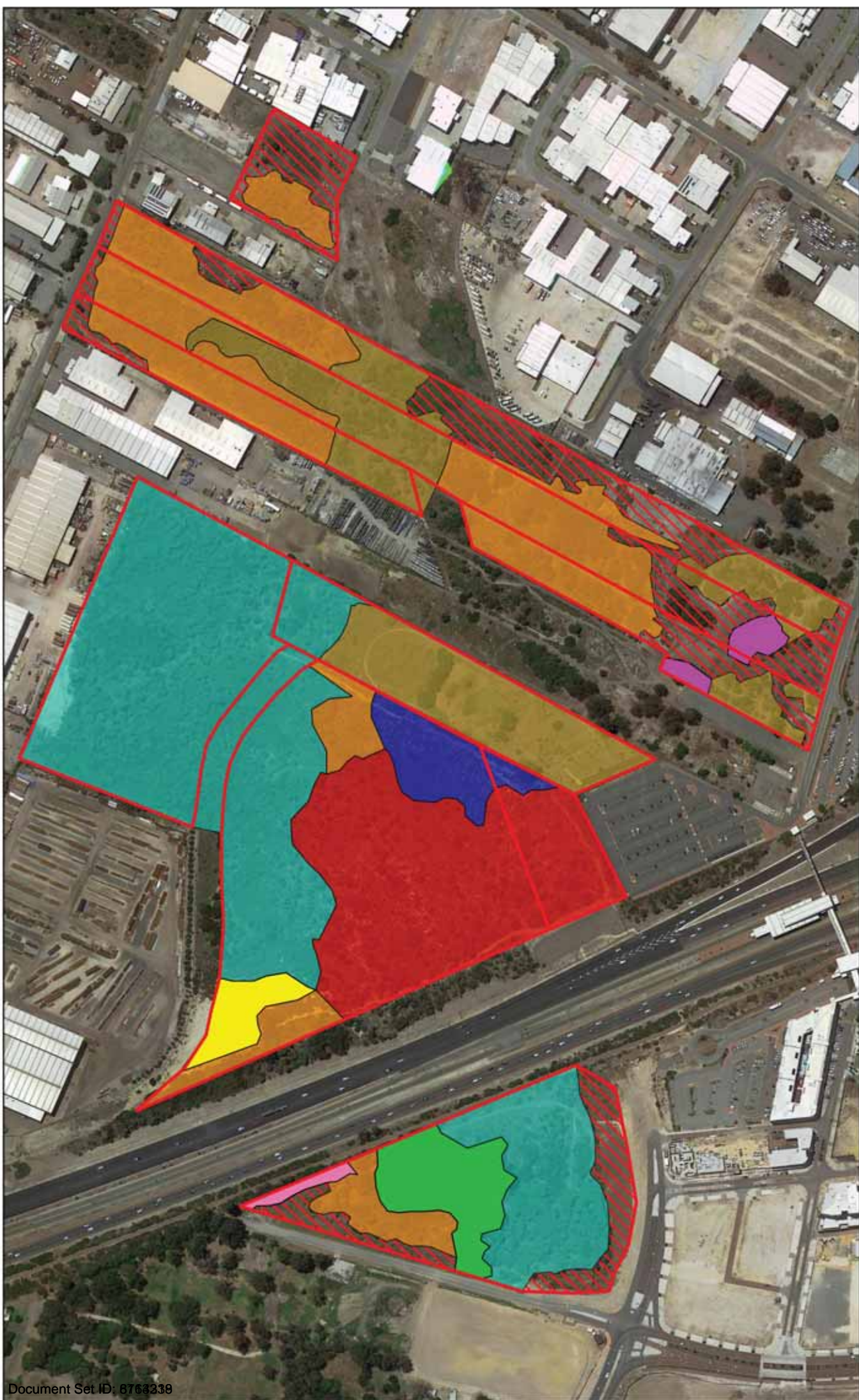
- C1 – Exclusion
- C2 – Eradication
- C3 – Management.

**Asparagus asparagoides* and **Zantedeschia aethiopica* require C3 management for the whole of the State. **Echium plantagineum* and **Gomphocarpus fruticosus* require C3 management in a variety of areas around the State but no specific management is required within the study area (DAFWA 2016).

4.2.2 Vegetation

Five intact and three degraded vegetation communities were described and delineated within the study area. This comprised of four woodlands, two woodland/wetland vegetation types, one heath and one degraded community/habitat which is a mosaic of shrublands (mostly introduced/non-endemic shrubs) and grasslands (introduced grasses/weeds). Each community is described in **Appendix F** and spatially mapped in **Figure 3**.

The condition of the vegetation was found to range from rating 3- 4 (Good to Very Good) to rating 7 (Completely Degraded). The majority of the study area is considered to be in Degraded to Good condition. The varying vegetation condition across the study area is presented in **Figure 4**.



- Legend**
- Survey Areas
 - BeEt
 - BaXp
 - Eg (d)
 - ErAl (d)
 - Mp
 - Mp (d)
 - MpAl
 - Mp
 - Xp
 - Cleared



Figure 3 - Vegetation Communities

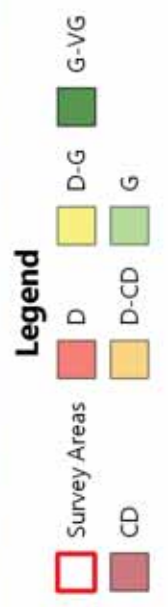


Figure 4 - Vegetation Condition

4.2.3 Fauna

Opportunistic fauna observations made during the September 2016 field survey are listed in **Appendix D**. A total of 25 native fauna species were observed (or positively identified from foraging evidence, scats, tracks, skeletons or calls) within the study area during the one day survey period. The use of the study area by five introduced species was also confirmed.

Evidence of three fauna species of conservation significance was observed during the field assessment. Carnaby's Black-cockatoo, listed as Endangered under the EPBC Act and as Schedule 2 under the WC Act was observed from evidence of chewed Banksia cones. The Forest Red-tailed Black-cockatoo, listed as Vulnerable under the EPBC Act and as Schedule 3 under the WC Act was observed flying overhead during the field survey and GHD also recorded this species flying over the area in 2015 (GHD 2015). Further evidence of this species' use of the site was evidenced from chewed Coastal Blackbutt (*Eucalyptus todtiana*) fruits. Diggings attributed to the Southern Brown Bandicoot/Quenda, a DPaW-listed Priority 4 species, were also found at several locations.

A fauna assessment of some areas of the currently defined study area was carried out by GHD in October 2015. During this assessment, which included a single day survey by a zoologist, in addition to several days by ornithologists from Birdlife Australia, 34 native fauna species were recorded. Eight introduced species were also observed.

GHD reported both Carnaby's and Forest Red-tailed Black-cockatoos as flying over the area, and the Rainbow Bee-eater (listed migratory species) was observed nesting in a sand embankment along North Lake Road. Evidence of the Southern Brown Bandicoot was also observed and the Perth Lined Lerista (skink; DPaW Priority 3 species) was also recorded.

Combining the results of the September 2016 field assessment and those of the GHD (2015) field assessment, a total of 47 fauna species have been recorded within the study area (as summarised in **Table 3**), these being comprised of:

- 34 birds (including four introduced species)
- five reptiles
- six mammals (including four introduced species)
- two frogs.

Table 3: Summary of Potential Vertebrate Fauna Species

Group	Total No. Potential Species	Potential No. Specially Protected Species	Potential No. Migratory Species	Potential No. Migratory Species	No. Species Recorded in Study Area During Survey
Amphibians	10	0	0	0	2
Reptiles	26	0	0	1	5
Birds	103 ⁶	3	2	0	34 ⁴
Non-Volant Mammals	9 ⁶	0	0	1	6 ⁴
Volant Mammals (Bats)	8	0	0	0	0
Total	155¹²	3	2	2	47⁸

NB: Detailed results presented in Appendix D

Superscript = No. of introduced species included in total

4.2.4 Fauna Habitats

Despite significant disturbance in some areas from past and current land uses, some sections of the study area are in relatively good condition and provide value as habitat to native fauna.

The study site was found to support five habitat types, consisting of woodlands and woodland/wetlands, one open heath/scrub and degraded areas. The five fauna habitats recorded are described below and their spatial extent across the study area is presented in **Figure 5**.

4.2.4.1 *Banksia Woodland*

The Banksia Woodland habitat consists of an overstorey of Banksia species (*Banksia attenuata*, *Banksia menziesii* and *Banksia ilicifolia*), occasionally with Coastal Blackbutt (*Eucalyptus todtiana*), over native shrubs and herbs, as well as grassy weeds in more degraded areas. The soils are deep, loose sands, mostly pale grey, but also light brown with some more loamy constituents in lower lying areas. The overstorey layer is up to 7 m tall and sparse in some areas, but denser in areas of better condition. The native understorey is degraded in some areas, but annually (during late winter and spring) is quite densely covered in weeds, and provides a moderate leaf litter cover. Many of the mid-strata shrubs, such as Grasstrees which dominate throughout the habitat, have foliage mostly down to the ground, providing good coverage for ground dwelling mammals and reptiles and with spacing suitable to enable easy movement. The open sand lenses are known to provide suitable habitat for the Perth Lined Lerista (Priority 4). The composition of Proteaceous species and other food source plants (e.g. *Eucalyptus todtiana*) for Threatened Black-cockatoos is quite abundant and varied, including most significantly, the presence of consistent Banksia stands. This habitat type does not support large trees suitable for nesting or night roosting habitat for Black-cockatoos.

4.2.4.2 *Paperbark Woodland/Swamp*

The Paperbark Woodland/Swamp habitat occurs in lower lying areas of the study site and is dominated by *Melaleuca preissiana*, which occurs occasionally with the introduced shrub, **Acacia longifolia* and mostly occurs over native shrubs such as *Hypocalymma angustifolium* or over dense stands of weeds, commonly **Fumaria capreolata*. The understorey density is similar across the habitat during late winter and spring, regardless of whether it consists of native species or weeds, and in such densities, provides ideal habitat for small ground-dwelling mammals and reptiles, including Southern Brown Bandicoots, for which evidence was apparent during the field assessment. Soils in the Paperbark Woodland/Swamp habitat type range from grey sands to brown loamy sands in the lower lying and wetter areas in the centre of the section west of the freeway, and in the northern-most sections north of the train station carpark. Soils are heavier and more compact than in the Banksia Woodland habitat. The overstorey is up to 9 m tall, with some very old and tall *Melaleuca preissiana* specimens present. There are few species present that provide foraging habitat for Threatened Black-cockatoos and large trees suitable for nesting or night roosting habitat for Black-cockatoos are largely absent. However, a single stag (historic death) Flooded Gum (*Eucalyptus rudis*) tree with a hollow considered potentially suitable for Black-cockatoo nesting is present (**Figure 6**).

4.2.4.3 *Tall Open Woodland*

The Tall Open Woodland habitat consists of an overstorey of tall (to over 15 m) Eucalypts, over little or no native understorey, ranging from sparse stands of the introduced **Acacia longifolia* to areas of little more than introduced grasses and other weeds. In this habitat, the trees are mature and most present are habitat trees with a DBH greater than 500 mm (**Figure 6**). Although areas of this habitat type interface closely with infrastructure and human activity (train station carparks and the Kwinana Freeway), which limits habitat potential at a ground-level, the height of the canopy provides excellent habitat for birds, including potential

nesting and night-roosting opportunities for Black-cockatoos; although no evidence of either activity was observed during the field assessment, nor is considered likely. No Black-cockatoo foraging habitat is present within this habitat type.

4.2.4.4 Open Heath

The Open Heath habitat is represented in a small section of the study area and consists of Grasstrees over an understorey of native shrubs, sedges and rushes, predominantly *Dasypogon bromeliifolius* and *Phlebocarya ciliata*, also with a relatively high abundance of introduced grasses. There are very few trees present, consisting mostly of sparse Banksias. The bare ground proportion in this habitat type is low, providing excellent coverage for reptiles and to a lesser degree, small mammals. The substrate is relatively soft, loose grey sands, well-suited to burrowing fauna. There is a lack of suitable foraging, nesting and night-roosting habitat for Threatened Black-cockatoos in the Open Heath habitat.

4.2.4.5 Degraded Open Areas

The Degraded Open Areas provide very little habitat for native fauna, with a high potential for vulnerability to native and introduced predators in most areas. This habitat type consists of mostly cleared areas supporting dense areas of weeds. A section in the north, immediately east of the Freeway includes rehabilitation which is sparse and appears to be regeneration of the Paperbark Woodland/Wetland habitat. Some areas of the study area, in the east and north-eastern sections support this habitat type in the form of mostly introduced and disturbance shrubs; mostly *Leptospermum laevigatum* (Victorian Teatree) and *Adenanthos cygnorum*, a native disturbance opportunist. In such areas, although not naturally occurring nor endemic, better coverage, food sources and therefore habitat is provided, which is more akin to that of the intact woodland habitats. There is a lack of suitable foraging, nesting and night-roosting habitat for Threatened Black-cockatoos in the Open Degraded Areas.



- Legend**
- Degraded open areas
 - Paperback Woodland/Swamp
 - Banksia Woodland
 - Open Heath
 - Tall open woodland
 - Survey Areas



Figure 5 - Fauna Habitats



- Legend**
- Survey Areas
 - Tuart
 - Tuart (Hollow/s)
 - Jarrah (Hollow/s)
 - Eucalyptus sp.
 - Flooded Gum (Potential Black-cockatoo nest)
 - Flooded Gum (Hollow/s)

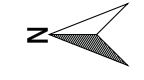


Figure 6 - Habitat Trees

4.2.5 Black-cockatoo Habitat Assessment

4.2.5.1 Breeding Habitat

The trees of the study area were assessed for their suitability in providing nesting habitat for Black-cockatoos, in accordance with DotEE criteria (DSEWPaC 2012). A number of trees were found to represent habitat trees, with a DBH of 500 mm or greater, consisting of representatives from the following suite of species, the locations of which are shown in **Figure 6**, with a summary provided in **Table 4**:

- Tuart - *Eucalyptus gomphocephala*
- Jarrah – *Eucalyptus marginata*
- Flooded Gum – *Eucalyptus rudis*
- planted, non-endemic *Eucalyptus* species.

One occurrence of a Flooded Gum which is an historic death (stag tree) provides a hollow considered suitably to potentially provide nesting/breeding habitat for Black-cockatoos (**Figure 6**).

Table 4: Summary of Potential Black-cockatoo Habitat Trees (DBH ≥ 500 mm) Recorded

Lot No.	Total No. Habitat Trees	No. Trees with no Hollows Observed	No. Trees with Hollows Considered Unsuitable for BC Nesting	No. Trees with Hollows Considered <u>Possibly</u> Suitable for BC Nesting	Tree Species			
					Tuart	Jarrah	Flooded Gum	Euc. sp. (non-endemic)
33	8	6	2	0	8	0	0	0
36	4	4	0	0	4	0	0	0
801	1	0	1	0	0	0	1	0
802	1	0	0	1	0	0	1	0
9500	4	2	2	0	0	2	0	2
Total	18	12	5	1	12	2	2	2

The field assessment identified 18 habitat trees (trees with a DBH of >500 mm) (**Figure 6**). Most trees (12) appeared not to contain hollows of any size. Five trees appeared to contain small hollows or possible small hollows, considered by unlikely to be suitable for Black-cockatoos to use for nesting purposes. One of these hollows appeared to be in use by Galahs.

One tree was identified as containing a hollow that appeared possibly big enough to allow the entry of a Black-cockatoo into a suitably sized and orientated trunk, but no evidence of actual use was observed. The probability of this actually representing a hollow that would be used by black cockatoos can be regarded as being very low.

Additional details on each habitat tree observed can be found in **Appendix G**.

4.2.5.2 Foraging Habitat

Following is a list of the key flora species recorded within the study area during the fauna assessment that are known to be used as a direct food source (i.e. fruits or flowers) by one or more species of Black-cockatoo:

- Jarrah - *Eucalyptus marginata*
- Coastal Blackbutt - *Eucalyptus todtiana*
- Sheoak - *Allocasuarina fraseriana*
- Candlestick Banksia - *Banksia attenuata*
- Firewood Banksia - *Banksia menziesii*
- Holly-leaved Banksia - *Banksia ilicifolia*
- Grass Tree - *Xanthorrhoea preissii*.

A number of other tree/shrub species present (e.g. Tuart, Flooded Gum and Acacia species) are also utilised as a food source by Black-cockatoos, but to a much lesser degree than those listed.

Some evidence of Black-cockatoos foraging onsite was observed during the field assessment, in the form of chewed Banksia cones (*Banksia attenuata* and *Banksia menziesii*) and Coastal Blackbutt (*Eucalyptus todtiana*) fruits. This evidence was attributed to Carnaby's Black-cockatoo and the Forest Red-tailed Black-cockatoo, respectively.

Foraging habitat within the subject site is mainly comprised of the Banksia Woodland which occupies approximately 9.5 hectares (~32.4%) of the study area.

4.2.5.3 Roosting Habitat

No existing roosting trees (trees used at night by Black-cockatoos to rest) were positively identified during the field survey, and given the limited number of larger trees present, Black-cockatoos are considered very unlikely to use the study area for this purpose.

5 DISCUSSION

5.1 FLORA

The total of 62 (57.9%) native species and 45 (42.1%) introduced (weed) species recorded within the project area represents a large proportion of weeds. This is expected, due to the close proximity of the study area to infrastructure, and areas of busy human activity, such as major transport arteries and cleared industrial areas.

Of the 107 vascular flora species recorded, only one could not be identified to species level (*Opuntia* sp.; Prickly Pear). This species does not have the potential to be a Threatened or Priority flora, as all *Opuntia* species occurring within Western Australia are introduced (weed) species. *Opuntia* species are not listed by DAFWA as Declared Pest weeds.

Four of the introduced (weed) species recorded are listed as Declared Pest plants under the *Biosecurity and Agriculture Management Act 2007*. **Asparagus asparagoides* (Bridal creeper) and **Zantedeschia aethiopica* (Arum Lily) require C3 management for the whole of the State, including within the project area. **Echium plantagineum* and **Gomphocarpus fruticosus* require C3 management in some areas around the State but not within the study area, where no specific control measures are required (DAFWA, 2016).

Asparagus asparagoides (Bridal Creeper) is regarded as one of Australia's worst weeds due to its invasiveness, potential for spread and economic and environmental impacts (DEE, 2016b). Rare native plants are threatened with extinction by Bridal Creeper. The species forms a thick mat of underground tubers which impedes the root growth of other native plants and often prevents seedling establishment (DEE, 2016b).

Zantedeschia aethiopica (Arum Lily) occurs in pasture and bushland, particularly in damp areas. It is able to form large spreading monocultures that choke native species, reduce biodiversity and decrease habitat and food resources for native animals (Cape to Cape Catchment Group, 2016). The two aforementioned species are listed as Declared Pest plants under the BAM Act and as such, landholders are required to manage and control them to reduce the size of infestations and prevent the spread of these weeds.

None of the recorded flora species are listed as Threatened under the WC Act or under the EPBC Act, nor are any listed as Priority Flora under the WC Act. However, the site is considered to potentially be suitable habitat for a number of Threatened and Priority Flora that have the potential to occur, based on habitat requirements and habitat suitability in the project area as summarised in **Table 5**.

Table 5: Likelihood of Occurrence of Threatened and Priority Flora

Species	Conservation Status	Habitat/Proximity and relevance of records	Likelihood of Occurrence
<i>Andersonia gracilis</i>	T	White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps. Not resulting from DPaW records.	LOW
<i>Caladenia huegelii</i>	T	Grey or brown sand, clay loam. Jarrah, <i>Banksia</i> or (less likely) <i>Mealaleuca</i> woodland. Lower slopes. Recent records nearby.	MODERATE
<i>Diuris micrantha</i>	T	Brown loamy clay. Winter-wet swamps, in shallow water. Not resulting from DPaW records.	LOW
<i>Diuris purdiei</i>	T	Grey-black sand, moist. Winter-wet swamps. Not resulting from DPaW records.	LOW
<i>Drakaea elastica</i>	T	White or grey sand. Low-lying situations adjoining winter-wet swamps. Often with <i>Kunzea</i> spp.. Not resulting from DPaW records.	LOW
<i>Drakaea micrantha</i>	T	White-grey sand. <i>Banksia</i> , Jarrah woodlands. Lower slopes. Not resulting from DPaW records.	LOW
<i>Lepidosperma rostratum</i>	T	Peaty sand, clay. Swamps.	LOW
<i>Acacia lasiocarpa</i> var. <i>bracteolate</i> (long peduncle)	P1	Grey or black sand over clay. Swampy areas, winter wet lowlands. Records in Jandakot.	MODERATE
<i>Thelymitra variegata</i>	P2	Sandy clay, sand, laterite.	LOW
<i>Byblis gigantea</i>	P3	Sandy-peat swamps. Seasonally wet areas. Records in Jandakot.	MODERATE
<i>Cyathochaeta teretifolia</i>	P3	Grey sand, sandy clay. Swamps, creek edges.	MODERATE
<i>Dampiera triloba</i>	P3	No habitat information found. Recorded from North Lake and Roe Highway extension area.	MODERATE
<i>Dodonaea hackettiana</i>	P3	Grey sands, peats, outcropping limestone. Locally recorded amongst weeds. Records in Jandakot.	MODERATE
<i>Eryngium pinnatifidum</i> subsp. <i>palustre</i>	P3	Claypans.	LOW
<i>Jacksonia gracillima</i>	P3	Grey-pale brown sands. Coastal Plain.	MODERATE
<i>Phlebocarya pilosissima</i> subsp. <i>pilosissima</i>	P3	White or grey sand, sand ridges, lateritic gravel. <i>Banksia</i> woodland.	MODERATE
<i>Stylidium paludicola</i>	P3	Peaty sand over clay. Winter wet habitats. Marri and <i>Melaleuca</i> woodland, <i>Melaleuca</i> shrubland.	LOW
<i>Microtis quadrata</i>	P4	Habitat preference not able to be located. Records in Jandakot.	MODERATE
<i>Ornduffia submersa</i>	P4	Aquatic herb.	LOW
<i>Stylidium longitubum</i>	P4	Sandy clay, clay. Seasonal wetlands. Records in Jandakot.	MODERATE
<i>Thysanotus glaucus</i>	P4	White, grey or yellow sand, sandy gravel. Open lenses.	LOW
<i>Tripterococcus</i> sp. <i>Brachylobus</i>	P4	No habitat information found.	MODERATE
<i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>	P4	Sand, sandy clay. Winter-wet depressions.	MODERATE

None of the Threatened or Priority flora species with the potential to occur in the project area are considered to be highly likely to occur. Rather all such species are considered to have a low, or moderate likelihood of occurrence, based on known habitat preferences and the proximity and currency of previous records.

Of the species considered to have a moderate likelihood of occurrence, only one is listed as Threatened, *Caladenia huegelii*. This species is known from several local populations, and the study area provides the preferred habitat for the species. Based on this, it is recommended that follow-up surveys be carried out to target this species during the appropriate season (early September), prior to specific development activities that would require clearing, to ensure avoidance of impacts to populations which may yet to be defined.

The survey was considered to have been conducted during optimal spring flowering period to identified the majority of species occurring within the study area. If possible within the timing constraints of the planning and development aspects of the project, it is recommended that an additional, second phase assessment be conducted during the complimentary season (autumn), to capture alternative-season flowering species and ephemerals, and/or during spring 2017, to compliment the results of the 2016 spring survey, and to best inform planning and development decisions regarding the wider CCE LSP area.

5.2 VEGETATION

The study area supports five intact and three degraded vegetation communities. Areas of the higher quality vegetation are found in the larger pocket of remnant vegetation, adjacent to the east side of the Kwinana Freeway, and this may be attributed to the proximity to the impacts of edge effects from current activities, as well as historic land uses.

All of the intact vegetation communities have been analysed in relation to species presence/absence and landform/soil types, in comparison to the Gibson *et al* (1994) dataset, in order to assign inferred Floristic Community Types (FCTs). A summary of the results of this analysis is presented below in **Table 6**, including the conservation status with regards to current TEC and PEC status, and the Gibson *et al* (1994) reservation and risk of extinction classification.

Table 6: Inferred FCTs of the Intact Vegetation Communities Recorded

Community Code	Brief Community Description	Inferred FCT	FCT Title	Conservation Significance
BaEt	Banksia over <i>Eucalyptus todtiana</i> woodland	23a	Central <i>Banksia attenuata</i> – <i>Banksia menziesii</i> woodlands	Likely a Commonwealth TEC FCT: well reserved; low risk
BaXp	Banksia over <i>Xanthorrhoea preissii</i> woodland	21a	Central <i>Banksia attenuata</i> – <i>Eucalyptus marginata</i> woodlands	Likely a Commonwealth TEC FCT: well reserved; low risk
Xp	<i>Xanthorrhoea preissii</i> heath	23a	Central <i>Banksia attenuata</i> – <i>Banksia menziesii</i> woodlands	Likely a Commonwealth TEC FCT: well reserved; low risk
Mp	<i>Melaleuca preissiana</i> woodland/swamp	4	<i>Melaleuca preissiana</i> damplands	Not a TEC or PEC FCT: well reserved; low risk
MpAI	<i>Melaleuca preissiana</i> over <i>*Acacia longifolia</i> woodland/swamp	4	<i>Melaleuca preissiana</i> damplands	Not a TEC or PEC FCT: well reserved; low risk

All inferred FCTs were documented in Gibson *et al* (1994) as “well reserved” and at “low risk” of extinction, and although none of the community types have been previously listed as a TEC or PEC, the recent Commonwealth listing of the Banksia woodlands of the Swan Coastal Plain TEC (DotEE 2016a) encompasses a number of *Banksia* woodlands, including those equivalent to FCTs 21a and 23a. This community type is typically described as having a prominent tree layer of Banksias with scattered Eucalypts and a species rich understorey. However, diagnosis of the presence of this TEC is more complicated than analysing results of a Level 1 or Level 2 flora and vegetation assessment. Specific information including patch size and regional context requires assessment and analysis, as well as plot-based data, in order to determine the presence of the TEC. However, based on the information collected as part of this study, it is considered highly likely that the areas mapped as *Banksia* woodland (communities BaEt and BaXp) are representative of the Commonwealth listed TEC. Some further assessment on patch size and quality on the vicinity, as well as analysis of replicate plot-based quadrat data within the *Banksia* woodland areas would appropriately confirm this, and would accurately define areas subject to Commonwealth protection.

Avoidance of the majority of the Banksia woodland area, likely to represent the TEC could be achieved by realigning the proposed North Lake Road to Beelihar Drive road alignment, as shown in **Figure 7**. Other currently proposed road alignments are considered well-placed to minimise impacts on areas of best quality vegetation and habitat within the study area.

The condition of the vegetation was found to range from rating 3- 4 (Good – Very Good) to rating 7 (Completely Degraded) in the Keighery (1994) scale. The majority of the study area is considered to be in Degraded to Good condition.

One of the EPA's objectives is to retain at least 10% of the pre-European extent of vegetation types in constrained areas in the Perth and Peel regions (EPA, 2015). The study area supports the Bassendean Complex-Central and South, which, according to the Local Biodiversity Program study (Western Australian Local Government Association 2013), is represented by 27.70% of its pre-European extent. This percentage exceeds the EPA threshold, based on a pre-European extent of 87,392.73 ha and 24,206.24 ha documented by WALGA in 2013 as remaining.

5.3 CONSERVATION SIGNIFICANT FAUNA SPECIES

The desktop review determined that 17 terrestrial fauna species of conservation significance have previously been recorded within the vicinity of the study area. The likelihood of the occurrence of these species in the study areas has been assessed, which is summarised below in **Table 7**.



- Legend**
- Survey Areas
 - Banksia_Woodlands
 - Existing Road Alignment Plans
 - Suggested Alternative Road Alignment

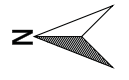


Figure 7 - Suggested Alternative Road Alignment

Table 7: Likelihood of Occurrence of Conservation Significant Fauna in the Study Area

Species	Common Name	Conservation Category			Habitat Preference	Likelihood of Occurrence
		EPBC	WC Act	DPaW		
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	S1	T(EN)	Permanent and seasonal freshwater wetlands, rarely estuarine habitats. Wetlands with tall, dense vegetation, particularly sedges/rushes/reeds.	LOW
<i>Calidris ferruginea</i>	Curlew Sandpiper	EN	S1	T(EN)	Intertidal mudflats, sheltered coastal areas; estuaries, bays, inlets, non-tidal swamps, lakes, lagoons near coast. Less in inland ephemeral/permanent lakes.	LOW
<i>Calyptorhynchus latirostris</i>	Carnaby's Black-cockatoo	EN	S2	T(EN)	Eucalypt woodland; Salmon Gum, Wandoo, Marri, Jarrah. Heath; Kwongan, Banksia/Hakea, other Proteaceous shrubs. Pines, Cape lilac.	MODERATE
<i>Calyptorhynchus banksia naso</i>	Forest Red-tailed Black-cockatoo	EN	S3	T(VU)	Eucalypt woodland; Salmon Gum, Wandoo, Marri, Jarrah. Heath; Kwongan, Banksia/Hakea, other Proteaceous shrubs. Pines, Cape lilac.	MODERATE
<i>Leipoa ocellata</i>	Malleefowl	VU	S1	T(VU)	Dry inland scrub, mallee. Large, contiguous areas of Mallee, woodlands with moderate to high levels of leaf litter.	LOW
<i>Rostratula australis</i>	Australian Painted Snipe	M/VU	S5	IA/T(VU)	Shallow freshwater (occasionally brackish) temporary or permanent wetlands; inundated grassland, dams. Grass, sedges/rushes/reeds, or samphire; Melaleuca.	LOW
<i>Numenius madagascariensis</i>	Eastern Curlew	EN	S1	IA/T(EN)	Sheltered coasts, mangrove swamps, bays, harbours and lagoons that contain mudflats and sandflats.	LOW
<i>Oxyura australis</i>	Blue-billed Duck	-	-	P4	Well vegetated freshwater swamps, large dams and lakes, winters on more open water. Occasionally salt lakes and estuaries freshened by floodwaters.	LOW
<i>Merops ornatus</i>	Rainbow Bee-eater	M	S5	IA	Open country, most vegetation types, dunes, banks; prefer lightly wooded, preferably sandy, country near water.	HIGH
<i>Lerista lineata</i>	Perth Lined Lerista	-	-	P3	White sands under areas of shrubs and heath where it inhabits loose soil and leaf litter particularly in association with Banksias.	HIGH
<i>Macropus irma</i>	Western Brush Wallaby	-	-	P4	Open forest, woodland, favouring open, seasonally wet flats with low grasses and open scrubby thickets. Mallee and heathland, uncommon in karri forest.	LOW
<i>Dasyurus geoffroii</i>	Chuditch	VU	S1	T(VU)	Jarrah (<i>Eucalyptus marginata</i>) forest	LOW
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	VU	S1	T(VU)	Unburnt Peppermint woodland but also Jarrah, Wandoo and Marri forest	LOW
<i>Myrmecobius fasciatus</i>	Numbat	VU	S1	T(VU)	Upland Jarrah forest, open eucalypt woodland, Banksia woodland and tall closed shrublands with termites in the soil, hollow logs and branches for shelter.	LOW
<i>Isodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	-	P4	Scrubby, dense vegetation; forest, woodland. Jarrah and Wandoo forests associated with water or wetlands.	LOW
<i>Throscodectes xiphos</i>	Cricket	EN	-	P1	Not known. Possibly heathlands and woodlands	LOW
<i>Synemon gratiosa</i>	Graceful Sunmoth	-	-	P4	Coastal dunes and woodlands supporting <i>Lomandra maritima</i> or <i>hermaphrodita</i> .	LOW

The results of the likelihood of occurrence analysis determined that all but four of the 17 conservation significant terrestrial fauna species assessed are unlikely to occur within or utilise the study area. A number of the species listed in **Table 7** may however utilise the habitats of the study areas as occasional visitors, but are unlikely to rely on it for their ongoing survival.

Whilst the likelihood of occurrence analysis did not incorporate a detailed literature review to ascertain the location and currency of previously recorded or known populations of each species, this can be applied to the species resulting in moderate or high likelihood scores, to further conclude risk of impact to these species.

5.3.1 Carnaby's Black-cockatoo

Carnaby's Black-cockatoo is listed as Schedule 2 under the WC Act and as Endangered under the EPBC Act. The species is confined to the south-west of Western Australia, north to the lower Murchison River and east to Nabawa, Wilroy, Waddi Forest, Nugadong, Manmanning, Durokoppin, Noongar (Moorine Rock), Lake Cronin, Ravensthorpe Range, head of Oldfield River, 20 km east south-east of Condingup and Cape Arid; also casual on Rottnest Island (Johnstone and Storr 1998).

The habitat of Carnaby's Black-cockatoo includes forests, woodlands, heathlands, farms. The species feeds preferentially on Banksia, Hakeas and Marri, but also other Proteaceous species and fruits from introduced trees such as Pines and Cape Lilac.

Carnaby's Black-cockatoo has specific nesting site requirements, with nests mostly in smoothed-barked eucalypts and in hollows ranging from 2.5 to 12 m above the ground, an entrance from 23 to 30 cm in diameter and a depth of 0.1 to 2.5 m (Johnstone and Storr, 1998).

Breeding occurs in winter/spring mainly in eastern forest and wheatbelt where they can find mature hollow bearing trees to nest in (Morcombe, 2003). Judging from records in the Storr-Johnstone Bird Data Bank, this species is currently expanding its breeding range westward and south into the Jarrah – Marri forest of the Darling Scarp and into the Tuart forests of the Swan Coastal Plain, including the region between Mandurah and Bunbury. Carnaby's Black-cockatoo has been known to breed close to the town of Mandurah, as well as at Dawesville, Lake Clifton and Baldivis (Ron Johnstone *pers. comm.*) and there are small resident populations on the southern Swan Coastal Plain near Mandurah, Lake Clifton and near Bunbury. At each of these sites the birds forage in remnant vegetation and adjacent pine plantations (Johnstone 2008).

Carnaby's Black-cockatoo lays eggs from July or August to October or November, with most clutches being laid in August and September (Saunders 1986). Birds in inland regions may begin laying up to three weeks earlier than those in coastal areas (Saunders 1977). The female incubates the eggs over a period of 28 to 29 days. The young depart the nest 10 to 12 weeks after hatching (Saunders 1977; Smith & Saunders 1986).

Evidence of foraging activity was observed at the study site during the September 2016 field assessment in the form of chewed banksia cones. Most of the remnant vegetation containing banksia and jarrah within the site represents potential foraging habitat. Carnaby's Black-cockatoo was also recorded flying over the study area by GHD in 2015 (GHD 2015), and overfly activity of the species is regularly observed in the Cockburn region (Kellie Bauer-Simpson, *pers. comm.*).

All of the 18 large trees (>500 mm DBH) recorded during the field survey would be considered by the DotEE as potential Black-cockatoo breeding habitat, though only one appears to possibly contain a hollow of a size potentially suitable for this purpose. The possibility of this tree or any others being used for breeding proposes now or in the future would be considered to be extremely low.

No evidence of Black-cockatoo night roosting on site was observed during a dusk observation on 27 September 2016.

The potential impact of future development at the site on Carnaby's Black-cockatoo would be loss and/or modification of some areas of foraging and potential (unlikely) breeding habitat.

5.3.2 Forest Red-tailed Black-cockatoo

The Forest Red-Tailed Black-cockatoo is listed as Schedule 3 under the WC Act and as Vulnerable under the EPBC Act. The species is found in the humid and subhumid south west, mainly hilly interior, north to Gingin and east to Mt Helena, Christmas Tree Well, North Bannister, Mt Saddleback, Rock Gully and the upper King River (Johnstone and Storr 1998).

Preferred habitat for Forest Red-Tailed Black-cockatoos is Eucalypt forests. The species feeds on Marri, Jarrah, Blackbutt, Karri, Sheoak and Snottygobble and nests in the large hollows of Marri, Jarrah and Karri (Johnstone and Kirkby 1999). In Marri, the nest hollows of the Forest Red-tailed Black-cockatoo range from 8 to 14 m above ground, the entrance 12 to 41 cm in diameter and the depth is one to five metres (Johnstone and Storr 1998).

Breeding for the species commences in winter/spring. There are few records of breeding in the Forest Red-tailed Black-cockatoo (Johnstone and Storr 1998), but eggs are known to be laid in October and November (Johnstone 1997; Johnstone and Storr 1998). Recent data however indicates that breeding in all months of the year occurs with peaks in spring and autumn–winter (Ron Johnstone *pers. comm.*). The incubation period is 29 to 31 days and young fledged at eight to nine weeks (Simpson and Day 2010).

Individuals of this species were observed flying overhead during the field survey and GHD also recorded this species flying over the area in 2015 (GHD 2015). Some foraging evidence (chewed Coastal Blackbutt fruits) was also attributed to this species, though Carnaby's Black-cockatoos also utilise this food source. All areas of remnant vegetation containing Jarrah, Coastal Blackbutt and Sheoak (The Banksia Woodland habitat) within the site represent potential foraging habitat.

The potential impact of future development at the site on the Forest Red-tailed Black-cockatoo would be loss and/or modification of some areas of foraging and potential (unlikely) breeding habitat.

5.3.3 Rainbow Bee-eater

One species, Rainbow Bee-eater (*Merops ornatus*) was determined to have a high likelihood of occurrence, based on the presence of suitable habitat, and as it was recorded by GHD (2015) breeding in a sand embankment along North Lake Road in 2015. The Rainbow Bee-eater is likely to utilise the study area in small numbers during the summer migratory period. This species is a common seasonal visitor to south west. Population numbers at any one location would however never be significant as the species usually breeds in pairs and only rarely in small colonies (Johnstone and Storr 1998). This species is a migratory bird, protected under international agreements (Japan-Australia Migratory Bird Agreement (JAMBA) and China-Australia Migratory Bird Agreement (CAMBA)).

The Rainbow Bee-eater is not considered globally threatened. There are no published estimates of the global population size, but it is assumed to be quite large as the Rainbow Bee-eater is widely distributed throughout all of Australia (except Tasmania) and eastern Indonesia, including Bali, the Lesser Sundas and Sulawesi, and east to Papua New Guinea, the Bismarck Archipelago and, rarely, the Solomon Islands. It is a vagrant visitor to locations further north including Palau, south-western Micronesia, Saipan, the northern Mariana Islands, and Miyako Island and the southern Ryuku Islands in Japan (del Hoyo *et al.* 2001; Higgins 1999). The species breeds mostly in Australia, which occurs between August to January, at which time the birds will be found mostly in their subterranean nests. The chosen habitats of the species are widely varied and versatile, and

include mainly open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (Higgins 1999). Thus, utilisation of the habitats of the study area, including open sandy ground, is possible. However, no nests were observed during the field survey. Minimisation of impacts could be achieved by limiting ground disturbing activities to February to July, outside the breeding season.

5.3.4 Perth Lined Lerista

Lerista lineata is listed as Priority 3 by DPaW and is found along the lower west coast from north of Perth and south to Leschenault Peninsula/Kemerton. It has also been found at Rottnest Island and Garden Island (Storr *et al.* 1999), but is most typically found in the southern suburbs of Perth (Bush *et al.* 2002).

Habitat: This small species of skink inhabits white sands (Storr *et al.* 1999) under areas of shrubs and heath where it inhabits loose soil and leaf litter (Nevill 2005) particularly in association with banksias (Bush *et al.* 2002).

Lerista lineata was recorded within the study area by GHD (2015) and has been recorded in other nearby bush remnants (ENV 2009, Phoenix 2010). Most of the Banksia dominated habitat appears to be suitable for this species to persist. This species is also known to inhabit gardens (Nevill 2005, Bush *et al.* 2010) so may persist in degraded areas and subsequent to development.

The potential impact of future development at the site on *Lerista lineata* would be loss and/or modification of some areas of habitat.

5.4 FAUNA HABITATS

The five habitat types defined and mapped for the study area vary in quality and value in terms of providing for native fauna, including species of conservation significance.

The Open Degraded Areas habitat provides very little value for native fauna, whilst the Heath habitat provides some, but less than the woodland habitats. The Tall Open Woodland habitats are also of lesser value, given their typically degraded nature, although given the mature trees, are an important resource for birds.

The Paperbark Woodland/Swamp habitat provides for a number of native birds, small mammals and reptiles, in particular in better quality sections east of the Kwinana Freeway. This habitat type is likely to support populations of the Priority 4 species, Southern Brown Bandicoot/Quenda. Additionally, within this habitat is a single Flooded Gum stag which supports a hollow potentially suitable for Threatened Black-cockatoo nesting.

Of greatest significance with regards to habitat is the Banksia Woodland habitat which occupies a total of 9.5 hectares of the study area. This habitat type includes some of the best quality vegetation in the study area and is suitable foraging habitat for Threatened Black-cockatoos. Clearing of areas greater than one hectare of this habitat would require referral to the Commonwealth DotEE.

5.5 WETLANDS

The study area supports one geomorphic "Multiple Use" Wetland, (Unique Feature Identifier UFI) 6652) which has been classified as a dampland (WA Atlas, 2016). Multiple Use (M category) wetlands have been evaluated to be poor in natural and human attribute. As such the key management objective for Multiple Use wetlands is to use, develop and manage the wetland in the context of water, town and environmental planning. Some of the revegetation recommendations provided in ENV (2008) for the rehabilitation of the Solomon Road Wetland could be considered as part of the CCE LSP, in order to enhance the natural and aesthetic value of areas retained as part of the ultimate development of the site. Such actions could include appropriate management of drainage and stormwater, suitable fire risk management and rehabilitation/landscaping treatments in the form of weed management and revegetation with locally endemic species.

The MNES report also included reference to the occurrence of Ramsar wetlands, Forrestdale and Thomsons Lakes, within 10 km. However, these results are not of significance as the proposed clearing will not impact either of these Ramsar sites.

5.6 ASSESSMENT AGAINST THE TEN CLEARING PRINCIPLES

The project has been broadly assessed against the Department of Environment Regulation (DER) ten clearing principles, based on information collected during the assessment. A summary of this assessment (assuming the entire study site would be cleared) and recommendations for impact avoidance are provided below in **Table 8**.

Table 8: Summary of the Assessment against the Ten Clearing Principles

Principle	Assessment	Outcome	Avoidance or Mitigation Recommendation/ Comment
1 (a) Native vegetation should not be cleared if it comprises a high level of biological diversity.	A total five intact vegetation communities and three degraded vegetation communities in varying condition, comprising 107 vascular flora species (57.9% native) were recorded. Five different vertebrate fauna habitats were found to be supported by the site, with 47 vertebrate fauna species recorded during the field assessment. This diversity is considered moderately low. No species of Priority flora were recorded during the field survey conducted in September 2016. The vegetation communities present at the site are not equivalent to any listed Priority Ecological Communities.	Proposed clearing is not at variance with this principle.	Follow-up flora survey during complimentary season (autumn) or during spring 2017 to further confirm the native flora species which indicates that no Priority Flora are present.
2 (b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a significant habitat for fauna indigenous to Western Australia.	Five fauna habitats were defined and mapped across the study site, which includes the Banksia Woodland habitat. This habitat occupies 9.5 hectares of the study site and is suitable for foraging by Threatened Black-cockatoos. A number of potential habitat trees were also recorded across the study site, with one located at 392497 mE, 6445689 mN supporting a hollow that could potentially be suitable for Black-cockatoo nesting.	Proposed clearing is at variance with this principle.	Avoid clearing areas of the Banksia Woodland habitat and avoid clearing the habitat tree located at 392497 mE, 6445689 mN.
3 (c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of rare flora	A number of Threatened flora species were determined to potentially be supported by the study area, based on the results of the desktop review. The site is considered suitable habitat for the Threatened orchid, <i>Caladenia huegelii</i> . However, no rare (Threatened) flora were recorded during the field assessment.	Proposed clearing is not likely to be at variance with this principle.	Follow-up flora survey during early to mid-September 2017, targeting <i>Caladenia huegelii</i> , to further confirm the absence of this species.
4 (d) Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of a Threatened Ecological Community (TEC).	Previous assessments have not determined the presence of TECs within a 5km radius of the study area (GHD, 2015). However, the recent listing of the Banksia Woodlands TEC by the Commonwealth DoEE is likely to apply to the entire extent of Banksia woodland (communities BaEt and BaXp) within the study area. Further qualitative assessment would be required to confirm the presence of this TEC.	Proposed clearing is likely to be at variance with this principle.	Undertake a follow-up assessment to diagnose the Banksia Woodland with regards to equivalence to the TEC.

Principle	Assessment	Outcome	Avoidance or Mitigation Recommendation/ Comment
<p>5 (e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in areas that have been extensively cleared.</p>	<p>The study area supports the Bassendean Complex-Central and South, which, according to the Local Biodiversity Program study (Western Australian Local Government Association 2013), is represented by 27.70% of its pre-European extent. This percentage exceeds the 10% EPA threshold for constrained areas of the Perth and Peel regions ((EPA, 2015), based on a pre-European extent of 87,392.73 ha and 24,206.24 ha documented by WALGA in 2013 as remaining.</p>	<p>Proposed clearing is not at variance with this principle.</p>	<p>NA</p>
<p>6 (f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland</p>	<p>The study area traverses one geomorphic "Multiple Use" Wetland, which has been classified as a dampland (WA Atlas, 2016). No other water waterways or wetlands are present within the immediately adjacent areas or are linked to the study area through surface drainage (GHD, 2015). Multiple Use (M category) allow for development in conjunction with and management of wetland values, in the context of water, town and environmental planning.</p>	<p>Proposed clearing is at variance with this principle.</p>	<p>Although the site supports a wetland, the classification of that wetland should allow for development in conjunction with suitable management. Obtaining further advice from the Department of Water once concept plans are drafted is recommended.</p>
<p>7 (g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.</p>	<p>The extent of existing clearing in the region of the study area is significant, comprising adjacent infrastructure and light commercial developments. The remnant vegetation present within the study area is mostly very degraded, although some better quality areas exist. Proposed clearing would result in further land degradation, although in the context of existing degradation, this is not considered significantly appreciable.</p>	<p>Proposed clearing is likely to be at variance with this principle.</p>	<p>Further degradation from clearing could be offset by enhancement of areas that are currently degraded, via appropriate management of weeds, bush fire risk, drainage and storm water, and by implementation of an appropriate rehabilitation/revegetation plan for any natural areas retained.</p>
<p>8 (h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.</p>	<p>The nearest conservation reserve to the study area is Thomsons Lake Nature Reserve, located approximately 3 km to the south-west of the study site. Any proposed clearing would not impact on this conservation area.</p>	<p>Proposed clearing is not at variance with this principle.</p>	<p>NA</p>

Principle	Assessment	Outcome	Avoidance or Mitigation Recommendation/ Comment
<p>9 (i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.</p>	<p>Data relating to groundwater (depth to) in the study area has not been made available and an analysis of surface water and groundwater has not been carried out as part of the flora and fauna assessment. However, generally, clearing of riparian and wetland vegetation that interacts with groundwater may have impacts on groundwater levels and potentially quality. Some areas of vegetation in the study area are specifically growing in association with surface or groundwater features, particularly the Mp and MpAI vegetation communities. Clearing vegetation can have impacts on surface water flows from rainfall run-off and this could impact the quality of surface water. However, there are no apparent areas of surface water in the study area, and the free draining sands present would be expected to result in negligible effects on surface run-off.</p>	<p>Proposed clearing may be at variance with this principle.</p>	<p>Minimise the areas of clearing of riparian/wetland vegetation where possible. Ensure suitable drainage features are incorporated into developments to avoid potential adverse impacts from run-off, and on surface and groundwater quality.</p>
<p>10 (j) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate the incidence or intensity of flooding.</p>	<p>Proposed clearing has the potential to cause flooding within and around the proposed development area, however, the free draining sands of the study area are likely to limit this. Furthermore, any proposed development would incorporate suitable drainage features that would suitably direct surface water and avoid any flooding in adjacent natural areas, if retained.</p>	<p>Proposed clearing is unlikely to be at variance with this principle.</p>	<p>Ensure suitable drainage features are incorporated into developments to avoid potential flooding.</p>

6 CONCLUSION AND RECOMMENDATIONS

The key ecological values associated with the study area are summarised as follows:

- Several Threatened and Priority flora species were identified during the desktop review as potentially occurring at the site, although none were recorded during the assessment.
- None of the flora species recorded are of any conservation significance.
- Five intact vegetation communities and three degraded vegetation communities were described and mapped within the study area, consisting of four woodlands, two woodland/wetland vegetation types, one heath and one degraded community.
- Areas of Banksia woodland (vegetation communities BaEt and BaXp) are likely to be representative of the newly listed Commonwealth TEC; *Banksia woodlands of the Swan Coastal Plain*.
- Five fauna habitats, consisting of woodlands and woodland/wetlands, one open heath/scrub and degraded areas were described and mapped across the study area.
- Evidence of Threatened Black-cockatoos (Carnaby's Black-cockatoo and Forest Red-tailed Black-cockatoo) was recorded during the site survey, including a direct sighting of Forest Red-tailed Black-cockatoos overflying the site and evidence of both species feeding on native tree fruits.
- Evidence of the Priority 4 species, Southern Brown Bandicoot/Quenda was observed in the form of diggings and this species is likely to inhabit the areas of dense understorey within the Paperbark Woodland/Swamp habitat, as well as probably the Banksia Woodland habitat.
- Rainbow Bee-eater (*Merops ornatus*) was determined to have a moderate likelihood of occurrence in the study area, based on recorded sightings by GHD (2015) and the presence of potentially suitable habitat.
- The site supports a dampland classified as a Multiple Use wetland (UFI 5562).

Below is a summary of the outcomes of the assessment against the ten clearing principles and impact mitigation/management and/or further study recommendations and comments:

- The proposed clearing is at variance with principle 2 (b), due to the presence of suitable foraging habitat and potential breeding habitat for Threatened Black-cockatoos, and likely habitat for the migratory bird species, Rainbow Bee-eater.
 - Impact mitigating recommendations:
 - Avoid or minimise clearing areas of the Banksia Woodland habitat
 - Avoid clearing the habitat tree located at 392497 mE, 6445689 mN
 - Limit ground disturbing activities (clearing and earthworks) to between February and July, which is outside the breeding season for Rainbow Bee-eater.
- The proposed clearing is at variance with principle 6 (f), due to the presence of a wetland at the site.
 - Recommendations:
 - Obtain advice from the Department of Water once concept plans are drafted, in order to achieve environmentally sensitive development in association with the wetland.
- The proposed clearing is likely to be at variance with principle 4 (d), due to the likely presence of the Banksia Woodlands TEC at the site.
 - Recommendations:
 - Undertake a follow-up assessment to confirm the presence and extent of the Banksia Woodland TEC at the site, which will also better inform potential offset requirements.

- The proposed clearing is likely to be at variance with principle 7 (g), due to the likelihood that it will cause appreciable land degradation.
 - Recommendations:
 - Consider options to offset impacts of further degradation by enhancement of areas that are currently degraded and may be retained.
- The proposed clearing may be at variance with principle 9 (i), due to the potential impacts on surface water and groundwater.
 - Impact mitigating recommendations:
 - Minimise the areas of clearing of riparian/wetland vegetation where possible.
 - Ensure suitable drainage features are incorporated into developments to avoid potential adverse impacts from run-off, and on surface and groundwater quality.
- The proposed clearing is unlikely to be, but may be at variance with principle 3 (c), due to the potential (although unlikely) presence of Threatened orchid, *Caladenia huegelii*.
 - Recommendation:
 - Consider a follow-up flora survey during early to mid-September 2017, targeting *Caladenia huegelii*, to further confirm the absence of this species. This assessment could also target other potentially occurring conservation significant flora, in order to ascertain their absence at the site.
- The proposed clearing is unlikely to be, but may be at variance with principle 10 (j), due to the potential (although unlikely) to cause flooding.
 - Recommendation:
 - Ensure suitable drainage features are incorporated into developments to avoid potential flooding.

Avoidance of the majority of the Banksia woodland area, likely to represent the TEC could be achieved by realigning the proposed North Lake Road to Beelihar Drive road alignment, as shown in **Figure 7**. Other currently proposed road alignments are considered well-placed to minimise impacts on areas of best quality vegetation and habitat within the study area.

The findings of the study suggest that any impacts to areas of the Banksia Woodland TEC or Black-Cockatoo foraging habitat would require referral to the Commonwealth DotEE. The DotEE has advised that development of the LSP itself would not require referral and that the City would only be required to refer for impacts to such areas that would result from road developments. Third parties who may develop the land within the LSP area would be required to refer the project under the EPBC Act where those developments may impact on the identified MNES (Small 2016 *pers. comm.*).

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APPENDIX A: NATUREMAP SPECIES REPORT

NatureMap Species Report

Created By Guest user on 26/09/2016

Current Names Only Yes
 Core Datasets Only Yes
 Method 'By Polygon'
 Vertices 32° 07' 45" S, 115° 50' 59" E 32° 07' 45" S, 115° 50' 60" E 32° 07' 18" S, 115° 51' 03" E 32° 06' 42" S, 115° 51' 09" E 32° 06' 47" S, 115° 51' 28" E 32° 07' 11" S, 115° 52' 36" E 32° 07' 42" S, 115° 52' 13" E 32° 07' 36" S, 115° 51' 56" E 32° 07' 40" S, 115° 51' 32" E 32° 07' 45" S, 115° 50' 59" E
 Conservation Status

Conservation Status	Species	Records
Non-conservation taxon	89	137
Priority 1	1	3
Priority 5	2	9
Protected under international agreement	1	1
Rare or likely to become extinct	2	2
TOTAL	95	152

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
Rare or likely to become extinct				
1.	1596 <i>Caladenia huegelii</i> (Grand Spider Orchid)		T	
2.	24146 <i>Myrmecobius fasciatus</i> (Numbat, Walpurti)		T	
Protected under international agreement				
3.	24598 <i>Merops ornatus</i> (Rainbow Bee-eater)		IA	
Priority 1				
4.	33994 <i>Throscodectes xiphos</i> (cricket)		P1	
Priority 5				
5.	25478 <i>Isoodon obesulus</i> (Southern Brown Bandicoot)		P5	
6.	24153 <i>Isoodon obesulus</i> subsp. <i>fusciventer</i> (Quenda, Southern Brown Bandicoot)		P5	
Non-conservation taxon				
7.	24560 <i>Acanthorhynchus superciliosus</i> (Western Spinebill)			
8.	25536 <i>Accipiter fasciatus</i> (Brown Goshawk)			
9.	42368 <i>Acritoscincus trilineatus</i> (Western Three-lined Skink)			
10.	44629 <i>Anilius australis</i>			
11.	24561 <i>Anthochaera carunculata</i> (Red Wattlebird)			
12.	24562 <i>Anthochaera lunulata</i> (Western Little Wattlebird)			
13.	17737 <i>Azolla pinnata</i>			
14.	<i>Barnardius zonarius</i>			
15.	741 <i>Baumea articulata</i> (Jointed Rush)			
16.	744 <i>Baumea laxa</i>			
17.	16636 <i>Boronia crenulata</i> subsp. <i>viminea</i>			
18.	5458 <i>Calytrix flavescens</i> (Summer Starflower)			
19.	5460 <i>Calytrix fraseri</i> (Pink Summer Calytrix)			
20.	<i>Calytrix</i> sp.			
21.	2794 <i>Carpobrotus aequilaterus</i> (Angular Pigface)	Y		
22.	6214 <i>Centella asiatica</i>			
23.	43380 <i>Chelodina collieii</i> (Oblong Turtle)			
24.	24980 <i>Christinus marmoratus</i> (Marbled Gecko)			
25.	25568 <i>Coracina novaehollandiae</i> (Black-faced Cuckoo-shrike)			
26.	25592 <i>Corvus coronoides</i> (Australian Raven)			
27.	25595 <i>Cracticus tibicen</i> (Australian Magpie)			
28.	25399 <i>Crinia glauerti</i> (Clicking Frog)			
29.	25400 <i>Crinia insignifera</i> (Squelching Froglet)			
30.	30899 <i>Ctenophorus adelaidensis</i> (Southern Heath Dragon, Western Heath Dragon)			
31.	25027 <i>Ctenotus australis</i>			
32.	25040 <i>Ctenotus gemmula</i> (Jewelled South-west Ctenotus (Swan Coastal Plain pop P3), skink)			
33.	40660 <i>Cycnogeton huegelii</i>			

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
34.	24322 <i>Cygnus atratus</i> (Black Swan)			
35.	30901 <i>Dacelo novaeguineae</i> (Laughing Kookaburra)	Y		
36.	<i>Descolea maculata</i>			
37.	25607 <i>Dicaeum hirundinaceum</i> (Mistletoebird)			
38.	11105 <i>Echinochloa crus-galli</i>	Y		
39.	<i>Eolophus roseicapillus</i>			
40.	20483 <i>Gastrolobium linearifolium</i>			
41.	3921 <i>Gastrolobium reticulatum</i>			
42.	6161 <i>Gonocarpus pithyoides</i>			
43.	24443 <i>Grallina cyanoleuca</i> (Magpie-lark)			
44.	25410 <i>Heleioporus eyrei</i> (Moaning Frog)			
45.	25119 <i>Hemiergis quadrilineata</i>			
46.	5173 <i>Hibbertia subvaginata</i>			
47.	24491 <i>Hirundo neoxena</i> (Welcome Swallow)			
48.	921 <i>Isolepis producta</i>			
49.	1188 <i>Juncus pallidus</i> (Pale Rush)			
50.	15498 <i>Kunzea glabrescens</i> (Spearwood)			
51.	<i>Latrodectus hasseltii</i>			
52.	8099 <i>Leontodon saxatilis</i> (Hairy Hawkbit)	Y		
53.	25661 <i>Lichmera indistincta</i> (Brown Honeyeater)			
54.	25415 <i>Limnodynastes dorsalis</i> (Western Banjo Frog)			
55.	25378 <i>Litoria adelaidensis</i> (Slender Tree Frog)			
56.	25388 <i>Litoria moorei</i> (Motorbike Frog)			
57.	7408 <i>Lobelia tenuior</i> (Slender Lobelia)			
58.	6458 <i>Lysinema elegans</i>			
59.	25654 <i>Malurus splendens</i> (Splendid Fairy-wren)			
60.	25758 <i>Megalurus gramineus</i> (Little Grassbird)			
61.	34676 <i>Meionectes brownii</i> (Swamp Raspwort)			
62.	<i>Metaballus litus</i>			
63.	15419 <i>Microtis media</i> subsp. <i>media</i>			
64.	25192 <i>Morethia obscura</i>			
65.	24223 <i>Mus musculus</i> (House Mouse)	Y		
66.	25252 <i>Notechis scutatus</i> (Tiger Snake)			
67.	14293 <i>Oenothera indecora</i> subsp. <i>bonariensis</i>	Y		
68.	16347 <i>Oenothera laciniata</i>	Y		
69.	24409 <i>Phaps chalcoptera</i> (Common Bronzewing)			
70.	1478 <i>Phlebocarya ciliata</i>			
71.	1479 <i>Phlebocarya filifolia</i>			
72.	24596 <i>Phylidonyris novaehollandiae</i> (New Holland Honeyeater)			
73.	4141 <i>Phyllota gracilis</i>			
74.	<i>Phytophthora cinnamomi</i>			
75.	4524 <i>Platytheca galioides</i>			
76.	25722 <i>Polytelis anthopeplus</i> (Regent Parrot)			
77.	25731 <i>Porphyrio porphyrio</i> (Purple Swamphen)			
78.	25732 <i>Porzana pusilla</i> (Baillon's Crake)			
79.	24771 <i>Porzana tabuensis</i> (Spotless Crake)			
80.	25511 <i>Pseudonaja affinis</i> (Dugite)			
81.	25259 <i>Pseudonaja affinis</i> subsp. <i>affinis</i> (Dugite)			
82.	25433 <i>Pseudophryne guentheri</i> (Crawling Toadlet)			
83.	4181 <i>Pultenaea reticulata</i>			
84.	<i>Purpureicephalus spurius</i>			
85.	24245 <i>Rattus rattus</i> (Black Rat)	Y		
86.	25534 <i>Sericornis frontalis</i> (White-browed Scrubwren)			
87.	25590 <i>Streptopelia senegalensis</i> (Laughing Turtle-Dove)	Y		
88.	24844 <i>Threskiornis molucca</i> (Australian White Ibis)			
89.	25519 <i>Tiliqua rugosa</i>			
90.	25207 <i>Tiliqua rugosa</i> subsp. <i>rugosa</i>			
91.	4383 <i>Tribulus terrestris</i> (Caltrop)	Y		
92.	25723 <i>Trichoglossus haematodus</i> (Rainbow Lorikeet)			
93.	150 <i>Triglochin stowardii</i>			
94.	98 <i>Typha domingensis</i> (Bulrush, Djandjid)			
95.	25765 <i>Zosterops lateralis</i> (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

Name ID Species Name

Naturalised

Conservation Code

¹Endemic To Query
Area

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly 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.

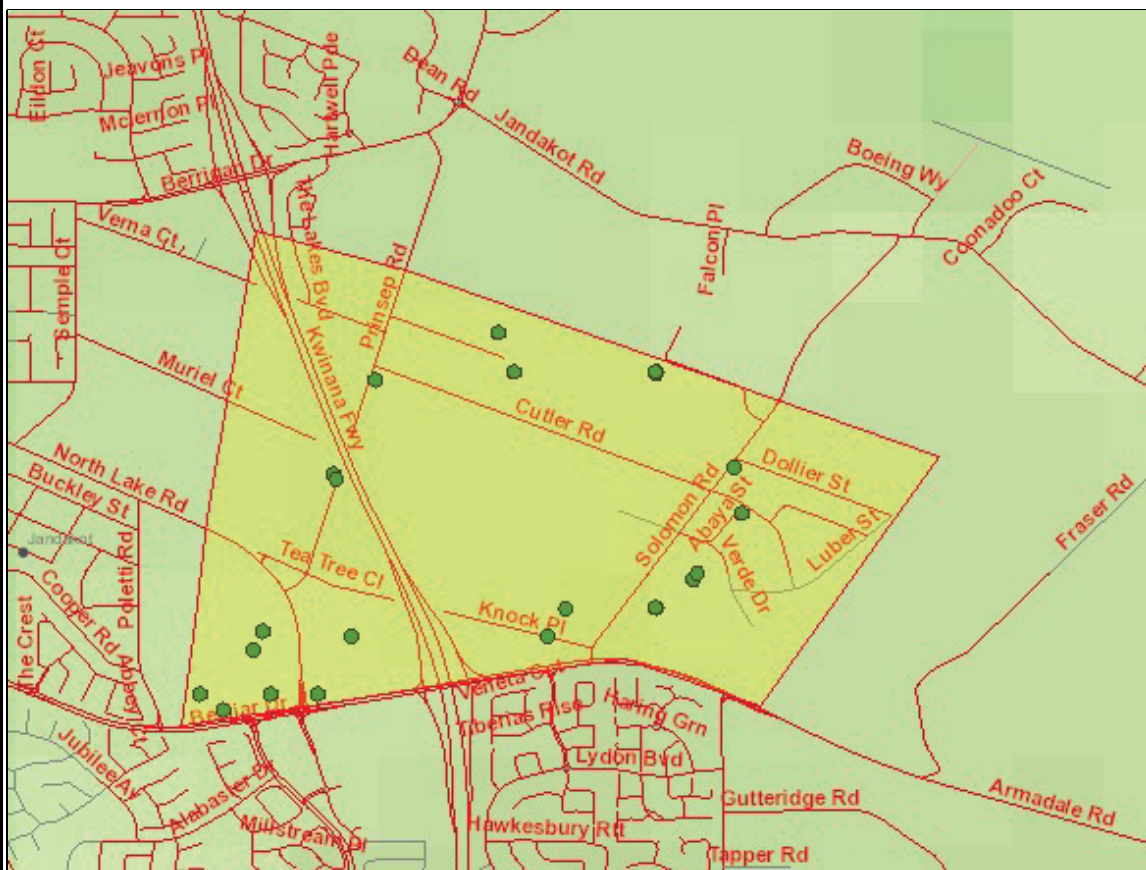
NatureMap

Mapping Western Australia's biodiversity

CCE LSP Project Area

Printed by Guest user on 26/9/2016

Query details : Current Names Only=Yes; Core Datasets Only=Yes; Method='By Polygon'; Vertices=32° 07' 45" S,115° 50' 59" E 32° 07' 45" S,115° 50' 60" E 32° 07' 18" S,115° 51' 03" E 32° 06' 42" S,115° 51' 09" E 32° 06' 47" S,115° 51' 28" E 32° 07' 11" S,115° 52' 36" E 32° 07' 42" S,115° 52' 13" E 32° 07' 36" S,115° 51' 56" E 32° 07' 40" S,115° 51' 32" E 32° 07' 45" S,115° 50' 59" E ;



Search Results

Selected

- Selected Species

All Results

- Non-conservation taxon
- Priority 1
- Priority 5
- Protected under international agreement
- Rare or likely to become extinct

Reference Layers

- Major WA Towns
- Major WA Towns
- Major WA Towns
- Roads

- Sealed
- Unsealed
- Track
- State Borders
- Australian Continent



NatureMap is a collaborative project of the Department of Parks and Wildlife, Western Australia, and the Western Australian Museum.

**APPENDIX B: EPBC ACT PROTECTED MATTERS
(MATTERS OF NATIONAL
ENVIRONMENTAL SIGNIFICANCE
(MNES))**



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: 26/09/16 19:59:27

[Summary](#)

[Details](#)

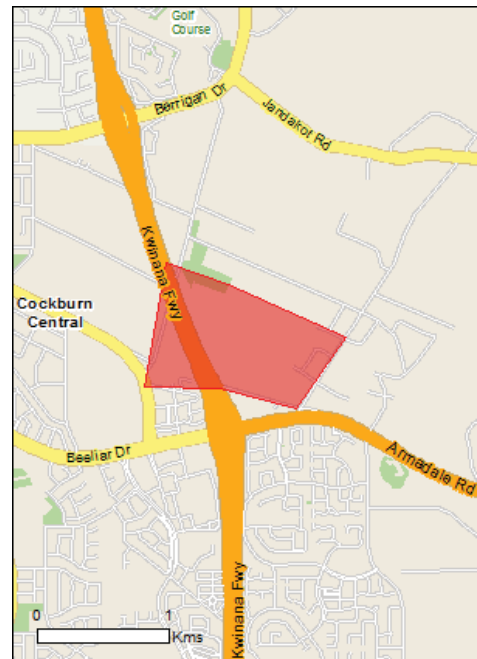
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

[Coordinates](#)

Buffer: 0.0Km



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:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	16
Listed Migratory Species:	6

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:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	11
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	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:	None
Regional Forest Agreements:	None
Invasive Species:	40
Nationally Important Wetlands:	None
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 10km of Ramsar

Listed Threatened Species	[Resource Information]	
Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	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
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Vulnerable	Species or species habitat may occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species

Name	Status	Type of Presence
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	habitat likely to occur within area Species or species habitat likely to occur within area
Drakaea elastica Glossy-leafed Hammer-orchid, Praying Virgin [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely 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

Migratory Terrestrial Species

Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
---	--	--

Migratory Wetlands Species

Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	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
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

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		
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

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to 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
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

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 Resources 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

Name	Status	Type of Presence
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 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
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
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 Asparagus [22473]		Species or species habitat likely to occur

Name	Status	Type of Presence
Asparagus plumosus Climbing Asparagus-fern [48993]		within area Species or species 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 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
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Protasparagus densiflorus Asparagus Fern, Plume Asparagus [5015]		Species or species habitat likely to occur within area
Protasparagus plumosus Climbing Asparagus-fern, Ferny Asparagus [11747]		Species or species habitat likely to 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
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

Name

Status

Type of Presence
habitat likely to occur within
area

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.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

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

-32.125249 115.858998,-32.125268 115.858998,-32.125122 115.853741,-32.117944 115.855308,-32.119216 115.859492,-32.122269 115.867603,-32.126431 115.864213,-32.125249 115.858998

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](#)
- [Parks and Wildlife Commission NT, Northern Territory Government](#)
- [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, Atherton and Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [Geoscience Australia](#)
- [CSIRO](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

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APPENDIX C: MUIR STRUCTURAL VEGETATION CLASSIFICATIONS

Life Form/Height Class	Canopy Cover			
	Dense 70-100%	Mid-dense 30-70%	Sparse 10-30%	Very sparse 2-10%
Trees >30m Trees 15-30m Trees 5-15m Trees <5m	Dense tall forest Dense forest Dense low forest A Dense low forest B	Tall forest Forest Low forest A Low forest B	Tall woodland Woodland Low woodland A Low woodland B	Open tall woodland Open woodland Open low woodland A Open low woodland B
Mallee Tree Form Mallee Shrub form	Dense tree mallee Dense shrub mallee	Tree mallee Shrub mallee	Open tree mallee Open shrub mallee	Very open tree mallee Very open shrub mallee
Shrubs >2m Shrubs 1.5-2m Shrubs 1-1.5m Shrubs 0.5-1m Shrubs <0.5m	Dense thicket Dense heath A Dense heath B Dense low heath C Dense low heath D	Thicket Heath A Heath B Low heath C Low heath D	Scrub Low scrub A Low scrub B Dwarf scrub C Dwarf scrub D	Open scrub Open low scrub A Open low scrub B Open dwarf scrub C Open dwarf scrub D
Mat plants Hummock grass Bunch grass >0.5m Bunch grass <0.5m Herbaceous spp.	Dense mat plants Dense hummock grass Dense tall grass Dense low grass Dense herbs	Mat plants Mid-dense hummock grass Tall grass Low grass Herbs	Open mat plants Hummock grass Open tall grass Open low grass Open herbs	Very open mat plants Open hummock grass Very open tall grass Very open low grass Very open herbs
Sedges >0.5m Sedges <0.5m	Dense tall sedges Dense low sedges	Tall sedges Low sedges	Open tall sedges Open low sedges	Very open tall sedges Very open low sedges
Ferns Mosses, Liverwort	Dense ferns Dense mosses	Ferns Mosses	Open ferns Open mosses	Very open ferns Very open mosses

Source: (Muir 1977)

APPENDIX D: OBSERVED AND POTENTIAL FAUNA SPECIES LIST

Observed and Potential Vertebrate Fauna List

Cockburn Central East - Local Structure Plan Area

Compiled by Greg Harewood - November 2016
 Approximate centroid = 32.21492°S and 115.85916°E
 Recorded (Sighted/Heard/Signs/Captured) = X

A = Harewood, G. (2016). Fauna Assessment of Cockburn Central East - Local Structure Plan Area. Unpublished report for Focused Vision Consulting.
 B = GHD (2015). North Lake Road Extension Ecological Assessment. Unpublished report for the City of Cockburn
 C = ENV (2009). Jandakot Airport Fauna Survey. Unpublished report for Jandakot Airport Holdings Pty Ltd.
 D = Phoenix Environmental Sciences (2011). Vertebrate Fauna Survey for the Roe Highway Extension Project. Unpublished report for South Metro Connect.
 E = Harewood, G. (2009) Fauna Survey (Level 2) East Rockingham WWTP Site and Pipeline Corridors. Unpublished report for ERM.
 F = DPaW (2016). NatureMap Database search. "By Circle" 115° 51' 36" E, 32° 07' 18" S – Study area (plus 8km buffer), 06/0102016.

Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Amphibia								
Myobatrachidae								
Ground or Burrowing Frogs								
<i>Crinia georgiana</i>	Quacking Frog	LC			X	X		X
<i>Crinia glauerti</i>	Clicking Frog	LC				X		X
<i>Crinia insignifera</i>	Squelching Froglet	LC				X		X
<i>Geocrinia leai</i>	Ticking Frog	LC						
<i>Heleioporus eyrei</i>	Moaning Frog	LC		X		X		X
<i>Limnodynastes dorsalis</i>	Western Banjo Frog	LC		X	X	X		X
<i>Myobatrachus gouldii</i>	Turtle Frog	LC				X		X

WC Act Status - S1 to S7, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, DPaW Priority Status - P1 to P4, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, Bush Forever Decreaser Species - Bh = habitat specialists, Bp = wide ranging species, Be = extinct in Perth Coastal Plain Region. IUCN Red List Category Definitions LC = Least Concern - see Appendix A and <http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria> for others.

Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
<i>Pseudophryne guentheri</i>	Crawling Toadlet	LC						X
Hylidae Tree or Water-Holding Frogs								
<i>Litoria adelaidensis</i>	Slender Tree Frog	LC			X	X		X
<i>Litoria moorei</i>	Motorbike Frog	LC				X		X

Reptilia

Diplodactylidae

Geckoes

<i>Strophurus spinigerus</i>	Soft Spiny-tailed Gecko						X	X
------------------------------	-------------------------	--	--	--	--	--	---	---

Gekkonidae

Geckoes

<i>Christinus marmoratus</i>	Marbled Gecko					X	X	X
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Pygopodidae

Legless Lizards

<i>Aprasia repens</i>	Sandplain Worm Lizard					X		X
-----------------------	-----------------------	--	--	--	--	---	--	---

<i>Delma fraseri</i>	Fraser's Legless Lizard				X		X	X
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<i>Lialis burtonis</i>	Burton's Legless Lizard					X	X	X
------------------------	-------------------------	--	--	--	--	---	---	---

<i>Pygopus lepidopodus</i>	Common Scaly Foot				X	X		X
----------------------------	-------------------	--	--	--	---	---	--	---

WC Act Status - S1 to S7, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, DPaW Priority Status - P1 to P4, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, Bush Forever Decreaser Species - Bh = habitat specialists, Bp = wide ranging species, Be = extinct in Perth Coastal Plain Region. IUCN Red List Category Definitions LC = Least Concern - see Appendix A and <http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria> for others.

Class	Common Name	Conservation Status	A	B	C	D	E	F
Family Species								
Agamidae								
Dragon Lizards								
<i>Ctenophorus adelaidensis</i>	Southern Heath Dragon							X
<i>Pogona minor</i>	Western Bearded Dragon			X	X	X	X	X
Varanidae								
Monitor's or Goanna's								
<i>Varanus gouldii</i>	Gould's Sand Monitor			X				X
<i>Varanus tristis</i>	Racehorse Monitor						X	

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Scincidae								
Skinks								
<i>Acritoscincus trilineatum</i>	Southwestern Cool Skink				X	X		
<i>Cryptoblepharus buechananii</i>	Fence Skink				X	X	X	X
<i>Ctenotus australis</i>	Western Ctenotus					X	X	X
<i>Ctenotus fallens</i>	West Coast Ctenotus					X	X	X
<i>Ctenotus impar</i>	Odd-striped Ctenotus							X
<i>Egernia napoleonis</i>	Salmon-bellied Skink					X		X
<i>Hemiergis quadrilineata</i>	Two-toed Mulch Skink				X	X	X	X
<i>Lerista elegans</i>	West Coast Four-toed Lerista				X	X	X	X
<i>Lerista lineata</i>	Perth Lined Lerista	P3		X		X		X
<i>Menetia greyii</i>	Dwarf Skink				X	X	X	X
<i>Morethia lineocellata</i>	West Coast Pale-flecked Morethia					X	X	X
<i>Morethia obscura</i>	Shrubland Pale-flecked Morethia					X	X	X
<i>Tiliqua rugosa</i>	Bobtail		X		X	X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Elapidae Elapid Snakes								
<i>Notechis scutatus</i>	Tiger Snake					X		X
<i>Pseudonaja affinis</i>	Dugite			X	X	X	X	X
<i>Simoselaps bertholdi</i>	Jan's Banded Snake							X

Aves

Phasianidae

Quails, Pheasants

<i>Coturnix pectoralis</i>	Stubble Quail	LC						X
<i>Coturnix ypsilophora</i>	Brown Quail	LC			X			X

Anatidae

Geese, Swans, Ducks

<i>Anas gracilis</i>	Grey Teal	LC				X		X
<i>Anas superciliosa</i>	Pacific Black Duck	LC			X	X		X
<i>Chenonetta jubata</i>	Australian Wood Duck	LC						X
<i>Tadorna tadornoides</i>	Australian Shelduck	LC				X		X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Ardeidae								
Hérons, Egrets, Bitterns								
<i>Ardea alba</i>	Great Egret	S5 Mig CA JA				X		X
<i>Ardea novaehollandiae</i>	White-faced Heron	LC				X		X
<i>Ardea pacifica</i>	White-necked Heron	LC						X
Threskiornithidae								
Ibises, Spoonbills								
<i>Platalea flavipes</i>	Yellow-billed Spoonbill	LC				X		X
<i>Threskiornis molucca</i>	Australian White Ibis	LC	X	X	X	X		X
<i>Threskiornis spinicollis</i>	Straw-necked Ibis	LC	X		X	X		X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Accipitridae								
Kites, Goshawks, Eagles, Harriers								
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk	Bp LC			X		X	X
<i>Accipiter fasciatus</i>	Brown Goshawk	Bp LC		X		X	X	X
<i>Aquila audax</i>	Wedge-tailed Eagle	Bp LC				X		X
<i>Aquila morphnoides</i>	Little Eagle	Bp LC			X		X	X
<i>Circus approximans</i>	Swamp Harrier	LC				X		X
<i>Circus assimilis</i>	Spotted Harrier	LC						X
<i>Elanus caeruleus</i>	Black-shouldered Kite	LC			X	X	X	X
<i>Haliastur sphenurus</i>	Whistling Kite	Bp LC				X	X	X
<i>Hamirostra isura</i>	Square-tailed Kite	Bp LC						

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Falconidae								
Falcons								
<i>Falco berigora</i>	Brown Falcon	Bp LC						X
<i>Falco cenchroides</i>	Australian Kestrel	LC	X	X	X	X	X	X
<i>Falco longipennis</i>	Australian Hobby	LC			X	X	X	X
<i>Falco peregrinus</i>	Peregrine Falcon	S7 Bp LC					X	X
Rallidae								
Rails, Crakes, Swamphens, Coots								
<i>Fulica atra</i>	Eurasian Coot	LC				X		X
<i>Gallinula tenebrosa</i>	Dusky Moorhen	Bh LC				X		X
<i>Gallinula ventralis</i>	Black-tailed Native-hen	LC				X		X
<i>Gallirallus philippensis</i>	Buff-banded Rail	LC						X
<i>Porphyrio porphyrio</i>	Purple Swamphen	LC				X		X
<i>Porzana fluminea</i>	Australian Spotted Crake	LC						X
<i>Porzana pusilla</i>	Baillon's Crake	LC						X
<i>Porzana tabuensis</i>	Spotless Crake	LC						X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Turnicidae								
Button-quails								
<i>Turnix varia</i>	Painted Button-quail	Bp LC						X
Columbidae								
Pigeons, Doves								
<i>Columba livia</i>	Domestic Pigeon	Introduced				X		X
<i>Ocyphaps lophotes</i>	Crested Pigeon	LC			X	X		X
<i>Phaps chalcoptera</i>	Common Bronzewing	Bh LC			X		X	X
<i>Streptopelia chinensis</i>	Spotted Turtle-Dove	Introduced		X	X	X		X
<i>Streptopelia senegalensis</i>	Laughing Turtle-Dove	Introduced		X	X	X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Psittacidae								
Parrots								
<i>Cacatua roseicapilla</i>	Galah	LC	X	X	X	X	X	X
<i>Cacatua sanguinea</i>	Little Corella	LC			X	X		X
<i>Cacatua tenuirostris</i>	Eastern Long-billed Corella	Introduced						X
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black-Cockatoo	S3 VU Bp VU A2c+3c+4c	X	X	X	X		X
<i>Calyptorhynchus latirostris</i>	Carnaby's Black-Cockatoo	S2 EN Bp EN A2bcde+3bcde+4bcde	X	X	X	X	X	X
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet	LC						X
<i>Neophema elegans</i>	Elegant Parrot	LC				X		X
<i>Platycercus icterotis icterotis</i>	Western Rosella (western ssp)	Bp LC						
<i>Platycercus spurius</i>	Red-capped Parrot	LC	X	X	X	X	X	X
<i>Platycercus zonarius</i>	Australian Ringneck Parrot	LC	X	X	X	X	X	X
<i>Polytelis anthopeplus</i>	Regent Parrot	LC						X
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	Introduced	X	X	X	X		X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Cuculidae Parasitic Cuckoos								
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	LC		X	X			X
<i>Chrysococcyx basalis</i>	Horsfield's Bronze Cuckoo	LC			X		X	
<i>Chrysococcyx lucidus</i>	Shining Bronze Cuckoo	LC	X		X	X		X
<i>Cuculus pallidus</i>	Pallid Cuckoo	LC						
Strigidae Hawk Owls								
<i>Ninox novaeseelandiae</i>	Boobook Owl	LC				X		X
Tytonidae Barn Owls								
<i>Tyto alba</i>	Barn Owl	LC					X	X
Podargidae Frogmouths								
<i>Podargus strigoides</i>	Tawny Frogmouth	LC						X
Caprimulgidae Nightjars								
<i>Eurostopodus argus</i>	Spotted Nightjar	LC						X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Aegothelidae Owlet-nightjars								
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	LC				X		X
Halcyonidae Tree Kingfishers								
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	Introduced	X	X		X	X	X
<i>Todiramphus sanctus</i>	Sacred Kingfisher	LC				X		X
Meropidae Bee-eaters								
<i>Merops ornatus</i>	Rainbow Bee-eater	S5 Mig JA LC		X		X	X	X
Maluridae Fairy Wrens, GrassWrens								
<i>Malurus splendens</i>	Splendid Fairy-wren	Bh LC	X	X	X	X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Acanthizidae								
Thornbills, Geryones, Fieldwrens & Whitefaces								
<i>Acanthiza apicalis</i>	Broad-tailed Thornbill	Bh LC				X	X	X
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	Bh LC			X	X		X
<i>Acanthiza inornata</i>	Western Thornbill	Bh LC				X	X	X
<i>Gerygone fusca</i>	Western Gerygone	LC	X	X	X	X	X	X
<i>Sericornis frontalis</i>	White-browed Scrubwren	Bh LC				X	X	X
<i>Smicromnis brevirostris</i>	Weebill	Bh LC				X	X	X
Pardalotidae								
Pardalotes								
<i>Pardalotus punctatus</i>	Spotted Pardalote	LC				X		X
<i>Pardalotus striatus</i>	Striated Pardalote	LC		X	X	X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Meliphagidae Honeyeaters, Chats								
<i>Acanthorhynchus superciliosus</i>	Western Spinebill	LC			X	X		X
<i>Anthochaera carunculata</i>	Red Wattlebird	LC	X	X	X	X	X	X
<i>Anthochaera lunulata</i>	Western Little Wattlebird	Bp LC		X	X	X		X
<i>Epthianura albifrons</i>	White-fronted Chat	LC			X			X
<i>Lichenostomus virescens</i>	Singing Honeyeater	LC	X	X	X	X	X	
<i>Lichmera indistincta</i>	Brown Honeyeater	LC	X	X	X	X	X	X
<i>Phylidonyris melanops</i>	Tawny-crowned Honeyeater	Bp LC						X
<i>Phylidonyris nigra</i>	White-cheeked Honeyeater	Bp LC			X	X		X
<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	Bp LC	X	X	X	X	X	X
Petroicidae Australian Robins								
<i>Petroica multicolor</i>	Scarlet Robin	Bh LC					X	X
Neosittidae Sitellas								
<i>Daphoenositta chrysoptera</i>	Varied Sittella	Bh LC				X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Pachycephalidae								
Crested Shrike-tit, Crested Bellbird, Shrike Thrushes, Whistlers								
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	Bh LC			X	X	X	X
<i>Pachycephala pectoralis</i>	Golden Whistler	Bh LC			X			X
<i>Pachycephala rufiventris</i>	Rufous Whistler	LC	X	X	X	X	X	X
Dicruridae								
Monarchs, Magpie Lark, Flycatchers, Fantails, Drongo								
<i>Grallina cyanoleuca</i>	Magpie-lark	LC		X	X	X	X	X
<i>Rhipidura fuliginosa</i>	Grey Fantail	LC	X			X	X	X
<i>Rhipidura leucophrys</i>	Willie Wagtail	LC	X	X	X	X	X	X
Campephagidae								
Cuckoo-shrikes, Trillers								
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	LC	X	X	X	X	X	X
<i>Lalage tricolor</i>	White-winged Triller	LC						

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Artamidae								
Woodswallows, Butcherbirds, Currawongs								
<i>Artamus cinereus</i>	Black-faced Woodswallow	Bp LC						X
<i>Artamus cyanopterus</i>	Dusky Woodswallow	Bp LC				X		X
Cracticidae								
Currawongs, Magpies & Butcherbirds								
<i>Cracticus tibicen</i>	Australian Magpie	LC	X	X	X	X	X	X
<i>Cracticus torquatus</i>	Grey Butcherbird	LC	X	X	X	X	X	X
Corvidae								
Ravens, Crows								
<i>Corvus coronoides</i>	Australian Raven	LC	X	X	X	X	X	X
Motacillidae								
Old World Pipits, Wagtails								
<i>Anthus australis</i>	Australian Pipit	LC					X	
Dicaeidae								
Flowerpeckers								
<i>Dicaeum hirundinaceum</i>	Mistletoebird	LC						X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Hirundinidae Swallows, Martins								
<i>Hirundo neoxena</i>	Welcome Swallow	LC				X	X	X
<i>Hirundo nigricans</i>	Tree Martin	LC		X	X	X	X	X
Sylviidae Old World Warblers								
<i>Cincloramphus cruralis</i>	Brown Songlark	LC						X
<i>Cincloramphus mathewsi</i>	Rufous Songlark	LC						X
Zosteropidae White-eyes								
<i>Zosterops lateralis</i>	Silvereye	LC	X	X	X	X	X	X
Mammalia								
Peramelidae Bandicoots								
<i>Isodon obesulus fusciventer</i>	Southern Brown Bandicoot	P4 LC	X	X	X	X	X	
Phalangeridae Brush-tail Possums, Cuscuses								
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	LC				X		X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Molossidae								
Freetail Bats								
<i>Austronomus australis</i>	White-striped Freetail-bat	LC			X	X		X
<i>Ozimops kitcheneri</i>	Southern Freetail-bat	LC				X	X	
Vespertilionidae								
Ordinary Bats								
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	LC			X	X	X	X
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	LC						
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	LC				X		X
<i>Nyctophilus gouldi</i>	Gould's Long-eared Bat	LC						
<i>Nyctophilus major</i>	Western Long-eared Bat	LC					X	
<i>Vespadelus regulus</i>	Southern Forest Bat	LC			X	X	X	X
Muridae								
Rats, Mice								
<i>Mus musculus</i>	House Mouse	Introduced		X	X	X	X	X
<i>Rattus rattus</i>	Black Rat	Introduced			X	X	X	X

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Class Family Species	Common Name	Conservation Status	A	B	C	D	E	F
Canidae								
Dogs, Foxes								
<i>Canis lupus familiaris</i>	Dog	Introduced	X	X			X	
<i>Vulpes vulpes</i>	Red Fox	Introduced	X		X	X	X	X
Felidae								
Cats								
<i>Felis catus</i>	Cat	Introduced		X	X	X	X	X
Leporidae								
Rabbits, Hares								
<i>Oryctolagus cuniculus</i>	Rabbit	Introduced	X	X	X	X	X	X

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APPENDIX E: FLORA SPECIES LIST (BY COMMUNITY)

* denotes introduced (weed) species
 DP denotes Declared Pest plants

Family	Species	N/I	Vegetation Community							
			BaEt	BaXp	Xp	Mp	MpAI	ErAI (d)	Eg (d)	i
Aizoaceae	<i>Carpobrotus edulis</i>	*	+	+	+					+
Apiaceae	<i>Daucus glochidiatus</i>	*	+	+						
Apocynaceae	<i>Gomphocarpus fruticosus</i>	DP		+						
Araceae	<i>Zantedeschia aethiopica</i>	DP				+				
Asparagaceae	<i>Asparagus asparagoides</i>	DP	+				+			
Asphodelaceae	<i>Trachyandra divaricata</i>	*								+
Asteraceae	<i>Arctotheca calendula</i>	*			+	+	+	+	+	+
	<i>Hypochaeris glabra</i>	*	+	+	+	+	+	+	+	+
	<i>Osteospermum ecklonis</i>	*								+
	<i>Sonchus oleraceus</i>	*		+						+
	<i>Ursinia anthemoides</i>	*	+	+						+
Boraginaceae	<i>Echium plantagineum</i>	DP		+						
Brassicaceae	<i>Brassica tournefortii</i>	*	+							+
Cactaceae	<i>Opuntia</i> sp.	*								+
Campanulaceae	<i>Wahlenbergia capensis</i>	*	+							
Caryophyllaceae	<i>Petrorhagia dubia</i>	*			+					
	<i>Allocauarina fraseri</i>			+	+					
Casuarinaceae	<i>Allocauarina humilis</i>		+							
	<i>Burchardia congesta</i>		+							
Colchicaceae	<i>Burchardia congesta</i>		+							
Crassulaceae	<i>Crassula colorata</i>		+		+					+
Cyperaceae	<i>Isolepis marginata</i>			+						+
	<i>Lepidosperma longitudinale</i>					+				
Dasyopogonaceae	<i>Dasyopogon bromeliifolius</i>			+	+					
Dilleniaceae	<i>Hibbertia hypericoides</i>		+							
	<i>Hibbertia subvaginata</i>		+			+	+			
Ecdeiocoleaceae	<i>Ecdeiocolea monostachya</i>									+
Elaeocarpaceae	<i>Tetratheca hirsuta</i>					+				
Ericaceae	<i>Conostephium minus</i>				+					
	<i>Leucopogon australis</i>					+				
	<i>Leucopogon conostephioides</i>		+							
Euphorbiaceae	<i>Euphorbia terracina</i>	*			+					+
	<i>Ricinus communis</i>	*		+					+	
Fabaceae	<i>Acacia longifolia</i>	*	+					+	+	+
	<i>Acacia pulchella</i>					+	+	+		
	<i>Acacia saligna</i>			+						
	<i>Bossiaea eriocarpa</i>		+							
	<i>Chamaecytisus palmensis</i>	*		+						+
	<i>Daviesia triflora</i>		+							
	<i>Gastrolobium capitatum</i>		+							
	<i>Gompholobium tomentosum</i>		+							
	<i>Hovea pungens</i>		+							
	<i>Jacksonia furcellata</i>		+	+						
	<i>Lupinus cosentinii</i>	*								+
	<i>Medicago polymorpha</i>	*				+		+	+	
	<i>Trifolium campestre</i>	*		+						+
<i>Vicia hirsuta</i>	*								+	
<i>Vicia sativa</i> subsp. <i>nigra</i>	*		+						+	
Geraniaceae	<i>Erodium botrys</i>	*		+						
	<i>Pelargonium capitatum</i>	*		+						+
Goodeniaceae	<i>Dampiera linearis</i>		+							

* denotes introduced (weed) species
 DP denotes Declared Pest plants

Family	Species	N/I	Vegetation Community							
			BaEt	BaXp	Xp	Mp	MpAI	ErAI (d)	Eg (d)	i
Haemodoraceae	<i>Anigozanthos humilis</i>		+							
	<i>Anigozanthos manglesii</i>		+							
	<i>Conostylis aculeata</i> subsp. <i>aculeata</i>		+							
	<i>Phlebocarya ciliata</i>		+		+					
Iridaceae	<i>Freesia alba</i> × <i>leichtlinii</i>	*								+
	<i>Gladiolus caryophyllaceus</i>	*	+	+	+					+
	<i>Patersonia occidentalis</i>	*	+							
	<i>Romulea rosea</i>	*	+							
	<i>Watsonia meriana</i>	*								+
Lauraceae	<i>Cassytha racemosa</i>					+	+			
Loranthaceae	<i>Nuytsia floribunda</i>		+	+						+
Malvaceae	<i>Brachychiton diversifolius</i>									+
Meliaceae	<i>Melia azedarach</i>	*								+
Myrtaceae	<i>Aotus gracillima</i>		+							
	<i>Astartea scoparia</i>					+	+			
	<i>Eremaea pauciflora</i> var. <i>pauciflora</i>		+							
	<i>Eucalyptus gomphocephala</i>								+	+
	<i>Eucalyptus marginata</i>			+						
	<i>Eucalyptus petiolaris</i>									+
	<i>Eucalyptus rudis</i>				+	+		+		
	<i>Eucalyptus todtiana</i>			+						
	<i>Hypocalymma angustifolium</i>		+	+		+	+			
	<i>Hypocalymma robustum</i>		+							
	<i>Kunzea glabrescens</i>					+	+			+
	<i>Leptospermum laevigatum</i>	*				+	+	+	+	+
	<i>Melaleuca preissiana</i>			+			+			+
	<i>Pericalymma ellipticum</i>						+			
	<i>Regelia inops</i>				+					
	<i>Scholtzia involucreta</i>		+		+					
Oleaceae	<i>Olea europaea</i>	*								+
Orchidaceae	<i>Caladenia flava</i>		+							
	<i>Diuris brumalis</i>		+							
	<i>Thelymitra crinita</i>		+			+				
Orobanchaceae	<i>Orobanche minor</i>	*		+						
Oxalidaceae	<i>Oxalis pes-caprae</i>	*		+						+
Papaveraceae	<i>Fumaria capreolata</i>	*	+	+	+	+	+	+	+	+
Poaceae	<i>Briza maxima</i>	*	+	+	+	+	+	+	+	
	<i>Briza minor</i>	*			+	+	+	+	+	
	<i>Bromus arenarius</i>	*		+	+					+
	<i>Cynodon dactylon</i>	*								+
	<i>Ehrharta calycina</i>	*					+	+	+	+
	<i>Ehrharta longiflora</i>	*		+	+	+	+	+	+	+
	<i>Lagurus ovatus</i>	*								+
	<i>Lolium rigidum</i>	*		+	+					+
	<i>Lysimachia arvensis</i>	*		+						
	<i>Stirlingia latifolia</i>	*								
Primulaceae	<i>Lysimachia arvensis</i>	*		+						
Proteaceae	<i>Adenanthos cygnorum</i>		+							+
	<i>Adenanthos obovatus</i>		+	+	+					
	<i>Banksia attenuata</i>				+					+
	<i>Banksia illicifolia</i>		+							
	<i>Banksia menziesii</i>		+	+	+					
	<i>Petrophile linearis</i>		+							
	<i>Stirlingia latifolia</i>		+							

* denotes introduced (weed) species
 DP denotes Declared Pest plants

Family	Species	N/I	Vegetation Community							
			BaEt	BaXp	Xp	Mp	MpAI	ErAI (d)	Eg (d)	i
Restionaceae	<i>Leptocarpus scariosus</i>		+							
	<i>Lyginia imberbis</i>		+							
Solanaceae	<i>Solanum linnaeanum</i>	*								+
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>				+			+		+
Zamiaceae	<i>Macrozamia riedlei</i>		+							
Total		45	48	35	22	22	18	12	11	43

APPENDIX F: SITE DESCRIPTIONS

BaEt

Low Woodland A of *Banksia attenuata* and *Eucalyptus tottiana* over *Xanthorrhoea preissii* over *Dasypogon bromeliifolius* and *Phlebocarya ciliata* in pale grey sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	10 m x 10 m
Habitat	Woodland
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Pale Grey
Soil Texture	Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	3-4 (Good to Very Good)
Disturbance Type	Weeds
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 25%



Species	Dominant Height (m)	Form	% cover
<i>Banksia attenuata</i>	6	Tree	7
<i>Eucalyptus tottiana</i>	5	Tree	5
<i>Banksia ilicifolia</i>		Tree	1
<i>Banksia menziesii</i>		Tree	1
<i>Xanthorrhoea preissii</i>	2	Shrub	3
<i>Acacia longifolia</i>		Shrub	1

Species	Dominant Height (m)	Form	% cover
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>		Shrub	1
<i>Adenanthos obovatus</i>		Shrub	1
<i>Allocasuarina humilis</i>		Shrub	1
<i>Bossiaea eriocarpa</i>		Shrub	1
<i>Eremaea pauciflora</i> var. <i>pauciflora</i>		Shrub	1
<i>Gastrolobium capitatum</i>		Shrub	1
<i>Gompholobium tomentosum</i>		Shrub	1
<i>Hibbertia hypericoides</i>		Shrub	1
<i>Hibbertia subvaginata</i>		Shrub	1
<i>Hovea pungens</i>		Shrub	1
<i>Hypocalymma angustifolium</i>		Shrub	1
<i>Hypocalymma robustum</i>		Shrub	1
<i>Jacksonia furcellata</i>		Shrub	1
<i>Daviesia triflora</i>		Shrub	1
<i>Aotus gracillima</i>		Shrub	1
<i>Leucopogon conostephioides</i>		Shrub	1
<i>Nuytsia floribunda</i>		Shrub	1
<i>Petrophile linearis</i>		Shrub	1
<i>Scholtzia involucrata</i>		Shrub	1
<i>Asparagus asparagoides</i> * (DP)		Climber	1
<i>Fumaria capreolata</i> *		Climber	1
<i>Dasyogon bromeliifolius</i>	0.4	Herb	10
<i>Phlebocarya ciliata</i>	0.3	Herb	10
<i>Anigozanthos humilis</i>		Herb	1
<i>Anigozanthos manglesii</i>		Herb	1
<i>Brassica tournefortii</i> *		Herb	1
<i>Burchardia congesta</i>		Herb	1
<i>Caladenia flava</i>		Herb	1
<i>Carpobrotus edulis</i> *		Herb	1
<i>Conostylis aculeata</i> subsp. <i>aculeata</i>		Herb	1
<i>Crassula colorata</i>		Herb	1
<i>Dampiera linearis</i>		Herb	1
<i>Daucus glochidiatus</i> *		Herb	1
<i>Diuris brumalis</i>		Herb	1
<i>Gladiolus caryophyllaceus</i> *		Herb	1
<i>Hypochaeris glabra</i> *		Herb	1
<i>Leptocarpus scariosus</i>		Herb	1
<i>Macrozamia riedlei</i>		Shrub	1
<i>Patersonia occidentalis</i>		Herb	1
<i>Romulea rosea</i> *		Herb	1

Species	Dominant Height (m)	Form	% cover
<i>Stirlingia latifolia</i>		Herb	1
<i>Thelymitra crinita</i>		Herb	1
<i>Ursinia anthemoides</i> *		Herb	1
<i>Wahlenbergia capensis</i> *		Herb	1
<i>Lyginia imberbis</i>		Sedge	1
<i>Briza maxima</i> *		Grass	1

BaXp

Low Woodland A of *Banksia attenuata* and *Banksia ilicifolia* over occasionally dominant patches of *Kunzea glabrescens*, with *Xanthorrhoea preissii* and **Acacia longifolia*, over mostly weeds, dominated by **Ehrharta calycina* and **Actotheca calendula*, in grey sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	10 m x 10 m
Habitat	Woodland
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Grey
Soil Texture	Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	4 (Good)
Disturbance Type	Weeds; Vehicle tracks
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 25%



Species	Dominant Height (m)	Form	% cover
<i>Banksia attenuata</i>	6	Tree	6
<i>Banksia ilicifolia</i>	7	Tree	3
<i>Allocasuarina fraseriana</i>		Tree	1
<i>Banksia menziesii</i>		Tree	1
<i>Eucalyptus marginata</i>		Tree	1
<i>Eucalyptus tottiana</i>		Tree	1
<i>Melaleuca preissiana</i>		Tree	1

Species	Dominant Height (m)	Form	% cover
<i>Xanthorrhoea preissii</i>	1.5	Shrub	3
<i>Kunzea glabrescens</i>	3	Shrub	2
<i>Acacia longifolia</i> *	3	Shrub	1
<i>Acacia saligna</i>		Shrub	1
<i>Adenanthos obovatus</i>		Shrub	1
<i>Chamaecytisus palmensis</i> *		Shrub	1
<i>Gomphocarpus fruticosus</i> *(DP)		Shrub	1
<i>Hypocalymma angustifolium</i>		Shrub	1
<i>Jacksonia furcellata</i>		Shrub	1
<i>Nuytsia floribunda</i>		Shrub	1
<i>Regelia inops</i>		Shrub	1
<i>Ricinus communis</i> *		Shrub	1
<i>Fumaria capreolata</i> *		Climber	1
<i>Arctotheca calendula</i> *	0.2	Herb	10
<i>Carpobrotus edulis</i> *		Herb	1
<i>Dasypogon bromeliifolius</i>		Herb	1
<i>Daucus glochidiatus</i> *		Herb	1
<i>Echium plantagineum</i> *(DP)		Herb	1
<i>Erodium botrys</i> *		Herb	1
<i>Gladiolus caryophyllaceus</i> *		Herb	1
<i>Hypochaeris glabra</i> *		Herb	1
<i>Lysimachia arvensis</i> *		Herb	1
<i>Orobanche minor</i> *		Herb	1
<i>Oxalis pes-caprae</i> *		Herb	1
<i>Pelargonium capitatum</i> *		Herb	1
<i>Raphanus raphanistrum</i> *		Herb	1
<i>Sonchus oleraceus</i> *		Herb	1
<i>Trifolium campestre</i> *		Herb	1
<i>Ursinia anthemoides</i> *		Herb	1
<i>Vicia sativa</i> subsp. <i>nigra</i> *		Herb	1
<i>Isolepis marginata</i>		Sedge	1
<i>Ehrharta calycina</i> *	1	Grass	40
<i>Briza maxima</i> *		Grass	1
<i>Bromus arenarius</i> *		Grass	1
<i>Ehrharta longiflora</i> *		Grass	1
<i>Lolium rigidum</i> *		Grass	1

Xp

Low Scrub A of *Xanthorrhoea preissii* over *Dasypogon bromeliifolius*, *Phlebocarya ciliata* and **Ehrharta calycina*, in grey sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	10 m x 10 m
Habitat/Waterway	Heath/Scrub
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Grey
Soil Texture	Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	4 (Good)
Disturbance Type	Weeds
Time since fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 20%



Species	Dominant Height (m)	Form	% cover
<i>Allocasuarina fraseriana</i>		Tree	1
<i>Eucalyptus rudis</i>		Tree	1
<i>Xanthorrhoea preissii</i>	2	Shrub	30
<i>Adenanthos obovatus</i>		Shrub	1
<i>Conostephium minus</i>		Shrub	1
<i>Scholtzia involucreta</i>		Shrub	1
<i>Fumaria capreolata*</i>		Climber	1

Species	Dominant Height (m)	Form	% cover
<i>Dasypogon bromeliifolius</i>	0.4	Herb	25
<i>Phlebocarya ciliata</i>	0.3	Herb	7
<i>Arctotheca calendula</i> *		Herb	1
<i>Carpobrotus edulis</i> *		Herb	1
<i>Crassula colorata</i>		Herb	1
<i>Euphorbia terracina</i> *		Herb	1
<i>Gladiolus caryophyllaceus</i> *		Herb	1
<i>Hypochaeris glabra</i> *		Herb	1
<i>Lolium rigidum</i> *		Herb	1
<i>Petrorhagia dubia</i> *		Herb	1
<i>Ehrharta calycina</i> *	1	Grass	50
<i>Briza maxima</i> *		Grass	1
<i>Briza minor</i> *		Grass	1
<i>Bromus arenarius</i> *		Grass	1
<i>Ehrharta longiflora</i> *		Grass	1

Mp

Low Woodland A of occasional *Eucalyptus rudis* over *Melaleuca preissiana* over occasionally dominant patches of *Kunzea glabrescens*, with *Xanthorrhoea preissii* and **Acacia longifolia*, over mostly weeds, dominated by **Ehrharta calycina*, in brown loamy sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	10 m x 10 m
Habitat/Waterway	Woodland/Wetland
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Brown
Soil Texture	Loamy Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	3-4 (Good to Very Good)
Disturbance Type	Weeds
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 40%



Species	Dominant Height (m)	Form	% cover
<i>Melaleuca preissiana</i>	9	Tree	9
<i>Eucalyptus rudis</i>	12	Tree	2
<i>Kunzea glabrescens</i>	3	Shrub	20
<i>Acacia longifolia</i> *	4	Shrub	4
<i>Xanthorrhoea preissii</i>	2	Shrub	3
<i>Acacia pulchella</i>		Shrub	1
<i>Astartea scoparia</i>		Shrub	1

Species	Dominant Height (m)	Form	% cover
<i>Hibbertia subvaginata</i>		Shrub	1
<i>Hypocalymma angustifolium</i>		Shrub	1
<i>Leptospermum laevigatum</i> *		Shrub	1
<i>Leucopogon australis</i>		Shrub	1
<i>Pericalymma ellipticum</i>		Shrub	1
<i>Tetradlea hirsuta</i>		Shrub	1
<i>Asparagus asparagoides</i> * (DP)		Climber	1
<i>Cassytha racemosa</i>		Climber	1
<i>Fumaria capreolata</i> *		Climber	1
<i>Arctotheca calendula</i> *		Herb	1
<i>Hypochaeris glabra</i> *		Herb	1
<i>Medicago polymorpha</i> *		Herb	1
<i>Thelymitra crinita</i>		Herb	1
<i>Zantedeschia aethiopica</i> * (DP)		Herb	1
<i>Lepidosperma longitudinale</i>		Sedge	1
<i>Ehrharta calycina</i> *	1	Grass	50
<i>Briza maxima</i> *		Grass	1
<i>Briza minor</i> *		Grass	1
<i>Ehrharta longiflora</i> *		Grass	1

MpAI

Low Woodland A of *Melaleuca preissiana* over **Acacia longifolia*, over mostly weeds, dominated by **Ehrharta calycina* and **Ehrharta longiflora* in brown loamy sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	10 m x 10 m
Habitat/Waterway	Woodland/Wetland
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Brown
Soil Texture	Loamy Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	4-6 (Degraded to Good)
Disturbance Type	Weeds
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 40%
Picture	

Species	Dominant Height (m)	Form	% cover
<i>Melaleuca preissiana</i>	6	Tree	12
<i>Kunzea glabrescens</i>		Shrub	2
<i>Acacia longifolia</i> *	5	Shrub	10
<i>Xanthorrhoea preissii</i>		Shrub	2
<i>Acacia pulchella</i>		Shrub	1
<i>Astartea scoparia</i>		Shrub	1
<i>Hibbertia subvaginata</i>		Shrub	1
<i>Hypocalymma angustifolium</i>		Shrub	1
<i>Leptospermum laevigatum</i> *		Shrub	1
<i>Asparagus asparagoides</i> * (DP)		Climber	1
<i>Cassytha racemosa</i>		Climber	1
<i>Fumaria capreolata</i> *		Climber	1
<i>Arctotheca calendula</i> *		Herb	1
<i>Hypochaeris glabra</i> *		Herb	1
<i>Medicago polymorpha</i> *		Herb	1
<i>Ehrharta calycina</i> *	1	Grass	50
<i>Ehrharta longiflora</i> *	1	Grass	4
<i>Briza maxima</i> *		Grass	1
<i>Briza minor</i> *		Grass	1

ErAI (d)

Degraded areas of *Eucalyptus rudis* over **Acacia longifolia* over weeds, dominated by **Ehrharta calycina* and **Ehrharta longiflora* in brown loamy sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	Relevé
Habitat/Waterway	Woodland
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Brown
Soil Texture	Loamy Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	6 (Degraded)
Disturbance Type	Weeds
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 40%

Species	Form	% cover
<i>Eucalyptus rudis</i>	Tree	10
<i>Acacia longifolia</i> *	Shrub	10
<i>Acacia pulchella</i>	Shrub	1
<i>Leptospermum laevigatum</i> *	Shrub	1
<i>Fumaria capreolata</i> *	Climber	1
<i>Arctotheca calendula</i> *	Herb	1
<i>Hypochaeris glabra</i> *	Herb	1
<i>Medicago polymorpha</i> *	Herb	1
<i>Ehrharta calycina</i> *	Grass	50
<i>Ehrharta longiflora</i> *	Grass	4
<i>Briza maxima</i> *	Grass	1
<i>Briza minor</i> *	Grass	1

Eg (d)

Degraded areas of *Eucalyptus gomphocephala* over weeds, dominated by **Ehrharta calycina* and **Ehrharta longiflora* in brown loamy sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	Relevé
Habitat/Waterway	Woodland
Slope	Moderate
Surface Layer	Loose Soil
Soil Colour	Grey
Soil Texture	Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	4-6 (Degraded to Completely Degraded)
Disturbance Type	Weeds, tracks
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 40%

Species	Form	% cover
<i>Eucalyptus gomphocephala</i>	Tree	10
<i>Leptospermum laevigatum</i> *	Shrub	1
<i>Ricinnis communis</i> *	Shrub	1
<i>Fumaria capreolata</i> *	Climber	1
<i>Arctotheca calendula</i> *	Herb	1
<i>Hypochaeris glabra</i> *	Herb	1
<i>Medicago polymorpha</i> *	Herb	1
<i>Ehrharta calycina</i> *	Grass	30
<i>Ehrharta longiflora</i> *	Grass	10
<i>Briza maxima</i> *	Grass	1
<i>Briza minor</i> *	Grass	1

i

Completely degraded areas of planted trees and shrubs and weeds, or weeds only, with occasional *Adenanthos cygnorum* subsp. *cygnorum* and *Xanthorrhoea preissii*, in grey or brown sands.

Botanist	Kellie Bauer-Simpson
Quadrat Dimensions	Relevé
Habitat/Waterway	Degraded; Shrubland/Grassland Mosaic
Slope	Gentle
Surface Layer	Loose Soil
Soil Colour	Grey/brown
Soil Texture	Sand
Rock Type	No Rocks
Rock Size and Abundance	No Rocks - N/A
Vegetation Condition	6 (Completely Degraded)
Disturbance Type	Weeds; Vehicle tracks
Time since Fire	No Evidence
Leaf Litter Distribution/Cover	Scattered; 5%

Typical Species	Form	% cover
<i>Brachychiton diversifolius</i> *	Tree	1
<i>Eucalyptus petiolaris</i> *	Tree	1
<i>Melia azedarach</i> *	Tree	1
<i>Olea europaea</i> *	Tree	1
<i>Leptospermum laevigatum</i> *	Shrub	15
<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	Shrub	10
<i>Acacia longifolia</i> *	Shrub	1
<i>Opuntia</i> sp.*	Shrub	1
<i>Solanum linnaeanum</i> *	Shrub	1
<i>Xanthorrhoea preissii</i>	Shrub	1
<i>Fumaria capreolata</i> *	Climber	1
<i>Arctotheca calendula</i> *	Herb	1
<i>Brassica tournefortii</i> *	Herb	1
<i>Chamaecytisus palmensis</i> *	Herb	1
<i>Euphorbia terracina</i> *	Herb	1
<i>Freesia alba</i> × <i>leichtlinii</i> *	Herb	1
<i>Gladiolus caryophyllaceus</i> *	Herb	1
<i>Hypochaeris glabra</i> *	Herb	1
<i>Lupinus cosentinii</i> *	Herb	1
<i>Osteospermum ecklonis</i> *	Herb	1
<i>Oxalis pes-caprae</i> *	Herb	1
<i>Pelargonium capitatum</i> *	Herb	1
<i>Sonchus oleraceus</i> *	Herb	1
<i>Trachyandra divaricata</i> *	Herb	1
<i>Trifolium campestre</i> *	Herb	1

Typical Species	Form	% cover
<i>Ursinia anthemoides</i> *	Herb	1
<i>Vicia hirsuta</i> *	Herb	1
<i>Vicia sativa</i> subsp. <i>nigra</i> *	Herb	1
<i>Watsonia meriana</i> *	Herb	1
<i>Ecdeiocolea monostachya</i>	Sedge	1
<i>Isolepis marginata</i>	Sedge	1
<i>Ehrharta calycina</i> *	Grass	60
<i>Bromus arenarius</i> *	Grass	1
<i>Carpobrotus edulis</i> *	Grass	1
<i>Cynodon dactylon</i> *	Grass	1
<i>Ehrharta longiflora</i> *	Grass	1
<i>Lagurus ovatus</i> *	Grass	1
<i>Lolium rigidum</i> *	Grass	1

APPENDIX G: HABITAT TREE DATA

mE	mN	Lot No.	Tree Species	Tree Height (m)	No. Hollows	Hollow Type 1	Hollow Size 1 (cm)	Hollow Type 2	Hollow Size 2 (cm)	Occupancy	Chew Marks	Potential Cockatoo Nest Hollow	Comments
392023	6445500	9500	Jarrah	15-20	1	Knot Hole	5-10			No Signs	No Signs	No	Depth of hollows unknown
392058	6445521	9500	Jarrah	15-20	2	Knot Hole	5-10	Spout Branch	5-10	Bees	No Signs	No	Partly dead – Hollow depths unknown
392054	6445367	9500	Non-endemic Eucalypt	20+	0					No Signs	No Signs	No	Planted Non-endemic
392024	6445383	9500	Non-endemic Eucalypt	20+	0					No Signs	No Signs	No	Planted Non-endemic
392547	6445161	33	Dead Tuart	20+	1	Knot Hole	10-20			Galahs	Galahs	No	Galah present - Hollow depth unknown
392552	6445161	33	Tuart	20+	0					No Signs	No Signs	No	
392556	6445152	33	Tuart	20+	0					No Signs	No Signs	No	
392557	6445147	33	Tuart	20+	0					No Signs	No Signs	No	
392614	6445213	33	Tuart	20+	0					No Signs	No Signs	No	
392597	6445225	33	Tuart	20+	0					No Signs	No Signs	No	
392590	6445226	33	Tuart	15-20	1	Spout Branch	5-10			No Signs	No Signs	No	Depth of hollows unknown
392571	6445205	33	Tuart	20+	0					No Signs	No Signs	No	
392571	6445204	36	Tuart	15-20	0					No Signs	No Signs	No	
392515	6445202	36	Tuart	20+	0					No Signs	No Signs	No	
392524	6445224	36	Tuart	20+	0					No Signs	No Signs	No	
392524	6445222	36	Tuart	20+	0					No Signs	No Signs	No	
392436	6445361	801	Flooded Gum	20+	1	Fissure	5-10			No Signs	No Signs	No	Depth of hollows unknown
392497	6445689	802	Dead Flooded Gum	10-15	2	Knot Hole	5-10	Spout Trunk	20+	No Signs	No Signs	Yes	Depth of hollows unknown



**COCKBURN CENTRAL EAST LOCAL STRUCTURE PLAN (CCE LSP)
AREA, TARGETED CALADENIA HUEGELII SURVEY**

JANUARY 2018

CITY OF COCKBURN



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EXECUTIVE SUMMARY

Focused Vision Consulting Pty Ltd (FVC) was commissioned during September 2017 by the City of Cockburn (the City) to undertake a targeted *Caladenia huegelii* survey within the Cockburn Central East Local Structure Plan (CCE LSP) area (study area).

A targeted survey of the study area was conducted by FVC on 27 September 2017. Two experienced botanists, Kellie Bauer-Simpson and Gabriela Martinez with an experienced field assistant, Will Bauer-Simpson, systematically assessed the suitable habitat areas of the study area for *Caladenia huegelii*. The searches were conducted via a series of parallel transects in accordance with the Department of the Environment (2013) Guidelines for Detecting Orchids Listed as 'Threatened'.

The timing of the survey (September) was considered optimal to conduct a targeted flora survey for *Caladenia huegelii*, and other Spider Orchid species such as *Caladenia longicauda* were also observed in flower during the survey.

Although a detailed search was carried out, no *Caladenia huegelii* plants were recorded.

1 INTRODUCTION

1.1 BACKGROUND

Focused Vision Consulting (FVC) was commissioned during September 2017 by the City of Cockburn (the City) to undertake a targeted *Caladenia huegelii* survey within the Cockburn Central East Local Structure Plan (CCE LSP) area (study area). This work is following a spring flora, vegetation, fauna and habitat assessment completed by FVC during 2016. The results of that study identified that the site provides suitable habitat for the species, and therefore *Caladenia huegelii* may be present within the study area. The study area encompasses a number of Lots, totalling 31.21 ha as shown in **Figure 1**, much of which was included in the targeted search, depending on habitat suitability, also shown in **Figure 1**.

This report provides the results of the Targeted *Caladenia huegelii* survey undertaken within the study area during September 2017.

1.2 LOCATION

The study area is located approximately 20 km south of the Perth CBD, directly adjacent to the Kwinana Freeway on both the western and eastern sides. On the western side of the freeway, the area is bounded by Kentucky Court and North Lake Road. To the east of the freeway, the study area is comprised of numerous lots between Cutler Road and Knock Place, Cockburn Central (**Figure 1**).

1.3 SCOPE OF WORK

The scope included a targeted *Caladenia huegelii* survey. The tasks required to be carried out included:

- undertaking systematic traverses of the study area, within suitable habitat, to search for *Caladenia huegelii* plants, where (if) plants were observed, recording the:
 - GPS location of each individual *Caladenia huegelii* allowing an inventory of the number of plants/population size
 - vegetation type and condition at the recorded location
 - condition of plants/populations recorded
- the preparation of a report that summarises results and includes:
 - a discussion on the results, including identification and spatial mapping of all occurrences of *Caladenia huegelii* within the study area
 - identification of any potential environmental impacts and develop management recommendations for the protection of the Threatened flora species.

The survey was carried out in accordance with:

- Department of the Environment (2013) Guidelines for Detecting Orchids Listed as 'Threatened' under the *Environment and Biodiversity Conservation Act 1999* (EPBC Act).



0 50 100 150 200 m

GDA 94 / MGA Zone 50

**Figure 1 - Cockburn Central East
Local Structure Plan Project Area**



Legend

 Project Area



2 EXISTING ENVIRONMENT

2.1 CLIMATE

The Swan Coastal Plain has a warm Mediterranean climate which is characterised by hot dry summers and cool to mild wet winters (Mitchell *et al.* 2002). Jandakot Airport (009172) is the closest meteorological recording station to Cockburn Central and has recorded an average annual rainfall of 823.5 mm (BoM 2017).

2.2 IBRA REGION

There are 89 recognised Interim Biogeographic Regionalisation for Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (Commonwealth of Australia 2013). The study area lies within the Swan Coastal Plain IBRA region and, at a finer scale, within the Perth subregion (Mitchell *et al.* 2002).

2.3 GEOLOGY AND SOILS

The study area lies within the Bassendean Dune System which consists of very old leached sands to various depths (GHD 2015) and are the oldest of the three dunes systems occurring on the Swan Coastal Plain. Sands within this system contain very little silt or clay and very low levels of nutrient elements (ESWA 2016).

Soils within the study area are mapped as three sub units of the Bassendean System (Schoknecht *et al.* 2004). They are described as:

- 212Bs_B1 - Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands with pale yellow B horizon
- 212Bs_B2 – Flat to very gently undulating sandplain with well to moderate well drained deep bleached grey sands with a pale yellow B horizon or weak iron organic hardpan
- 212Bs_B4 – Broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depth generally greater than 1.5 m by clay or less frequently a strong iron organic hardpan.

2.4 VEGETATION

The study area is located on the Swan Coastal Plain and has been broadly characterised by Beard (1990) as “e2Mb cbLi - Medium very sparse woodland; jarrah, with low woodland; Banksia and Casuarina (Association 1001)”.

Vegetation of the Perth subregion comprises heath and/or Tuart (*Eucalyptus gomphocephala*) woodlands on limestone, Jarrah (*Eucalyptus marginata*) and *Banksia* woodlands on Quaternary marine dunes and Marri (*Corymbia calophylla*) on colluvial and alluvial sands (Mitchell *et al.* 2002).

Vegetation complexes within the study area have been defined by Heddle *et al.* (1980) and are based on vegetation in association with landforms and underlying geology. One vegetation complex Bassendean complex – central and south as described by Heddle *et al.* (1980) occurs within the study area. This complex ranges from woodlands of *Eucalyptus marginata*, *Allocasuarina* and *Banksia* on sand dunes to a low woodland of *Melaleuca* species, and sedge lands on the low-lying depressions and swamps.

3 SPECIES PROFILE

3.1 CALADENIA HUEGELII

3.1.1 Conservation Significance

Caladenia huegelii was classified as Threatened (Declared Rare Flora – Extant) in November 1990 under the *Wildlife Conservation Act, 1950* (WC Act) and listed under Schedules 1 to 4 of the Wildlife Conservation (Rare Flora) Notice for Threatened Flora. It is a species of flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F (20) of the WC Act. *Caladenia huegelii* is also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The species is also ranked Critically Endangered (CR) under World Conservation Union (IUCN 2001) criterion B2ab (i, ii, iii, iv) due to the severe fragmentation of populations and the continuing decline in the extent of its occurrence, area of occupancy, quality of habitat and number of locations.

3.1.2 Ecology, Habitat and Distribution

Caladenia huegelii grows up to 60 cm tall with a single erect, pale green, hairy leaf and one or two (rarely three) predominantly pale greenish-cream flowers 7-10 cm across, with variable suffusions, lines and spots of red-maroon. Floral odour is absent. The sepals end in slender light brown to yellow clubs. The large labellum is prominently two coloured with a pale greenish-cream base and a uniformly dark maroon recurved apex. The leaf is densely hirsute to 4 mm long. Leaves are visible from May to November. Flowering occurs from September to October, with not all adult plants producing a flower each year. Some plants have been recorded not to produce a leaf each year and remain as a dormant tuberoid below ground (Hopper and Brown 2001).

Correct identification of *Caladenia huegelii* can only be carried out when it is in flower as a range of *Caladenia* species produce similar leaves (DEC 2009).

The preferred habitat of *Caladenia huegelii* is well drained, deep sandy soils in areas of mixed woodland of Jarrah (*Eucalyptus marginata*), Candlestick Banksia (*Banksia attenuata*), Holly Banksia (*Banksia ilicifolia*) and Firewood Banksia (*Banksia menziesii*) with scattered Sheoak (*Allocasuarina fraseriana*) and Marri (*Corymbia calophylla*) over dense Blueboy (*Stirlingia latifolia*), Swan River Myrtle (*Hypocalymma robustum*), Yellow buttercups (*Hibbertia hypericoides*), Buttercups (*Hibbertia subvaginata*), Balga (*Xanthorrhoea preissii*), coastal jugflower (*Adenanthos cuneatus*) and *Conostylis* species (DEC 2009).

Caladenia huegelii is found in the Jarrah Forest and Swan Coastal Plain Bioregions of Western Australia. A review of available information on populations held by the Department of Biodiversity Conservation and Attractions (DBCA) in 2017 indicated that 41 known records of the species are held at the Western Australian Herbarium (DBCA 2017).

4 METHODOLOGY

The areas of suitable habitat within the CCE LSP study area were determined based on previous vegetation mapping (FVC 2016). Suitable habitat was determined to encompass the two Banksia woodland units (BeEt and BaXp, as mapped by FVC (2016)) in better than degraded condition (Degraded to Good, or better). On a finer scale, some sections of the suitable habitat (Banksia woodland) were found to be either cleared since the 2016 spring survey, or not specifically suitable habitat for *Caladenia huegelii*, due to domination of dense stands of introduced Victorian Tea-tree (*Leptospermum laevigatum*). These areas were therefore not searched in detail (mostly impenetrable) and are presented in **Figure 2**.

A targeted flora survey of the suitable habitat areas within the, study area was carried out on 27 September 2017 during the optimal flowering period for *Caladenia huegelii*. The survey was conducted in accordance with the Department of the Environment (2013) Guidelines for Detecting Orchids Listed as 'Threatened'.

Two experienced FVC botanists, Kellie Bauer-Simpson and Gabriela Martinez and an experienced field assistant, Will Bauer-Simpson, systematically assessed the suitable habitat areas for the presence of *Caladenia huegelii* individuals. A series of parallel transects, spaced approximately 10 m apart were traversed for the search, to ensure all areas of suitable habitat was inspected. Where the habitat is in poorer condition, the spacing of traverses was made broader, as the occurrence of *Caladenia huegelii* was considered much less likely, since native understorey in these locations is greatly reduced, mostly due to weed domination.

Navigation of the sweeps were carried out using a combination of Garmin handheld Global Positioning System (GPS), tablets using the customized software program Mappt™ and magnetic compasses. The traverses made by field personnel for the searches are shown in **Figure 3**.

If individuals or suspected individuals of *Caladenia huegelii* flora were observed, the following data was to be recorded:

- GPS location of each individual plant allowing an inventory of the number of plants/population size
- vegetation type and condition at the recorded location
- condition of plants/populations recorded.



0 50 100 150 200 m


GDA 94 / MGA Zone 50

Figure 2 - Study Areas



Legend

 Project Area

 Unsuitable Habitat

 Mapped Banksia Woodland

 Cleared





0 50 100 150 200 m

GDA 94 / MGA Zone 50

Figure 3 - Search Traverses



Legend

- Project Area
- Search Traverses
- Search Areas



5 RESULTS

No flowering *Caladenia huegelii* individuals were observed or recorded during the survey September 2017 survey conducted within areas of suitable habitat within the CCE LSP study area.

Two *Caladenia* were observed during the survey; *Caladenia flava* and *Caladenia longicauda*. These two species are very common in the south-west of Western Australia and are of no conservation significance.

6 DISCUSSION AND CONCLUSION

A targeted survey of the study area was conducted by FVC on 27 September 2017. Results from previous surveys conducted by FVC in 2016 identified two vegetation types within the study area, BeEt and BaXp, which provided suitable habitat for *Caladenia huegelii* and therefore were included in the targeted search as shown in **Figure 2**.

The timing of the survey (September) was considered optimal to conduct a targeted flora survey for *Caladenia huegelii* as other orchids such as the Spider Orchid species, *Caladenia longicauda* were also observed in flower during the survey.

Although a detailed survey was carried out within suitable habitat within the site, no *Caladenia huegelii* plants were observed or recorded.

7 REFERENCES

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Appendix 7 Vegetation assessment (PGV Environmental 2023)

COCKBURN SURF PARK

VEGETATION ASSESSMENT

Prepared for: Aventura

Report Date: 27 January 2023

Version: 3

Report No. 2022-656

The logo for PGV Environmental is located in the bottom right corner of the page. It features the letters 'PGV' in a large, bold, white sans-serif font. Below 'PGV', the word 'ENVIRONMENTAL' is written in a smaller, white, all-caps sans-serif font. The background of the logo area is a vibrant orange with a subtle, curved white line that sweeps across the bottom of the page.

PGV
ENVIRONMENTAL

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Figure 1:	Site Location
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Figure 3:	Vegetation Types
Figure 4:	Vegetation Condition
Figure 5:	Banksia Woodland TEC
Figure 6:	Black Cockatoo Foraging Habitat
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Appendices

Appendix 1:	Cockburn Central East Local Structure Plan (CCE LSP) Area, Targeted <i>Caladenia huegelii</i> Survey (Focused Vision, 2017)
Appendix 2:	Quadrat Data

1 INTRODUCTION

Aventuur has been selected to construct a Surf Park on Lot 800 and Pt Lot 9001 Prinsep Road, Cockburn (Figure 1). The Surf Park development will occupy about 5.7ha (the site) (Figure 2).

The Surf Park is proposed to include a surfing lagoon, boutique hotel, health and wellness centre, offices, functions and event spaces, performance academy, beach club and restaurants.

The site is mostly covered in native vegetation. Construction of the Surf Park would remove all of the native vegetation. PGV Environmental was commissioned by Aventuur to undertake a vegetation assessment to provide information on the following:

- A description and map of the vegetation types;
- A description and map of the condition of the vegetation;
- An assessment of the conservation significance of the vegetation;
- An assessment of any Black Cockatoo habitat; and
- Determine whether a referral is required under the Commonwealth EPBC Act.

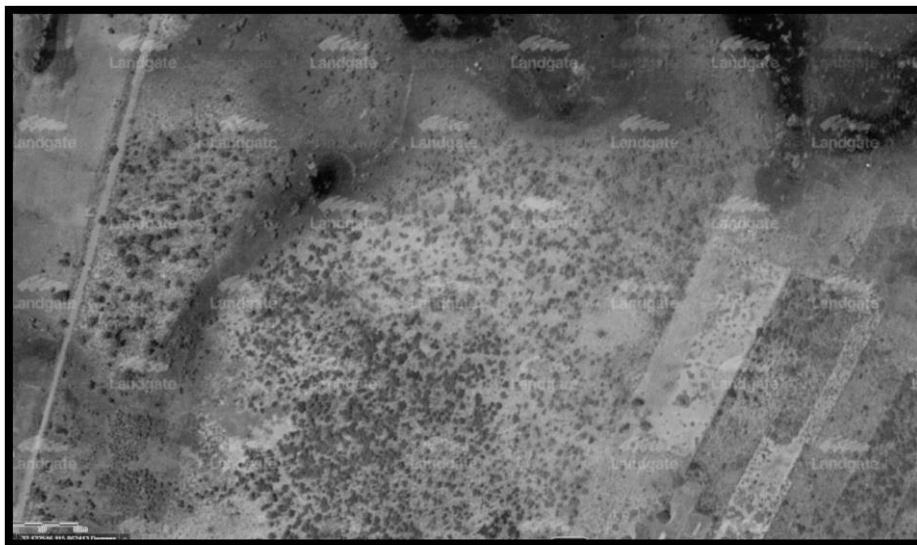
2 SITE DESCRIPTION

2.1 Land Use

2.1.1 Historical Land Use

The earliest available historic aerial photograph on-line from 1953 shows that the site is vegetated with varying levels of disturbance (Plate 1) (Landgate, 2022). Some areas to the east of the site appear to have been cleared for agricultural use.

Plate 1: Aerial Photograph 1953 (Landgate, 2022)



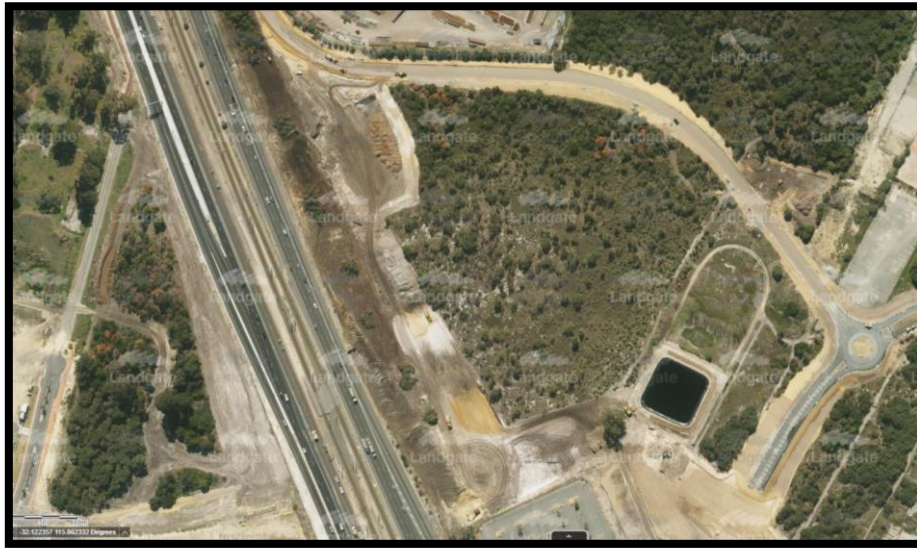
The aerial photograph from 1979 shows the trees on the site have been thinned out and the site partially cleared (Plate 2) (Landgate, 2022).

Plate 2: Aerial Photograph 1979 (Landgate, 2022)



The Freeway was constructed on the western side in 1989 and Prinsep Road on the northern boundary was constructed in 2020 (Plate 3). The road on the southeastern side was constructed in 2021.

Plate 3: Aerial Photograph May 2020 (Landgate, 2021)



2.1.2 Heritage

There are no Aboriginal Heritage Sites or Places mapped on the site (Appendix 3) (DPLH, 2022).

Heritage sites can be listed under the following lists/registers:

- World Heritage Sites;
- National Heritage Sites;
- Commonwealth Heritage Sites; and
- Sites on the Western Australian Heritage Council Register.

There are no listed Heritage Sites or Interim Heritage Sites on the site (National Map, 2022; Heritage Council of Western Australia, 2022; DAWE, 2022).

2.1.3 Current Land Use

The site is currently vegetated and not used.

2.2 Topography

The site slopes up from a low point of around 26m AHD at the northern end to 31m AHD at the southwestern end (Figure 2).

2.3 Wetlands

The northern end of the site is mapped as a wetland (blue colour on Plate 4). The wetland is identified as UFI 6652 and is classified as a Multiple Use Dampland. Damplands are seasonally waterlogged basins. Wetland UFI 6652 extends off-site, including to the north of Prinsep Road on Lot 802.

Plate 4: Wetland Mapping



2.4 Vegetation

2.4.1 Previous Survey

A previous survey of the site was undertaken by Focussed Vision Consulting for the City of Cockburn in 2016 and a follow up targeted survey in 2017 as part of a wider survey of the Cockburn Central East Local Structure Plan area (Focussed Vision Consulting, 2018). The initial flora and vegetation survey was a Level 1 (now called Reconnaissance) survey, however was undertaken in a lot of detail with a full species list compiled from spring surveys and a vegetation type and condition map prepared. The Targeted Survey is provided as Appendix 1.

Focussed Vision Consulting mapped four vegetation types on the surf park site as follows:

- BaEt – Banksia over *Eucalyptus todtiana* woodland
- BaXp – Banksia over *Xanthorrhoea preissii* woodland
- Xp – *Xanthorrhoea preissii* heath
- Mp – *Melaleuca preissiana* over **Acacia longifolia* woodland/swamp

The BaEt, BaXp and Xp vegetation types were considered by Focussed Vision Consulting to likely meet the requirement of the Commonwealth listed Banksia Woodlands of the Swan Coastal Plain TEC and recommended further assessment of patch size and quality to confirm this assessment.

Focussed Vision Consulting mapped the vegetation condition ranging from Degraded-Good up to Good-Very Good.

No Threatened or Priority plant species were recorded on the site.

2.4.2 Methodology

An assessment of the vegetation on the site was undertaken by Dr Paul van der Moezel of PGV Environmental initially on 30 September 2021 and again on 3 December 2021. The assessment included walking the site to describe vegetation type and condition. The boundary of the Banksia dominated vegetation was mapped with a hand-held GPS and with the assistance of a recent tree survey prepared by MNG surveyors.

Three quadrats were assessed in the Banksia vegetation type during the 3 December 2021 survey. The work had not been commissioned at the time of the 30 September survey.

The survey did not include a flora survey. The results of the Focussed Vision Consulting survey with regards to possible Threatened and Priority species occurring on the site are considered valid and are recent (spring survey 5 years old and targeted survey 4 years old).



2.4.3 Vegetation Type


Three vegetation types were described and mapped on the site as shown on Figure 3 and described in Table 1.

The vegetation types are very similar to those described for the site by Focussed Vision Consulting (2019). Focussed Vision Consulting included *Eucalyptus todtiana* in one of their vegetation types with *Banksia attenuata*. PGV Environmental recorded *Eucalyptus todtiana* on the site but considered it was not in great abundance to use in a vegetation type description. PGV Environmental also recorded more *Banksia menziesii* on the site than *B. attenuata* and therefore used both species in the vegetation type description rather than just *B. attenuata* used by Focussed Vision Consulting. The slight differences in terminology are a small technical difference and of no conservation consequence.

The portion of Lot 9001 included in the development footprint does not contain any native plants. Some Victorian Teatree and a Cape Lilac tree occur in this area.

Table 1: Vegetation Types on the Site

Vegetation Type	Description	Photograph
<p>BmBa <i>Banksia menziesii</i>/<i>B. attenuata</i> Low open Woodland over <i>Xanthorrhoea preissii</i> Open Shrubland over <i>Phlebocarya ciliata</i> Open Low Heath</p>	<p>This is the most common vegetation type on the site occurring on the southern two-thirds of the site on dry, sandy upland soils. <i>Banksia menziesii</i> and <i>B. attenuata</i> were 4-6m high and 5-20% canopy cover. <i>Eucalyptus todtiana</i> and <i>Allocasuarina fraseriana</i> (Sheoak) are also tree species occurring in some areas. The understorey was low and often appeared very weedy with a high visual cover of Veldtgrass (<i>Ehrharta calycina</i>). However, beneath the Veldtgrass is an often dense cover of low shrubs particularly <i>Phlebocarya ciliata</i>, <i>Dasypogon bromeliifolius</i> and <i>Lyginia barbata</i>.</p> <p>Total area = 3.156ha</p>	
<p>Xp <i>Xanthorrhoea preissii</i> Shrubland over <i>Phlebocarya ciliata</i> Closed Low Heath</p>	<p>This vegetation type occurred on the eastern side of the site on dry, sandy soils. The area contained only a few <i>Allocasuarina fraseriana</i> (Sheoak) trees and no <i>Banksia</i> trees. <i>Xanthorrhoea preissi</i> and <i>X. brunonis</i> occurred up to 1m high and moderately dense over a dense ground cover of <i>Phlebocarya ciliata</i>, <i>Dasypogon bromeliifolius</i> and <i>Lyginia barbata</i>.</p> <p>Total area = 0.80ha</p>	

Vegetation Type	Description	Photograph
<p>Mp <i>Melaleuca preissiana</i> Low Open Woodland over <i>Kunzea glabrescens</i> Tall Shrubland over <i>Astartea affinis</i>/ <i>Hypocalymma angustifolium</i> Open Low Heath</p>	<p>This vegetation type occurs at the northern end of the site associated with a mapped Multiple Use wetland. <i>Melaleuca preissiana</i> (Paperbark) trees are 5-6m high and low density mixed with the introduced woody weed small tree <i>Acacia longifolia</i>. <i>Kunzea glabrescens</i> (Spearwood) is a common large shrub over an open understorey of native wetland species such as <i>Astartea affinis</i> and <i>Hypocalymma angustifolium</i> and abundant Veldtgrass (<i>Ehrharta longiflora</i>).</p> <p>Total area = 1.40ha</p>	

2.4.4 Floristic Community Type

An assessment of the Floristic Community Type (FCT) was undertaken by comparing the species in the three quadrats sampled with the data in Table 12 in Gibson *et al.* (1994). Using this method, the BmBa Low Open Woodland vegetation type has the strongest correlation with FCT 23a ‘Central *Banksia attenuata* – *Banksia menziesii* woodlands’. The Xp vegetation type did not have a quadrat. However, based on the very similar understorey species to the BmBa vegetation type, it is likely representative of FCT23a, even though there are no *Banksia* trees. A Floristic Community Type is identified by the combination of all species rather than one or two individual species. Therefore, even though the two *Banksia* species are absent, the FCT with their names in the title, can still apply.

The *Melaleuca preissiana* vegetation type is considered to be representative of FCT 4 ‘*Melaleuca preissiana* damplands’.

The result of the FCT assessment is very similar to the assessment by Focussed Vision Consulting for their vegetation types on the site. The only difference is one small area mapped by Focussed Vision Consulting as BaXp near the north-east corner of the site was assessed by them as FCT 21a ‘Central *Banksia attenuata*-*Eucalyptus marginata* woodlands’ rather than FCT 23a.

2.4.5 Vegetation Condition

The condition of the vegetation was assessed according to the system of Keighery as described in Bush Forever (Government of Western Australia, 2000) (Table 2).

The condition of the main vegetation type (BmBa – *Banksia* woodland) was rated in Good-Very Good condition (Figure 4). The abundance of Perennial Veldtgrass (*Ehrharta calycina*) and presence of other weed species including in some places Bridal Creeper (*Asparagus asparagoides*) prevented the vegetation from being rated as Excellent.

The area of *Xanthorrhoea preissii* Shrubland had an intact native understorey but lacked a tree cover. Examination of historic aerial photographs indicates that this area may have been cleared of trees in the past and has not regenerated. The Good rating reflects the change in structure due to the clearing of trees in the past.

The Paperbark wetland vegetation was rated in Degraded-Good condition. The low rating was due to the abundance of Sydney Wattle (*Acacia longifolia*) mixed with the Paperbark trees and a high cover of weeds in the understorey, mainly grassy weeds like *Ehrharta longiflora* (Annual Veldtgrass) and *Briza maxima* (Blowfly Grass).

The vegetation condition rating and map are similar to the condition rating and mapping by Focussed Vision Consulting for the site.

Table 2: Vegetation Condition Rating Scale.

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

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

Source: Government of Western Australia, 2000.

2.5 Vegetation Significance

2.5.1 Ecological Community

At the level of Floristic Community Type (FCT) neither of the two FCTs assessed as being on the site, FCT 23a and FCT 4, are a Threatened or Priority Ecological Community at State level or Commonwealth level.

However, FCT 23a is part of the Banksia Woodlands of the Swan Coastal Plain TEC (Banksia Woodland TEC) which is listed under the EPBC Act. Not every area containing Banksia trees is automatically a part of the Banksia Woodland TEC. The area needs to meet certain criteria to qualify as the TEC. Further analysis of whether the vegetation on the site meets the definition of the Banksia Woodland TEC follows.

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

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

The vegetation type Xp - *Xanthorrhoea preissii* Shrubland over *Phlebocarya ciliata* Closed Low Heath, which adjoins the BmBa vegetation type, does not have any Banksia trees and examination of historic aerial photos shows the area has been lightly treed for many decades. The Xp vegetation type is considered buffer vegetation to the Banksia woodland and, according to the Banksia Woodland TEC Conservation Advice, a buffer "is not part of the ecological community and is not formally protected as part of the matter of national significance".

Table 3: Assessment of the Banksia Woodland of the Swan Coastal Plain TEC.

Feature	Characteristic	BmBa vegetation type
Banksia Species	<p>The patch must include at least one of the following diagnostic species:</p> <ul style="list-style-type: none"> • <i>Banksia attenuata</i> (Candlestick Banksia) • <i>Banksia menziesii</i> (Firewood Banksia) • <i>Banksia prionotes</i> (Acorn Banksia) • <i>Banksia ilicifolia</i> (Holly-Leaved Banksia). 	<p>Area mapped as BmBa contain both <i>Banksia attenuata</i> and <i>B. menziesii</i>.</p>
Vegetation Structure	<ul style="list-style-type: none"> • A distinctive upper sclerophyllous layer of low trees (occasionally large shrubs more than 2 m tall) typically dominated or codominated³ by one or more of the <i>Banksia</i> species (<i>B. attenuata</i>, <i>B. menziesii</i>, <i>B. ilicifolia</i>, <i>B. prionotes</i>). • An emergent tree layer of medium or tall (>10 m) height <i>Eucalyptus</i> or <i>Allocasuarina</i> (Sheoak) species may sometimes be present above the <i>Banksia</i> canopy. • An understorey that is often highly species-rich consists of: <ul style="list-style-type: none"> – A layer of sclerophyllous shrubs of various heights; and, – A herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs, that sometimes includes grasses. The development of a ground layer may vary depending on the density of the shrub layer and disturbance history. 	<p><i>Banksia attenuata</i> and <i>B. menziesii</i> very common tree layer with <i>Eucalyptus todtiana</i> and <i>Allocasuarina fraseriana</i> occasionally present.</p> <p>Understorey not highly species rich but contain sclerophyllous shrubs of various heights as well as rushes, sedges and forbs.</p>
Vegetation Condition	<p>An area of Banksia woodland needs to be at least in Good condition to be considered the TEC.</p>	<p>Condition rated as Good-Very Good which is above the minimum condition category</p>
Patch Size	<p>The Banksia woodland TEC needs to meet a minimum ‘patch’ size depending on its condition to qualify as the TEC, as follows:</p> <ul style="list-style-type: none"> • ‘Pristine’ – no minimum patch size • ‘Excellent’ – 0.5ha • ‘Very Good’ – 1ha • ‘Good’ – 2ha 	<p>Area of BmBa vegetation calculated at 3.156ha (tbc) (Figure 5). The area of Xp vegetation is contiguous with the BmBa type does not contain any Banksia trees and therefore is not part of the Banksia patch. The size of the BmBa vegetation type is larger than the minimum criteria of 2ha for Good condition vegetation.</p>
Conclusion		Meets the criteria for Banksia Woodlands of the Swan Coastal Plain TEC.

2.5.2 Wetland

The wetland mapped in the northern part of the site corresponds very well to the Paperbark (Mp) vegetation type which is typically found in wetlands. Therefore, the boundary of the wetland is considered very accurate. The wetland is classified as a Multiple Use wetland. Multiple Use wetlands have very few ecological attributes and functions. The portion of wetland on the site contains a Paperbark woodland in Degraded to Good condition. The management category is likely to be at the upper end of Multiple Use but not as high to be rated in the higher categories of Resource Enhancement or Conservation. The portion of wetland UFI 6652 on Lot 802 to the north contains a much larger Paperbark woodland that covers most of the lot and is in Very Good condition.

2.5.3 Black Cockatoo Habitat

The Banksia trees on the site provide foraging habitat for Carnaby's and Baudin's Black Cockatoos. The few *Eucalyptus todtiana* and *Allocasuarina fraseriana* trees provide limited foraging habitat for Forest Red-tailed Black Cockatoos. All three Black Cockatoo species are listed under the EPBC Act.

No tall trees occur on the site that provide roosting or breeding habitat for any of the Black Cockatoo species.

The total area of foraging habitat on the site, represented by the BmBa vegetation type is shown in Figure 6 and calculated to be 3.156ha.

2.6 Fauna

2.6.1 Previous Survey

Focussed Vision Consulting (2017) undertook a Level 1 Fauna Survey (now known as a Basic Fauna Survey). The desktop component of the survey identified 143 native animals as potentially occurring in the area, three of which were Conservation Significant species being;

The species that are identified as possibly present on the site are:

- Carnaby's Black Cockatoo (*Calyptorhynchus (Zanda) latirostris*) (Endangered);
- Forest Red-tailed Black Cockatoos (*Calyptorhynchus (Zanda) banksii naso*) (Vulnerable);
- Rainbow Bee-eater (*Merops ornatus*) (Marine);
- Perth Slider, Lined Skink (*Lerista lineata*) (Priority 3); and
- Southern Brown Bandicoot, Quenda (*Isoodon fusciventer*) (Priority 4).

Additionally, habitat may occur for:

- Baudin's Black Cockatoo (*Calyptorhynchus (Zanda) baudinii*) (Endangered) which is increasingly being recorded on the Swan Coastal Plain; and
- Black-striped Snake (*Neelaps calonotos*) (Priority 3).

2.6.2 Fauna Habitat

There were three fauna habitats identified on the site by Focussed Vision Consulting (2017) as follows:

- Banksia Woodland habitat;
- Paperbark Woodland/Swamp habitat; and
- Open Degraded Areas habitat.

Fauna habitat can be assessed using a number of factors including, the size of the habitat, the level of habitat connectivity, availability of specific resources (eg. tree hollows) and overall vegetation quality. The habitat was assessed according to the following categories:

High Quality Fauna Habitat – These areas closely approximate the vegetation mix and quality that would have been in the area prior to any disturbance. The habitat has connectivity with other habitats and is likely to contain the most natural vertebrate fauna assemblage.

Very Good Fauna Habitat - These areas show minimal signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) and generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be minimally affected by disturbance.

Good Fauna Habitat – These areas showed signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be affected by disturbance.

Disturbed Fauna Habitat – These areas showed signs of significant disturbance. Many of the trees, shrubs and undergrowth are cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, contain weeds or have been damaged by vehicle or machinery. Habitats are fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.

Highly Degraded Fauna Habitat – These areas often have a significant loss of vegetation, an abundance of weeds, and a large number of vehicle tracks or are completely cleared. Limited or no fauna habitat connectivity. Faunal assemblages in these areas are likely to be significantly different to what might have been in the area pre-disturbance. (Coffey Environments, 2009).

The habitat on the is considered to be Good Fauna habitat as the vegetation is disturbed but there is some connectivity to other habitat.

2.6.3 Biodiversity Value

It is not possible to assess the biodiversity value at a genetic level based on the information available, however due to the current development on the site the biodiversity value at the genetic level is highly likely to have been impacted by predation by cats and foxes.

3 EPBC ACT REFERRAL ADVICE

3.1 General

Any proposed Action that could lead to a significant impact on a Matter of National Environmental Significance (MNES) listed under the EPBC Act is required to be referred to the Commonwealth Department of Agriculture, Water and the Environment to determine whether it needs to be fully assessed or not.

The relevant MNES on the site are:

- 3.156ha of Black Cockatoo foraging habitat; and
- 3.156ha of Banksia Woodlands of the Swan Coastal Plain TEC

3.2 Banksia Woodland TEC

3.2.1 Referral

There are no specific referral guidelines for the Banksia Woodland TEC. The significance of an impact is determined by the EPBC Act Significant Impact Guidelines 1.1. The Banksia Woodland TEC is listed as an Endangered TEC. The Significant Impact Guidelines 1.1 list seven actions that are likely to have a significant impact on an Endangered ecological community. The first action is the 'reduction in the extent of an ecological community'. As there is no threshold to the amount of vegetation that can be cleared before it is considered significant, any clearing of Banksia Woodland TEC may have a significant impact.

The Surf Park development would result in the clearing of 3.156ha of Banksia Woodland TEC. On this basis, a Referral under the EPBC Act is recommended.

3.2.2 Banksia Woodland Regional Context

To ascertain the context of Banksia Woodland on the site compared to surrounding secure reserves within 12km an analysis of Bush Forever sites has been undertaken. The amount of Banksia Woodland TEC present in reserves is shown in Table 6 (Government of Western Australia, 2000). There is 2,089.5ha of Banksia Woodland TEC in Bush Forever sites within 12km in the surrounding area. The 3.156ha on site represents 0.15% of the amount within 12km. There are additional areas of remnant vegetation on sites that are not included in Bush Forever sites that also contain Banksia Woodland TEC but are not included in this calculation.

Table 6: Banksia Woodland TEC in Surrounding Bush Forever Sites (12km radius)

Site Number	Reserve Name	Inferred Area of Banksia Woodland (ha)	FCT
125	Holmes Street Bushland, Southern River/Huntingdale	Upland – 29.7	23a
244	North Lake and Bibra Lake, North Lake/Bibra Lake	Upland – 72	23a and 28
245	Ken Hurst Park, Leeming	Upland - 33	23a
253	Harrisdale Swamp and Adjacent Bushland, Forrestdale	Upland – 68.4	23a

Site Number	Reserve Name	Inferred Area of Banksia Woodland (ha)	FCT
262	Piarra Nature Reserve, Forrestdale	Upland – 21.8	21a and 21c
263	Banjup Bushland, Banjup	Upland – 32.9	21c, 22, 23a
267	Mandogalup Road Bushland, Hope Valley	95.9	25 with Banksia and 28
269	The Spectacles	Upland – 183	28
270	Sandy Lake and Adjacent Bushland, Anketell	Upland – 73.8	21a
336	Wireless Hill Park, Ardross	35.2	28
342	Anstey/Keane Dampland and Adjacent Bushland, Forrestdale	Uplands – 92.9	21c and 23a
344	Dennis De Young Reserve and Gibbs Road Swamp Bushland, Banjup/Forrestdale	Uplands – 94.4	21c and 22
345	Forrestdale Lake and Adjacent Bushland, Forrestdale	Upland – 93.5	21a and 21c
347	Wandi Nature Reserve and Anketell Road Bushland, Wandii/Oakford	Upland – 221.3	22 and 23a
348	Modong Nature Reserve and Adjacent Bushland, Oakford	Upland – 130.1	21c and 23a
388	Jandakot Airport, Jandakot	Upland – 241.6	21c, 22 and 23a
389	Acourt Road Bushland, Banjup	Upland – 170.9	21c, 22 and 23a
390	Fraser Road Bushland, Banjup	Upland – 126.6	23a
391	Thomsons Lake Nature Reserve and Adjacent Bushland, Beeliar	Upland – 33.7	28
392	Harry Waring Marsupial Reserve, Wattleup	Upland – 217.8	21a, 23a and 28
456	Nicholson Road Bushland, Langford/Thornlie	Upland – 7.1	23a
492	Lyon Road Bushland, Banjup	Upland – 13.9	21a, 21c and 23a
Total		2,089.5	

3.2.3 Banksia Woodland Significance of Impact

The impact of clearing the Banksia Woodland TEC has been analysed in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (SEWPaC, 2006). The significance of an impact, according to the Significant Impact Guidelines depends on the sensitivity, value and quality of the environment and the intensity, duration, magnitude and geographic extent of the impacts. The significant impact criteria for listed flora and fauna species and ecological communities depend on the category of listing, eg. Endangered, Vulnerable or Migratory. The significant impact guidelines relevant to the Banksia Woodland TEC and analysis of proposed clearing for the Surf Park are set out below.

1. Reduce the extent of an ecological community.

Clearing of the site for the Surf Park will result in the removal of 3.156ha of the Banksia Woodland TEC. Contextually there are more than 2,000ha of Banksia Woodland in secure reserves in Bush

Forever sites within 12km so the proposed clearing represents 0.15% of the area that is in nearby secure reserves.

Impact: Known

2. *Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.*

The vegetation on site represents an isolated patch of a fragmented TEC, as a result of surrounding rural land uses. The site is not considered to be an important linkage across an already fragmented landscape

Impact: Unlikely

3. *Adversely affect habitat critical to the survival of an ecological community.*

The TEC on the site meets the key diagnostic characteristics and condition thresholds and therefore is considered to be critical habitat, however there are more than 2,000ha of larger, consolidated patches of the TEC that are better quality examples of the TEC within 12km that have a high level of protection.

Impact: Unlikely

4. *Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.*

Clearing on the site will be required to be undertaken in accordance with *Better Urban Water Management* guidelines (WAPC, 2008) and will require hydrological management procedures to be included as part of a Development Application such that any nearby water dependent ecosystems will not be impacted.

Impact: Unlikely

5. *Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.*

The area of TEC that could be directly impacted will not impact on the composition of any nearby areas of TEC. There will be no offsite impacts to areas of native vegetation such as dieback and changes to groundwater as these will be controlled by conditions of the Development Application to mitigate the risk.

Impact: Unlikely

6. *Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:*
 - *assisting invasive species, that are harmful to the listed ecological community, to become established, or*
 - *causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.*

The clearing of the site will not increase any artificial pollutants that may impact on surrounding areas or other occurrences of the TEC. Weed spread from the clearing of the site is not likely to impact on other occurrences as none occur adjacent to the site.

Impact: Unlikely

7. *Interfere with the recovery of an ecological community.*

Section 5 of the Approved Conservation Advice discusses priority research and conservation actions and states: *It is more practical and cost-effective to maintain existing high quality remnants than to allow their degradation and then attempt rehabilitation of these or other areas.* The site is not considered to contain a high quality remnant as it has been completely cleared in the past. Clearing would not interfere with the recovery of other areas of the TEC.

Impact: Unlikely

3.3 Black Cockatoos

3.3.1 Referral

The EPBC Act referral guidelines for three threatened Black Cockatoo species (SEWPaC, 2012) (Black Cockatoo Referral Guidelines) contain thresholds over which any impact is likely to have a high risk of a significant impact. The thresholds for roosting and breeding habitat do not apply to the site as these do not exist. The threshold for foraging habitat is the clearing of more than 1ha of quality habitat. While the Referral Guidelines do not define ‘quality’, the Banksia trees are considered prime foraging species on the Swan Coastal Plain for Carnaby’s and Baudin’s Black Cockatoos and are therefore rated as quality. The *Eucalyptus tottiana* and *Allocasuarina fraseriana* trees on the site are too few to be rated as quality foraging habitat for Forest Red-tailed Black Cockatoos.

The proposed Surf Park development would result in the clearing of 3.156ha of low to moderate quality Banksia woodland foraging habitat and on this basis, a Referral under the EPBC Act is recommended.

3.3.2 Black Cockatoo Species

Carnaby’s Black Cockatoo (*Calyptorhynchus latirostris*)

Carnaby’s Black Cockatoo is found in the south-west of Australia from Kalbarri through to Ravensthorpe. It has a preference for feeding on the seeds of *Banksia*, *Hakea*, *Eucalyptus*, *Grevillea*, *Pinus* and *Allocasuarina* spp. It is nomadic, often moving toward the coast after breeding. It breeds in tree hollows that are 2.5 – 12m above the ground and have an entrance of 23-30cm with a depth of 1-2.5m. Nesting mostly occurs in smooth-barked trees (e.g. Salmon Gum, Wandoo, Red Morrell). Eggs are laid from July to October, with incubation lasting 29 days (DoE, 2014).

The site is inside the boundary of the modelled distribution for Carnaby’s Black Cockatoos (SEWPaC, 2012). The site is shown as being within an unconfirmed breeding area but is not within a confirmed breeding area (National Map, 2022).

Baudin's Black Cockatoo (*Calyptorhynchus baudinii*)

Baudin's Black Cockatoo is most common in the far south-west of Western Australia. It is known to breed from the southern forests north to Collie and east to near Kojonup. Baudin's Black Cockatoo is typically found in vagrant flocks and utilises the taller, more open Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) woodlands where it feeds mainly on Marri seeds and various Proteaceous species (Johnstone, Johnstone and Kirkby, 2011).

The site is inside the modelled 'Known Foraging Area' distribution for Baudin's Black Cockatoos (SEWPaC, 2012).

Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)

Forest Red-tailed Black Cockatoos are endemic to the humid to sub-humid south-west of Western Australia (SEWPaC, 2012). The range of Forest Red-tailed Black Cockatoos is bound by Gingin in the north to Mt Helena, Christmas Tree Well, West Dale, North Bannister, Mt Saddleback, Kojonup, Rocky Gully, upper King River and Green Range (east of Albany) (SEWPaC, 2012; DoE, 2014). It nests in tree hollows with a depth of 1-5m, that are predominately Marri, Jarrah and Karri (*E. diversicolor*) and it feeds primarily on the seeds of Marri and Jarrah (Johnstone, Johnstone and Kirkby, 2011).

The site is inside the modelled distribution for Forest Red-tailed Black Cockatoos (SEWPaC, 2012).

3.3.3 Habitat Survey

PGV Environmental undertook a Black Cockatoo habitat assessment on 3 March and 7 October 2021 in accordance with the *EPBC Act referral guidelines for three threatened Black Cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris, Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii, Forest red-tailed Black Cockatoo (vulnerable) Calyptorhynchus banksii naso* (SEWPaC, 2012) (Black Cockatoo Referral Guidelines) and the methodology that is outlined in the SPRAT Database for each of the Black Cockatoo species for Black Cockatoo Habitat Assessments.

The survey area was traversed on foot and information on Black Cockatoo foraging, roosting and breeding habitat was assessed. The extent, type and quality of the vegetation present, including the presence and extent of plants known to be used by Black Cockatoos was investigated.

3.3.4 Habitat definitions

Foraging Habitat

'Foraging habitat' for Black Cockatoos is determined from the plant species that are present in the survey area and evidence of feeding such as direct observation of birds or by chewed nuts and cones. Foraging plants utilised by each species of Black Cockatoo varies, with Carnaby's Black Cockatoo foraging on Eucalypts, pines and proteaceous species, whereas Forest Red-tailed Cockatoos prefer Eucalypts and Allocasuarina and many exotic species and Baudin's prefer mostly seeds of marri and jarrah, also Allocasuarina cones (SEWPaC, 2012).

Foraging habitat was identified by comparing the literature on plant species known to be foraged upon by black cockatoos against the vegetation within the site.

Roosting Habitat

‘Roosting habitat’ is usually evident due to the presence of Black Cockatoos in the survey area in the evening and early morning and if there are scats or moulted feathers under the roosting area. Black Cockatoos utilise a wide range of native and non-native trees, situated within a variety of land-use types. Roosting habitat is generally in tall (average of > 25 m) tree species that have relatively thick trunks (average DBH of 1 m) and medium foliage density (average of 50 %), and that are not too densely forested amongst other trees (average tree crown connectivity of 20 %) (Le Roux, 2017). Black cockatoos rely upon the availability of suitable night roosting sites in proximity to foraging resources, and particularly on access to water, which are usually within 2 km of the roost (SEWPac, 2012).

Breeding Habitat

‘Breeding habitat’ is defined as trees of species known to support breeding within the range of the species which either have a suitable nest hollow OR have a DBH of 500mm or greater (SEWPac, 2012). Past studies have found that on average hollow openings are 25 cm x 27 cm (Saunders *et al.*, 1982, Saunders and Dawson, 2017) and 30 cm x 34 cm (Johnstone *et al.*, 2013). The height of a hollow entrance off the ground is on average 14.49 m (Johnstone *et al.*, 2013). Nearly all hollows that are used for nesting by Black Cockatoos are located in the main trunk and have a vertical aspect (Johnstone *et al.*, 2013, Saunders and Dawson, 2017). Black Cockatoos are large birds with shoulders that are about 100 mm wide, therefore they require hollows with an entrance bigger than this (as shown above they are typically much larger), but the internal dimensions (depth and floor base) need to be much larger in order for it to be suitable to lay eggs in and for adults to be able to move around.

Previous research has found for Carnaby’s Black Cockatoo a mean depth of 1.2 m and a floor diameter of 40 cm is required in order for it to be suitable to lay eggs in and for adults to be able to move around (Johnstone *et al.*, 2013, Saunders and Dawson 2017).

3.3.5 Foraging

The site contains four species that are recognised as foraging habitat for Black Cockatoos (Table 4). The site contains four species that are recognised as foraging habitat for Black Cockatoos (Davies 1966; Saunders 1980; Johnstone and Storr 1998; Johnstone and Kirkby 1999; Valentine and Stock, 2008; Groom 2011; Johnstone *et al.*, 2011; SEWPac, 2012; Johnstone, *et al.*, 2013; Johnstone *et al.*, 2016) as shown in Table 4. The total area of foraging habitat is 3.156ha.

Table 4: Foraging Species for Black Cockatoos

Species	Common Name	Carnaby’s Black Cockatoo	Baudin’s Black Cockatoo	Forest red-tailed Black Cockatoo
<i>Allocasuarina fraseriana</i>	Sheoak	None	Low	High
<i>Banksia attenuata</i>	Candlestick Banksia	High	High	None
<i>Banksia menziesii</i>	Firewood Banksia	High	High	None
<i>Eucalyptus tottiana</i>	Blackbutt	Moderate	Moderate	Moderate

The foraging habitat value was rated using the *Scoring system for the assessment of foraging value of vegetation for Black Cockatoos* (BCE, 2020) as Low to Moderate foraging value (as defined in the scoring system as *Woodland with tree banksias 5-10% projected foliage cover*), providing a site score

of 3. The site context score is 0 as the site is 0.035% of the surrounding habitat (as assessed in section 3.3.8) and the species density (stocking rate) is also 0 with no evidence of foraging on the site. The scoring system assigns a total score of 3 for the foraging habitat on the site.

3.3.6 Roosting

Black Cockatoos are known to roost overnight in tall trees including native and introduced eucalypts and pine trees generally in close proximity to a fresh water source. The site does not contain roosting habitat for Black Cockatoos and roosting has not been recorded on the site (DoP, 2011; Peck *et al.*, 2018; National Map, 2022). The nearest roosting sites are reported to be around 1.9km to the north-west, 1.8km to the south-west and 3.4km to the south-east (National Map, 2022).

3.3.7 Breeding

Black Cockatoos are known to breed in hollows of large eucalypts, including Jarrah, Tuart and Marri trees. The site is not known as a breeding site for Black Cockatoos (DoP, 2011; National Map, 2022).

The Black Cockatoo Referral Guidelines define trees of certain species with a DBH of 300 to 500mm or greater, dependent on the tree species, as breeding habitat regardless of the presence or not of hollows. The theory behind this definition is the concept that while the trees may not currently contain hollows, they are mature enough that in the next 50 years or so a hollow might form and be of use to Black Cockatoos for the purposes of breeding.

There are no trees on the site that meet the definition of breeding habitat or potential breeding habitat.

3.3.8 Regional Context

To assist in determining the significance of any impact on Black Cockatoo habitat on the site an assessment of Black Cockatoo habitat within the vicinity of the site was undertaken. There are at least 11 Bush Forever sites within 12km as shown in Table 5 and Figure 7. There is 9,105ha of habitat within 12km and 4,861ha (greater than 53%) of these are in Bush Forever. The proposed clearing represents 0.035% of the foraging habitat within 12km of the site.

Table 5: Surrounding Bush Forever Sites

Site Number	Reserve Name
125	Holmes Street Bushland, Southern River/Huntingdale
224	Canning River Regional Park and Adjacent Bushland, Riverton to Langford
244	North Lake and Bibra Lake, North Lake/Bibra Lake
245	Ken Hurst Park, Leeming
247	Manning Lake and Adjacent Bushland, Hamilton Hill/Spearwood
253	Harrisdale Swamp and Adjacent Bushland, Forrestdale
254	South Lake
256	Yangebup and Little Rush Lakes, Yangebup
262	Piarra Nature Reserve, Forrestdale
263	Banjup Bushland, Banjup
267	Mandogalup Road Bushland, Hope Valley
269	The Spectacles
270	Sandy Lake and Adjacent Bushland, Anketell
336	Wireless Hill Park, Ardross
337	Booragoon Lake, Booragoon

Site Number	Reserve Name
339	Piney Lake Reserve, Winthrop
342	Anstey/Keane Dampland and Adjacent Bushland, Forrestdale
344	Dennis De Young Reserve and Gibbs Road Swamp Bushland, Banjup/Forrestdale
345	Forrestdale Lake and Adjacent Bushland, Forrestdale
347	Wandi Nature Reserve and Anketell Road Bushland, Wandi/Oakford
348	Modong Nature Reserve and Adjacent Bushland, Oakford
388	Jandakot Airport, Jandakot
389	Acourt Road Bushland, Banjup
390	Fraser Road Bushland, Banjup
391	Thomsons Lake Nature Reserve and Adjacent Bushland, Beeliar
392	Harry Waring Marsupial Reserve, Wattleup
393	Wattleup Lake and Adjacent Bushland, Wattleup/Mandogalup
456	Nicholson Road Bushland, Langford/Thornlie
492	Lyon Road Bushland, Banjup

3.3.9 EPBC Act Significant Impact Guidelines 1.1

According to the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013), the significance of the impact on Black Cockatoos depends on the sensitivity, value and quality of the environment and the intensity, duration, magnitude and geographic extent of the impacts. The category of listing (for example; Endangered, Vulnerable or Migratory) determines the significant impact criteria for listed flora and fauna species and ecological communities.

This assessment assumes all of the foraging and potential breeding trees on the site would be cleared for the surf park. Using this assumption, the clearing would result in approximately 3.156ha of foraging habitat for Carnaby's Black Cockatoos, Forest Red-tailed Black Cockatoos and Baudin's Black Cockatoos.

The following assessments are for the Carnaby's Black Cockatoo and Baudin's Black Cockatoo which are listed as Endangered and the Forest Red-tailed Black Cockatoo which is listed as Vulnerable.

Carnaby's and Baudin's Black Cockatoos

The impact on Carnaby's Black Cockatoos and Baudin's Black Cockatoos from clearing the Black Cockatoo habitat on the site has been assessed against the criteria set out in the Significant Impact Guidelines 1.1 for the impact on an Endangered species and is shown below:

- *Lead to a long-term decrease in the size of a population*

There are no trees on the site to support breeding or roosting for Black Cockatoos. There are large areas (in excess of 9,000ha) within 12km consisting that contain large areas of foraging, roosting and potential breeding habitat. Therefore, clearing of the site will not result in this outcome.

- *Reduce the area of occupancy of the species*

Clearing of the site will not result in a reduction of any known breeding and roosting habitat. The clearing will result in a reduction of 3.156ha of Low to moderate value foraging habitat. Within 12km

of the site, however, there is more than 9,000ha of foraging habitat, of which more than 4,800ha is in formal reserves. Therefore clearing of the site will not result in this outcome.

- *Fragment an existing population into two or more populations*

Clearing of the site is unlikely to fragment the population of Carnaby's Black Cockatoos in the area into sub-populations due to the amount of habitat within 12 km of the site providing linkages between areas of Black Cockatoo habitat. Carnaby's Black Cockatoos and Baudin's Black Cockatoos can fly large distances between foraging areas. Clearing of the site will therefore not result in this outcome.

- *Adversely affect habitat critical to the survival of a species*

There is no breeding or roosting habitat for Carnaby's Black Cockatoos or Baudin's Black Cockatoos on the site. The 3.156ha of low to moderate value foraging habitat is not considered to be critical to the survival of the species due to the large amount of foraging and potential breeding habitat within 12km of the site. Clearing will result in a reduction in habitat by 0.035%, therefore clearing of the site would not result in this outcome.

- *Disrupt the breeding cycle of a population*

The site contained no breeding habitat or potential breeding habitat therefore clearing of the site would not result in this outcome.

- *Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

Clearing of the site will not result in this outcome due to the large extent of Black Cockatoo habitat reserved within 12km of the site and the reduction in foraging habitat is less than 0.035%.

- *Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*

Clearing of the site will not result in the establishment of an invasive species harmful to Carnaby's Black Cockatoos.

- *Introduce disease that may cause the species to decline*

Clearing of the site will not cause disease to be introduced therefore will not result in this outcome.

- *Interfere with the recovery of the species*

The Carnaby's Black Cockatoos that would utilise the site have access to greater than 9,000ha of habitat within 12km in reserves. Therefore, any clearing of habitat on the site would not interfere substantially with the recovery of the species.

The conclusion of this assessment in accordance with the criteria set out in the Significant Impact Guidelines 1.1 is that the proposed clearing will not have a significant impact on Carnaby's Black Cockatoos or Baudin's Black Cockatoos.

Forest Red-tailed Black Cockatoo

The impact on Forest Red-tailed Black Cockatoos from clearing the Black Cockatoo habitat on the site has been assessed against the criteria set out in the Significant Impact Guidelines 1.1 for the impact on a Vulnerable species and is shown below:

- *Lead to a long-term decrease in the size of an important population of a species*

In the Significant Impact Guidelines 1.1 an important population is defined as “a population that is necessary for a species’ long-term survival and recovery” and may be “key source populations either for breeding or dispersal, populations that are necessary for maintaining genetic diversity, and/or populations that are near the limit of the species’ range”.

There was no evidence of breeding occurring on the site and the surrounding area contains greater than 9,000ha that provides large areas of foraging and breeding habitat for Cockatoos that utilise the site. Development of the site would therefore not result in this outcome.

- *Reduce the area of occupancy of an important population*

There are no trees on the site for Forest Red-tailed Black Cockatoos to breed in or roost on. Clearing of the site will reduce the area of foraging available by 3.156ha of foraging habitat, however there is greater than 9,000ha of foraging habitat within 12km of the site in surrounding reserves therefore clearing of the site would not result in this outcome.

- *Fragment an existing important population into two or more populations*

The large area of reserves containing habitat within 12km of the site that provide foraging and potential breeding habitat. Forest Red-tailed Black Cockatoos can fly large distances between foraging areas. Therefore, clearing of the site would not result in this outcome.

- *Adversely affect habitat critical to the survival of a species*

There is no breeding habitat for Forest Red-tailed Black Cockatoos breed on the site and there are large areas of foraging habitat within 12km of the site, as formal reserves, therefore the site is not considered critical to the survival of these species.

- *Disrupt the breeding cycle of an important population*

There are no trees on the site for Forest Red-tailed Black Cockatoos to breed in. Therefore clearing of the site would not result in this outcome.

- *Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

The large areas of foraging and breeding habitat located in reserves within 12km of the site would prevent the population from declining as a result of clearing of the site.

- *Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*

Clearing the site will not result in invasive species being introduced, therefore would not result in this outcome.

- *Introduce disease that may cause the species to decline*

Clearing the site will not result in disease being introduced, therefore would not result in this outcome.

- *Interfere substantially with the recovery of the species*

The Forest Red-tailed Black Cockatoos that would utilise the site have access to an area greater than 9,000ha of Black Cockatoo habitat within 12km in reserves. Therefore, the clearing of 3.156ha of foraging habitat on the site would not interfere substantially with the recovery of these species.

In accordance with the criteria set out in the Significant Impact Guidelines 1.1 the conclusion of this assessment is that clearing the site would not have a significant impact on Forest Red-tailed Black Cockatoos.

4 CONCLUSIONS

The Vegetation Assessment of the proposed Cockburn Surf Park concludes the following:

- Native vegetation occurs on about 4.8ha of the site;
- Three native vegetation types were recorded, including Banksia Low Open Woodland and *Xanthorrhoea preissii* Shrubland on the dry, sandy parts of the site and *Melaleuca preissiana* Low Open Woodland on the low-lying northern part of the site;
- The condition of the vegetation ranged from Degraded-Good for the *Melaleuca preissiana* vegetation type to Good-Very Good for the Banksia woodland;
- The Banksia woodland and *Xanthorrhoea preissii* Shrubland vegetation types correspond to Floristic Community Type 23a 'Central *Banksia attenuata* – *Banksia menziesii* woodlands'. The *Melaleuca preissiana* vegetation type corresponds to FCT 4 '*Melaleuca preissiana* damplands';
- The two FCTs are not a Threatened or Priority Ecological Community at State or Commonwealth level. The Banksia woodland vegetation type was assessed as being part of the Banksia Woodlands of the Swan Coastal Plain TEC which is listed as Endangered under the EPBC Act. There is 3.156ha of Banksia Woodland TEC on the site;
- The *Melaleuca preissiana* vegetation type correlates well with a mapped wetland at the northern end of the site. The wetland is classified as a Multiple Use Dampland which extends off-site including on Lot 802 to the north. PGV Environmental considers the vegetation in the wetland is at the high end of the Multiple Use rating;
- Referral under the EPBC Act is recommended for the impact on 3.156ha of Banksia Woodland TEC;
- The impact on the Banksia Woodland TEC is not likely to be significant as the TEC is fragmented and degraded and there is more than 2,000 ha of the Banksia Woodland TEC within 12 km of the site with a level of protection through Bush Forever classification. The level of clearing equates to only 0.15% of the amount of Banksia woodland in secure reserves within 12km of the site;
- The Banksia woodland vegetation type contains foraging habitat for Carnaby's and Baudin's Black Cockatoos and limited foraging habitat for Forest Red-tailed Black Cockatoos. There is 3.156ha of low to moderate value foraging habitat on the site;
- The proposed development would result in the clearing of around 3.16ha of Black Cockatoo foraging habitat. Therefore, a Referral under the EPBC Act is recommended; and
- The impact to Black Cockatoos is not likely to be significant under the Significant Impact Guidelines due to the low to moderate value of the habitat and the regional context in which there is more than 9,000ha of Black Cockatoo Habitat.

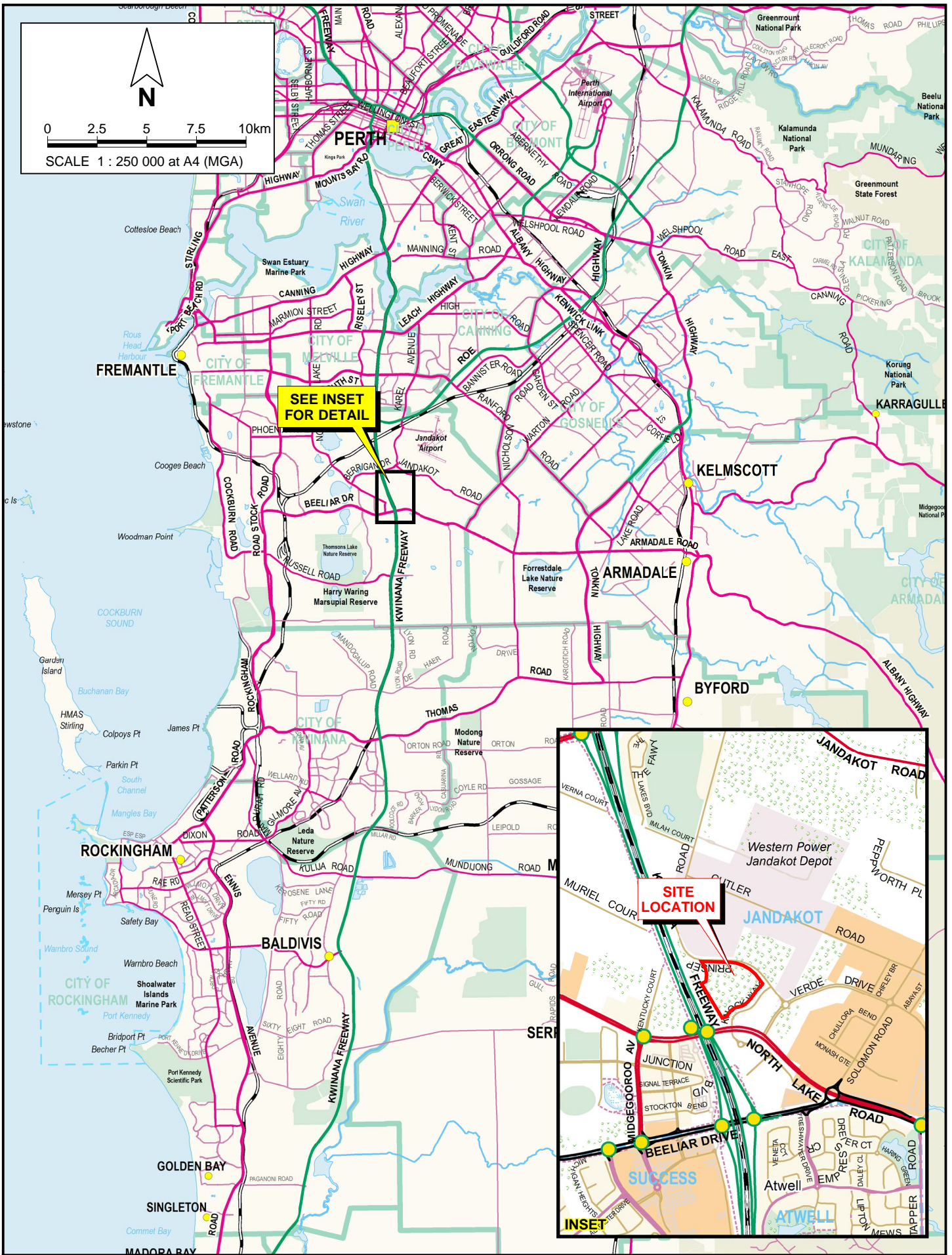
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FIGURES



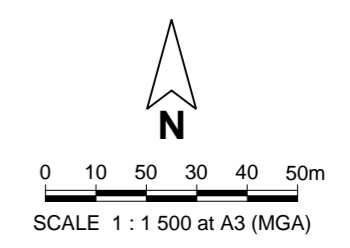
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Drawn: P. van der Moezel Job: 10219 Rpt: 2022-656	Date: 26 Jan 2023 Revision: A

Aventuur
VEGETATION ASSESSMENT
COCKBURN SURF PARK

SITE LOCATION

Figure 1



- Legend**
- - - Site Boundary
 - Cadastral Boundary
 - Topographic Contour

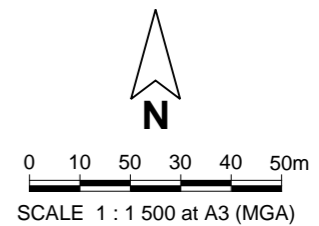
CONTOUR SOURCE: Dept. of Agriculture, 2000.
 CADASTRAL SOURCE: Landgate, February 2022.
 AERIAL PHOTOGRAPH SOURCE: NearMap, flown December 2021.

		Aventuur VEGETATION ASSESSMENT COCKBURN SURF PARK	
		Drawn: P. van der Moezel	Date: 26 Jan 2023
Job: 10219	Rpt: 2022-656	Revision: A	

SITE BOUNDARY AND TOPOGRAPHY

PINPOINT CARTOGRAPHICS (08) 9562 7136 2022-656-102.dgn

Figure 2



- Legend**
- - - Site Boundary
 - Cadastral Boundary
 - Quadrat Location
 - Vegetation Type Boundary
 - Mp Vegetation Type

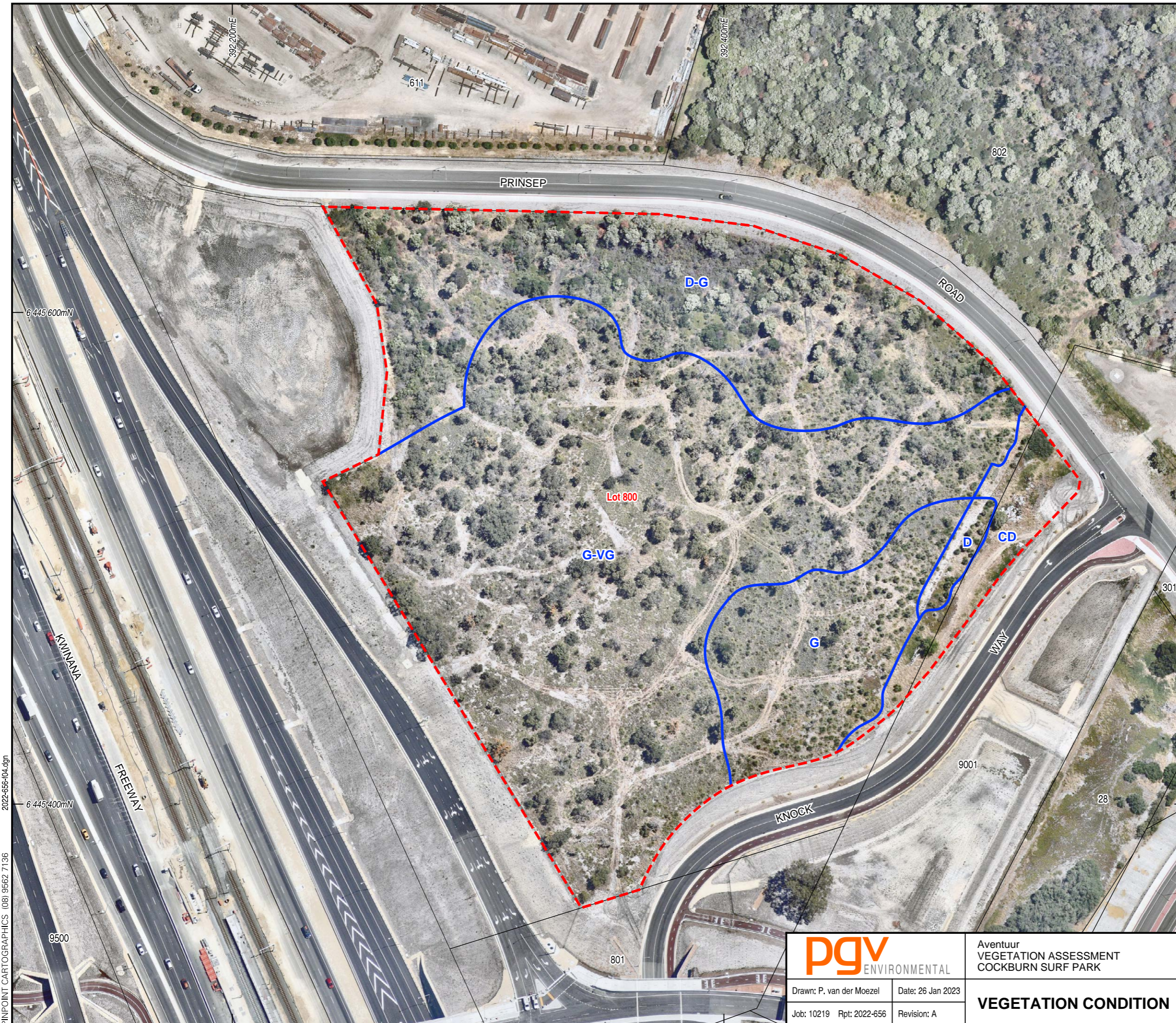
- Vegetation Types**
- BmBa**
Banksia menziesii/B. attenuata Low open Woodland over *Xanthorrhoea preissii* Open Shrubland over *Phlebocarya ciliata* Open Low Heath
- Xp**
Xanthorrhoea preissii Shrubland over *Phlebocarya ciliata* Closed Low Heath
- Mp**
Melaleuca preissiana Low Open Woodland over *Kunzea glabrescens* Tall Shrubland over *Astartea affinis/ Hypocalymma angustifolium* Open Low Heath

CADASTRAL SOURCE: Landgate, February 2022.
 AERIAL PHOTOGRAPH SOURCE: NearMap, flown December 2021.

		Aventura VEGETATION ASSESSMENT COCKBURN SURF PARK	
		VEGETATION TYPES	
Drawn: P. van der Moezel	Date: 26 Jan 2023		
Job: 10219 Rpt: 2022-656	Revision: A		

Figure 3

PINPOINT CARTOGRAPHICS (08) 9562 7136 2022-656-103.dgn



0 10 50 30 40 50m
SCALE 1 : 1 500 at A3 (MGA)

Legend

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

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

- P - Pristine**
Pristine or nearly so, no obvious signs of disturbance.
- Ex - Excellent**
Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species.
- VG - Very Good**
Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
- G - Good**
Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
- D - Degraded**
Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
- CD - Completely Degraded**
The structure of the vegetation is no longer intact and the areas is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.
- CI - Cleared**
No native vegetation remaining.

CADASTRAL SOURCE: Landgate, February 2022.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown December 2021.



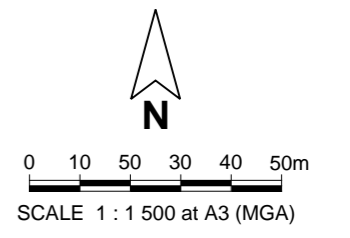
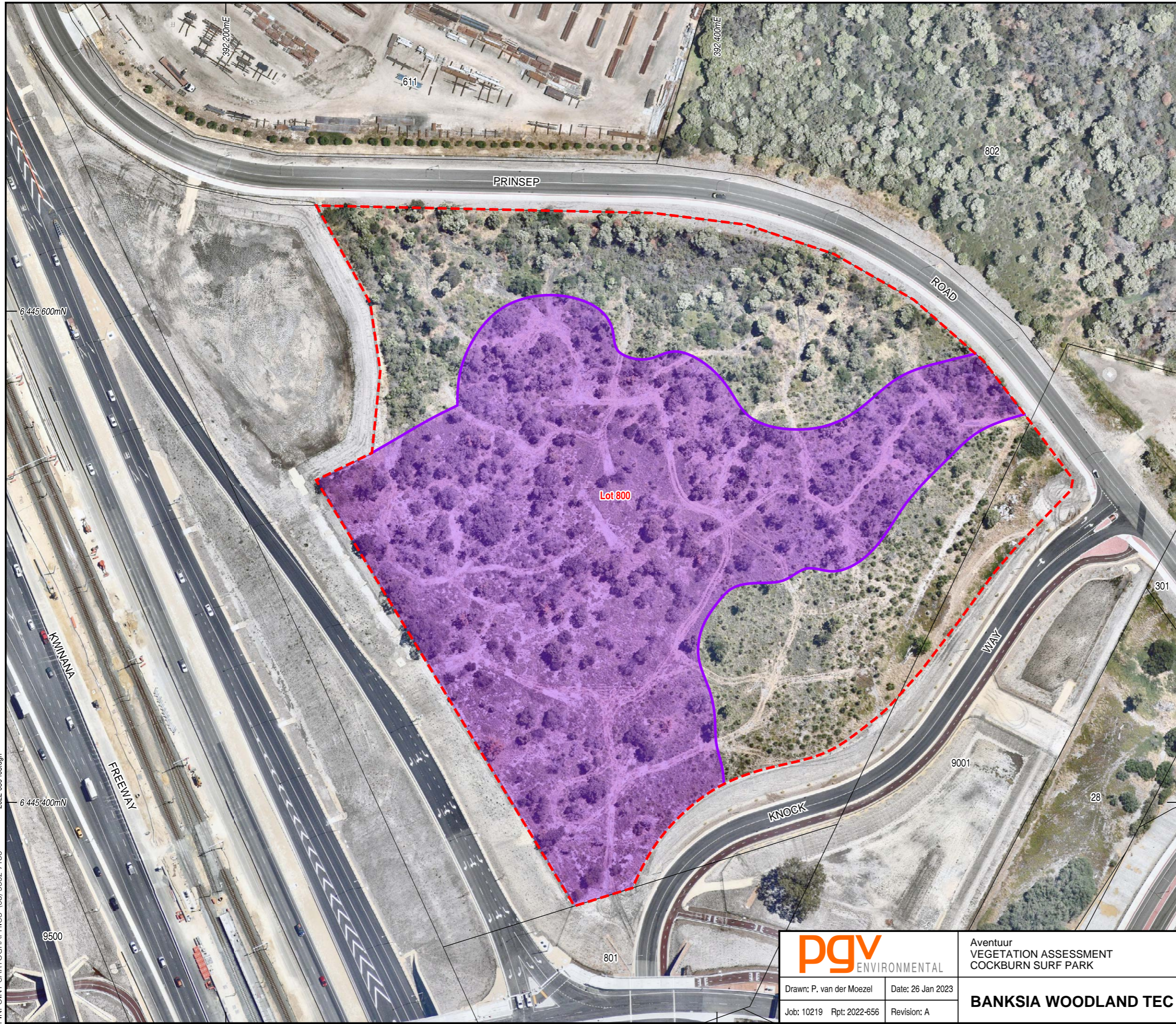
Aventuur
VEGETATION ASSESSMENT
COCKBURN SURF PARK

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Job: 10219 Rpt: 2022-656 Revision: A

VEGETATION CONDITION

Figure 4

PINPOINT CARTOGRAPHICS (08) 9562 7136 2022-656-104.dgn



- Legend**
- - - Site Boundary
 - Cadastral Boundary
 - Banksia Woodland TEC

CADASTRAL SOURCE: Landgate, February 2022.
 AERIAL PHOTOGRAPH SOURCE: NearMap, flown December 2021.

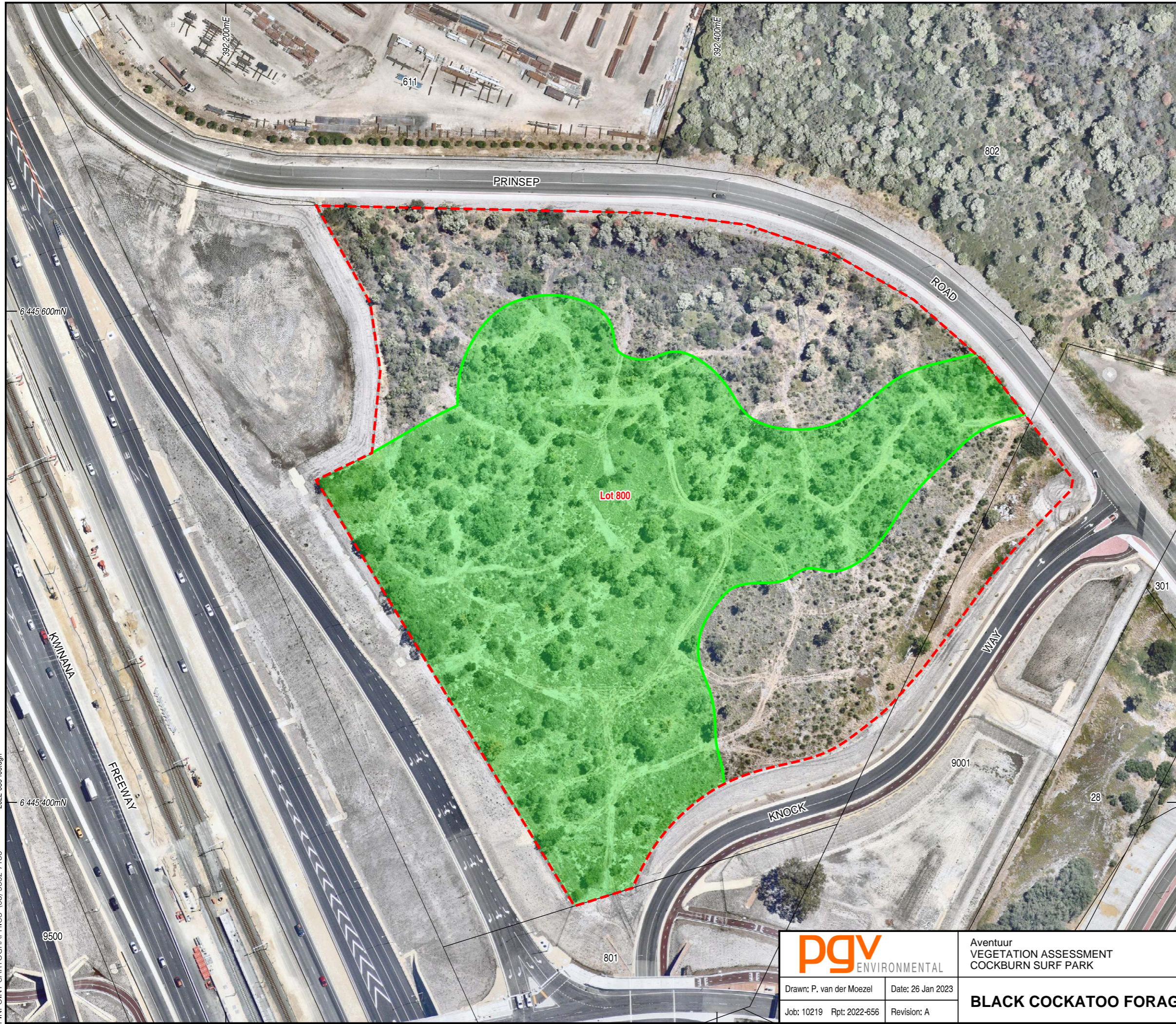
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Drawn: P. van der Moezel	Date: 26 Jan 2023
Job: 10219 Rpt: 2022-656	Revision: A

Aventuur
 VEGETATION ASSESSMENT
 COCKBURN SURF PARK

BANKSIA WOODLAND TEC

Figure 5



0 10 50 30 40 50m
 SCALE 1 : 1 500 at A3 (MGA)

- Legend**
- - - Site Boundary
 - Cadastral Boundary
 - Black Cockatoo Foraging Habitat

CADASTRAL SOURCE: Landgate, February 2022.
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		Aventura VEGETATION ASSESSMENT COCKBURN SURF PARK	
		BLACK COCKATOO FORAGING HABITAT	
Drawn: P. van der Moezel	Date: 26 Jan 2023		
Job: 10219 Rpt: 2022-656	Revision: A		

Figure 6

PINPOINT CARTOGRAPHICS (08) 9562 7136

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APPENDIX 1

**Cockburn Central East Local Structure
Plan (CCE LSP) Area, Targeted *Caladenia
huegelii* Survey (Focused Vision, 2017)**



**COCKBURN CENTRAL EAST LOCAL STRUCTURE PLAN (CCE LSP)
AREA, TARGETED CALADENIA HUEGELII SURVEY**

JANUARY 2018

CITY OF COCKBURN



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EXECUTIVE SUMMARY

Focused Vision Consulting Pty Ltd (FVC) was commissioned during September 2017 by the City of Cockburn (the City) to undertake a targeted *Caladenia huegelii* survey within the Cockburn Central East Local Structure Plan (CCE LSP) area (study area).

A targeted survey of the study area was conducted by FVC on 27 September 2017. Two experienced botanists, Kellie Bauer-Simpson and Gabriela Martinez with an experienced field assistant, Will Bauer-Simpson, systematically assessed the suitable habitat areas of the study area for *Caladenia huegelii*. The searches were conducted via a series of parallel transects in accordance with the Department of the Environment (2013) Guidelines for Detecting Orchids Listed as 'Threatened'.

The timing of the survey (September) was considered optimal to conduct a targeted flora survey for *Caladenia huegelii*, and other Spider Orchid species such as *Caladenia longicauda* were also observed in flower during the survey.

Although a detailed search was carried out, no *Caladenia huegelii* plants were recorded.

1 INTRODUCTION

1.1 BACKGROUND

Focused Vision Consulting (FVC) was commissioned during September 2017 by the City of Cockburn (the City) to undertake a targeted *Caladenia huegelii* survey within the Cockburn Central East Local Structure Plan (CCE LSP) area (study area). This work is following a spring flora, vegetation, fauna and habitat assessment completed by FVC during 2016. The results of that study identified that the site provides suitable habitat for the species, and therefore *Caladenia huegelii* may be present within the study area. The study area encompasses a number of Lots, totalling 31.21 ha as shown in **Figure 1**, much of which was included in the targeted search, depending on habitat suitability, also shown in **Figure 1**.

This report provides the results of the Targeted *Caladenia huegelii* survey undertaken within the study area during September 2017.

1.2 LOCATION

The study area is located approximately 20 km south of the Perth CBD, directly adjacent to the Kwinana Freeway on both the western and eastern sides. On the western side of the freeway, the area is bounded by Kentucky Court and North Lake Road. To the east of the freeway, the study area is comprised of numerous lots between Cutler Road and Knock Place, Cockburn Central (**Figure 1**).

1.3 SCOPE OF WORK

The scope included a targeted *Caladenia huegelii* survey. The tasks required to be carried out included:

- undertaking systematic traverses of the study area, within suitable habitat, to search for *Caladenia huegelii* plants, where (if) plants were observed, recording the:
 - GPS location of each individual *Caladenia huegelii* allowing an inventory of the number of plants/population size
 - vegetation type and condition at the recorded location
 - condition of plants/populations recorded
- the preparation of a report that summarises results and includes:
 - a discussion on the results, including identification and spatial mapping of all occurrences of *Caladenia huegelii* within the study area
 - identification of any potential environmental impacts and develop management recommendations for the protection of the Threatened flora species.

The survey was carried out in accordance with:

- Department of the Environment (2013) Guidelines for Detecting Orchids Listed as 'Threatened' under the *Environment and Biodiversity Conservation Act 1999* (EPBC Act).



0 50 100 150 200 m

GDA 94 / MGA Zone 50

**Figure 1 - Cockburn Central East
Local Structure Plan Project Area**



Legend

 Project Area



2 EXISTING ENVIRONMENT

2.1 CLIMATE

The Swan Coastal Plain has a warm Mediterranean climate which is characterised by hot dry summers and cool to mild wet winters (Mitchell *et al.* 2002). Jandakot Airport (009172) is the closest meteorological recording station to Cockburn Central and has recorded an average annual rainfall of 823.5 mm (BoM 2017).

2.2 IBRA REGION

There are 89 recognised Interim Biogeographic Regionalisation for Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (Commonwealth of Australia 2013). The study area lies within the Swan Coastal Plain IBRA region and, at a finer scale, within the Perth subregion (Mitchell *et al.* 2002).

2.3 GEOLOGY AND SOILS

The study area lies within the Bassendean Dune System which consists of very old leached sands to various depths (GHD 2015) and are the oldest of the three dunes systems occurring on the Swan Coastal Plain. Sands within this system contain very little silt or clay and very low levels of nutrient elements (ESWA 2016).

Soils within the study area are mapped as three sub units of the Bassendean System (Schoknecht *et al.* 2004). They are described as:

- 212Bs_B1 - Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands with pale yellow B horizon
- 212Bs_B2 – Flat to very gently undulating sandplain with well to moderate well drained deep bleached grey sands with a pale yellow B horizon or weak iron organic hardpan
- 212Bs_B4 – Broad poorly drained sandplain with deep grey siliceous sands or bleached sands, underlain at depth generally greater than 1.5 m by clay or less frequently a strong iron organic hardpan.

2.4 VEGETATION

The study area is located on the Swan Coastal Plain and has been broadly characterised by Beard (1990) as “e2Mb cbLi - Medium very sparse woodland; jarrah, with low woodland; Banksia and Casuarina (Association 1001)”.

Vegetation of the Perth subregion comprises heath and/or Tuart (*Eucalyptus gomphocephala*) woodlands on limestone, Jarrah (*Eucalyptus marginata*) and *Banksia* woodlands on Quaternary marine dunes and Marri (*Corymbia calophylla*) on colluvial and alluvial sands (Mitchell *et al.* 2002).

Vegetation complexes within the study area have been defined by Heddle *et al.* (1980) and are based on vegetation in association with landforms and underlying geology. One vegetation complex Bassendean complex – central and south as described by Heddle *et al.* (1980) occurs within the study area. This complex ranges from woodlands of *Eucalyptus marginata*, *Allocasuarina* and *Banksia* on sand dunes to a low woodland of *Melaleuca* species, and sedge lands on the low-lying depressions and swamps.

3 SPECIES PROFILE

3.1 CALADENIA HUEGELII

3.1.1 Conservation Significance

Caladenia huegelii was classified as Threatened (Declared Rare Flora – Extant) in November 1990 under the *Wildlife Conservation Act, 1950* (WC Act) and listed under Schedules 1 to 4 of the Wildlife Conservation (Rare Flora) Notice for Threatened Flora. It is a species of flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F (20) of the WC Act. *Caladenia huegelii* is also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The species is also ranked Critically Endangered (CR) under World Conservation Union (IUCN 2001) criterion B2ab (i, ii, iii, iv) due to the severe fragmentation of populations and the continuing decline in the extent of its occurrence, area of occupancy, quality of habitat and number of locations.

3.1.2 Ecology, Habitat and Distribution

Caladenia huegelii grows up to 60 cm tall with a single erect, pale green, hairy leaf and one or two (rarely three) predominantly pale greenish-cream flowers 7-10 cm across, with variable suffusions, lines and spots of red-maroon. Floral odour is absent. The sepals end in slender light brown to yellow clubs. The large labellum is prominently two coloured with a pale greenish-cream base and a uniformly dark maroon recurved apex. The leaf is densely hirsute to 4 mm long. Leaves are visible from May to November. Flowering occurs from September to October, with not all adult plants producing a flower each year. Some plants have been recorded not to produce a leaf each year and remain as a dormant tuberoid below ground (Hopper and Brown 2001).

Correct identification of *Caladenia huegelii* can only be carried out when it is in flower as a range of *Caladenia* species produce similar leaves (DEC 2009).

The preferred habitat of *Caladenia huegelii* is well drained, deep sandy soils in areas of mixed woodland of Jarrah (*Eucalyptus marginata*), Candlestick Banksia (*Banksia attenuata*), Holly Banksia (*Banksia ilicifolia*) and Firewood Banksia (*Banksia menziesii*) with scattered Sheoak (*Allocasuarina fraseriana*) and Marri (*Corymbia calophylla*) over dense Blueboy (*Stirlingia latifolia*), Swan River Myrtle (*Hypocalymma robustum*), Yellow buttercups (*Hibbertia hypericoides*), Buttercups (*Hibbertia subvaginata*), Balga (*Xanthorrhoea preissii*), coastal jugflower (*Adenanthos cuneatus*) and *Conostylis* species (DEC 2009).

Caladenia huegelii is found in the Jarrah Forest and Swan Coastal Plain Bioregions of Western Australia. A review of available information on populations held by the Department of Biodiversity Conservation and Attractions (DBCA) in 2017 indicated that 41 known records of the species are held at the Western Australian Herbarium (DBCA 2017).

4 METHODOLOGY

The areas of suitable habitat within the CCE LSP study area were determined based on previous vegetation mapping (FVC 2016). Suitable habitat was determined to encompass the two Banksia woodland units (BeEt and BaXp, as mapped by FVC (2016)) in better than degraded condition (Degraded to Good, or better). On a finer scale, some sections of the suitable habitat (Banksia woodland) were found to be either cleared since the 2016 spring survey, or not specifically suitable habitat for *Caladenia huegelii*, due to domination of dense stands of introduced Victorian Tea-tree (*Leptospermum laevigatum*). These areas were therefore not searched in detail (mostly impenetrable) and are presented in **Figure 2**.

A targeted flora survey of the suitable habitat areas within the, study area was carried out on 27 September 2017 during the optimal flowering period for *Caladenia huegelii*. The survey was conducted in accordance with the Department of the Environment (2013) Guidelines for Detecting Orchids Listed as 'Threatened'.

Two experienced FVC botanists, Kellie Bauer-Simpson and Gabriela Martinez and an experienced field assistant, Will Bauer-Simpson, systematically assessed the suitable habitat areas for the presence of *Caladenia huegelii* individuals. A series of parallel transects, spaced approximately 10 m apart were traversed for the search, to ensure all areas of suitable habitat was inspected. Where the habitat is in poorer condition, the spacing of traverses was made broader, as the occurrence of *Caladenia huegelii* was considered much less likely, since native understorey in these locations is greatly reduced, mostly due to weed domination.

Navigation of the sweeps were carried out using a combination of Garmin handheld Global Positioning System (GPS), tablets using the customized software program Mappt™ and magnetic compasses. The traverses made by field personnel for the searches are shown in **Figure 3**.

If individuals or suspected individuals of *Caladenia huegelii* flora were observed, the following data was to be recorded:

- GPS location of each individual plant allowing an inventory of the number of plants/population size
- vegetation type and condition at the recorded location
- condition of plants/populations recorded.



0 50 100 150 200 m

GDA 94 / MGA Zone 50

Figure 2 - Study Areas



Legend

- Project Area
- Mapped Banksia Woodland
- Cleared
- Unsuitable Habitat








0 50 100 150 200 m

GDA 94 / MGA Zone 50

Figure 3 - Search Traverses



Legend

-  Project Area
-  Search Traverses
-  Search Areas



5 RESULTS

No flowering *Caladenia huegelii* individuals were observed or recorded during the survey September 2017 survey conducted within areas of suitable habitat within the CCE LSP study area.

Two *Caladenia* were observed during the survey; *Caladenia flava* and *Caladenia longicauda*. These two species are very common in the south-west of Western Australia and are of no conservation significance.

6 DISCUSSION AND CONCLUSION

A targeted survey of the study area was conducted by FVC on 27 September 2017. Results from previous surveys conducted by FVC in 2016 identified two vegetation types within the study area, BeEt and BaXp, which provided suitable habitat for *Caladenia huegelii* and therefore were included in the targeted search as shown in **Figure 2**.

The timing of the survey (September) was considered optimal to conduct a targeted flora survey for *Caladenia huegelii* as other orchids such as the Spider Orchid species, *Caladenia longicauda* were also observed in flower during the survey.

Although a detailed survey was carried out within suitable habitat within the site, no *Caladenia huegelii* plants were observed or recorded.

7 REFERENCES

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APPENDIX 2

Quadrat Data

QUADRAT CC1

50 392347 E 6445466 N

Vegetation: *Banksia menziesii*/*B. attenuata* Low Open Woodland over
Phlebocarya ciliata/*Lyginia barbata* Open Low Heath and **Ehrharta calycina* Grassland

Condition: Good

Soil Type: Grey sand

Landform: Flat

Date: 3.12.21

Recorder: Paul van der Moezel



QUADRAT (10 x 10m)

SPECIES	HEIGHT (m)	COVER (%)
<i>Banksia menziesii</i>	4	5
<i>Banksia attenuata</i>	2	1
<i>Adenanthos cygnorum</i>	1.8	1
* <i>Ehrharta calycina</i>	1	30
* <i>Gladiolus caryophyllaceus</i>	0.7	<1
<i>Hibbertia hypericoides</i>	0.5	1
<i>Arnocrinum preissii</i>	0.5	<1
<i>Phlebocarya ciliata</i>	0.4	30
<i>Burchardia congesta</i>	0.4	<1
<i>Patersonia occidentalis</i>	0.4	<1
<i>Lechenaultia floribunda</i>	0.4	<1
<i>Bossiaea eriocarpa</i>	0.4	<1
<i>Lyginia barbata</i>	0.3	20
* <i>Briza maxima</i>	0.3	5
* <i>Ursinia anthemoides</i>	0.3	5
<i>Dasypogon bromeliifolius</i>	0.3	2
<i>Pultenaea</i> sp	0.3	<1

SPECIES	HEIGHT (m)	COVER (%)
<i>*Sonchus oleraceus</i>	0.3	<1
<i>Restio sp</i>	0.4	<1
<i>Dampiera linearis</i>	0.2	1
<i>Petrophile linearis</i>	0.2	<1
<i>*Carpobrotus edulis</i>	0.1	1
<i>Laxmannia squarrosa</i>	0.1	<1

* introduced species

QUADRAT CC2

50 392497 E 6445546 N

Vegetation: *Banksia menziesii*/*B. attenuata* Low Open Woodland over
Xanthorrhoea preissii Shrubland over *Dasypogon*
bromeliifolius/*Phlebocarya ciliata* Closed Low Heath

Condition: Very Good

Soil Type: Dark grey sand

Landform: Flat

Date: 3.12.21

Recorder: Paul van der Moezel



QUADRAT (10 x 10m)

SPECIES	HEIGHT (m)	COVER (%)
<i>Banksia menziesii</i>	6	10
<i>Banksia attenuata</i>	6	5
<i>Xanthorrhoea preissii</i>	2	25
* <i>Ehrharta calycina</i>	1	1
* <i>Avena fatua</i>	0.7	<1
* <i>Gladiolus caryophyllaceus</i>	0.7	<1
<i>Burchardia congesta</i>	0.5	<1
* <i>Bromus diandrus</i>	0.4	1
* <i>Sonchus oleraceus</i>	0.4	<1
<i>Phlebocarya ciliata</i>	0.3	70
<i>Dasypogon bromeliifolius</i>	0.3	25
<i>Lomandra hermaphrodita</i>	0.3	1
<i>Bossiaea eriocarpa</i>	0.3	<1
* <i>Briza maxima</i>	0.2	<1
* <i>Briza minor</i>	0.2	<1
* <i>Asparagus asparagoides</i>	Climber	2

* introduced species

QUADRAT CC3

50 392308 E 6445540 N

Vegetation: *Banksia menziesii*/*B. attenuata* Low Open Woodland over
Xanthorrhoea preissii Open Shrubland over *Phlebocarya ciliata* Open
Low Heath

Condition: Good

Soil Type: grey sand

Landform: Gentle Slope

Date: 3.12.21

Recorder: Paul van der Moezel



QUADRAT (10 x 10m)

SPECIES	HEIGHT (m)	COVER (%)
<i>Banksia menziesii</i>	6	20
<i>Banksia attenuata</i>	5	2
<i>Xanthorrhoea preissii</i>	1.4	4
<i>Macrozamia riedlei</i>	1.3	2
* <i>Ehrharta calycina</i>	1.2	20
<i>Anigozanthos manglesii</i>	0.8	1
* <i>Avena fatua</i>	0.6	<1
* <i>Gladiolus caryophyllaceus</i>	0.5	<1
<i>Gastrolobium capitatum</i>	0.5	<1
<i>Phlebocarya ciliata</i>	0.4	20
<i>Patersonia occidentalis</i>	0.4	1
<i>Dasypogon bromeliifolius</i>	0.4	1
* <i>Pelargonium capitatum</i>	0.4	1
<i>Gompholobium tomentosum</i>	0.4	<1
<i>Bossiaea eriocarpa</i>	0.4	<1
<i>Burchardia congesta</i>	0.4	<1

SPECIES	HEIGHT (m)	COVER (%)
<i>*Briza maxima</i>	0.3	2
<i>*Ursinia anthemoides</i>	0.3	1
<i>Scholtzia involucrata</i>	0.3	<1
<i>Hibbertia subvaginata</i>	0.3	<1
<i>Restio sp</i>	0.3	<1
<i>Lomandra hermaphrodita</i>	0.2	1
<i>Caustis dioica</i>	0.2	1
<i>Petrophile linearis</i>	0.2	<1
<i>*Carpobrotus edulis</i>	0.1	2
<i>Desmocladius flexuosus</i>	0.1	1
<i>Laxmannia squarrosa</i>	0.1	<1
<i>Conostylis aculeata</i>	0.1	<1
<i>*Romulea rosea</i>	0.1	<1

* introduced species

Appendix 8 Environmental Offset Strategy (PGV Environmental 2022c)

26 July 2022

Andrew Ross

Aventuur Australia Pty Ltd
ABN 24 643 061 250
PO Box 910
SOUTH FREMANTLE WA 6162

Dear Andrew,

RE: Cockburn Surf Park – Summary of Environmental Offset Options

Following is our assessment of a potential environmental offset package that would be suitable for the Cockburn Surf Park project.

1 Background

The Cockburn Surf Park site contains about 5.4ha of native vegetation. The Surf Park will clear most of the vegetation, however with an intention to retain as many mature trees as part of the landscape design where possible.

The vegetation at the lower northern end is Paperbark woodland in Degraded-Good condition. The Paperbark woodland (1.4ha) is mapped as a Multiple Use wetland which extends off-site including on Lot 802 to the north of Prinsep Road.

The vegetation in the southern upland areas is Banksia woodland and Grass Tree (*Xanthorrhoea preissii*) Shrubland in Good-Very Good condition. The Banksia woodland vegetation type has been assessed as being part of the Banksia Woodlands of the Swan Coastal Plain ecological community which is listed as a Threatened Ecological Community (TEC) under the Commonwealth EPBC Act and a Priority Ecological Community (PEC) at State level. Around 3.16ha of the Banksia Woodland TEC/PEC occurs on the site.

The Banksia woodland vegetation type contains foraging habitat for Carnaby's and Baudin's Black Cockatoos and limited foraging habitat for Forest Red-tailed Black Cockatoos. Around 3.16ha of foraging habitat occurs on the site.

A summary of the site characteristics is provided on the following table.

Feature	Significance	Area (ha)	Quality
<i>Banksia menziesii</i> / <i>B. attenuata</i> Low Open Woodland	Banksia Woodlands of the Swan Coastal Plain TEC and PEC	3.16ha	Good-Very Good ¹
<i>Xanthorrhoea preissii</i> Shrubland	Upland vegetation with no specific conservation significance	0.80ha	Good ¹
<i>Melaleuca preissiana</i> Low Open Woodland	Multiple Use Wetland	1.40ha	Degraded-Good ¹
<i>Banksia menziesii</i> / <i>B. attenuata</i> Low Open Woodland	Black Cockatoo Foraging Habitat, primarily Carnaby's and Baudin's Cockatoos	3.16ha	Low-Moderate ² Overall score - 3 ²

¹ – Keighery scale

² – Bamford Consulting Ecologists June 2020 *Scoring system for the assessment of foraging value of vegetation for Carnaby's Black-Cockatoo*

2 Offset Requirements

2.1 Commonwealth EPBC Act

The proposed development has been referred under the EPBC Act and deemed to be a Not a Controlled Action. As a result, no further assessment is required at Commonwealth level and no offsets are required.

2.2 State

2.2.1 EP Act assessment

The EPA Services section of DWER has indicated in discussions with the project team that a referral under Section 38 Part IV of the *Environmental Protection Act 1986* (EP Act) should be made and that a full assessment by the EPA may be required. If a full assessment is undertaken by the EPA, an offset package to manage any residual impacts on matters deemed significant by the EPA is highly likely to be required.

2.2.2 Clearing Permit

If the proposal is assessed under Part IV of the EP Act, then a clearing permit would not be required.

The EPA may decide that assessment under Part IV is not necessary and the proposed clearing could be assessed under the Part V clearing permit process. In that situation, Aventura will apply for a clearing permit that will contain an offset package to offset the impact on Banksia Woodland PEC and Black Cockatoos.

A clearing permit for the Paperbark vegetation should not require an offset. The clearing permit granted in 2019 for the construction of Prinsep Road, (CPS 8386/1) approved the clearing of 1.8ha of vegetation from the same wetland as occurs on the Surf Park site. No offset was required as a condition of that clearing permit. The vegetation in the road reserve was mapped as the same vegetation type and condition as the area on the Surf Park site in the survey undertaken by Focussed Vision (2018). PGV Environmental's understanding of the State Offset Calculator is that only wetlands

of conservation significance need to be offset. The wetland on the site is not mapped as Conservation Significant or has the values of a Conservation Significant wetland.

3 Offset Options

There are several different strategies that can be included in an offset package and include:

- Purchase of unreserved land containing the matters of significance that require offsetting and ceding the land free of cost to the Conservation Commission. The land should be suitable to be incorporated into the conservation estate. Uncleared rural land adjacent to existing conservation reserves or National Parks are favoured for this approach;
- Funding the management of existing conservation reserves to improve their overall condition. The conservation reserve needs to contain the matters that require offsetting, and the works need to demonstrate an improvement in the condition of the matters being offset. Importantly any funds proposed need to be additional to management costs being expended by a State agency or local government authority;
- Change the zoning of an area of bushland that contains the matters required to be offset from non-reserved to a conservation reservation of some sort;
- Apply a Conservation Covenant on a private area of bushland that contains the matters required to be offset; or
- A mix of the above four options.

It is possible to offset two or more matters with one site. For example a Banksia Woodland TEC also contains Black Cockatoo foraging habitat. You do not have to purchase or manage one site to offset the Banksia Woodland TEC and another site to offset the Black Cockatoos, one site would do. This is the case with the Cockburn Surf Park site.

The area of land that needs to be acquired and/or managed under the options above is determined using the DWER offset calculator.

4 Offset Calculator Results

The DWER offset calculator is a spreadsheet where some numbers are input by the operator and others are calculated by the spreadsheet algorithm. There is some subjectivity in several of the numbers that the operator needs to input, for example the 'confidence in result' boxes, 'time until ecological benefit' and 'quality of the area to be cleared' and 'quality of the offset site'. Apart from the quality of the area to be cleared and offset site, for the calculations that follow we have used numbers that have been accepted on other projects we have been involved with.

The quality of the area to be cleared is based on the description of the site and the quality of any offset sites to be purchased or managed is an initial assessment based on aerial photographs which can be backed up by on-site assessment. The objective in the calculator is to achieve at least a 100% offset.

The offset calculator spreadsheets for the various options are provided in Attachment 1. The results are as follows:

Banksia Woodland PEC

Using the DWER Offset Calculator, to achieve at least a 100% offset to clear 3.16ha of Banksia Woodland PEC will require the following:

- Purchase of an offset site, most likely in the Shire of Gingin close to the Moore River National Park – 18.3ha
- Regenerate a degraded portion of a nearby local conservation reserve. In discussions with the City of Cockburn, Aventura has identified an area of 1ha in the Rose Shanks Reserve that would benefit from regeneration. Rose Shanks Reserve is managed by the City and contains native vegetation as well as areas previously cleared for sand mining and other activities. Regenerating 1ha of the Reserve will achieve 22.5% of the offset. The regeneration would require the planting of appropriate locally endemic species as well as management of weeds and pest fauna to ensure that the regenerated areas match the environmental values of the remainder of the reserve. To achieve the full 100% offset target will require additional offset options including purchase of an offset site. The Offset Calculator indicates that the residual offset requirement after the regeneration of 1ha of Rose Shanks Reserve will require the purchase of a 14.2ha offset site.

Carnaby's Black Cockatoos

Using the DWER Offset Calculator, to achieve at least a 100% offset to clear 3.16ha of Black Cockatoo foraging habitat will require the following:

- Purchase an offset site. There are options to purchase sites with foraging habitat on the Swan Coastal Plain in the Shire of Gingin and in close proximity to the Moore River National Park – 8ha (assumes a high-quality site with an 8 out of 10 rating. A lower quality site would not usually be considered as suitable to be an offset which would be added to the conservation estate)
- Revegetating 1ha of Rose Shanks Reserve would achieve 47.3% of the offset. To achieve the full 100% offset will require the purchase of a further 14.2ha offset site.

A consideration in determining the offset value of revegetating Black Cockatoo foraging habitat is the offset calculator assumes that the density of Banksias to be planted is the same as the density to be cleared. The density of Banksia trees on the Surf Park site is very low. The 3.16 ha of Banksia woodland contains only 231 Banksia trees, as counted using the surveyor's (MNG) Feature Survey (29 Oct 2021). That gives a density of 73 trees/ha. In comparison the density of Banksia trees in a typical Banksia woodland on the Gngara Mound commonly ranges from 400-1400 stems/ha.

The revegetation in Rose Shanks Reserve would be undertaken to reflect a more typical Banksia Woodland, resulting in at least double the number of Banksias planted and therefore double the food resources for Carnaby's Black Cockatoo compared to the proposed clearing. The offset calculator does not have the functionality to give a result for a higher density of trees being planted in an offset revegetation site. However, if planting at the same density as the area being cleared gives a 47.3% offset for revegetating 1ha, planting at a density of 154 Banksias per hectare, should result in a 100% offset.

Planting at a higher density of Banksia trees, however, does not affect the Banksia Woodland PEC offset calculations as a Banksia woodland with 73 trees per hectare is considered the same as a Banksia woodland with a higher density of trees.

DWER – Black Cockatoo Foraging Habitat

Strategy	Proposed Clearing	Area to be Offset	Size of Offset Site	Ratio	% Offset achieved	Location of Proposed Offset	Cost
<ul style="list-style-type: none"> Purchase Offsite 	Black Cockatoo Forging Habitat	3.16ha	8ha	2.5	100.9%	Gingin Area	\$/ha tbd 10 years management \$100,000 @ \$5,000/yr
<ul style="list-style-type: none"> Regenerate 1ha Habitat and Purchase Offsite 	Black Cockatoo Forging Habitat	3.16ha	Regenerate 1ha Purchase 4.2ha		47.3% regenerate 53.0% purchase = 100.3%	Rose Shanks Reserve Gingin Area	\$50,000 @ \$50,000/ha + purchase price of 4.2ha and 10 yr mgt

DWER – Banksia Woodland PEC

Strategy	Proposed Clearing	Area to be Offset	Size of Offset Site	Ratio	% Offset achieved	Location of Proposed Offset	Cost
<ul style="list-style-type: none"> Purchase Offsite 	Banksia Woodland PEC	3.16ha	18.3ha	5.8	100%	Gingin Area	\$/ha tbd
<ul style="list-style-type: none"> Regenerate 1ha PEC and Purchase Offsite 	Banksia Woodland PEC	3.16ha	Regenerate 1ha and purchase 14.2ha		22.5% regenerate 77.6% purchase = 100.1%	Rose Shanks Reserve Gingin Area	\$60,000 @ \$60,000/ha + purchase price of 14.2ha and 10 yr mgt

5 Conclusions

The simplest offset option would be the purchase of an offset site that contains Banksia Woodland PEC and also functions as Carnaby's Black Cockatoo foraging habitat. According to the DWER Offset Calculator results the Banksia Woodland PEC requires more land to be purchased than Black Cockatoo habitat with 18.3ha required using the DWER calculator compared to the purchase of 8ha of Carnaby's Black Cockatoo habitat.

Revegetation of a degraded portion of the Rose Shanks Reserve near to the Surf Park site has merit in demonstrating replacement of foraging habitat and Banksia Woodland PEC in close proximity to the site. However, the cost of successful regeneration is far higher per hectare than the cost of purchasing an offset site. A mix of regeneration and purchase of an offset site would lower the cost of the offset package but may add more complexities with regards to compliance, with two separate components to manage potentially over different timeframes. Revegetation as part of the offset package should give credit should be applied to planting Banksia trees at a higher density than that cleared.

Please contact me if you require any clarification of this advice.

Yours sincerely



Paul van der Moezel
Managing Director

Attachment 1: Offset Calculator Spreadsheets

Offsets Calculator Spreadsheets

DWER – Black Cockatoo Foraging Habitat

Step 1: Determining conservation significance

Key:

- Data to be entered
- Drop-down selection
- Automatically-generated scores
(Or, if appropriate, manual data entry permitted)

Area / feature (Impact site)

Conservation significance determination for the environmental value impacted									
Conservation significance	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; padding: 5px;">Description</td> <td style="padding: 5px; background-color: yellow;">Carnaby's Black Cockatoo</td> </tr> <tr> <td style="padding: 5px;">Type of environmental value</td> <td style="padding: 5px; background-color: #f4a460;">Species (flora/fauna)</td> </tr> <tr> <td style="padding: 5px;">Conservation significance of environmental value</td> <td style="padding: 5px; background-color: #f4a460;">Rare/threatened species - endangered</td> </tr> <tr> <td style="padding: 5px;">Conservation significance score</td> <td style="padding: 5px; background-color: #cccccc;">1.2%</td> </tr> </table>	Description	Carnaby's Black Cockatoo	Type of environmental value	Species (flora/fauna)	Conservation significance of environmental value	Rare/threatened species - endangered	Conservation significance score	1.2%
Description	Carnaby's Black Cockatoo								
Type of environmental value	Species (flora/fauna)								
Conservation significance of environmental value	Rare/threatened species - endangered								
Conservation significance score	1.2%								

Please select <i>area</i> or <i>feature</i> for the calculations	Area
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Step 2: Calculating significant residual impact

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Carnaby's Black Cockatoo
---------------------------------	-----------------------------

Area (impact site)

Part A: Significant impact calculation <i>Area</i>		
	Description	Quantum of impact
Significant impact	Significant impact (hectares)	3.16
	Quality (scale)	3.00
	Total quantum of impact	0.95

Part B: Rehabilitation credit calculation <i>Area (onsite)</i>					
	Description	Proposed rehabilitation (area in hectares)	Time until ecological benefit (years)		
Rehabilitation Credit					
		Current quality of rehabilitation site (scale)		Confidence in rehabilitation result (%)	
		Future quality WITHOUT rehabilitation (scale)		Rehabilitation credit	0.00
		Future quality WITH rehabilitation (scale)			

Part C: Significant residual impact calculation <i>Area</i>		
	Description	Quantum of impact
Significant residual impact	Total quantum of impact	0.95
	Rehabilitation credit	0.00
	Significant residual impact	0.95

WA Environmental Offsets Calculator

Step 3: Calculating offsets

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Camaby's Black Cockatoo	Significant impact (step 2, part A)	3.16
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	0.95

Area (offset site)

Offset calculation Area							
Offsets calculation	Description	Proposed offset (area in hectares)	8.00	Duration of offset implementation (maximum 20 years)	20.00	Offset value	0.96
		Current quality of offset site (scale)	8.00	Time until offset site secured (years)	1.00		100.9%
		Future quality WITHOUT offset (scale)	7.00	Risk of future loss WITHOUT offset (%)	10.0%		
		Future quality WITH offset (scale)	8.00	Risk of future loss WITH offset (%)	5.0%		
		Time until ecological benefit (years)	1.00				
		Confidence in offset result (%)	90.0%				
						OFFSET ADEQUATE?	NO

Step 1: Determining conservation significance

Key:

- Data to be entered
- Drop-down selection
- Automatically-generated scores
(Or, if appropriate, manual data entry permitted)

Area / feature (Impact site)

Conservation significance determination for the environmental value impacted									
Conservation significance	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; padding: 5px;">Description</td> <td style="padding: 5px; background-color: yellow;">Carnaby's Black Cockatoo</td> </tr> <tr> <td style="padding: 5px;">Type of environmental value</td> <td style="padding: 5px; background-color: #f4a460;">Species (flora/fauna)</td> </tr> <tr> <td style="padding: 5px;">Conservation significance of environmental value</td> <td style="padding: 5px; background-color: #f4a460;">Rare/threatened species - endangered</td> </tr> <tr> <td style="padding: 5px;">Conservation significance score</td> <td style="padding: 5px; background-color: #cccccc;">1.2%</td> </tr> </table>	Description	Carnaby's Black Cockatoo	Type of environmental value	Species (flora/fauna)	Conservation significance of environmental value	Rare/threatened species - endangered	Conservation significance score	1.2%
Description	Carnaby's Black Cockatoo								
Type of environmental value	Species (flora/fauna)								
Conservation significance of environmental value	Rare/threatened species - endangered								
Conservation significance score	1.2%								

Please select <i>area</i> or <i>feature</i> for the calculations	Area
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Step 2: Calculating significant residual impact

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Carnaby's Black Cockatoo
---------------------------------	-----------------------------

Area (impact site)

Part A: Significant impact calculation Area				
Significant impact	Description	Quantum of impact		
	Banksia Woodland TEC	Significant impact (hectares)	3.16	
		Quality (scale)	3.00	
		Total quantum of impact		0.95

Part B: Rehabilitation credit calculation Area (onsite)					
Rehabilitation Credit	Description	Proposed rehabilitation (area in hectares)		Time until ecological benefit (years)	
		Current quality of rehabilitation site (scale)		Confidence in rehabilitation result (%)	
		Future quality WITHOUT rehabilitation (scale)		Rehabilitation credit	0.00
		Future quality WITH rehabilitation (scale)			

Part C: Significant residual impact calculation Area		
Significant residual impact	Total quantum of impact	0.95
	Rehabilitation credit	0.00
	Significant residual impact	0.95

Step 3: Calculating offsets

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Camaby's Black Cockatoo	Significant impact (step 2, part A)	3.16
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	0.95

Area (offset site)

Offset calculation Area							
Offsets calculation	Description	Proposed offset (area in hectares)	1.00	Duration of offset implementation (maximum 20 years)	10.00	Offset value	0.45
	Revegetate Rose Shanks Reserve	Current quality of offset site (scale)	1.00	Time until offset site secured (years)	1.00		47.3%
		Future quality WITHOUT offset (scale)	1.00	Risk of future loss WITHOUT offset (%)	10.0%		
		Future quality WITH offset (scale)	7.00	Risk of future loss WITH offset (%)	5.0%		
	Time until ecological benefit (years)	10.00					
	Confidence in offset result (%)	90.0%				OFFSET ADEQUATE?	NO

Step 1: Determining conservation significance

Key:

- Data to be entered
- Drop-down selection
- Automatically-generated scores
(Or, if appropriate, manual data entry permitted)

Area / feature (Impact site)

Conservation significance determination for the environmental value impacted									
Conservation significance	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; padding: 5px;">Description</td> <td style="padding: 5px; background-color: yellow;">Carnaby's Black Cockatoo</td> </tr> <tr> <td style="padding: 5px;">Type of environmental value</td> <td style="padding: 5px; background-color: #f4a460;">Species (flora/fauna)</td> </tr> <tr> <td style="padding: 5px;">Conservation significance of environmental value</td> <td style="padding: 5px; background-color: #f4a460;">Rare/threatened species - endangered</td> </tr> <tr> <td style="padding: 5px;">Conservation significance score</td> <td style="padding: 5px; background-color: #cccccc;">1.2%</td> </tr> </table>	Description	Carnaby's Black Cockatoo	Type of environmental value	Species (flora/fauna)	Conservation significance of environmental value	Rare/threatened species - endangered	Conservation significance score	1.2%
Description	Carnaby's Black Cockatoo								
Type of environmental value	Species (flora/fauna)								
Conservation significance of environmental value	Rare/threatened species - endangered								
Conservation significance score	1.2%								

Please select <i>area</i> or <i>feature</i> for the calculations	Area
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Step 2: Calculating significant residual impact

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Carnaby's Black Cockatoo
---------------------------------	-----------------------------

Area (impact site)

Part A: Significant impact calculation Area		
	Description	Quantum of impact
Significant impact	Significant impact (hectares)	3.16
	Quality (scale)	3.00
	Total quantum of impact	0.95

Part B: Rehabilitation credit calculation Area (onsite)				
	Description	Proposed rehabilitation (area in hectares)	Time until ecological benefit (years)	
Rehabilitation Credit				
		Current quality of rehabilitation site (scale)		Confidence in rehabilitation result (%)
		Future quality WITHOUT rehabilitation (scale)		Rehabilitation credit
		Future quality WITH rehabilitation (scale)		0.00

Part C: Significant residual impact calculation Area		
	Description	Quantum of impact
Significant residual impact	Total quantum of impact	0.95
	Rehabilitation credit	0.00
	Significant residual impact	0.95

WA Environmental Offsets Calculator

Step 3: Calculating offsets

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Camaby's Black Cockatoo	Significant impact (step 2, part A)	3.16
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	0.95

Area (offset site)

Offset calculation Area							
Offsets calculation	Description	Proposed offset (area in hectares)	4.20	Duration of offset implementation (maximum 20 years)	20.00	Offset value	0.50
		Current quality of offset site (scale)	8.00	Time until offset site secured (years)	1.00		53.0%
		Future quality WITHOUT offset (scale)	7.00	Risk of future loss WITHOUT offset (%)	10.0%		
		Future quality WITH offset (scale)	8.00	Risk of future loss WITH offset (%)	5.0%		
		Time until ecological benefit (years)	1.00				
		Confidence in offset result (%)	90.0%				
						OFFSET ADEQUATE?	NO

Offsets Calculator Spreadsheets

DWER – Banksia Woodland PEC

Step 1: Determining conservation significance

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores (Or, if appropriate, manual data entry permitted)

Area / feature (Impact site)

Conservation significance determination for the environmental value impacted									
Conservation significance	<table border="1"> <tr> <td>Description</td> <td style="background-color: yellow;">Banksia Woodland PEC</td> </tr> <tr> <td>Type of environmental value</td> <td style="background-color: #f4a460;">Ecological community</td> </tr> <tr> <td>Conservation significance of environmental value</td> <td style="background-color: #f4a460;">Priority ecological community</td> </tr> <tr> <td>Conservation significance score</td> <td style="background-color: #cccccc;">0.1%</td> </tr> </table>	Description	Banksia Woodland PEC	Type of environmental value	Ecological community	Conservation significance of environmental value	Priority ecological community	Conservation significance score	0.1%
Description	Banksia Woodland PEC								
Type of environmental value	Ecological community								
Conservation significance of environmental value	Priority ecological community								
Conservation significance score	0.1%								

Please select area or feature for the calculations	Area
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Step 2: Calculating significant residual impact

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Banksia Woodland PEC
---------------------------------	----------------------

Area (impact site)

Part A: Significant impact calculation Area		
	Description	Quantum of impact
Significant impact	Significant impact (hectares)	3.16
	Quality (scale)	7.00
	Total quantum of impact	2.21

Part B: Rehabilitation credit calculation Area (onsite)				
	Description	Proposed rehabilitation (area in hectares)	Time until ecological benefit (years)	
Rehabilitation Credit				
		Current quality of rehabilitation site (scale)		Confidence in rehabilitation result (%)
		Future quality WITHOUT rehabilitation (scale)		Rehabilitation credit
		Future quality WITH rehabilitation (scale)		0.00

Part C: Significant residual impact calculation Area		
	Description	Quantum of impact
Significant residual impact	Total quantum of impact	2.21
	Rehabilitation credit	0.00
	Significant residual impact	2.21

Step 3: Calculating offsets

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Banksia Woodland PEC	Significant impact (step 2, part A)	3.16
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	2.21

Area (offset site)

Offset calculation Area							
Offsets calculation	Description	Proposed offset (area in hectares)	18.30	Duration of offset implementation (maximum 20 years)	20.00	Offset value	2.21
		Current quality of offset site (scale)	8.00	Time until offset site secured (years)	1.00		100.0%
		Future quality WITHOUT offset (scale)	7.00	Risk of future loss WITHOUT offset (%)	10.0%		
		Future quality WITH offset (scale)	8.00	Risk of future loss WITH offset (%)	5.0%		
		Time until ecological benefit (years)	1.00				
		Confidence in offset result (%)	90.0%				
						OFFSET ADEQUATE?	YES

Step 1: Determining conservation significance

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores (Or, if appropriate, manual data entry permitted)

Area / feature (Impact site)

Conservation significance determination for the environmental value impacted									
Conservation significance	<table border="1"> <tr> <td style="background-color: #cccccc;">Description</td> <td style="background-color: yellow;">Banksia Woodland PEC</td> </tr> <tr> <td style="background-color: #cccccc;">Type of environmental value</td> <td style="background-color: #f4a460;">Ecological community</td> </tr> <tr> <td style="background-color: #cccccc;">Conservation significance of environmental value</td> <td style="background-color: #f4a460;">Priority ecological community</td> </tr> <tr> <td style="background-color: #cccccc;">Conservation significance score</td> <td style="background-color: #cccccc;">0.1%</td> </tr> </table>	Description	Banksia Woodland PEC	Type of environmental value	Ecological community	Conservation significance of environmental value	Priority ecological community	Conservation significance score	0.1%
Description	Banksia Woodland PEC								
Type of environmental value	Ecological community								
Conservation significance of environmental value	Priority ecological community								
Conservation significance score	0.1%								

Please select area or feature for the calculations	Area
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Step 2: Calculating significant residual impact

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Banksia Woodland PEC
------------------------------	----------------------

Area (impact site)

Part A: Significant impact calculation Area			
Significant impact	Description	Quantum of impact	
	Banksia Woodland TEC	Significant impact (hectares)	3.16
		Quality (scale)	7.00
		Total quantum of impact	2.21

Part B: Rehabilitation credit calculation Area (onsite)					
Rehabilitation Credit	Description	Proposed rehabilitation (area in hectares)	Time until ecological benefit (years)		
		Current quality of rehabilitation site (scale)		Confidence in rehabilitation result (%)	
		Future quality WITHOUT rehabilitation (scale)		Rehabilitation credit	0.00
		Future quality WITH rehabilitation (scale)			

Part C: Significant residual impact calculation Area		
Significant residual impact	Total quantum of impact	2.21
	Rehabilitation credit	0.00
	Significant residual impact	2.21

Step 3: Calculating offsets

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Banksia Woodland PEC	Significant impact (step 2, part A)	3.16
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	2.21

Area (offset site)

Offset calculation Area							
Offsets calculation	Description	Proposed offset (area in hectares)	1.00	Duration of offset implementation (maximum 20 years)	10.00	Offset value	0.50
	Revegetate Rose Shanks Reserve	Current quality of offset site (scale)	1.00	Time until offset site secured (years)	1.00		22.5%
		Future quality WITHOUT offset (scale)	1.00	Risk of future loss WITHOUT offset (%)	10.0%		
		Future quality WITH offset (scale)	7.00	Risk of future loss WITH offset (%)	5.0%		
	Time until ecological benefit (years)	10.00					
	Confidence in offset result (%)	90.0%	<table border="1" style="display: inline-table;"> <tr> <td style="background-color: #d9d9d9;">OFFSET ADEQUATE?</td> <td style="background-color: #d9d9d9;">NO</td> </tr> </table>				OFFSET ADEQUATE?
OFFSET ADEQUATE?	NO						

Step 1: Determining conservation significance

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores (Or, if appropriate, manual data entry permitted)

Area / feature (Impact site)

Conservation significance determination for the environmental value impacted									
Conservation significance	<table border="1"> <tr> <td>Description</td> <td style="background-color: yellow;">Banksia Woodland PEC</td> </tr> <tr> <td>Type of environmental value</td> <td style="background-color: #f4a460;">Ecological community</td> </tr> <tr> <td>Conservation significance of environmental value</td> <td style="background-color: #f4a460;">Priority ecological community</td> </tr> <tr> <td>Conservation significance score</td> <td style="background-color: #cccccc;">0.1%</td> </tr> </table>	Description	Banksia Woodland PEC	Type of environmental value	Ecological community	Conservation significance of environmental value	Priority ecological community	Conservation significance score	0.1%
Description	Banksia Woodland PEC								
Type of environmental value	Ecological community								
Conservation significance of environmental value	Priority ecological community								
Conservation significance score	0.1%								

Please select area or feature for the calculations	Area
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Step 2: Calculating significant residual impact

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Banksia Woodland PEC
---------------------------------	----------------------

Area (impact site)

Part A: Significant impact calculation Area				
Significant impact	Description	Quantum of impact		
		Significant impact (hectares)	3.16	
		Quality (scale)	7.00	
		Total quantum of impact	2.21	

Part B: Rehabilitation credit calculation Area (onsite)					
Rehabilitation Credit	Description	Proposed rehabilitation (area in hectares)	Time until ecological benefit (years)		
		Current quality of rehabilitation site (scale)		Confidence in rehabilitation result (%)	
		Future quality WITHOUT rehabilitation (scale)		Rehabilitation credit	0.00
		Future quality WITH rehabilitation (scale)			

Part C: Significant residual impact calculation Area		
Significant residual impact	Total quantum of impact	2.21
	Rehabilitation credit	0.00
	Significant residual impact	2.21

Step 3: Calculating offsets

Key:

	Data to be entered
	Drop-down selection
	Automatically-generated scores

Environmental value (step 1)	Banksia Woodland PEC	Significant impact (step 2, part A)	3.16
		Rehabilitation credit (step 2, part B)	0.00
		Significant residual impact (step 2, part C)	2.21

Area (offset site)

Offset calculation Area							
Offsets calculation	Description	Proposed offset (area in hectares)	14.20	Duration of offset implementation (maximum 20 years)	20.00	Offset value	1.72
		Current quality of offset site (scale)	8.00	Time until offset site secured (years)	1.00		77.6%
		Future quality WITHOUT offset (scale)	7.00	Risk of future loss WITHOUT offset (%)	10.0%		
		Future quality WITH offset (scale)	8.00	Risk of future loss WITH offset (%)	5.0%		
		Time until ecological benefit (years)	1.00				
		Confidence in offset result (%)	90.0%				
						OFFSET ADEQUATE?	NO