Metropolitan Road Improvement Alliance

Detailed Flora and Vegetation Assessment

Armadale Road to North Lake Road Bridge Project

Doc Number: W81020-REP-EN-0801

Document Approval

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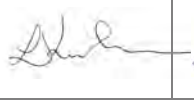
Signature:						

REVISION RECORDING

Rev	Date	By	Description of Revision	Approved
A	10/12/2017	F. de Wit	Internal Review	
B	12/12/2017	F. de Wit	Draft Submission to Client	
C	27/03/2018	F. de Wit	Draft Submission to Client	
0	5/04/2018	F. de Wit	Final for Issue	

1 EXECUTIVE SUMMARY

Main Roads Western Australia required a detailed flora and vegetation assessment for the Armadale Road to North Lake Road Bridge Project. The detailed flora and vegetation assessment included a desktop assessment, informed by updated government database searches and relevant biological surveys undertaken within and in the vicinity of the survey area. A field survey was undertaken in June, 2017 (Survey 1) at which time seven permanent quadrats were established and floristic data collected from these and one relevé. Only native vegetation in Good or better condition was represented by quadrat data. Survey 2 was undertaken in September, 2017 at which time all quadrats and some relevés were visited and all flora species were recorded.

Targeted surveys for *Drakaea elastica* and *Caladenia huegelii* were undertaken during their respective ideal survey season. No Threatened orchids or other species were recorded in the survey area.

Quadrat flora data was analysed using PC Ord and included cluster analysis of Project quadrats, and Bray Curtis similarity indices for the Floristic Community Type assessment. A sub-set of the Keighery *et al.* (2012) Swan Coastal Plain dataset was used to determine the representative FCTs within the survey area as described in Gibson *et al.* (1994) and Bush Forever (Government of WA, 2000). The FCT analysis inferred the presence of two Floristic Community Types (FCTs) including FCT23a Central *B. attenuata-B. menziesii* Woodlands and FCT4 *M. preissiana* damplands.

Quadrat data and FCT analysis results informed the Banksia Woodlands of the SCP TEC assessment. The Banksia Woodlands TEC was identified and mapped at one location including 5.87 ha Banksia Woodland near Cockburn Central. This patch also represents a Priority 3 Banksia community listed by DBCA.

Six native vegetation types were mapped including three Banksia Woodlands, one Marri Woodland, and two Wetlands. All vegetation types have been impacted from weed invasion and urban development.

Three Declared Pest species were recorded, including Arum Lily (**Zantedeschia aethiopica*), Bridal Creeper (**Asparagus asparagoides*) and Opuntioid Cactus (**Opuntia stricta*). These were largely restricted to degraded cleared land and the Wetland vegetation type.

Rainfall in 2017 has varied slightly from mean anticipated monthly rainfall. The impact of the changing rainfall patterns on flora species remains unclear, however it could have led to a reduction in annual species, in particular herbs. This is not considered to have significantly impacted on survey results.

INTRODUCTION

1.1 Background

Main Roads Western Australia are proposing to construct a flyover bridge over Kwinana Freeway connecting Armadale Road to North Lake Road. A four lane dual carriageway with grade separated duck 'n' dive intersections and elevated roundabouts will also be constructed at the intersections of: Armadale Road, Tapper Road, and Verde Drive; and Armadale Road and Solomon Road.

There will be modifications to the existing intersection at Midgegooroo Avenue and North Lake Road and at grade left in/left out intersections at Verde Drive east end, Public Transport Authority (PTA) parking, Knock Place and Lot 1 on Armadale Road. A two lane collector distributor (CD) road will be installed southbound from Berrigan Drive to Armadale Road. This upgrade will provide a direct link between Armadale and North Lake Road, improve access to the Kwinana Freeway and Cockburn Central Station, support residential and commercial expansion in the area and complement other significant road improvements.

A detailed flora and vegetation assessment is required to identify and map environmental values within a defined survey area that encompasses the Project and surrounding native vegetation. The assessment will be used to inform approval documentation.

1.2 Location

The Project survey area is located in the City of Cockburn approximately 16-22 km south of Perth city centre in Western Australia. The Project extends from Armadale Road at Tapper Road to North Lake Road and includes the southbound collector distributor (CD) roads from Berrigan Drive to approximately 1.6 km south of Armadale Road and includes a patch of native vegetation northeast of Armadale Road and Kwinana Freeway Corner (near Cockburn Train Station). The survey area is shown in Figure 1.

1.3 Objectives

The objective of the detailed flora and vegetation assessment was to determine the environmental value of native vegetation present in the survey area. The specific objectives of the flora and vegetation assessment were to:

- complete a desktop assessment
- undertake a field survey incorporating two 'scoring events' and targeted Threatened flora searches
- assess significance of vegetation by inferring the Floristic Community Type
- map vegetation units and condition

This report presents a description of the flora and vegetation values of the survey area including existing environment, methods, field survey and data analysis results, figures and supporting detailed appendices.

PROJECT ID 60539165
CREATED BY RNM
APPROVED BY FdeWit
LAST MODIFIED 03 APR 2018

Metropolitan Road Improvement Alliance

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DATUM GDA 1994, PROJECTION PERTH COASTAL GRID 1994

0 200 400 600 800
metres

1:23,000 when printed at A4

LEGEND

Survey Area

Data sources: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Survey Area

ARMADALE ROAD TO NORTH LAKE ROAD BRIDGE

MAIN ROADS WESTERN AUSTRALIA

Figure

1

Map Document: \\auper1gis01\geo\Client_Data\MRIA\08_Armadale Road Extension\02_MXDs\04_Survey_Flora\Fig1_SurveyArea_V1_A4P.mxd (fotheringhamd)

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2 LEGISLATIVE FRAMEWORK

2.1 EPBC Act

2.1.1 Matters of National Environmental Significance

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the main piece of Federal legislation protecting biodiversity in Australia. All Matters of National Environmental Significance (MNES) are listed under the EPBC Act. These include:

- listed threatened species and ecological communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- world Heritage properties
- national Heritage places
- Great Barrier Reef Marine Park
- a water resource, in relation to coal seam gas development and large coal mining development
- nuclear actions.

If an action is likely to have a significant impact on a MNES this action must be referred to the Minister for the Environment for a decision on whether assessment and approval is required under the EPBC Act.

2.1.2 Flora and fauna

Species at risk of extinction are recognised at a Commonwealth level and are categorised in one of six categories as outlined in Table 1.

Table 1 Categories of Species Listed under Schedule 179 of the EPBC Act (Commonwealth)

Conservation	Code Category
Ex	Extinct Taxa
ExW	Extinct in the Wild
CE	Critically Endangered
E	Endangered
V	Vulnerable
CD	Conservation Dependent
OS	Other specially protected fauna

2.1.3 Vegetation Communities

Communities can be classified as Threatened Ecological Communities (TECs) under the EPBC Act. The EPBC Act protects Australia's ecological communities by providing for:

- identification and listing of ecological communities as threatened
- development of conservation advice and recovery plans for listed ecological communities
- recognition of key threatening processes
- reduction of the impact of these processes through threat abatement plans.

Categories of federally listed TECs are described in Table 2.

Table 2 Categories of TECs that are listed under the EPBC Act

Conservation Code	Category
CE	Critically Endangered If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
E	Endangered If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
V	Vulnerable If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

2.2 Western Australian legislation

2.2.1 Flora and fauna

Threatened flora are plants which have been assessed as being at risk of extinction (DEC 2012). Under the *Wildlife Conservation Act* 1950 (WC Act), the Minister for the Environment may declare species of flora to be protected if they are considered to be in danger of extinction, rare or otherwise in need of special protection (WAH 1998-).

Plants and animals that are considered Threatened and need to be specially protected because they are under identifiable threat of extinction are listed under the WC Act. These categories are defined in Table 3.

Table 3 Conservation codes for WA flora and fauna listed under the Wildlife Conservation Act 1950 updated November 2015

Code	Category
CR	Critically endangered species / Schedule 1
EN	Endangered species / Schedule 2
VU	Vulnerable species / Schedule 3
EX	Presumed extinct species / Schedule 4
IA	Migratory birds protected under an international agreement (fauna only) / Schedule 5
CD	Special conservation (fauna only) / Schedule 6
OS	Special protection for reasons other than those already mentioned (fauna only) / Schedule 7

Species that have not yet been adequately surveyed to warrant being listed under the WC Act, or are otherwise data deficient, are added to a Priority Lists under Priorities 1, 2 or 3 by the State Minister for Environment. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. Categories and definitions of Priority Flora and Fauna species are provided in Table 4.

Table 4 Conservation codes for WA flora and fauna as listed by DPaW and endorsed by the Minister for Environment

Conservation Code	Category
Priority One	Poorly Known Species
Priority Two	Poorly Known Species
Priority Three	Poorly Known Species
Priority Four	Rare, Near Threatened and other species in need of monitoring

2.2.2 Vegetation Communities

Threatened Ecological Communities (TECs) are naturally occurring biological assemblages that occur in a particular type of habitat and that may be subject to processes that threaten to destroy or significantly modify the assemblage across its range. TECs are listed by both state and commonwealth legislation.

Vegetation communities in Western Australia are described as TECs if they have been endorsed by the Western Australian Minister for Environment following recommendations made by the Threatened Species Scientific Committee. Categories of TECs are defined in Table 5.

Department of Biodiversity, Conservation and Attractions (DBCA) maintains a database of state listed TECs which is available for online searches via their website. Possible TECs that do not meet survey criteria or are not adequately defined are listed as Priority Ecological Communities (PECs) under Priorities 1, 2 and 3. Ecological communities that are adequately known and are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. Conservation dependent communities are classified as Priority 5. PECs are endorsed by the Minister for Environment are categories are described in Table 6.

DBCA requires that all Priority and Threatened ecological communities are considered during environmental impact assessments and clearing permit applications.
There is currently no formal protection afforded to TECs or PECs listed at the state level.

Table 5 Conservation codes for State listed Ecological Communities

Conservation Code	Category
PD	Presumed Totally Destroyed
CR	Critically Endangered
EN	Endangered
VU	Vulnerable

Table 6 Categories for Priority Ecological Communities

Conservation	Code Category
P1	Priority One: poorly-known ecological communities
P2	Priority Two: poorly-known ecological communities
P3	Priority Three: poorly known ecological communities
P4	Priority Four: ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list.
P5	Priority Five: communities that are not threatened but subject to a specific conservation program.

3 METHODS

3.1 Desktop

A desktop study was undertaken to gather background information and determine the appropriate level of survey. Sources used to inform the desktop study included government database search results (March 2017) and other biological surveys undertaken in the local area, including:

- DBCA Threatened and Priority flora and communities database as obtained by Main Roads
- WA Herbarium database
- Protected Matters Search Tool (co-ordinates: 32° 07' 32.52 115° 51' 40.14 with a 5km buffer)
- Naturemap (same co-ordinates as above) (DBCA, 2017)
- Kwinana Freeway Widening Project (AECOM, 2017)
- Armadale Road Duplication EIA (Strategen, 2017)
- Karel Avenue Upgrade Project (AECOM, 2017)

The search results were reviewed to assess the potential presence of conservation significant environmental values. All conservation significant matters including flora, fauna and communities were reviewed and a likelihood of occurrence was completed based on the categories outlined in Table 7.

Following the desktop study, it was determined that a detailed flora and vegetation assessment, including the establishment of permanent quadrats was required. In particular, the presence of the Banksia Woodland of the Swan Coastal Plain TEC, and potential for PECs and conservation significant flora species, warranted a detailed field survey.

Table 7 Categories of likelihood of occurrence for species and communities

Likelihood Category	Flora	Communities
Likely to occur	Habitat is present in the survey area and the species has been recorded in close proximity to the survey area	Known occurrences of the community in close proximity to the survey area. Vegetation looks the same within the known occurrence and survey area based on aerial imagery. Geographic location is similar to the survey area
May occur	Habitat may be present and/or the species has been recorded in close proximity to the survey area	Known occurrence of the community in the local area, and/or vegetation looks the same within known occurrence and survey area based on aerial imagery. Geographic location is similar to the survey area
Unlikely to occur	No suitable habitat is present and the species has not been recorded in close proximity to the survey area	Known occurrence of the community in close proximity to the survey area however geographic location does not occur in survey area

3.2 Field Survey

The detailed flora and vegetation survey included undertaking two field surveys collecting data from permanent quadrats and relevés in areas of remnant native vegetation. The survey was conducted in accordance with EPA (2016) Technical Guidance for Flora and Vegetation Surveys for Environmental Impact Assessments.

The first field survey was undertaken by Floora de Wit (flora collection permit SL011912) and Lyn van Gorp (flora collection permit SL011913) on 21 and 26 June and 26 July, 2017. Floora de Wit has 10 years' experience undertaking flora and vegetation assessments on the Swan Coastal Plain. Floora completed a Bachelor of Science in Environmental Biology (Environmental Restoration) and completed a Postgraduate Diploma in Environmental Management and Impact Assessment. Lyn van Gorp has more than 7 years' experience in environmental management and impact assessment, and 3 years' of technical botanical experience. Lyn completed a Bachelor of Environmental Science (Natural Resource Science).

The first survey presented the opportunity to establish 10x10 m permanent quadrats and traverse all areas of native vegetation on foot to document the environmental values. The first field survey was also used to determine where suitable habitat for threatened species may occur. Seven permanent quadrats were established within the survey area and floristic data collected. All quadrats were scored again on 1 September, 2017 by Floora de Wit and field assistant Laura Fisher.

Quadrats followed DBCA's Standard Operating Procedure (SOP) No. 6.1 – Establishing Vegetation Quadrats (DEC, 2009). Quadrats were 10x10 metres (m) defined by a measuring tape and all four corners permanently marked with jarrah pegs. Data collected from quadrats included the presence of plant species, their cover abundance, structural composition of vegetation, physical environment, and presence/absence of disturbance. Each sample point location was given a unique site number, and the following parameters recorded:

- date
- location using hand-held GPS (accuracy of 5 m)
- sample site type (quadrat/relevé and size)
- photograph (northwest corner)
- soil details (type, colour, moisture)
- landform
- vegetation condition using the Keighery (1994) scale and description of disturbance
- fire history
- comprehensive species list
    - estimated height
    - estimated percentage cover (for trees both percentage within quadrat and within community was recorded to enable better description of vegetation community).

Attempts were made to select quadrat locations that were not positioned in a boundary or transition zone. However due to the small patches of native vegetation, and considerable disturbance that has affected these patches, this was not always possible. A summary of survey effort is shown in Table 8.

The flora data from Main Roads Kwinana Freeway Northbound Widening and Karel Avenue was used to provide additional context and inform vegetation unit mapping.

Table 8 Survey sample effort

Community	Survey effort	
	Within survey area	Relevant
BaHhMp	Two quadrats ARM07 and ARM08	Two quadrats Kwinana Freeway Northbound Widening Project
BmEpEc	Three quadrats ARM02, ARM03 and ARM04	Two quadrats Kwinana Freeway Northbound Widening Project
MpAsHr	Two quadrats ARM05 and ARM06 and one relevé KW03	Relevé was completed for Kwinana Freeway Northbound Widening Project
BaXpEc	One relevé KW02	Three quadrats from Kwinana Freeway Northbound Widening Project
CcAhCc	Aerial imagery and observation only	Two relevés Kwinana Freeway Northbound Widening Project

3.3 Threatened species targeted survey

Two Threatened orchid species were identified in the desktop study are potentially occurring in the survey area, including *Drakaea elastica* and *Caladenia huegelii*.

A targeted survey was undertaken for *D. elastica* on 10 August, 2017 by Senior Botanist Floora de Wit assisted by Cassandra House. The wetland community MpAsHr was traversed on foot with suitable habitat searched utilizing transects surveyed at 5/10 m spacing. Habitat targeted included vegetation fringing winter-wet and wetland areas that include *Kunzea glabrescens*. *D. elastica* habitat in the survey area was considered marginal habitat due to the significant degradation of the patch of vegetation including a dominance of perennial and annual weeds present in the understorey strata. Patches of bare sand under thickets were particularly targeted at this location.

A targeted survey was undertaken for *C. huegelii* in Banksia woodland vegetation within the survey area. Prior to commencing the survey, known populations of *Caladenia huegelii* were checked for flowering. This included a large population in bushland east of the project area; south east of Jandakot Road and Ghostgum Avenue in Jandakot and a smaller population east of Roe Highway and north of Brookfield Rail in Jandakot. When at least 60% of the populations were observed in flower the targeted survey was undertaken. Checks of known populations were undertaken on the following dates:

- 7 September – Jandakot Airport 'Industrial Park' population (DBCA population 56); leaves present near markers and population not flowering
- 13 September – Jandakot Airport 'Industrial Park' population (DBCA population 56); leaves present near markers, flower stalk present on one plant and population not flowering
- 19 September – Jandakot Airport 'Industrial Park' population (DBCA population 56); leaves present near markers, flower stalk present on one plant and population not flowering. Fraser Road population (DBCA population 42) mostly in flower (>80%) (Plate 1). Survey was commenced.

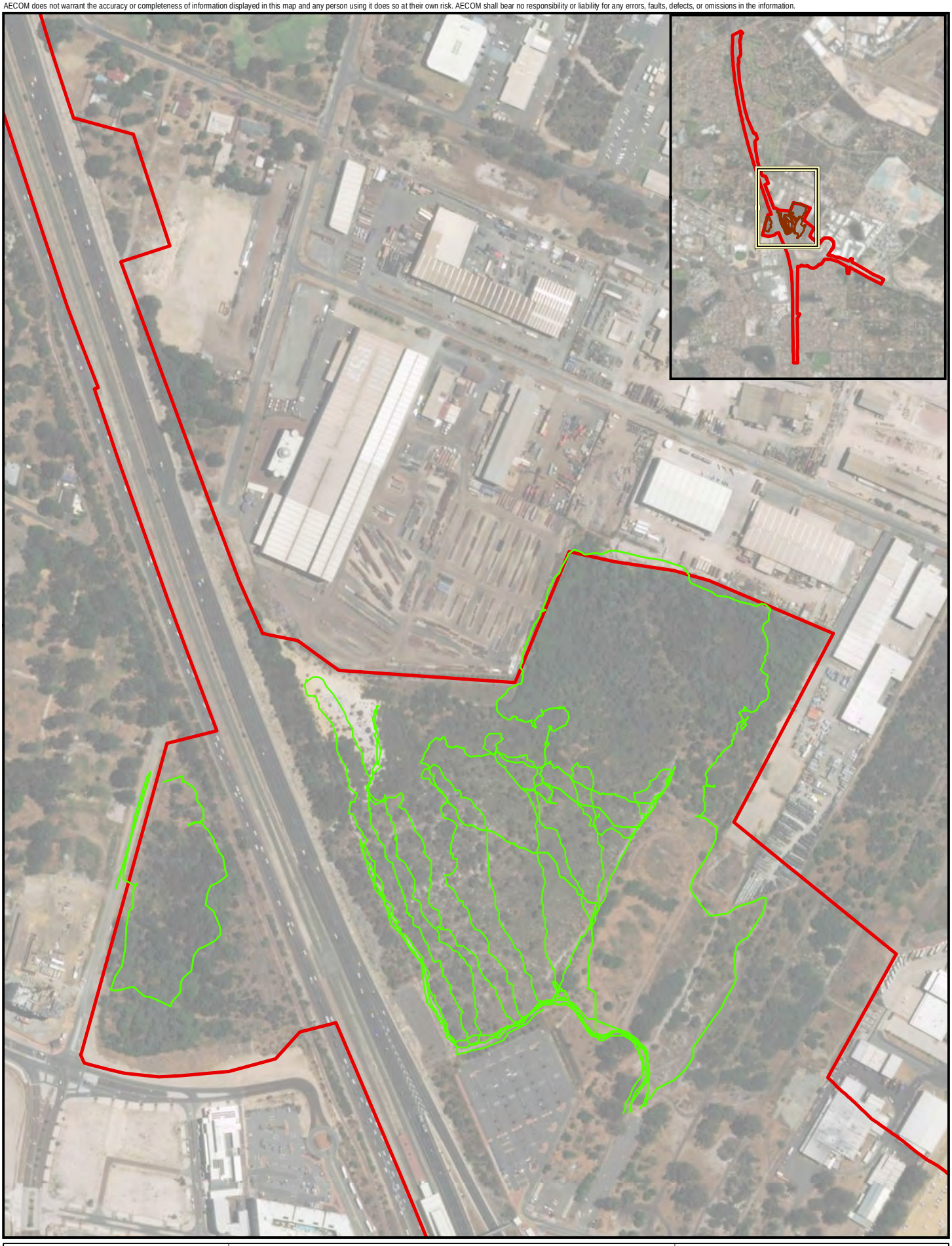
The survey was undertaken on 26 and 27 September by Senior Botanist Catherine Krens (flora collecting licence SL011901) and Environmental Scientists Danielle Sullivan. Parallel survey transects were walked at 5 to 15 m apart within suitable habitat (Figure 2). Survey transects were logged on handheld Garmin Differential GPS units to demonstrate survey effort if required.

All *Caladenia* species similar in appearance to *Caladenia huegelii* were recorded. Orchid texts (Hoffman & Brown, 2011 and Liddelow, 2015) and reference images taken of known populations were used to determine any potential *Caladenia huegelii* individuals. The following information was recorded for each potential *Caladenia huegelii* population:

- Waypoint of each population
- Number of individual plants within 1m
- Photograph of each individual plant within the population.

Plate 1 *Caladenia huegelii* in flower at Fraser Road population (DBCA population 42)

Targeted surveys followed methods prescribed in the Draft Orchid Survey Guidelines (Commonwealth of Australia, 2013). Factors to improve the detectability of orchids were considered and are addressed in Table 9. The identification of orchids encountered was based on their key morphological features defined by Jones (2006) and Brown *et al.* (2013).



PROJECT ID 60539165
CREATED BY RNM
APPROVED BY FdeWit
LAST MODIFIED 03 APR 2018

Metropolitan Road Improvement Alliance

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DATUM GDA 1994, PROJECTION PERTH COASTAL GRID 1994

0 50 100 150 200
metres

1:5,000 when printed at A4

LEGEND

Caladenia huegelii survey effort
Survey Area

Data sources: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Caladenia huegelii Survey Effort

ARMADALE ROAD TO NORTH LAKE ROAD BRIDGE

MAIN ROADS WESTERN AUSTRALIA

Figure

2

Map Document: \\auper1gis01\geo\Client_Data\MRIA\08_Armadale Road Extension\02_MXDs\04_Survey_Flora\Fig2_Caladenia_Huegelii_v1_A4P.mxd (fotheringhamd)

A4 size

Table 9 Factors considered to improve detectability of *Drakaea elastica*

Factor	*D. elastica*	*C. huegelii*
Use of appropriate personnel	Floora de Wit is a Senior Botanist with more than 10 years' experience in the consulting industry. She has undertaken targeted orchid surveys of similar scope at various locations on the Swan Coastal Plain. Floora has liaised with Andrew Brown from DBCA on numerous occasions to verify optimal orchid survey timing.	The survey was led by Catherine Krens a senior botanist with over 10 years' experience in planning and conducting targeted flora surveys including surveys for *Caladenia huegelii* within the Swan Coastal Plain region. Catherine's experience in undertaking *Caladenia huegelii* surveys increased the potential for detection and reduced the chance of recording false 'negatives' and 'positives'.
Determining the optimal timing of survey	The survey was undertaken in mid-August prior to their flowering period. This maximises the opportunity to see the plant leaf.	The optimal time for survey is from late September to October. Known populations were checked weekly for flowering from early September (7 to 19 September) and the Survey was undertaken on 26 and 27 September.
Characterisation of the study area	Preliminary mapping undertaken following first quadrat-scoring field survey. Marginal habitat identified on edge of wetland in ecotone where wetland grades into Banksia woodland.	Preliminary mapping undertaken following first quadrat-scoring field survey. Banksia woodlands were mapped and identified as requiring targeted surveys.
Establishing a sample design	Meandering transects were walked through marginal habitat to assess whether systematic transects were required. No ideal habitat was recorded within the survey area, only marginal habitat represented by MpAsHr.	Transects of 5-10 m spacings were walked at a slow pace to search for the orchid.
Applying sufficient survey effort	Two people walked meandering transects approximately 10m apart. GPS track logs were obtained to verify survey effort. The presence of dominant grass weeds and Arum Lily, as well as lacking exposed sandy surfaces and thickets of *Kunzea* determined the habitat as marginal.	GPS track logs were obtained to verify survey effort. All *Caladenia* Spider Orchids were photographed and their identification confirmed by Andrew Brown (DBCA).

3.4 Vegetation classification, data analysis and mapping

Vegetation mapping was undertaken following the first field survey. This allowed for additional quadrats and relevés to be completed during the second survey where gaps in representation were identified. Units that were degraded or representing rehabilitation and/or planted vegetation were not represented in relevés or quadrats. These were mapped as observations recorded on field maps.

Mapping was undertaken using Arc GIS 10.4 and aerial imagery taken August 2017. Historical aerial imagery was used to assess historical clearing footprints. The National Vegetation Information System (NVIS) (ESCAVI, 2003) classification system was used to map and describe the vegetation types at a Level VI sub-association scale. This includes the dominant growth form, height, cover and up to five species for all strata and a mapping code.

Vegetation types were defined by analysing floristic data using cluster dendrograms and similarity indices. Quadrat species lists were imported in statistical program PC Ord and cluster analysis undertaken using Ward's distance measure, nearest neighbour, and Bray-Curtis similarity indices. Presence absence and scaled percentage foliage cover (Braun-Blanquet scale) was considered. The analysis results identified quadrats that were most similar to one another and therefore likely to represent the same vegetation type. and suitable for representing the same vegetation unit.

The comprehensive Keighery *et al.,* (2012) southern Swan Coastal Plain dataset (SCP dataset) was used to determine the Floristic Community Types (FCT) of each quadrat/vegetation type. A mapping exercise was used to identify SCP quadrats that were within 40 km of the survey area. This included 539 quadrats representing 53 FCTs. The sub-set was reconciled with the Project quadrat data and reviewed for compatibility. Nomenclature of flora species followed the WA Plant Census, current at the time the analysis was undertaken. The combined dataset was imported in PC Ord. The Bray-Curtis similarity index was used to identify the most similar SCP quadrats, and their associated FCT.

Additional quadrat and desktop information such as geology, soils, landscape and historical disturbance was considered to determine the final FCT, including descriptions provided in the Gibson *et al.* (1994) reference material and Bush Forever (Government of WA, 2000). Inferred FCT results presented in this report identifies the most similar SCP dataset quadrats relevant for each Project quadrat, the similarity of these quadrats (represented as percentage) and what FCT they represent.

Patches of native vegetation that may represent the Banksia Woodlands TEC were assessed using methods outlined in the Banksia Woodlands Conservation Advice (TSSC, 2016). The document provides detailed descriptive methods for determining the presence of the TEC, and are therefore not comprehensively provided here. In summary, the identification of the TEC comprises four steps:

- Step 1: use key diagnostic characteristics to determine if TEC is present, informed by the quadrat data, FCT analysis results and vegetation type mapping
- Step 2: determine condition of patch
- Step 3: determine size of patch and consider minimum size threshold
- Step 4: consider context of a patch that may affect the outcome

The assessment methods implemented and comprehensive results is provided in **Appendix B**.

Vegetation condition was mapped using the Keighery (1994) vegetation condition scale, informed by quadrat data, survey observations, and weed infestations recorded.

3.5 Limitations

Limitations are inherent with any biological assessment. The limitations associated with the biological assessment are outlined in Table 10, as specified in EPA (2016) Flora Survey Technical Guide. The limitation assessment scale ranges from “not”, “minor”, “moderate”, “significant”.

Table 10 Limitations of the assessment

Limitation	Flora and vegetation assessment
Availability of contextual information on the region	**Not a limitation.** Sufficient resources for the Swan Coastal Plain were available to provide contextual information including Beard (1981), Heddle *et al*. (1980) vegetation mapping, Perth @ 3.5 million (Government of WA, 2015) and the Gibson *et al.* (1994) and Keighery *et al.* (2012) swan coastal plain datasets. Two other projects undertaken by the Metropolitan Road Improvement Alliance (MRIA) were undertaken simultaneously and were subject to a detailed flora and vegetation assessment. These Projects provided additional contextual information, in particular for survey effort end extend of vegetation units.
Competency/experience of consultant conducting survey	**Not a limitation.** The flora and vegetation assessment was led by Floora de Wit who has more than 10 years’ experience conducting surveys of similar scope. Advice from Val English and Andrew Brown was sought where necessary to discuss the significant Banksia TEC and threatened orchids. DBCA taxonomist Mike Hislop was consulted to assist in identification of cryptic flora species.
Proportion of flora/fauna identified, recorded and/or collected (based on sampling, timing and intensity)	**Not a limitation.** Floristic data was collected from seven permanent quadrats and one relevés. 111 flora species were recorded, of which four could not be identified to species level. These were confirmed not to represent significant flora species. Vegetation units were represented by three or more quadrats taking into account Projects for Main Roads undertaken in survey areas adjacent to this Project.
Completeness (was relevant area fully surveyed)	**Not a limitation**. All native vegetation was visited and data collected from quadrats or relevés. Rehabilitated areas were not all visited, but easily distinguishable from aerial imagery and historical imagery showing extent of clearing for previous road projects.
Remoteness and/or access problems	**Not a limitation.** All areas of native and planted vegetation were accessible on foot.
Timing, weather, season, cycle	**Minor limitation.** Rainfall in 2017 varied considerably from mean rainfall records. Val English has suggested that 2017 would be a poor year for herb species (pers. Comm, 18 July, 2017). The influence of changes in rainfall patterns is yet unknown for WA flora species, in particular how it influences annual species germination, flowering periods, and presence of orchids. The above-average rainfall in July and August suggests an adequate spring survey season, therefore the variable rainfall is considered only a minor limitation.

Limitation	Flora and vegetation assessment
Disturbances (e.g. fire flood, accidental human intervention) which affected results of the survey	**Minor limitation.** Historical aerial imagery was obtained from Landgate to assess the history of clearing. The majority of the survey area has been cleared in 1995 following construction of Kwinana Freeway. Furthermore, significant edge effects from clearing and weed invasion has affected the entire survey area. This is a reflection of human settlement rather than a disturbance that has impacted on survey results.

4 EXISTING ENVIRONMENT

4.1 Climate

The Project is located in Perth which experiences a Mediterranean climate. A Mediterranean climate is characterised by warm to hot dry summers and mild to cool wet winters. The mediterranean climate in Australia is a result of the Indian Ocean High, a high pressure cell that shifts towards the poles in summer and the equator in winter, playing a major role in the formation of the deserts of Western Australia, and the Mediterranean climate of southwest and south-central Australia. Precipitation occurs during winter months, with the possibility of some summer storms.

Rainfall data was obtained from the Jandakot Aero weather station (no. 9172) (see Figure 3). The climate data in the 12 months preceding the survey shows a fluctuating rainfall pattern. The significant rainfall event in February and higher than average rainfall in March, may have impacted on the presence of herbs and annual species during the first field survey (Survey 1) undertaken in June. It is unclear what the impact of the varying rainfall pattern is on annuals, herbs, and flowering periods. Val English suggested that spring 2017 would be poor for herbs (pers. Comm.). This is not considered to have a significant impact on the survey results. Rainfall was also above average in July and August, leading to a good spring field season for Survey 2. Rainfall is therefore not anticipated to be a limiting factor for this project.

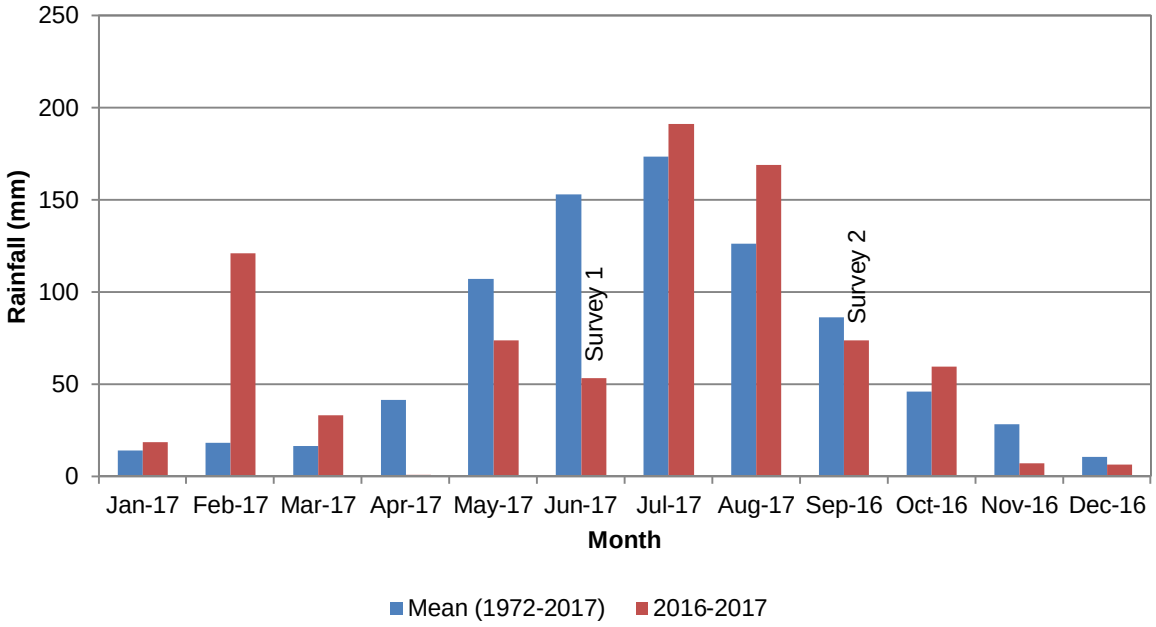


Figure 3 Monthly rainfall for 12 months preceding the field survey measured at Jandakot Aero station 9172 (BOM, 2017)

4.2 IBRA Region

The Swan Coastal Plain bioregion, described in CALM (2002), includes Perth and the outer suburbs (excluding the Hills suburbs). The Swan Coastal Plain consists of the Dandaragan Plateau and the Perth Coastal Plain and is comprised of a narrow belt less than 30km wide of Aeolian, alluvial and colluvial deposits of Holocene or Pleistocene age (Gibson et al 1994). A complex series of seasonal fresh water wetlands, alluvial river flats, coastal limestone and several offshore islands are included in the bioregion. Younger sandy areas and limestone are dominated by heath and/or tuart woodlands, while Banksia and Jarrah-Banksia woodlands are found on the older dune systems. The outwash plains at the foot of the Darling Escarpment were once dominated by *Casuarina obesa*-Marri woodlands and Melaleuca shrublands. Extensive clearing has occurred on the Swan Coastal Plain for urban and agricultural development. The region is divided into the Dandaragan Plateau and the Swan Coastal Plain subregions.

The Swan Coastal Plain subregion, described by Mitchell et al. (2002), is a low-lying coastal plain covered with woodlands dominated by Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. The area includes a complex series of seasonal wetlands and includes Rottnest, Carnac and Garden Islands. Land use is predominantly cultivation, Conservation, urban and rural residential. The area contains a number of rare features including Holocene dunes and wetlands and a large number of rare and threatened species and ecological units.

4.3 Vegetation

Beard (1981) mapped the vegetation on the Swan Coastal Plain. The survey area intersects with the Beard vegetation association 1001, described as 'Medium very sparse woodland; Jarrah, with low woodland; *Banksia* & *Casuarina*' (Beard, 1981).

The survey area occurs in the Bassendean Complex central and south vegetation complex under the Heddle *et al.* (1980) classification system. This is described as vegetation ranging from woodland of *Eucalyptus marginata – Allocasuarina fraseriana* - *Banksia* spp. to low woodland of *Melaleuca* spp. and sedgelands on the moister sites.

4.4 Soils and geology

The survey area is located on Bassendean Sands, a basal conglomerate overlain by dune quartz sand with heavy mineral concentrations (Geological Survey of WA & Geoscience Australia, 2008). The soils are mapped as Cb39, described as subdued dune-swale terrain: chief soils are leached sands on the low dunes. Associated are small areas of other sand soils.

5 DESKTOP RESULTS

5.1 Threatened and Priority Ecological Communities

The desktop study results show the Banksia Woodlands of the Swan Coastal Plain TEC (Banksia Woodlands TEC) has been mapped within the survey area. The mapping of the Banksia Woodland TEC is based on the Commonwealth's 'likely to occur' areas and incorporates broad-scale mapping of areas most likely to contain the TEC. The desktop results are therefore an indicative distribution.

The Banksia Woodlands TEC was listed under the EPBC Act as Endangered on 16 September 2016. The community incorporates woodland of *Banksia* species with scattered Eucalypts and other tree species over a species rich mix of sclerophyllous shrubs, graminoids, and forbs. The community shows high endemism and considerable local variation in species composition across its range. It is restricted to the southwest of WA on the Swan Coastal Plain. It occurs mainly on deep Bassendean and Spearwood sands or occasionally on Quindalup sands.

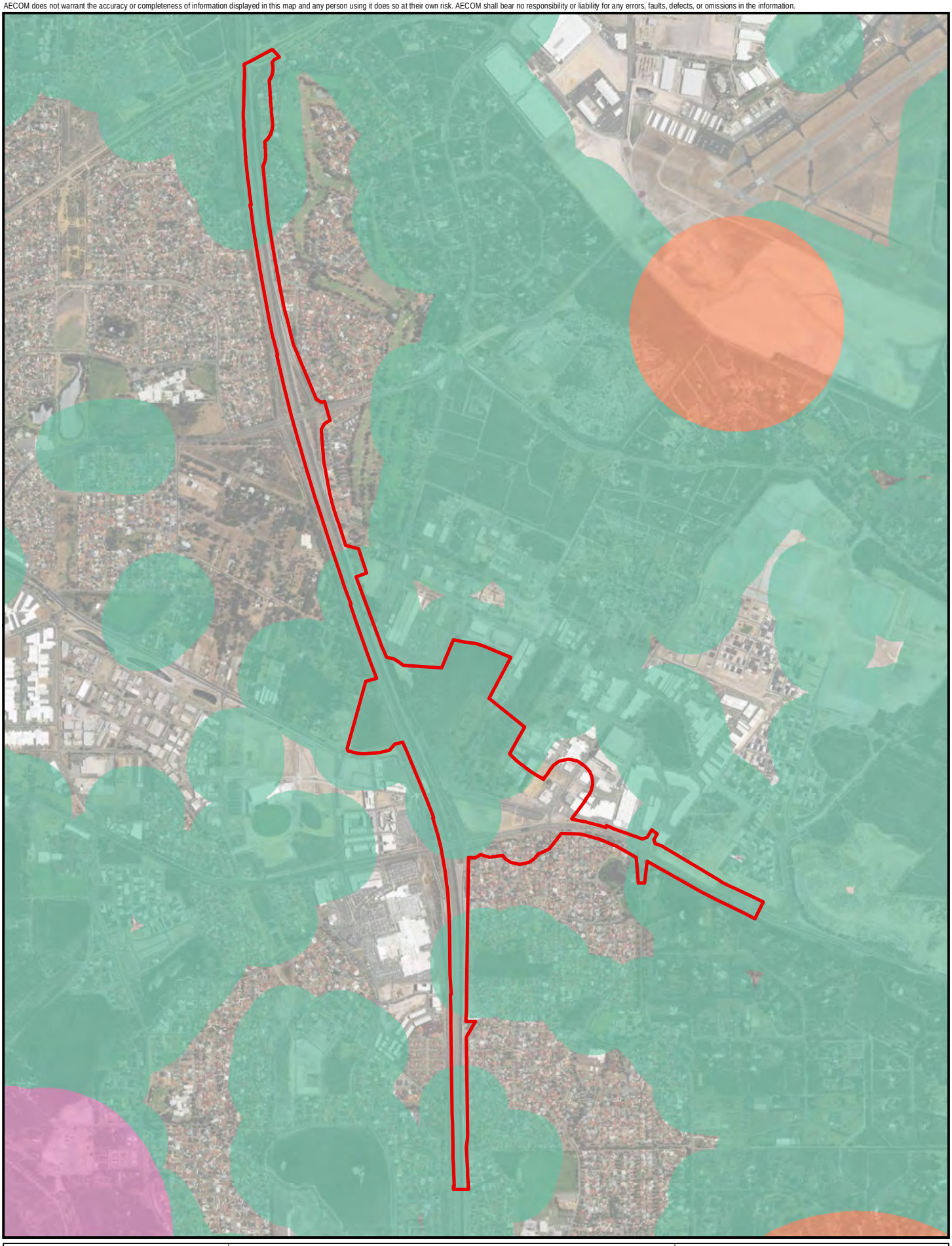
The Banksia Woodlands TEC relates to three Threatened communities at the State-level and eight Priority Ecological Communities (PECs). Four of these PECs were identified in the desktop study. The TECs and PECs descriptions, conservation status and likelihood of occurrence assessment is presented in Table 11 and mapped in Figure 4.

All patches of native vegetation within the survey area that were considered to potentially represent the TEC were assessed individually as per the TSSC (2016) conservation advice. The detailed TEC diagnostic criteria, methods for assessment, and results are presented in Appendix B.

Table 11 Priority Ecological Communities that may or are likely to be present in the survey area

Community Description	Cons. Status	Likelihood of occurrence
Banksia Woodlands of the Swan Coastal Plain TEC Distinctive upper sclerophyllous layer of low trees dominated or co-dominated by one or more Banksia species. Emergent tree layer may be present including Eucalyptus and/or Allocasuarina. Understorey of high biodiversity. There are four PECs related to this TEC that are relevant to the survey area:	EPBC Act: Endangered	Mapped in survey area
Wooded wetlands which support colonial waterbird nesting areas Includes Chandala, Booragoon Lake, unnamed wetland near Pinjarra, McCarleys Swamp.	State: P2	Unlikely
Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *B. menziesii*. Other Banksia species that can dominate in the community are *B. prionotes or B.ilicifolia*. It typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands.	State: P3	Mapped in survey area

Community Description	Cons. Status	Likelihood of occurrence
Low-lying *Banksia attenuata* woodlands or shrublands (FCT21c) Occurs sporadically between Gingin and Bunbury. Occupies low lying wetter sites and is variously dominated by *Melaleuca preissiana*, *Banksia attenuata, B. menziesii*, *Regelia ciliata, Eucalyptus marginata* or *Corymbia calophylla*. Structurally, this community type may be either a woodland or occasionally shrubland.	State: P3	Likely
***Banksia ilicifolia* woodlands (FCT22)** Low lying sites generally consisting of *Banksia ilicifolia – B. attenuata* woodlands, but *Melaleuca preissiana* woodlands and scrubs are also recorded. Occurs on Bassendean and Spearwood systems in the central Swan Coastal Plain north of Rockingham. Typically has very open understorey, and sites are likely to be seasonally waterlogged.	State: P2	Likely



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LAST MODIFIED 05 APR 2018

Metropolitan Road Improvement Alliance

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DATUM GDA 1994, PROJECTION PERTH COASTAL GRID 1994

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LEGEND

Survey Area

TEC PEC

- Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region, Priority 3
- Banksia ilicifolia woodlands, Priority 2
- Northern Spearwood shrublands and woodlands, Priority 3

Data sources: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Desktop Threatened and Priority Ecological Communities

ARMADALE ROAD TO NORTH LAKE ROAD BRIDGE

MAIN ROADS WESTERN AUSTRALIA

Figure

4

Map Document: G:\Client_Data\MRIA\08_Armadale Road Extension\02_MXDs\04_Survey_Flora\Fig4_TPEC.mxd (fotheringhamd)

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5.2 Threatened and Priority flora

Twenty eight Threatened and Priority species were identified as potentially occurring within the survey area, including seven mushrooms and 21 flora species. Very little is known of the Priority mushrooms, and their inclusion in impact assessment is unclear. For this reason, they have been omitted from further assessment.

Four flora species listed under the EPBC Act, one species listed under the WC Act and 16 Priority flora were identified as potentially occurring within the survey area. Of these, nine species are considered likely to occur:

- *Caladenia huegelii* listed under the EPBC Act and WC Act was considered likely to occur due to the close proximity of known populations and the presence of Banksia Woodlands
- *Synaphea* sp. Fairbridge Farm listed under the WC Act was considered likely to occur as it favours winter-wet flats with weedy grasses
- seven Priority flora are considered likely to occur due to the presence of the wetland and Banksia on sandy soils.

The species considered likely to occur are outlined in Table 12. A comprehensive list is presented in Appendix A and mapped in Figure 5.

Table 12 Threatened and Priority flora species that may or are likely to occur within the projects areas

Taxon	Habitat	Likelihood	Cons. Code
Byblis gigantea	Sandy-peat swamps. Seasonally wet areas.	Likely	State: P3
Caladenia huegelii	Deep sandy soils in *Banksia-Eucalyptus marginata* woodlands.	Likely	EPBC Act: E WC Act: CR
Cyathochaeta teretifolia	Grey sand, sandy clay. Swamps, creek edges.	Likely	State: P3
Dodonaea hackettiana	Sand. Outcropping limestone.	Likely	State: P4
Jacksonia gracillima	Associated with edges of swamp on sandy soils.	Likely	State: P3
Jacksonia sericea	Calcereous and sandy soils. Recorded in *Banksia* and *Melaleuca preissiana* woodland.	Likely	State: P4
Microtis quadrata	Sandy clay swamps, black peaty soil.	Likely	State: P4
Stylidium longitubum	Sandy clay, clay. Seasonal wetlands.	Likely	State: P4
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	Near winter-wet flats in low woodland with weedy grasses.	Likely	WC Act: CR

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LEGEND

Survey Area

TPFL

T

WA Herb

3

T

Data sources: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Desktop Threatened and Priority Flora

ARMADALE ROAD TO NORTH LAKE ROAD BRIDGE

MAIN ROADS WESTERN AUSTRALIA

Figure

5

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6 FIELD SURVEY RESULTS

6.1 Threatened communities

The Banksia Woodlands TEC was confirmed as occurring in the survey area at one location for 5.87 ha (see Figure 6). A comprehensive assessment for determining the presence of the Banksia Woodlands of the Swan Coastal Plain TEC (Banksia Woodlands) was applied to three distinct vegetation patches, including:

- Patch 1: Cockburn Central
- Patch 2: Brookfield Rail/Kwinana Freeway
- Patch 3: Kentucky Court

The TEC assessment confirmed the Banksia vegetation within patch 1 as representing the Endangered Banksia Woodlands TEC. The patch was mapped as Degraded to Very Good, with variations representing weed infestations. In accordance with the Conservation Advice, for the TEC assessment the entire patch was classified as 'Good' condition, informed by weed foliage cover and species diversity. This vegetation also represents the Priority 3 Banksia Dominated Woodlands of the SCP.

Additional ecological attributes increases the significance of the vegetation in this patch, including its role as a buffer for the adjacent wetland, providing fauna refuge and habitat, and limited values as an ecological linkage between isolated areas of vegetation in the local area.

Patch 2 did not meet the minimum condition and size threshold to be considered the Banksia Woodland TEC. Patch 2 includes a small area (0.93 ha) of remnant native vegetation confined to Kwinana Freeway east roadside, a noise wall and the Brookfield Rail corridor. All native vegetation surrounding this patch was cleared in the 1990's for urban development and the Freeway. Vegetation condition is degrading from weed invasion and encroachment from planted non-native vegetation and escaped garden species. Illegal dumping of garden waste from adjacent residential houses and rubbish from freeway drivers was observed. It is likely that current degrading processes will continue, slowly reducing the biodiversity and value of this area over time.

Patch 3 does not represent the Banksia Woodlands TEC, failing to meet the condition and size thresholds (0.46 ha of Good condition vegetation). The comprehensive Banksia Woodlands TEC assessment for patch 1 and 2 is presented in **Appendix B**, supported by the Quadrat data presented in **Appendix D**.

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LEGEND

Survey Area

TEC

Patch 1 Banksia Woodlands of the SCP (Endangered)
Patch 2
Patch 3

PEC

Banksia Dominated Woodlands of the SCP (Priority 3)

Data sources: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Conservation Significant Communities

ARMADALE ROAD TO NORTH LAKE ROAD BRIDGE

MAIN ROADS WESTERN AUSTRALIA

Figure

6

Map Document: G:\Client_Data\MRIA\08_Armadale Road Extension\02_MXDs\04_Survey_Flora\Fig6_Cons_Sig_Communities.mxd (fotheringhamd)

A4 size

6.2 Inferred FCT

The survey area is located on the Bassendean – Central and South vegetation complex as mapped by Heddle (1980). As such, FCTs in the SCP dataset not occurring on this complex were not included in the FCT analysis. Relevés are not comparable to the SCP dataset and were therefore excluded.

Three quadrats in community BmEpEc were assessed. They all showed highest similarity to FCT23a Central *B. attenuata-B. menziesii* Woodlands and FCT23b Northern *B. attenuata-B. menziesii* Woodlands. FCT23b was excluded as it occurs north of Perth, therefore FCT23a is the inferred FCT. Two quadrats in community BaHhMp were assessed, showing highest similarity to FCT23a Central *B. attenuata-B. menziesii* Woodlands (44-46% similarity).

FCT23a is associated with the Banksia Woodlands of the SCP Endangered TEC at the federal level and the Priority 3 Banksia Dominated Woodlands of the SCP. It is restricted to the Bassendean system between Bullsbrook to Woodman Point and is characterised by high species richness (62 species/100m^2) (Gibson *et al.,* 1994).

Two quadrats in the wetland community MpAsHr were assessed and considered representative of FCT4 *Melaleuca preissiana* Damplands. This fits the description of the wetland, and it occurs on the Bassendean land system. FCT4 is not considered a PEC or TEC at state or federal level.

Table 13 Inferred FCT for Quadrats completed in the survey area. Includes vegetation condition, highest similarity, a review and the final inferred FCT

Quadrat Details	Condition	Similarity	Review of Result	Final FCT
BmEpEc				
ARM02	Very Good	54% (ELE28; 23b) 53% (ELE17; 23b) 53% (perth06; 23a)	FCT23b is excluded as it occurs in the northern suburbs (Gibson *et al.,* 1994).	FCT23a Central *B. attenuata-B. menziesii* Woodlands
ARM03	Very Good	57% (ELE03; 23b) 56% (ELE08; 23b)	See above	FCT23a Central *B. attenuata-B. menziesii* Woodlands
ARM04	Very Good	45% (WAND-1; 23a) 44% (perth06; 23a)	FCT23a is a good fit.	FCT23a Central *B. attenuata-B. menziesii* Woodlands
MpAsHr				
ARM05	Very Good	33% (ELE32; 4) 32% (MP11; S02)	FCT4 is a good fit for this wetlands quadrat on Bassendean system. Low similarity due to lack of common sedges, rushes and herbs.	FCT4 *M. preissiana* damplands
ARM06	Very Good	24% (m4601; S11) 24% (MODO-2; 21c) 24% (perth10; 4)	FCT4 is a good fit for this wetlands quadrat on Bassendean system. Low similarity likely a reflection of degraded vegetation and lack of sedges, rushes and herbs.	FCT4 *M. preissiana* damplands
BaHhMp				
ARM07	Good	46% (bibra01; 23a) 44% (Tele01; 23a)	23a is a good fit. *E. marginata* is rare in this community (yet occurs in the quadrat). Historical imagery shows a small stand of trees at this location prior to clearing in extensive Banksia woodland.	FCT23a Central *B. attenuata-B. menziesii* Woodlands
ARM08	Good	46% (THOM-2; 24) 44% (Tele01; 23a)	FCT24 occurs on Spearwood dunes.	FCT23a Central *B. attenuata-B. menziesii* Woodlands

6.3 Vegetation types

Five native vegetation types were mapped and described including three Banksia woodlands, a Marri woodland and one Paperbark wetland. The Banksia woodlands include types BaHhMp, BmEpEc and BaXpEc which represent 7.44 ha of remnant native vegetation. Types BaHhMp and BmEpEc are situated on grey sandy soils, and were assessed as Degraded to Very Good condition. Weed invasion, edge effects and illegal dumping are the dominant degrading processes present. Type BaXpEc is on the west side of Kwinana Freeway and was considered Degraded. Partial historical clearing and weed invasion has displaced the majority of native species.

Community type BmEpEc is locally and regionally significant as representatives of the Banksia Woodlands TEC (federal level) and Priority 3 PEC (state level), see Section 6.1. Community types BaXpEc and BaHhMp did not meet the minimum condition and size thresholds to be considered representative of the Banksia Woodlands TEC.

The Paperbark wetland type MpAsHr incorporates 10.3 ha of riparian vegetation. This vegetation type was inundated in July for approximately 80% of the area, reducing to approximately 20% inundation in September. The centre of the wetland supports dense stands of *M. preissiana* over sparse understorey, grading to tall shrubland of *Astartea scoparia* and *Kunzea* glabrescens on the edges. The wetland is considered both locally and regionally significant for its ecological functions including hydrological values, habitat refuge and its role as buffer for the Banksia Woodlands TEC.

One partially cleared patch of trees was mapped, characterised by mature native and some non-native trees over mixed non-native shrubs and grassland. Three non-native community types were recorded, representing rehabilitated road reserve and planted vegetation.

Details of all vegetation types mapped for this Project are detailed in Table 14 and shown in Figure 7.

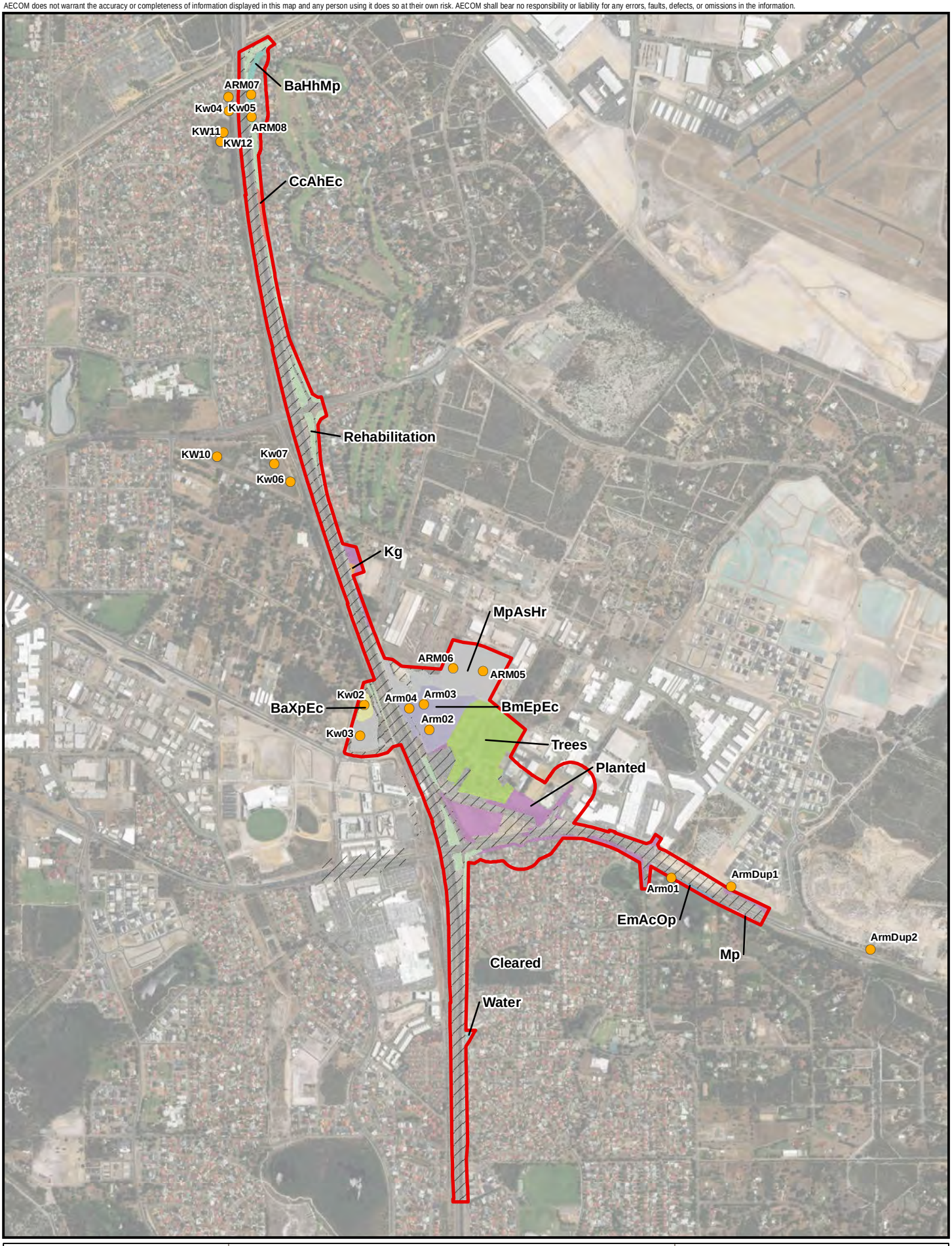
Table 14 Vegetation types recorded in the survey area

Code	Description	Details	Photograph
Woodlands			
BaHhMp	*Banksia attenuata, Eucalyptus marginata, Banksia menziesii* and some *Banksia ilicifolia* and *Nuytsia floribunda* mid woodland over *Hibbertia hypericoides*, *Allocasuarina humilis, Stirlingia latifolia, Hypocalymma robustum* and *Xanthorrhoea preissii* mid open shrubland with *Mesomelaena pseudostygia*, *Schoenus laevigatus*, *Tetraria octandra* and *Tetraria capillaris* sparse sedgeland with *Platysace tenuissima, Patersonia occidentalis*, *Chamaescilla corymbosa* and *Burchardia congesta* low sparse forbland.	Survey effort: two quadrats (ARM07-08) Species richness: 44 native and nine weed species Area: 0.93 ha Condition: Very Good to Good	
BmEpEc	*Banksia menziesii, Banksia attenuata, Eucalyptus todtiana* and occasional *Nuytsia floribunda* low open woodland over *Eremaea pauciflora, Stirlingia latifolia, Hibbertia hypericoides, Hibbertia subvaginata* and *Allocasuarina humilis* mid shrubland with **Ehrharta calycina, *Briza maxima* and **Avena barbata* tall grassland over *Dasypogon bromeliifolius, Patersonia occidentalis, Lomandra preissii, Lomandra micrantha* and *Dampiera linearis* low herbland with *Desmocladus flexuosus, Lyginia barbata, Desmocladus fasciculatus* and *Hypolaena exsulca* low open rushland. Represents Banksia Woodland TEC and Priority 3 PEC.	Survey effort: three quadrats (ARM02-04) Species richness: 63 native and 14 weed species Area: 5.87 ha Condition: Degraded to Very Good	

Code	Description	Details	Photograph
BaXpEc	*Banksia attenuata, Banksia menziesii* and *Eucalyptus todtiana* low woodland over *Xanthorrhoea preissii*, *Scholtzia involucrata, Hypocalymma robustum*, *Macrozamia riedlei* and *Bossiaea eriocarpa* mid open shrubland with **Ehrharta calycina, *Briza maxima, *Avena barbata* and **Lagurus ovatus* mid tussock grassland over *Dasypogon bromeliifolius, *Carpobrotus edulis* and **Pelargonium capitatum* low open forbland with *Lepidosperma squamatum* low sparse sedgeland and *Hypolaena exsulca* open rushland. Significant infestation of **Acacia longifolia* has displaced many native flora species.	Survey effort: KW02. Supported by Quadrats KW06 & 07, KW10 completed for Kwinana Freeway Northbound Widening Project. Species richness: 43 native and 19 weed species (14 native and 6 weed species within survey area) Area: 0.64 ha Condition: Degraded	
CcAhEc	*Corymbia calophylla, Eucalyptus marginata, Banksia menziesii* and *Allocasuarina fraseriana* mid open forest over *Allocasuarina humilis, Kunzea glabrescens, Hibbertia hypericoides, Acacia lasiocarpa* var. *lasiocarpa* and *Bossiaea eriocarpa* mid open shrubland with **Ehrharta calycina, *Briza maxima, *Avena barbata* and **Briza m*inor low tussock grassland with *Mesomelaena pseudostygia*, *Lepidosperma leptostachyum*, and *Lepidosperma squamatum* low sparse sedgeland and *Desmocladus flexuosus* low sparse rushland. One degraded patch of this community in Kwinana Freeway road reserve. Not accessible due to noise wall and residential housing. Community represented by quadrats located west of Kwinana Freeway.	Survey effort: KW04-05 completed for Kwinana Freeway Northbound Widening Project. Species richness: 25 native and nine weed species. Area: 0.46 ha Condition: Good	

Code	Description	Details	Photograph
Wetlands			
MpAsHr	*Melaleuca preissiana* with occasional *Eucalyptus marginata* and *Banksia ilicifolia* (on edges) mid open forest over *Astartea scoparia, *Acacia longifolia* subsp. *longifolia*, and *Kunzea glabrescens* tall shrubland over *Lepidosperma gladiatum* and *Cyperus congestus* low open sedgeland with *Hypocalymma robustum* sparse low shrubs with **Zantedeschia aethiopica, Carpobrotus edulis, Hypochaeris glabra* and **Asparagus asparagoides* mid open forbland. This vegetation type description is based on three quadrats including two quadrats located outside the survey area east of Kwinana Freeway north of Cockburn Station. Significant population of two Declared Pests occur in this vegetation type. Inferred FCT unclear, low similarity to FCT11 – Wet Forests and Woodlands in Seasonal Wetlands.	Survey effort: two quadrats (ARM07-08) and one relevé (KW03) Species Richness: 19 native and 10 weed species Area: 10.3 ha Condition: Degraded to Good	
EmAcOp	*Eucalyptus marginata* subsp. *marginata* mid isolated trees over *Agonis flexuosa* low isolated trees over *Adenanthos cygnorum* subsp. *cygnorum* tall shrubland over **Oxalis pes-caprae, Pteridium esculentum, *Zantedeschia aethiopica, *Watsonia meriana* and **Fumaria capreolata* tall herbland. Supports significant population of Declared Pest species **Zantedeschia aethiopica*.	Survey effort: one relevé and observational data Species richness: four native and eight weed species. Area: 0.47 ha Condition: Degraded to Completely Degraded	

Code	Description	Details	Photograph
Planted			
Rehab	Comprising of Australian and local natives dominated by species from Myrtaceae, Fabaceae and Proteaceae families. Rehabilitation on road batters following clearing associated with historical freeway construction and upgrades.	Survey effort: Observation points Area: 6.04 ha	
Degraded Veg.	Trees: mature native and some non-native trees over mixed non-native shrubs and grassland Kg: *Kunzea glabrescens* thickets Mp: *Melaleuca preissiana* (mapped for Strategen, 2017) Planted: non-native species	Area: 19.05 ha	
Cleared	Devoid of vegetation including exposed soil (sand) and hard-surface	Area: 55.75 ha	



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LEGEND

- Survey Area
- Flora Quadrats

Vegetation Communities

- BaHhMp
- BaXpEc
- BmEpEc
- CcAhEc
- Cleared
- EmAcOp
- Kg
- Mp
- MpAsHr
- Planted
- Rehabilitation
- Trees
- Water

Data sources: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Vegetation Units

ARMADALE ROAD TO NORTH LAKE ROAD BRIDGE

MAIN ROADS WESTERN AUSTRALIA

Figure 7

Map Document: G:\Client_Data\MRIA\08_Armadale Road Extension\02_MXDs\04_Survey_Flora\Fig7_VegetationTypes.mxd (fotheringhamd)

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6.4 Vegetation condition

Vegetation condition ranged between Completely Degraded to Very Good. Current degrading processes include weed invasion, edge effects, significant invasive Declared Pest species, 9illegal rubbish dumping, and clearing (see Plate 2 and Plate 3).

Condition mapping is shown in Figure 8 with their total extent provided in Table 15.

Table 15 Vegetation condition mapped in the survey areas

Condition scale	Area (ha)
Very Good	11.45
Good	5.33
Degraded	8.17
Cleared	32.04
Completely Degraded	42.79

Plate 2 Illegal dumping in cleared land adjacent to wetland vegetation near Cockburn Central

Plate 3 Arum Lily Infestation in wetland vegetation east of Kwinana Freeway

6.5 Flora

6.5.1 Threatened and Priority Flora

No species listed as Declared Rare Flora or Threatened (T or X) under the WC Act or as Threatened under the EPBC Act were recorded from within the survey area. No Priority Flora species were recorded within the survey area.

The *Drakaea elastica* targeted survey did not identify any individual plants or populations within the marginal habitat present in the survey area. The habitat was considered marginal due to the significant disturbance recorded in this patch. The patch was characterised by a wetland and associated lower slopes with *Kunzea glabrescens*. Weeds represented a significant proportion of the understorey species (20-50%).

No populations of *Caladenia huegelii* were recorded within or immediately outside of the survey area. The Grand Spider Orchid (*Caladenia huegelii*) is a large terrestrial orchid growing to 60 cm tall. It has 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. The sepals end in slender light brown to yellow clubs. Its large labellum is prominently two-coloured with a pale greenish-cream base and a uniformly dark maroon recurved apex (Hopper and Brown 2001). It occurs in deep sandy soil in dense undergrowth within mixed Jarrah and Banksia woodlands.

One of the key diagnostic features is its long, fine, sometimes split fringes, which extend well above the column (Brown et al. 1998). Most *Caladenia* species observed during the survey did not have this feature, however because of the cryptic nature of the *Caladenia* genus other *Caladenia* species were also recorded within the project area. These included:

- *Caladenia arenicola* (Plate 4)
- *Caladenia flava*.

One patch of Banksia Woodland (BmBpEc) was included in the targeted *C. huegelii* survey. An area consisting of *Eucalyptus* woodland (Tuart – Vegetation unit Eg) east of the *Banksia* woodland (BmEpEc) was search in the western portion as the majority of the area was degraded and cleared. Rehabilitation areas adjacent to the Kwinana Freeway were considered unsuitable habitat

as they had been planted with a mixture of species not representative of the preferred habitat of the orchid.

Plate 4 *Caladenia arenicola* found in the survey area

6.5.2 Inventory of Flora Species

A total of 120 species from 89 genera and 44 families were recorded within the survey area. The total includes 97 (80%) locally native species and 23 (20%) introduced (exotic) or naturalised weed species.

Families with the highest native species representation are Myrtaceae (12 species), Fabaceae (11 species), and Proteaceae (9 species). The list of vascular flora species ordered by family and vegetation type in which they occur is presented in **Appendix C**. Quadrat floristic data recorded is presented in **Appendix D**.

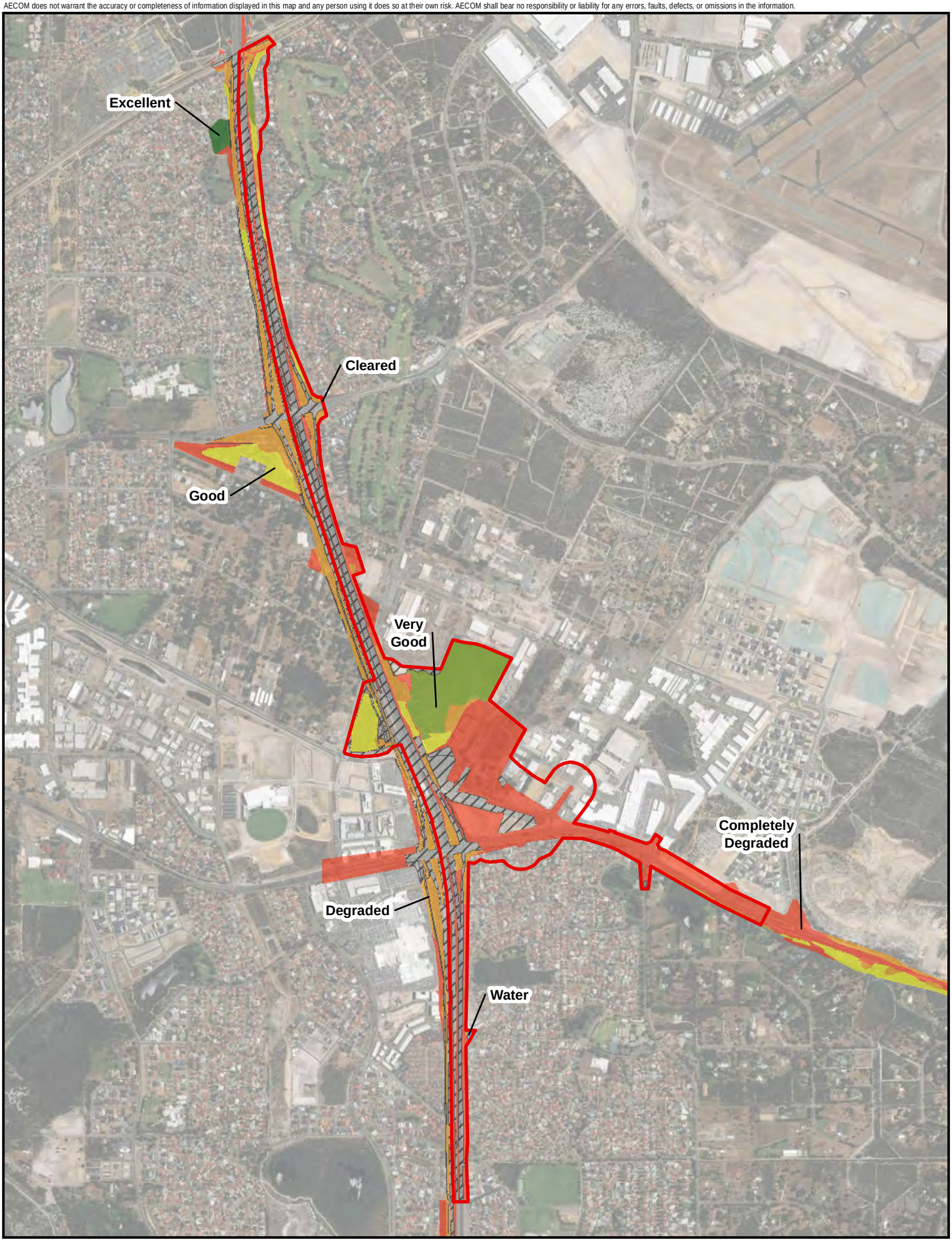
6.5.3 Weed Species

Twenty-three introduced species were recorded from the survey area. Of these three species are listed as Declared Pests, including the Arum Lily (**Zantedeschia aethiopica*), Bridal Creeper (**Asparagus asparagoides*) and Opuntioid Cactus (**Opuntia stricta*). Declared Pests are listed under the *Biosecurity and Agricultural Management Act 2007* (BAM Act). Pursuant to the BAM Act, these species are subject to restrictions on movement or sale and landholders are obliged to carry out control measures to prevent their spread.

The Arum Lily and Bridal Creeper infestations were restricted to wetland vegetation types MpAsHr and EmAcOp (Plate 3). The Optunioid Cactus was recorded in partially cleared degraded vegetation adjacent to Cockburn Central carpark.

Weeds were recorded in all quadrats and relevés. This demonstrates the degraded condition of many of the patches of vegetation and the incursion of weeds from roadsides, gardens and parklands.

Plate 5 **Left- Arum Lily infestation; Right-Bridal Creeper recorded**



PROJECT ID 60539165
CREATED BY DGF
APPROVED BY FdeWit
LAST MODIFIED 03 APR 2018

Metropolitan Road Improvement Alliance

N

DATUM GDA 1994, PROJECTION PERTH COASTAL GRID 1994

0 200 400 600 800
metres

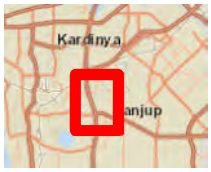
1:22,500 when printed at A4

LEGEND

Survey Area

Condition

- Cleared
- Water
- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded



Data sources: Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Vegetation Condition

ARMADALE ROAD TO NORTH LAKE ROAD BRIDGE

MAIN ROADS WESTERN AUSTRALIA

Figure

8

Map Document: G:\Client_Data\MRIA\08_Armadale Road Extension\02_MXDs\04_Survey_Flora\Fig8_VegCondition.mxd (fotheringhamd)

A4 size

7 CONCLUSION

A detailed flora and vegetation assessment was undertaken for the Armadale Road to North Lake Road Bridge project. The assessment included a desktop study, multiple field surveys, FCT analysis and reporting. Permanent quadrats were scored in July and September. A targeted *Drakaea elastica* survey was undertaken in August, and *Caladenia huegelii* surveys were completed in September.

The Banksia Woodlands of the SCP Endangered TEC listed under the EPBC Act as Endangered was mapped in two patches including Cockburn Central and Brookfield Rail/Kwinana Freeway. The TEC includes 5.87 ha of Banksia Woodlands in Good to Very Good condition. Both patches represent a Priority 3 PEC at the state level.

Six remnant native vegetation types were described and mapped, including:

- Banksia Woodland type BaHhMp (0.93 ha): inferred FCT23a, did not meet minimum condition and size threshold for TEC
- Banksia Woodland type BmEpEc (5.87 ha), inferred FCT23a, confirmed to represent the Banksia Woodlands TEC and Priority 3 PEC
- Banksia Woodland type BaXpEc (0.64 ha), considerably degraded, did not meet minimum size and condition thresholds for TEC, unlikely to represent PEC
- Wetland type MpAsHr (10.3 ha), locally and regionally significant for its hydrological and habitat refuge functions
- Wetland type EmAcOp (0.47 ha), mapped as degraded
- Marri Woodland CcAhEc (0.46 ha) isolated occurrence between noise wall and Freeway, inaccessible.

Four non-native/mostly cleared vegetation types were also mapped, including rehabilitation, Eg (*E. gomphocephala* stand on cleared land), and planted.

Targeted Threatened orchid surveys did not identify conservation significant orchid species within the survey area. No significant limitations were identified that may have affected the survey outcomes therefore it is considered unlikely that these orchids occur in the survey area.

Three Declared Pest species were recorded, including Arum Lily (**Zantedeschia aethiopica*), Bridal Creeper (**Asparagus asparagoides*) and Opuntioid Cactus (**Opuntia stricta*). Declared Pests were largely restricted to Wetland type MpAsHr and disturbed areas.

The detailed flora and vegetation assessment for the Project was completed successfully with minimal limitations identified that may have affected the outcomes of the survey results. No additional work is recommended at this time.

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Appendix A: Flora Desktop Results

Appendix A Armadale Road to North Lake Road Bridge Flora Desktop Results

The table below shows all Threatened and Priority flora species that have been historically recorded in the vicinity of the survey area and an assessment of their occurrence likelihood.

Table 1 Comprehensive desktop results based on database searches and previous biological surveys undertaken in the vicinity

Taxon	Habitat	Count Date	Flowering period	Likelihood	Cons. Code
Plants					
Acacia lasiocarpa var. *bracteolata* long peduncle variant (G.J. Keighery 5026)	Grey or black sand over clay. Swampy areas, winter wet lowlands.	1957	May-Aug	May	State: P1
Byblis gigantea	Sandy-peat swamps. Seasonally wet areas.	1991	Sep-Jan	Likely	State: P3
Caladenia huegelii	Deep sandy soils in *Banksia-Eucalyptus marginata* woodlands.	2014	Sep-Oct	Likely	EPBC Act: E WC Act: CR
Cyathochaeta teretifolia	Grey sand, sandy clay. Swamps, creek edges.	2008	Unknown	Likely	State: P3
Dampiera triloba	Sandy rises, peaty sand over clay.	2015	Aug-Dec	May	State: P3
Diuris purdiei	Under dense shrubs in seasonally-wet swamps and drainage lines. Grey black sand. Records from one population near Nicholson Road.	1990	Sep-Oct	May	EPBC Act: E WC Act: EN
Dodonaea hackettiana	Sand. Outcropping limestone.	2005	Jul-Oct	Likely	State: P4
Drakaea elastica	Grows in sandy soil in *Banksia* woodlands and tall shrublands, usually dominated by *Kunzea* thickets. White or grey sand, low-lying situations adjoining winter-wet swamps.	2005	Oct-Nov	May	EPBC Act: E WC Act: CR
Drakaea micrantha	Grows in open sandy patches where competition has been removed. Occurs in infertile grey sands in Banksia, Jarrah, and Common Sheoak woodland or forest and is often found under thickets of Spearwood (*Kunzea ericifolia*).	1988	Sep-Oct	May	EPBC Act: V WC Act: EN
Hydrocotyle striata	Clay. Springs.	1970	Unknown	Unlikely	State: P1

Taxon	Habitat	Count Date	Flowering period	Likelihood	Cons. Code
Jacksonia gracillima	Associated with edges of swamp on sandy soils.	2011	Unknown	Likely	State: P3
Jacksonia sericea	Calcereous and sandy soils. Recorded in *Banksia* and *Melaleuca preissiana* woodland.	2015	Dec-Feb	Likely	State: P4
Microtis quadrata	Sandy clay swamps, black peaty soil.	1960	Unknown	Likely	State: P4
Phlebocarya pilosissima subsp. *pilosissima*	White or grey sand, lateritic gravel.	1978	Aug-Oct	Unlikely	State: P3
Pimelea calcicola	Sand. Coastal limestone ridges.	1999	Sep-Nov	May	State: P3
Stylidium longitubum	Sandy clay, clay. Seasonal wetlands.	1973	Oct-Dec	Likely	State: P4
Stylidium paludicola	Peaty sand over clay. Winter wet habitats. Marri and Melaleuca woodland and shrublands	1999	Oct-Dec	May	State: P3
Styphelia filifolia	Recorded in Banksia woodland and low forest.	2002	Unknown	May	State: P3
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	Near winter-wet flats in low woodland with weedy grasses.	2004	Oct	Likely	WC Act: CR
Thelymitra variegata	Sandy clay, sand, laterite.	1959	Jun-Sep	Unlikely	State: P2
Tripterococcus sp. Brachylobus (A.S. George 14234)	Historically recorded winter wet flats with peaty to clay sand amongst low heath.	1999	Unknown	May	State: P4
Mushrooms					
Amanita carneiphylla	Deeply rooting in sandy soil, solitary or in small scattered groups.	2016	Unknown	Unlikely	State: P3
Amanita drummondii	No information.	2015	Unknown	Unknown	State: P3
Amanita fibrillopes	No information.	2014	Unknown	Unknown	State: P3
Amanita griseibrunnea	No information.	1995	Unknown	Unknown	State: P2
Amanita quenda	No information.	2016	Unknown	Unknown	State: P1
Amanita wadjukiorum	No information.	2015	Unknown	Unknown	State: P3
Amanita wadulawitu	No information.	2008	Unknown	Unknown	State: P2

Appendix B: Banksia Woodlands TEC Assessment Methods and Results

Appendix B Banksia Woodlands of the Swan Coastal Plain Criteria

1.0 Introduction

The Banksia Woodlands of the Swan Coastal Plain community (Banksia Woodlands) was listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) as Endangered on 16 September 2016. The Banksia Woodlands incorporates woodland of Banksia species with scattered Eucalypts and other tree species over a species rich mix of sclerophyllous shrubs, graminoids, and forbs. The community shows high endemism and considerable local variation in species composition across its range. It is restricted to the southwest of WA on the Swan Coastal Plain. It occurs mainly on deep Bassendean and Spearwood sands or occasionally on Quindalup sands. Banksia Woodlands relate to three Threatened communities at the State-level and eight Priority Ecological Communities (PECs).

2.0 Methods

The Threatened Species Scientific Committee (TSSC) developed a comprehensive conservation advice document (2016) which provides a detailed description, methods for identifying the community, current threats, research priorities and conservation actions required. Identifying this community is described in detail using four steps:

- Step 1: use key diagnostic characteristics to determine if TEC is present
- Step 2: determine condition of patch, see Section 1.3
- Step 3: consider if patch meets minimum size threshold using spatial data and aerial imagery to define the boundary of patches, see Section 1.4
- Step 4: surrounding context of a patch must be taken into account when considering factors that add to the importance of a patch that meets the condition thresholds.

The key diagnostic characteristics summarise the main features that characterise the Banksia Woodland (presented in results tables, Section 2.0). The condition categories are applied to identify the varying quality of patches, usually as a result of degradation, and ensure that patches of high quality are considered a Matter of National Significance (MNES). The condition of the patch is informed by species richness of quadrat data compared to available datasets, most notably the Gibson *et al.* (1994) and Keighery *et al.* (2012) Swan Coastal Plain datasets, and weed cover. The condition of the patch and size thresholds are then used to determine whether the quality of the patch is suitable to meet MNES standards.

A detailed flora and vegetation field survey was undertaken for the Project following methods outlined in the Flora Survey Technical Guide (EPA, 2016). Three permanent quadrats were established and scored on 21 June, 2017 by Senior Botanist Floora de Wit and Environmental Scientist Lyn van Gorp. Quadrats were scored again on 2 September, 2017 by Floora de Wit. Approximately 45 minutes was spent at each quadrat. Floristic data collected from quadrats was analysed and used to inform the Banksia TEC Assessment.

Detailed methods used for this Project is presented in Section 3 of the main Report.

2.1 Condition assessment

Determining the condition of Banksia Woodlands TEC vegetation is informed by quadrat data and species richness compared to a regional dataset (where available). The results of the condition assessment may vary slightly in scale compared to the vegetation condition mapping undertaken as part of the flora and vegetation assessment. In particular, patches are represented by quadrats located in vegetation in the best condition. Degradation of edges of patches are not mapped separately.

The condition of vegetation of each patch needs to be determined in accordance with the following:

- The condition assessment of a patch should be centred on the area of highest native floristic diversity and/or cover of the patch.
- Timing of surveys and recent disturbance should be taken into account
- Surrounding context of a patch should be considered
- Certain vegetation components of Banksia Woodlands community merit consideration as critical elements to protect. Three components are recognised as threatened in their own right i.e. Priority Ecological Communities
- A relevant expert may be useful to help identify the ecological community and its condition.
- Vegetation must be in 'Good' or better condition in accordance with Table 1.

Table 1 Condition Table

Keighery (1994) Vegetation Condition Scale	Indicative Condition Thresholds	
	Typical Native Vegetation Composition	Typical Weed Cover
Pristine No obvious signs of disturbance	Native plant species diversity fully retained or almost so[1]	Zero or almost no weed cover/abundance
Excellent Vegetation structure intact, disturbance only affecting individual species, weeds are non-aggressive species.	High native plant species diversity[1]	Less than 10%
Very Good Vegetation structure altered, obvious signs of disturbance (e.g. repeated fires, dieback, logging, grazing). Aggressive weeds present.	Moderate native plant species diversity[1]	5 – 20%
Good Vegetation structure altered but retains basic vegetation structure or ability to regenerate it. Obvious signs of disturbance (from partial clearing, dieback, logging, grazing). Presence of very aggressive weeds.	Low native plant species diversity[1]	5 – 50%
Degraded Basic vegetation structure severely impacted by disturbance. Requires intensive management. Disturbance evident such as partial clearing, dieback, logging and grazing. Presence of very aggressive weeds at high density.	Very low native plant species diversity[1]	20 – 70%
Completely Degraded Vegetation structure is no longer intact and the area	Very low to no native species diversity[1]	Greater than 70%

Keighery (1994) Vegetation Condition Scale	Indicative Condition Thresholds	
is completely or almost completely without native flora. Equivalent to 'Parkland Cleared'.		

1. relative to expected natural range of diversity for that vegetation unit e.g. Floristic Community Type where comparative data exists.

2.2 Patch size thresholds

Minimum patch size thresholds vary according to the vegetation condition, including:

- Pristine – no minimum patch size
- Excellent – 0.5 ha or 5,000 m^2 (50 x 100 m)
- Very Good – 1 ha or 10,000 m^2 (100 x 100 m)
- Good – 2 ha or 20,000 m^2 (200 x 100 m)'

2.3 Patch context

Contextual information for each patch that may affect the outcome of the TEC assessment should be considered. The Conservation Advice (TSSC, 2016) details a number of contextual factors, the most relevant for this Project include:

- Land use history and landscape position of patch including position relative to surrounding vegetation
- Patch size, variation in condition, and functionality. Tracks, breaks and gaps within a patch that are less than 30 m and do not significantly alter the overall functionality of the ecological community are considered part of the same patch.
- Variation in canopy cover, quality or condition of vegetation across a patch should not be considered evidence of multiple patches
- A minimum buffer zone of 20-50 m is recommended for all patches of Banksia Woodlands TEC. Buffer zones ideally comprise a contiguous area immediately adjacent to a patch of the ecological community. Larger buffer zones should be considered for patches of particularly high conservation value, or if patches are down slope of drainage lines or a source of nutrient enrichment, or groundwater drawdown.
- Restored vegetation is not excluded provided it meets the key diagnostic criteria, condition threshold and patch size.
- Identify limitations that may have affected the TEC assessment outcome, including survey effort, sample size, seasonality, historical disturbance, etc.
- Surrounding environment, landscape context and other significance considerations including biodiversity (areas with high diversity and low disturbance provide greater value), and habitat corridors/linkages.

3.0 TEC Assessment Results

3.1 Patch 1 Cockburn Central

Patch 1 includes an area of remnant native vegetation located north of Cockburn Central train station. This area was identified in the desktop study as potentially representing the Banksia Woodland TEC and was therefore represented by three permanent quadrats. The area is bordered by Kwinana Freeway, light industrial land use and a wetland.

The TEC assessment confirmed that the Banksia vegetation of patch 1 represents the Banksia Woodland TEC. The presence of the wetland, and potential habitat refuge values add to the overall functionality and value of the patch. The vegetation condition varies within the patch between Good to Very Good due to invasion of significant weed infestations. Two Declared Pest weeds were recorded just outside the boundary of the TEC which have the potential to spread.

Location	Northeast of Kwinana Freeway and Cockburn Central train station.
Key diagnostic characteristics	Meets all diagnostic characteristics, outlined in Table below.
Condition	Good to Very Good. 0.5-62% weed foliage cover (Veldt Grass had highest foliage cover). Two Declared Pest species recorded at edge of patch (**Zantedeschia aethiopica* and **Asparagus asparagoides*). 36-48 flora species recorded in Quadrats.
Patch size	5.87 ha
Additional features	Patch provides limited linkage between vegetation patch west of Kwinana Freeway and Jandakot native vegetation. Area not easily accessible to the public thereby giving it more protection from inappropriate use (rubbish dumping etc.).
Land use history	Remnant native vegetation affected by degradation from surrounding urban development. Banksia vegetation is adjacent to *M. preissiana* wetland vegetation. Patch likely affected by stormwater runoff due to low geographical position.
Any variations in patch	Yes, edge effects, rubbish dumping, weed invasion, encroachment of road rehabilitation species.
Buffer zone present	Buffer present along 50% of patch edge. Buffer includes a wetland classified as Multiple Use which retains native riparian Paperbark woodland. The southeast edge is bordered by cleared land which has retained native and non-native tall trees over perennial common weed species. The west edge is bordered by the Kwinana Freeway road reserve which includes a mix of native and non-native species and includes some thickets of *Kunzea* shrubs. Urban development borders the remaining edges.
Sampling protocol	Three permanent quadrats were scored on 21 June and 2 September, 2017 by Floora de Wit. Approximately 45

	minutes was spent at each quadrat.
Disturbance history	Indirect impacts from urban development.
Surrounding environment	Adjacent land use includes Kwinana Freeway (west), Cockburn Central train station (south), and light industrial (southeast, east and north), and a wooded wetland (northeast).

Plate 1 Photographs of varying condition within patch

Key diagnostic characteristics	Response
Location and physical environment	
Patch on Swan Coastal Plain or adjacent lower parts of the Darling and Whicher escarpments that lie within the Jarrah Forest bioregion to the immediate east and south of the Swan Coastal Plain.	Swan Coastal Plain
Soils and landform	
Typically occurs on: deep Bassendean, Spearwood sands, occasionally on Quindalup sands, sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau. Sometimes on transitional substrates, sandflats.	Bassendean Sands
Structure: The structure of the ecological community is a low woodland to forest with the following features:	
Distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated by one or more of the *Banksia* species identified below. Highly species-rich understorey that consists of 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.	Low open woodland dominated by *Banksia attenuata, Banksia menziesii* and patches of *Eucalyptus todtiana.* occasional *Nuytsia floribunda* recorded. Understorey includes rushes, sedges, sclerophyllous shrubs, herbs and a grassland stratum.
Composition	
Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *Banksia menziesii.* Other *Banksia* species that dominate in some examples are *B. prionotes* or *B. ilicifolia*. Must include at least one of the following diagnostic species: • Banksia attenuata • Banksia menziesii • Banksia prionotes • Banksia ilicifolia Emergent tree layer often includes *Corymbia calophylla, E. marginata,* or less commonly *E. gomphocephala*. Other trees of a medium height may be present and may be co-dominant with the Banksia species across a patch, include *E. todtiana, Nuytsia floribunda, Allocasuarina fraseriana, Callitris arenaria*, *Callitris pyramidalis* and *Xylomelum occidentale*.	The two dominant *Banksia* trees represent 8 - 58% of overstorey foliage cover. Patches of *E. todtiana* representing 15% foliage cover. Vegetation includes 30 sclerophyllous shrubs (5-40% cover), three sedges (0.5-1%), four rushes (2-18%), 35 herbs (4-14%) and three grasses (weeds; 0.2-60%). Weed invasion at edge of patch.
Contra-indicators	
Patches clearly dominated by *Banksia littoralis* are not part of the TEC	No
Patches clearly dominated by *Banksia burdettii* are not the TEC	No

FCT20c – Eastern shrublands and woodlands, corresponds with a separate EPBC ecological community listing, Shrublands and Woodlands of the eastern Swan Coastal Plain. Occurrences of this FCT should be considered under that separate listing.	No

3.3 Patch 2 Brookfield Rail/Kwinana Freeway

Patch 2 includes a small linear corridor of remnant native vegetation bordered by Kwinana Freeway, Brookfield Rail and a noise wall abutting residential houses. This small patch represents an isolated patch of native vegetation that was not cleared for Kwinana Freeway. The vegetation has been isolated from other areas of native vegetation, and subject to a number of impacts including weed invasion, garden plant escapees, rubbish, and edge effects. The diversity of native species was low, in particular the herbs which have been replaced by perennial weeds such as Veldt Grass and Pelargonium.

This patch is **not considered** to represent the Banksia Woodland TEC. It does not meet the minimum size and condition thresholds for Very Good condition at 0.93 ha. The value of this patch is further reduced by its isolation, inaccessible to non-aerial native fauna, and has no buffer.

Location	Southeast corner of Brookfield Rail and Kwinana Freeway intersection in Jandakot.
Key diagnostic characteristics	Meets all key diagnostic characteristics. Low biodiversity of understorey strata caused by weed invasion and isolation of patch from other areas of native vegetation.
Condition	Very Good, 35-39 species per quadrat, weed cover 1-2% in quadrats, significant weed invasion on edge of patch.
Patch size	0.93 ha
Additional features	Isolated, no buffer, limited value as habitat refuge.
Land use history	Surrounding vegetation cleared around 1995 for Kwinana Freeway construction. Urban development encroaching area since 1985.
Any variations in patch	Significant edge effects, invasive weed species has reduced understorey biodiversity, escaped garden plants are establishing, roadside rehabilitation species are encroaching.
Buffer zone present	No buffer present. Road reserve may be considered to have some buffer qualities.
Sampling protocol	Two permanent quadrats were established and scored on 26 June and again on 2 September, 2017 by Floora de Wit. Approximately 45 minutes was spent at each quadrat.
Disturbance history	Surrounding vegetation cleared for development which has isolated this patch from other areas of native vegetation.
Surrounding environment	Patch is confined between Kwinana Freeway and some young rehabilitated road reserve and a noise wall directly adjacent to houses. Landscaping and the rail access track has created mounds of sand along the north edge supporting escaped garden plants, weeds and some native species.

Plate 2 Patch 2 confined between Kwinana Freeway, Brookfield Rail and a noise wall

Key diagnostic characteristics	Response
Location and physical environment	
Patch on Swan Coastal Plain or adjacent lower parts of the Darling and Whicher escarpments	Swan Coastal Plain
Soils and landform	
Typically occurs on: deep Bassendean, Spearwood sands, occasionally on Quindalup sands, sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau.	Bassendean Sands
Structure: The structure of the ecological community is a low woodland to forest with the following features:	
Distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated by one or more of the *Banksia* species identified below. Highly species-rich understorey that consists of 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.	*Banksia menziesii* and *B. attenuata* represent 6-15% of canopy foliage cover co-dominated by *Eucalyptus marginata* subsp. *marginata* representing 5-10% canopy cover. Understorey biodiversity reduced as a result of weed invasion and displacement.
Composition	

Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *Banksia menziesii.* Other *Banksia* species that dominate in some examples are *B. prionotes* or *B. ilicifolia*. Must include at least one of the following diagnostic species: • Banksia attenuata • Banksia menziesii • Banksia prionotes • Banksia ilicifolia Emergent tree layer often includes *Corymbia calophylla, E. marginata,* or less commonly *E. gomphocephala*. Other trees of a medium height may be present and may be co-dominant with the Banksia species across a patch, include *E. todtiana, Nuytsia floribunda, Allocasuarina fraseriana, Callitris arenaria*, *Callitris pyramidalis* and *Xylomelum occidentale*.	Canopy co-dominated by *B. menziesii, B. attenuata* and *E. marginata* subsp. *marginata.* Understorey includes 23 sclerophyllous shrubs (30-40%), three sedges (0.5-5%), two rushes (0.5%), 12 herbs (sparse; 0.5-1%) and one grass (1-2%). Species would increase with additional survey effort.
Contra-indicators	
Patches clearly dominated by *Banksia littoralis* are not part of the TEC	No
Patches clearly dominated by *Banksia burdettii* are not the TEC	No
FCT20c – Eastern shrublands and woodlands is not the TEC	No

3.5 Patch 3 Kentucky Court

This patch **does not represent** the Banksia Woodlands of the Swan Coastal Plain TEC. The community appears to represent an ecotone between planted/disturbed vegetation, the adjacent *M. preissiana* wetland community, and FCT21c – Low lying *B. attenuata* shrubland or woodland (see Patch 3). Given its isolation from other patches of native vegetation, planted species have invaded and dominate the tall shrub strata. *Banksia* species are present in low densities, and the patch is restricted to 0.64 ha.

The patch is considered Degraded due to the high weed cover and low species diversity. This, along with the patch size and lacking some of the key diagnostic characteristics, support the assessment that it **does not** meet the criteria to be considered the Banksia Woodlands of the Swan Coastal Plain TEC.

Location	Ecotone patch on the corner of Kentucky Court and North Lake Road
Key diagnostic characteristics	Does not meet key diagnostic criteria
Condition	Degraded – weed cover 20-70%, very low native species diversity.
Patch size	0.64 ha
Additional features	Buffer zone to wetland community
Land use history	No clearing in past 20 years.
Any variations in patch	Significant variation of species present as dictated by presence of weeds including **Acacia longifolia* and **Zantedeschia aethiopica*.
Buffer zone present	No, adjacent to wetland, roadside rehabilitation and cleared areas.
Sampling protocol	One 10x10 quadrat scored in winter and spring of 2017.
Disturbance history	No historical clearing evident. Significant weed invasion.
Surrounding environment	Cleared, planted, and wetland.

Plate 3 Patch 4represented by KW02

Key diagnostic characteristics	Response
Location and physical environment	
Patch on Swan Coastal Plain or adjacent lower parts of the Darling and Whicher escarpments that lie within the Jarrah Forest bioregion to the immediate east and south of the Swan Coastal Plain.	Swan Coastal Plain
Soils and landform	
Typically occurs on: deep Bassendean, Spearwood sands, occasionally on Quindalup sands, sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau. Sometimes on transitional substrates, sandflats.	Bassendean Sands

Structure: The structure of the ecological community is a low woodland to forest with the following features:	
Distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated by one or more of the *Banksia* species identified below; AND Emergent trees *Eucalyptus* or *Allocasuarina* species may sometimes be present above the *Banksia* canopy; AND Highly species-rich understorey that consists of 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.	Some *E. marginata* present, no species rich understorey due to invasive species and historical disturbance.
Composition	
Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *Banksia menziesii.* Other *Banksia* species that dominate in some examples of the ecological community are *B. prionotes* or *B. ilicifolia*; AND Must include at least one of the following diagnostic species: • *Banksia attenuata* • *Banksia menziesii* • *Banksia prionotes* • *Banksia ilicifolia* Emergent tree layer often includes *Corymbia calophylla, E. marginata,* or less commonly *E. gomphocephala*; AND Other trees of a medium height may be present and may be co-dominant with the *Banksia* species across a patch, include *E. todtiana, Nuytsia floribunda, Allocasuarina fraseriana, Callitris arenaria, Callitris pyramidalis* and *Xylomelum occidentale*; AND	Not mostly dominated by *Banksia* species. No high diversity of shrub and herb species. Aligns with FCT21a Central *B. attenuata-E. marginata* woodlands of which it represents 26% species richness.
Contra-indicators	
Patches clearly dominated by *Banksia littoralis* are not part of the TEC	No
Patches clearly dominated by *Banksia burdettii* are not the TEC	No
FCT20c – Eastern shrublands and woodlands, corresponds with a separate EPBC ecological community listing, Shrublands and Woodlands of the eastern Swan Coastal Plain. Occurrences of this FCT should be considered under that separate listing.	No

Appendix C: Flora Species List, Armadale/North Lake Road Bridge Project, 2017

Appendix C Flora Species List, Armadale/North Lake Road Bridge Project, 2017

Note: * denotes weed species and DP identifies Declared Pest species

Family	Taxon	BaHhMp	BaXpEc	BmAhLb	MpAsHr	EmAcOp	Non-native
Aizoaceae							
	* *Carpobrotus edulis*		x				x
Anarthriaceae							
	Lyginia barbata	x		x			
Araceae							
	* DP *Zantedeschia aethiopica*		x	x	x	x	
Araliaceae							
	Trachymene pilosa			x			
Asparagaceae							
	Laxmannia squarrosa	x		x			
	Lomandra caespitosa			x			
	Lomandra hermaphrodita	x		x			
	Lomandra micrantha			x			
	Lomandra nigricans			x			
	Lomandra preissii	x	x	x			
	* DP *Asparagus asparagoides*		x	x	x		
Asteraceae							
	* *Hypochaeris glabra*			x	x	x	x
	* *Ursinia anthemoides*			x			x
	* *Arctotheca calendula*	x		x		x	x
	* *Sonchus ?oleraceus*			x		x	x
	* *Conyza bonariensis*	x					x
Cactaceae							
	* DP *Opuntia stricta*						x
Casuarinaceae							
	Allocasuarina humilis	x		x			
Colchicaceae							
	Burchardia congesta	x		x			
Crassulaceae							
	Crassula colorata var. *colorata*			x			
Cyperaceae							
	Cyperus congestus				x		
	Lepidosperma gladiatum				x		
	Lepidosperma leptostachuym	x					

Appendix C Flora Species List, Armadale/North Lake Road Bridge Project, 2017

Note: * denotes weed species and DP identifies Declared Pest species

Family		Taxon	BaHhMp	BaXpEc	BmAhLb	MpAsHr	EmAcOp	Non-native
		Lepidosperma squamatum			x			
		Mesomelaena pseudostygia	x					
		Schoenus clandenstinus	x					
		Schoenus curvifolius			x			
		Schoenus laevigatus			x			
Dasypogonaceae								
		Dasypogon bromeliifolius	x	x	x	x		
Dennstaedtiaceae								
		Pteridium esculentum				x	x	
Dilleniaceae								
		Hibbertia huegelii	x					
		Hibbertia hypericoides	x		x			
		Hibbertia subvaginata			x			
Droseraceae								
		Drosera erythrorhiza subsp. *erythrorhiza*			x			
		Drosera pallida	x		x			
Ericaceae								
		Astroloma sp.			x			
		Conostephium pendulum			x			
Euphorbiaceae					x			
	*	*Euphorbia terracina*			x			x
Fabaceae								
		Acacia pulchella var. *glaberrima*	x		x	x		
		Bossiaea eriocarpa	x	x	x			
		Daviesia divaricata subsp. *divaricata*	x					
		Daviesia nudiflora	x					
		Daviesia triflora	x		x			
		Gastrolobium capitatum			x			
		Gompholobium tomentosum	x		x	x		
		Hardenbergia comptoniana	x					
		Hovea pungens			x			
		Hovea trisperma	x		x			
		Jacksonia furcellata			x			
	*	*Acacia longifolia* subsp. *longifolia*		x	x	x		x

Appendix C Flora Species List, Armadale/North Lake Road Bridge Project, 2017

Note: * denotes weed species and DP identifies Declared Pest species

Family		Taxon	BaHhMp	BaXpEc	BmAhLb	MpAsHr	EmAcOp	Non-native
	*	*Acacia* sp. Planted				x		x
Geraniaceae								
	*	*Pelargonium capitatum*	x			x		x
Goodeniaceae								
		Dampiera linearis		x	x			
		Scaevola canescens	x					
Haemodoraceae								
		Anigozanthos humilis subsp. *humilis*			x			
		Anigozanthos manglesii subsp. *manglesii*			x			
		Conostylis aurea			x			
		Conostylis juncea			x			
		Conostylis setigera subsp. *setigera*		x				
		Conostylis setosa	x					
		Haemodorum laxum			x			
Hemerocallidaceae								
		Arnocrinum preissii			x			
		Caesia micrantha		x				
		Dianella revoluta			x			
Iridaceae								
		Patersonia occidentalis	x		x			
	*	*Watsonia ? meriana*					x	x
	*	*Gladiolus caryophyllaceus*	x	x	x	x		
	*	*Romulea rosea*				x		
Lauraceae								
		Cassytha ?glabella forma *racemosa*				x		
Loranthaceae					x	x		
		Nuytsia floribunda			x	x		
Montiaceae								
		Calandrinia glandulifera			x			
Myrtaceae								
		Agonis flexuosa				x	x	
		Astartea scoparia				x		
		Calytrix flavescens			x			
		Calytrix sp.	x					

Appendix C Flora Species List, Armadale/North Lake Road Bridge Project, 2017

Note: * denotes weed species and DP identifies Declared Pest species

Family		Taxon	BaHhMp	BaXpEc	BmAhLb	MpAsHr	EmAcOp	Non-native
		Eremaea pauciflora	x	x	x			
		Eucalyptus marginata subsp. *marginata*	x	x			x	
		Eucalyptus todtiana			x			
		Hypocalymma robustum	x		x	x		
		Kunzea glabrescens		x	x	x		
		Leptospermum spinescens			x			
		Melaleuca preissiana				x		
		Scholtzia involucrata	x		x			
Oleaceae								
		Olea europaea	x					x
Orchidaceae								
		Caladenia flava subsp. *flava*			x	x		
		Diuris corymbosa		x	x			
		Pterostylis sanguineus	x		x	x		
		Pterostylis sp.				x		
Oxalidaceae								
	*	*Oxalis pes-caprae*					x	x
Papaveraceae								
	*	*Fumaria capreolata*	x	x	x	x	x	
Pittosporaceae								
		Billardiera ?fusiformis	x					
Poaceae								
		Amphipogon turbinatus	x					
	*	*Avena barbata*	x		x			x
	*	*Briza maxima*	x		x	x		x
	*	*Ehrharta calycina*	x		x			x
Polygalaceae					x			
		Comesperma confertum			x			
Primulaceae			x					
		Lysimachia arvensis	x				x	
Proteaceae								
		Adenanthos cygnorum subsp. *cygnorum*	x		x			
		Adenanthos obovatus		x		x		
		Banksia attenuata	x		x			

Appendix C Flora Species List, Armadale/North Lake Road Bridge Project, 2017

Note: * denotes weed species and DP identifies Declared Pest species

Family	Taxon	BaHhMp	BaXpEc	BmAhLb	MpAsHr	EmAcOp	Non-native
	Banksia ilicifolia		x				
	Banksia littoralis				x		
	Banksia menziesii	x		x			
	Petrophile linearis	x		x			
	Stirlingia latifolia	x		x			
Restionaceae							
	Desmocladus fasciculatus			x			
	Desmocladus flexuosus	x		x			
	Dielsia stenostachya				x		
	Hypolaena exsulca			x			
Rhamnaceae							
	Spyridium globulosum	x					
Rubiaceae							
	Opercularia vaginata	x					
Rutaceae							
	Philotheca spicata			x			
Solanaceae							
*	*Solanum nigrum*	x		x			x
* DP	*Solanum linnaeanum*						x
Stylidiaceae							
	Stylidium repens			x			
Xanthorrhoeaceae							
	Xanthorrhoea preissii	x	x	x	x		
Zamiaceae							
	Macrozamia riedlei	x		x			

Appendix D: Quadrat Data

Appendix D Armadale Quadrat Data

Releve Arm01	**Location:** -32.128834 115.87023	**Survey 1:** 21/6/2017
Topography: Lower Slope	**Soils:** Sand, dry	**Colour:** White
Vegetation description: Pteridium esculentum degraded wetland edge with grasses		
TEC: None		
Condition: Degraded, fence, weeds		
Additional notes: Roadside edge, wetland edge. Wetland partly filled with planted vegetation.		

*	Taxon	Height cm	Foliage %
	Adenanthos cygnorum subsp. *cygnorum*	250	15
	Agonis flexuosa	700	5
	Eucalyptus marginata subsp. *marginata*	1600	5
*	*Fumaria capreolata*	20	0.1
*	*Oxalis pes-caprae*	30	25
	Pteridium esculentum	100	50
*	*Watsonia ? meriana*	120	5
* DP	*Zantedeschia aethiopica*	70	2

Note: * depicts an introduced (weed) species

Quadrat Arm02	Location: -32.122767 115.85857	Survey Date 1: 21/6/2017 Survey Date 2: 02/9/2017
Topography: Mid Slope	Soils: Sand, dry	Colour: Grey
Vegetation description: BmAhLb Banksia woodland		
TEC: Banksia woodland of the SCP (Endangered), Banksia Dominated Woodlands of the SCP (P3)		
Condition: Good, weeds		
Additional notes: Grass dominated understorey, opuntia nearby, open overstorey		

*	Taxon	Height cm	Foliage %
	Adenanthos cygnorum subsp. *cygnorum*	250	Oppo
	Arnocrinum preissii	40	0.1
* DP	*Asparagus asparagoides*	10	Oppo
	Astroloma pallidum	20	0.2
*	*Avena barbata*	50	1
	Banksia attenuata	500	0.3
	Banksia menziesii	1000	15
	Bossiaea eriocarpa	30	0.01
*	*Briza maxima*	30	0.2
	Burchardia congesta	80	0.1
	Conostephium pendulum	40	0.2
	Conostylis aurea	30	0.1
	Crassula colorata var. *colorata*	5	0.1
	Dampiera linearis	30	0.4
	Desmocladus flexuosus	20	0.1
	Drosera pallida		0.1

*	Taxon	Height cm	Foliage %
*	*Ehrharta calycina*	80	60
	Eucalyptus todtiana	1100	15
*	*Fumaria capreolata*	5	0.1
*	*Gladiolus caryophyllaceus*	60	0.1
	Gompholobium tomentosum	100	1
	Haemodorum laxum		
	Hibbertia hypericoides	70	3
	Hibbertia subvaginata	30	0.2
	Hovea pungens	40	0.2
	Hypocalymma robustum	40	0.2
*	*Hypochaeris glabra*		0.4
	Lomandra preissii	40	0.1
	Lyginia barbata	50	2
	Nuytsia floribunda	500	0
	Patersonia occidentalis	40	5
	Petrophile linearis	20	0.2
	Philotheca spicata	30	0.2
	Scholtzia involucrata	30	0.3
*	*Solanum nigrum*	40	Oppo
	Stirlingia latifolia	20	0.1
	Stylidium repens	10	0.1
	Trachymene pilosa	2	0.1
*	*Ursinia anthemoides*	4	0.01
	Xanthorrhoea preissii		

Note: * depicts an introduced (weed) species

Quadrat Arm03	**Location:** -32.121728 115.858333	**Survey Date 1:** 21/6/2017 **Survey Date 2:** 02/9/2017
Topography: Mid Slope	**Soils:** Sandy loam, dry	**Colour:** Medium Brown
Vegetation description: BmAhLb Banksia woodland		
TEC: Banksia woodland of the SCP (Endangered), Banksia Dominated Woodlands of the SCP (P3)		
Condition: Very Good, near track		
Additional notes:		

*	Taxon	Height cm	Foliage %
	Acacia pulchella var. *glaberrima*	80	2
	Adenanthos cygnorum subsp. *cygnorum*	30	0.01
	Allocasuarina humilis	190	5
	Anigozanthos manglesii subsp. *manglesii*	70	0.5
* DP	*Asparagus asparagoides*	10	Oppo
*	*Avena barbata*	90	0.02
	Banksia attenuata	1000	0.1
	Banksia menziesii	1000	8
	Bossiaea eriocarpa	60	0.5
*	*Briza maxima*	25	0.2
	Burchardia congesta	80	0.02
	Caladenia flava subsp. *flava*	5	0.1
	Calytrix flavescens	30	3
	Comesperma confertum	50	0.1
	Conostephium pendulum		
	Conostylis aurea	30	0.1

*	Taxon	Height cm	Foliage %
	Crassula colorata var. *colorata*	2	0.1
	Dampiera linearis	25	0.5
	Dasypogon bromeliifolius	60	0.5
	Daviesia triflora	80	3
	Desmocladus fasciculatus	15	0.1
	Desmocladus flexuosus	20	1
	Drosera erythrorhiza subsp. *erythrorhiza*	0	0.1
	Drosera pallida	40	0.01
	Eremaea pauciflora	90	10
	Eucalyptus todtiana	800	0
*	*Fumaria capreolata*	20	0.1
*	*Gladiolus caryophyllaceus*	50	0.02
	Hibbertia subvaginata	20	3
	Hovea pungens		
*	*Hypochaeris glabra*	0	0.2
	Kunzea glabrescens	160	1
	Laxmannia squarrosa	10	0.02
	Leptospermum spinescens	130	0.1
	Lomandra caespitosa	30	0.1
	Lomandra micrantha	40	1
	Lomandra nigricans	30	0.01
	Lomandra preissii	40	0.01
	Lyginia barbata	70	3
	Macrozamia riedlei	150	Oppo
	Nuytsia floribunda	700	Oppo
	Petrophile linearis	20	0.01
	Philotheca spicata		
	Pterostylis sanguineus	17	0.01
	Schoenus curvifolius	20	0.1
	Scholtzia involucrata	30	0.01
	Stirlingia latifolia	110	10
	Trachymene pilosa	2	0.1
*	*Ursinia anthemoides*	5	0.1
	Xanthorrhoea preissii	140	1
	Schoenus grandiflorus	30	0.5

Note: * depicts an introduced (weed) species

Quadrat Arm04	Location: -32.121886 115.857616	Survey Date 1: 21/6/2017 Survey Date 2: 02/9/2017
Topography: Mid Slope	Soils: Sand, moist	Colour: Medium Brown
Vegetation description: BmAhLb Banksia woodland		
TEC: Banksia woodland of the SCP (Endangered), Banksia Dominated Woodlands of the SCP (P3)		
Condition: Very Good, weeds		
Additional notes:		

*	Taxon	Height cm	Foliage %
*	*Acacia longifolia* subsp. *longifolia*	120	Opp
	Acacia pulchella var. *glaberrima*		Opp
	Adenanthos cygnorum subsp. *cygnorum*		Opp
	Anigozanthos humilis subsp. *humilis*		Opp
	Anigozanthos manglesii subsp. *manglesii*	10	0.1
*	*Arctotheca calendula*	5	0.1
	Arnocrinum preissii		Opp
* DP	*Asparagus asparagoides*	10	0.01
	Banksia attenuata	1100	50
	Banksia menziesii	800	8
*	*Briza maxima*	20	1
	Burchardia congesta	70	0.05
	Caladenia flava subsp. *flava*	10	0.01
	Calandrinia granulifera		Opp
	Comesperma confertum	30	0.02
	Conostephium pendulum	40	0.1

*	Taxon	Height cm	Foliage %
	Conostylis aurea	30	0.1
	Conostylis juncea	20	Opp
	Dampiera linearis	17	0.02
	Dasypogon bromeliifolius	40	10
	Desmocladus flexuosus	15	18
	Dianella revoluta var. divaricata		Opp
	Diuris corymbosa		Opp
*	*Ehrharta calycina*	80	5
	Eremaea pauciflora	60	3
	Eucalyptus todtiana	1000	15
*	*Euphorbia terracina*		Opp
*	*Fumaria capreolata*	20	0.01
	Gastrolobium capitatum	80	Opp
*	*Gladiolus caryophyllaceus*	70	0.2
	Hibbertia hypericoides	90	7
	Hibbertia subvaginata	40	3
	Hovea pungens		
	Hovea trisperma	20	Opp
	Hypolaena exsulca		0.1
	Jacksonia furcellata		Opp
	Kunzea glabrescens		Opp
	Laxmannia squarrosa		Opp
	Lepidosperma squamatum	50	1
	Lomandra hermaphrodita	20	0.01
	Lomandra micrantha	30	0.1
	Lomandra nigricans		Opp
	Lomandra preissii	40	2
	Nuytsia floribunda	120	0.5
	Patersonia occidentalis	50	1
	Philotheca spicata	50	Opp
	Schoenus curvifolius		Opp
*	*Solanum nigrum*	40	0.2
*	*Sonchus ?oleraceus*	15	Opp
	Stirlingia latifolia		Opp
* DP	*Zantedeschia aethiopica*	15	0.02

Note: * depicts an introduced (weed) species

Quadrat Arm05	Location: -32.120368 115.861179	Survey Date 1: 26/7/2017 Survey Date 2: 02/9/2017
Topography: Wetland	Soils: Sand, moist	Colour: Dark Brown
Vegetation description: MpAsHr M. preissiana over thicket Astartea over weeds		
TEC: None		
Condition: Very Good, wetland		

*	Taxon	Height cm	Foliage %
*	*Acacia longifolia* subsp. *longifolia*	700	25
	Acacia pulchella var. *glaberrima*		
	Adenanthos obovatus		
* DP	*Asparagus asparagoides*		3
	Astartea scoparia	250	50
	Banksia littoralis		
*	*Briza maxima*	50	10
	Cassytha ?glabella forma *racemosa*		4
	Dasypogon bromeliifolius		
*	*Fumaria capreolata*	20	0.1
	Gompholobium tomentosum		
	Hypocalymma robustum	100	4
*	*Hypochaeris glabra*	1	3
	Melaleuca preissiana	700	25
	Nuytsia floribunda		
	Xanthorrhoea preissii		

Note: * depicts an introduced (weed) species

Quadrat Arm06	**Location:** -32.120246 115.859738	**Survey Date 1:** 26/7/2017 **Survey Date 2:** 02/9/2017
Topography: Wetland	**Soils:** Clay loam, moist	**Colour:** Black
Vegetation description: MpAsHr M. preissiana over thicket Astartea over weeds		
TEC: None		
Condition: Very Good, wetland		
Additional notes:		

*	Taxon	Height cm	Foliage %
*	*Acacia longifolia* subsp. *longifolia*	500	20
* DP	*Asparagus asparagoides*		1
	Astartea scoparia	250	30
*	*Briza maxima*	40	10
	Caladenia flava subsp. *flava*	20	0.1
*	*Fumaria capreolata*	20	0.1
*	*Gladiolus caryophyllaceus*	100	0.1
	Hypocalymma robustum	100	8
*	*Hypochaeris glabra*	2	5
	Kunzea glabrescens	300	
	Lepidosperma gladiatum	40	10
	Melaleuca preissiana	1200	15
	Pterostylis sanguineus	30	0.2
	Pterostylis vittata	10	0.01
*	*Romulea rosea*	10	1

Note: * depicts an introduced (weed) species

Quadrat Arm07	**Location:** -32.096753 115.849986	**Survey Date 1:** 26/6/2017 **Survey Date 2:** 02/9/2017
Topography: Flat	**Soils:** Sand	**Colour:** Medium Brown
Vegetation description: BaHhMp E. marginata and Banksia over native shrubs		
TEC: Banksia Dominated Woodlands of the SCP (P3)		
Condition: Good, weeds		
Additional notes:		

*	Taxon	Height cm	Foliage %
	Acacia pulchella var. *glaberrima*	70	0.4
	Adenanthos cygnorum subsp. *cygnorum*		Opp
	Allocasuarina humilis	120	8
	Amphipogon turbinatus	40	0.1
*	*Avena barbata*	80	0.3
	Banksia attenuata	500	Opp
	Banksia menziesii	500	6
	Billardiera ?fusiformis		Opp
*	*Briza maxima*	20	0.3
	Burchardia congesta	30	0.03
	Calytrix flavescens	40	0.2
	Conostylis setosa	10	0.1
	Daviesia divaricata subsp. *divaricata*	100	1
	Daviesia triflora		
	Desmocladus flexuosus	20	0.3
	Drosera pallida	30	0.01

*	Taxon	Height cm	Foliage %
*	*Ehrharta calycina*	80	0.5
	Eremaea pauciflora	80	6
	Eucalyptus marginata subsp. *marginata*	600	5
*	*Gladiolus caryophyllaceus*	30	0.1
	Hardenbergia comptoniana		Opp
	Hibbertia huegelii	20	0.1
	Hibbertia hypericoides	70	3
	Hovea trisperma	40	0.01
	Hypocalymma robustum	20	0.1
	Laxmannia squarrosa	10	0.01
	Lepidosperma leptostachyum		Opp
	Lomandra hermaphrodita	20	0.1
	Lomandra preissii		Opp
	Lysimachia arvensis	5	0.1
	Macrozamia riedlei		Opp
	Mesomelaena pseudostygia	70	0.5
	Opercularia vaginata	20	0.1
	Petrophile linearis	30	0.2
	Pterostylis sanguineus		Opp
	Scaevola canescens	15	Opp
	Schoenus clandestinus	10	0.01
	Scholtzia involucrata	40	1
	Stirlingia latifolia	120	5
	Xanthorrhoea preissii	120	4

Note: * depicts an introduced (weed) species

Quadrat Arm08	**Location:** -32.097660 115.850018	**Survey Date 1:** 26/6/2017 **Survey Date 2:** 02/9/2017
Topography: Mid Slope	**Soils:** Sand, dry	**Colour:** Medium Brown
Vegetation description: BaHhMp E. marginata and Banksia over native shrubs		
TEC: Banksia Dominated Woodlands of the SCP (P3)		
Condition: Good, weeds		
Additional notes:		

*	Taxon	Height cm	Foliage %
	Allocasuarina humilis	60	1
*	*Arctotheca calendula*	5	0.01
*	*Avena barbata*	50	0.05
	Banksia attenuata	700	10
	Banksia menziesii	700	5
	Bossiaea eriocarpa	20	0.1
*	*Briza maxima*	25	0.4
	Burchardia congesta	30	0.02
*	*Conyza bonariensis*	120	0.1
	Dasypogon bromeliifolius	25	Opp
	Daviesia nudiflora	50	0.5
	Desmocladus flexuosus	20	0.2
*	*Ehrharta calycina*	60	1
	Eucalyptus marginata subsp. *marginata*	1100	10
*	*Fumaria capreolata*	15	0.2
*	*Gladiolus caryophyllaceus*	50	0.05

*	Taxon	Height cm	Foliage %
	Gompholobium tomentosum	30	0.1
	Hardenbergia comptoniana	40	1
	Hibbertia hypericoides	40	20
	Hovea trisperma	20	0.1
	Hypocalymma robustum	80	6
	Lepidosperma leptostachyum	30	0.1
	Lomandra preissii	20	Opp
	Lyginia barbata	30	0.1
	Macrozamia riedlei	300	Opp
	Mesomelaena pseudostygia	60	5
	Olea europaea	200	0.5
	Patersonia occidentalis	50	0.1
	Patersonia occidentalis	40	0.1
*	*Pelargonium capitatum*	40	0.5
	Petrophile linearis	70	0.1
	Scholtzia involucrata	30	Opp
*	*Solanum nigrum*	15	Opp
	Spyridium globulosum	200	0.2
	Stirlingia latifolia	60	6
	Xanthorrhoea preissii	100	5

Note: * depicts an introduced (weed) species

Relevé KW02	**Location:** -32.121761 115.855449	**Survey 1:** 22/6/2017 **Survey 2:** 01/9/2017
Topography: Wetland	**Soils:** Sand, moist	**Colour:** Dark brown
Vegetation description: MpAsHr, *E. marginata* over *Kunzea glabrescens* and *Xanthorrhoea preissii* over weeds		
TEC: None		
Inferred FCT: 21a Central *B. attenuata-E. marginata* woodlands		
Condition: Good, weeds and edge effects		
Additional notes: Ecotone wetland to terrestrial. Difficult to determine community		

*	Taxon	Height cm	Foliage %
	Banksia ilicifolia	800	4
	Banksia sp. Dead	800	4
	Eucalyptus marginata	500	5
*	*Acacia longifolia* subsp. *longifolia*	400	20
	Kunzea glabrescens	300	10
	Xanthorrhoea preissii	250	25
	Adenanthos obovatus		
	Bossiaea eriocarpa	30	0.01
	Eremaea pauciflora	40	0.1
	Caesia micrantha	50	2
* DP	*Asparagus asparagoides*		1
*	*Carpobrotus edulis*	15	10
	Conostylis setigera subsp. *setigera*	20	0.1
	Dampiera linearis	20	0.1

*	Taxon	Height cm	Foliage %
	Dasypogon bromeliifolius	50	2
	Diuris corymbosa	40	0.01
*	*Fumaria capreolata*	20	0.1
*	*Gladiolus caryophyllaceus*	30	0.02
	Lomandra preissii	30	0.1
* *DP*	*Zantedeschia aethiopica*	50	0.5

Note: * depicts an introduced (weed) species

Relevé KW03	Location: -32.123007 115.855259	Date: 22/6/2017
Topography: Wetland	Soils: Sand	Colour: Dark Brown
Vegetation description: MpAsHr, *Melaleuca preissiana* over weeds		
TEC: None		
Inferred FCT: FCT11 – wet forests and woodlands in seasonal wetlands		
Condition: Degraded, weeds		
Additional notes: Wetland		

*	Taxon	Height cm	Foliage %	Comments
	Melaleuca preissiana	700	80	
*	*Acacia* sp. Planted	400	7	
	Astartea scoparia	250	3	
	Cyperus congestus	80	1	
	Dielsia stenostachya	20	1	
* DP	*Asparagus asparagoides*	30	2	
*	*Fumaria capreolata*	20	5	
*	*Pelargonium capitatum*	50	4	
* DP	*Zantedeschia aethiopica*	90	50	
	Poaceae sp.	20	20	

Note: * depicts an introduced (weed) species