APPENDIX D

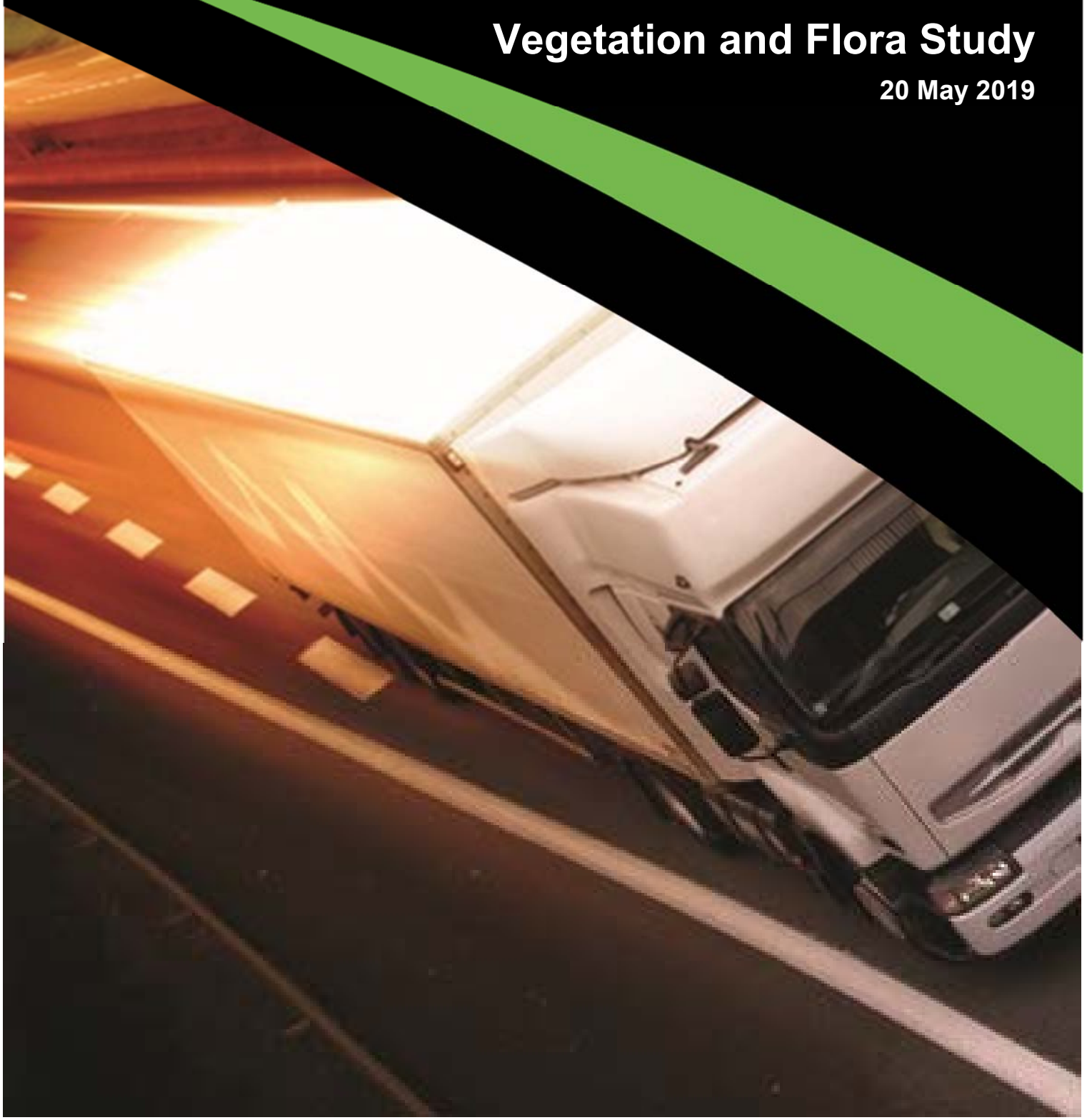
BORR Northern and Central Sections Vegetation and Flora Assessment (BORR IPT 2019c) – Part 1 (part 1 of 8)

BORR Team

Bunbury Outer Ring Road
Northern and Central Sections

Vegetation and Flora Study

20 May 2019



Executive Summary

The Commissioner of Main Roads Western Australia (Main Roads) is proposing to construct and operate the Northern and Central sections of the Bunbury Outer Ring Road (BORR) project (Figure 1, Appendix A). The BORR is a planned Controlled Access Highway linking the Forrest Highway and Bussell Highway, and will provide a high standard route for access to the Bunbury Port. The completed BORR will also provide an effective bypass of Bunbury for inter-regional traffic and freight, reducing traffic on the local road network, and facilitate proposed development to the east of the city of Bunbury.

BORR forms a major component of the planned regional road network for the Greater Bunbury area. The concept for the road was originally developed by Main Roads in the early 1970s.

The proposed BORR comprises three sections:

- 'BORR Northern Section' – Forrest Highway to Boyanup-Picton Road
- 'BORR Central Section' – Boyanup-Picton Road to South Western Highway (south), an existing 4 km section which was completed in May 2013, along with a 3 km extension of Willinge Drive southwards to South Western Highway
- 'BORR Southern Section' – South Western Highway (near Bunbury Airport) to Bussell Highway.

This document refers to BORR Northern and Central Sections only. Main Roads commissioned the BORR IPT to undertake a biological assessment for BORR Northern and Central Sections (the Project). The purpose of the assessment was to delineate key flora and vegetation values within the survey area.

This report is subject to, and must be read in conjunction with, the limitations and assumptions contained throughout the report.

Key findings

Vegetation

Seventeen vegetation types as well as cleared areas, planted vegetation and rehabilitated areas were identified and described for the survey area. The majority of the survey area was rated Completely Degraded in condition (81 %). The road reserves and patches of vegetation within private land holdings had some areas rated as Good to Very Good (10.61 ha / 1.88 % of the survey area); these areas showed few weed species, had structural layers present and few signs of disturbance. These occurred along sections of Forrest Highway, near the South Western Highway, near the current BORR Central termination and the Boyanup Picton Road and along the Preston and Collie rivers. The remainder of the road reserves and agricultural lands were rated as Degraded to Completely Degraded in condition.

Three conservation significant ecological communities were identified:

- Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC) – listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Banksia dominated woodlands of the Swan Coastal Plain IBRA region Priority Ecological Community (PEC) – listed as Priority 3 by DBCA
- Claypans of the Swan Coastal Plain / Herb rich shrublands in claypans (SCP08) (TEC) – listed as Critically Endangered under the EPBC Act and Vulnerable under the BC Act. This community may occur, however further studies are required to determine the floristics and condition.

Although not considered to be a TEC or PEC, the vegetation unit along the Preston River is an example of a riverine community that has largely disappeared on the southern Swan Coastal Plain and is regionally significant.

Flora

Three hundred and sixty four flora species (including subspecies and varieties) were recorded during the field assessments. This comprised of 207 native species and 157 introduced / planted flora species. Of the introduced species, four are listed as Declared Pests under the *Biosecurity and Management Act 2007* and/or as a Weeds of National Significance. No EPBC Act or *Biodiversity Conservation Act 2016* (BC Act) listed flora were recorded within the survey area. Three DBCA Priority-listed flora species were recorded *Chamaescilla gibsonii* (Priority 3), *Acacia semitrullata* (Priority 4) and *Caladenia speciosa* (Priority 4).

The likelihood of occurrence assessment post-field survey for conservation significant species concluded that three species are known to occur (including one species not identified in the desktop assessment), three species are likely to occur, 26 species possibly occur and 16 species are unlikely to occur within the survey area.

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Document Control

Revision	Date	Description	Prepared	Reviewed	Approved
A	04/04/2019	Draft for Main Roads Review	M. Toner	M. Braimbridge	MB
0	20/05/2019	Final Document	M. Toner	M. Braimbridge	FH

1 INTRODUCTION

1.1 Project background

The Commissioner of Main Roads Western Australia (Main Roads) is proposing to construct and operate the Northern and Central sections of the Bunbury Outer Ring Road (BORR) project (Figure 1, Appendix A). The BORR is a planned Controlled Access Highway linking the Forrest Highway and Bussell Highway, and will provide a high standard route for access to the Bunbury Port. The completed BORR will also provide an effective bypass of Bunbury for inter-regional traffic and freight, reducing traffic on the local road network, and facilitate proposed development to the east of the city of Bunbury.

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The proposed BORR comprises three sections:

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- 'BORR Southern Section' – South Western Highway (near Bunbury Airport) to Bussell Highway.

This document refers to BORR Northern and Central Sections only.

1.2 Purpose of this report

The purpose of this study is to identify the vegetation and flora within the survey area in order to inform project design and environmental approvals.

The aim of the study was to:

- Identify, map and describe vegetation types
- Assess and map the condition of vegetation
- Identify and map the location of Threatened and Priority Ecological Communities
- Identify areas of high floristic value including those that provide habitat for conservation significant flora, wetland / riparian vegetation, vegetation types that are poorly represented and those with high diversity
- Map the location of conservation significant species.

1.3 Project location

1.3.1 Survey area

The survey area assessed in this flora and vegetation study covers approximately 1,128 hectares (ha) and includes existing road reserves, agricultural land and native vegetation. The *Diuris drummondii* survey was restricted suitable areas within the Project Development Envelope (PDE). The PDE is approximately 623 ha and contained within the survey area.

The survey area is mapped in Figure 2, Appendix A.

1.3.2 Study area

A study area was defined for the desktop based searches of the assessment and includes a 5 km buffer of the survey area for the purpose of flora and vegetation database searches.

1.4 Scope of works

The scope of works for the flora and vegetation survey included:

- A desktop review of publically available information and relevant reports to determine the environmental values of the survey area
- A botanical survey (survey area) to identify:
  - Vegetation community types present, including presence of any Threatened or Priority Ecological Communities (TECs or PECs) or other significant vegetation
  - Vegetation condition, including the location of any Weeds of National Significance (WONS) or Declared Weeds
  - Flora species present including introduced species
  - The presence or potential presence of any Threatened or Priority Flora
- Preparation of a report (this document) that:
  - Documents the results of the desktop assessment and field survey, including mapping
  - Identifies and discusses potentially occurring significant flora and vegetation communities
- Provision of spatial files in GIS format.

1.5 Relevant legislation

In Western Australia (WA) significant communities, and flora and fauna are protected under both Federal and State Government legislation. In addition, regulatory bodies also provide a range of guidance and information on expected standards and protocols for environmental surveys.

An overview of key legislation and guidelines, conservation codes and background information relevant to this project are provided in Appendix B.

1.6 Limitations and assumptions

This report has been prepared by BORR IPT for Main Roads and may only be used and relied on by Main Roads for the purpose agreed between BORR IPT and the Main Roads as set out in section 1.2 of this report.

BORR IPT otherwise disclaims responsibility to any person other than Main Roads arising in connection with this report. BORR IPT also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by BORR IPT in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. BORR IPT has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by BORR IPT described in this report. BORR IPT disclaims liability arising from any of the assumptions being incorrect.

BORR IPT has prepared this report on the basis of information provided by Main Roads and others who provided information to BORR IPT (including Government authorities), which BORR IPT has not independently verified or checked beyond the agreed scope of work. BORR IPT does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of infrastructure, services and vegetation, and access. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. BORR IPT does not accept responsibility arising from, or in connection with, any change to the site conditions. BORR IPT is also not responsible for updating this report if the site conditions change.

This report has assessed the flora values within the survey area, as shown in Figure 1, Appendix A. Should the survey area change or be refined, further assessment may be required.

2 METHODOLOGY

2.1 Desktop assessment

Prior to the commencement of the field survey, a desktop assessment was undertaken to identify relevant environmental information pertaining to both the survey area and study area and to assist in survey design. The desktop assessment involved a review of:

- The Department of the Environment and Energy (DEE) Protected Matters Search Tool (PMST) to identify communities and species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) potentially occurring within the study area (DEE 2018a) (Appendix C)
- The Department of Biodiversity, Conservation and Attractions (DBCA) TEC and PEC database to determine the potential for significant ecological communities to be present within the study area (provided by Main Roads)
- The DBCA NatureMap database for flora species previously recorded within the study area (DBCA 2007–) (Appendix C)
- The DBCA Threatened (Declared Rare) and Priority Flora database (TPFL) and the WA Herbarium database (WAHERB) for Threatened and Priority flora species listed under the *Biodiversity Conservation Act 2016* (BC Act) (which replaced the *Wildlife Conservation Act 1950*) or listed as priority by DBCA, previously recorded within the study area (provided by Main Roads)
- Existing datasets including previous vegetation mapping of the survey area, aerial photography, geology/soils and hydrology information to provide background information on the variability of the environment, likely vegetation units and to identify areas with potential to contain TECs, PECs, and Threatened and Priority listed flora species
- Previous studies undertaken within or in close proximity to the survey area (provided by Main Roads).

2.2 Field assessment

GHD botanists completed a detailed vegetation and flora assessment of the survey area in August, September (spring) and November 2018. A targeted *Diuris drummondii* (Tall Donkey Orchid) survey was also completed in December 2018 (Table 2-1).

Table 2-1 Flora and vegetation survey timing and effort

Date	Survey effort	Field team
20 – 22 August 2018	Late winter / early spring reconnaissance assessment of wetland areas within the survey area.	Two senior botanists
17 – 20 September 2018	Spring detailed survey within the survey area	Two senior botanists and two ecologists
21 November 2018	Late spring detailed survey within the survey area.	One senior botanist and one ecologist
17 – 19 December 2018	*Diuris drummondii* targeted search of 20 locations within the PDE.	Two senior botanists and one ecologist

The field survey was undertaken to verify the results of the desktop assessment, identify and describe the dominant vegetation units, assess vegetation condition, and identify and record vascular flora species present at the time of survey. Searches for conservation significant or other significant ecological communities and flora species were also undertaken during the field survey.

The survey methodology employed by GHD was undertaken with reference to the Environmental Protection Authority (EPA) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) and previous versions of the guidance.

Data collection

Field survey methods involved a combination of sampling quadrats and photographic reference points located in identified vegetation units and traversing the survey area by foot / vehicle. In total, 38 non-permanent quadrats and 159 photographic reference points (PPs) were described throughout the survey area (Figure 2, Appendix A). Quadrat and PP data is provided in Appendix D.

Quadrats (measuring 10 m x 10 m – area of 100 m^2) were located within each identified vegetation unit. A minimum of three quadrats were located within each identified vegetation unit, where possible. For several of the vegetation types, their occurrence was restricted to two or less locations. These vegetation types did not have three quadrats (i.e. there was insufficient representation of the vegetation unit across the survey area to allow for more quadrats). Some of the vegetation types were only present in either a Degraded or Completely Degraded condition. The survey method for these vegetation types was to use PPs. At each PP, the vegetation type / condition was noted and searches for native flora via walking traverses was undertaken.

Field data at each quadrat was recorded on a pro-forma data sheet and included the parameters detailed in Table 2-2.

Table 2-2 Data collected during the field survey

Aspect	Measurement
Collection attributes	Site code, personnel/recorder; date, quadrat dimensions, photograph of the quadrat.
Physical features	Aspect, slope, landform, soil attributes, ground surface cover, leaf and wood litter.
Location	Coordinates recorded in GDA94 datum using a hand-held Global Positioning System (GPS) tool to accuracy approximately ± 5 m.
Vegetation condition	Vegetation condition was assessed using the condition rating scale adapted by EPA (2016) for the South West Botanical Province.
Disturbance	Level and nature of disturbances (e.g. weed presence, fire and time since last fire, impacts from grazing, exploration activities).
Flora	List of dominant flora from each structural layer. List of all species within the quadrat including stratum, average height and cover (using National Vegetation Information System (NVIS))

A flora inventory was compiled from species listed in described quadrats, PPs and from opportunistic floristic records throughout the survey area.

Vegetation units

Vegetation units were identified and boundaries delineated using a combination of aerial photography, topographical features, field data/observations and statistical analyses.

Vegetation units were described based on structure, dominant species and cover characteristics as defined by quadrat data and field observations. Vegetation unit descriptions follow NVIS and are consistent with NVIS Level V (Association). At Level V up to three species per stratum are used to describe the association (ESCAVI 2003).

Statistical analyses

PRIMER v6 (Clarke and Gorley 2006) was used to examine the similarity between sites using collected data. A presence/absence matrix was created of all species (including perennials and annuals) present in BORR IPT quadrats. The dissimilarity between quadrats was determined using the Bray-Curtis measure and the Resemblance function in PRIMER. A Cluster analysis (using Agglomerative Hierarchical Clustering technique) based on group average was undertaken using the Bray-Curtis similarity matrix and results presented as a dendrogram (Appendix E). In addition, a nonmetric multi-dimensional scaling analysis (MDS) was undertaken using the Bray-Curtis similarity matrix and results presented as a two dimensional scatter plot. Analysis was run using three scenarios:

- All species (base quadrat data)
- Native species only (weed species removed from each quadrat)
- Species that occur only once (singles) removed from each quadrat.

The outputs of the PRIMER analysis were used to inform decisions on vegetation units.

Comparison of vegetation units with regional datasets

Statistical analysis

The SWA dataset (accessed through *NatureMap*) is derived from a database compiled and maintained over many years, combining the results of a number of floristic studies (conducted between 1990 and 1996) on plant communities of the Swan Coastal Plain (SWA) Bioregion, south of Moore River. The SWA dataset includes sampling site details, the flora collected at these sampling sites and the floristic community type (FCT) assigned to these sampling sites. The taxonomy of the flora in the SWA dataset used is current as of December 2018 (updated by GHD).

PRIMER v6 (Clarke and Gorley 2006) was used to compare the BORR IPT quadrats to existing data (where available) for FCTs described on the SWA. SWA site locations within a 5 km buffer of the survey area were located and the FCTs represented by these sites were identified. Additional SWA quadrats were also selected for TECs and PECs that were identified in the desktop assessment but did not have quadrats within the 5 km buffer. All site locations for these FCTs from the SWA dataset were extracted, along with those identified in the desktop searches (e.g. TEC and PEC searches).

Representative quadrats from each FCT selected for the analysis are shown in Table 2-3.

The BORR IPT and SWA dataset quadrat data was combined, reconciled to align nomenclature and a presence/absence matrix created of all species (including perennials and annuals). Singleton species (those occurring in only one quadrat) were removed from the matrix as well as species that were only identified to family or genus level. The dissimilarity between quadrats was determined using the Bray-Curtis measure and the Resemblance function in PRIMER. A Cluster analysis (using Agglomerative Hierarchical Clustering technique) based on group average was undertaken using the Bray-Curtis similarity matrix and results presented as a dendrogram. In addition, a nonmetric multi-dimensional analysis (MDS) was undertaken using the Bray-Curtis similarity matrix and results presented as a two dimensional scatter plot. A factor was added to the output to define sample groups by FCT. The outputs of the PRIMER analysis were used to inform decisions on vegetation units.

It is noted that PRIMER can be limited in use for this purpose as analysis is based on all species recorded in quadrats and does not take into account dominance of species. Further interpretation of statistical

results, coupled with multiple field surveys and desktop information is needed to determine whether the vegetation units are representative of a certain FCT.

Table 2-3 List of SWA quadrats used in PRIMER analysis

Floristic Community Type Name and ID	Status	Quadrats
Southern *Corymbia calophylla* woodlands on heavy soils (1b)	TEC	AMBR-1, AMBR-4, AMBR-6, AMBR-9, AMBRAL-1, CAPEL-5, CARB-1, CARB-2, CARB-4, R116703, YALLIN-1, YOON-1
Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands (3c)	TEC	DUCK-1, DUCK-2, ELLEN-6, PEARCE-2, talb1, talb12, talb13, talb4, WATER-3, yarl01
Melaleuca preissiana damplands (4)		AMBR-3, C58-1, CAPEL-3, dian02, FL-1, FL-9, GUTHR-1, Hamp01, kailis03, KOOLI-1, Light03, low14a, LYONS-1, MELA-1, MGK02, MUK02, PAYNE-1, Plant02, PLINE-4, R116701, Ravs01, rowe02, white03, WHITE-2
Mixed shrub damplands (5)		AUSTB-4, AUSTB-5, GUTHR-4, Hamp02, HARRY-3, jand06, low08, low09a, low09b, Mill01, MILT-1, PAGA-1, PAGA-3, perth02, pinj09, PLINE-5, Swamp01, vines02
Weed dominated wetlands on heavy soils (6)		card10, card11, card4, ELLEN-7, much02, PEARCE -1, Sunday01, TWIN-1, TWIN-2, TWIN-3, TWIN-4
Herb rich saline shrublands in clay flats (7)	TEC ^	AUSTB-1, BAMBUN-1, BAMBUN-3, BULL-6, BULL-8, CARAB-2, FISH-1, FISH-2, gosn10, mrnp01, mrnp03, MUCK-2, Punr01, RUAB-4, Swamp02, WN021MNR, YOON-3, YULE-5
Herb rich shrublands in claypans (8)	TEC ^	C58-3, FL-3, FL-7, gosn08, Hay01, MEELON-1, MEELON-2, MUD-2, MUD-3, MUD-6, MUD-7, MUD-9, waro 03, waro 04, WATER-4
Dense shrublands on clay flats (9)	TEC ^	brick4, BYRD-1, DUCK-3, MANEA-1, Pind02, welr02, WONN-3, yarl02
Wet forests and woodlands (11)		AUSTB-3, beel03, BULL-12, C71-1, CARAB-3, HARRY-6, hymus01, hymus02, low10b, MODO-3, rowe01, TWIN-11, yuri04
Deeper wetlands on heavy soils (13)		C58-2, CAPEL-4, McLART-1, MILT-2, PAGA -2, RUAB -3, WATER-1, WATER-2
Melaleuca rhaphiophylla – Gahnia trifida seasonal wetlands (17)		Chid056, cool 01, cool 04, cool 11, ELLIS-1, Hay02, Ieda03, Ieda04, LESCH-6, MTB-5, PAGA-5, Possum5
Shrublands on calcareous silts (18)	TEC	boot01, boot03, ELE13, ELLIS-2, ELLIS-3, Hay05, xbeer02
Central *Banksia attenuata – Eucalyptus marginata* woodlands (21a)	PEC *	AUSTRA-1, BULLER-1, C71-2, C71-3, CAPEL-7, CLIFT01, CORON-1, CRAMPT-1, CRAMPT-2, DRAIN-1, FL-4, gelor02, Hamp03, KEME-2, KOOLI-2, MANEA-2, MGK01, MILT-6, NINE-2, PLINE-3, REDL-1, RIVD-2, Sunday02
Southern *Banksia attenuata* woodlands (21b)	PEC *	boyan01, buffer01, CAPEL-1, CAPEL-2 CARB-3, dard02, gibson01, kelly02, MANEA-3, MGK03, MGK04, R116702, RUAB-1, RUAB-2
Southern *Eucalyptus gomphocephala* and/or	PEC **	bold16, bunb01, C71-4, colriv01, CORON-2, gelro01, GMaid01, GMaid02, GMaid03, GMaid04, KEME-1, LYONS-

Floristic Community Type Name and ID	Status	Quadrats
Agonis flexuosa woodlands (25)		2, MEAL-1, MINN-1, MINN-2, MINN-3, much04, MYALUP-2, NMaid05, tokyu01, vines01, yela03
Astartea aff. *fascicularis*/ *Melaleuca* species dense shrublands (S01)		Cavs07, Della01, gosn06, pinj15, raven04, Swamp03, yang03
Acacia saligna wetlands (S05)		ELE09, ELE10, ELE35, ELE36, Hay03, Hay04
Low lying *Banksia attenuata* woodlands or shrublands (21c)	PEC*	5C07, BULLER-3, DEJONG02, dillo01, ELE02, ELE22, ELE25, ELE27, ELE29, FL-5, FL-6, hymus03, hymus04, jand05, KEME-3, low01, low06a, low06b, low07, MODO-2, PLINE-7, raven03, SF03, TWIN-7, TWIN-8, white05, YULE-3
Shrublands on dry clay flats (10a)	TEC^	C58-4, FISH-3, FISH-4, FL-2, gosn11, KOOLJ-6, KOOLJ-7, pinj10, Plant01, Punr03, waro-5, YULE-4
Quindalup *Eucalyptus gomphocephala* and/or *Agonis flexuosa* woodlands (30b)	PEC	LESCH-1, LESCH-2, LESCH-3, LESCH-4, LESCH-5, NMaid04, PEPB-1, pip01, Possum3, Possum4

^ A component of the Critically Endangered Claypans of the Swan Coastal Plain EPBC listed TEC.

* A component of the Endangered *Banksia* Woodlands of the Swan Coastal Plain EPBC listed TEC.

** Can be a component of the Endangered *Banksia* Woodlands of the Swan Coastal Plain EPBC listed TEC.

Vegetation condition

The vegetation condition was assessed and mapped in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces of Western Australia (devised by Keighery (1994) and adapted by EPA (2016). The scale recognises the intactness of vegetation and consists of six rating levels. The vegetation condition rating scale is located in Appendix B.

Flora identification and nomenclature

Species well known to the survey botanists were identified in the field; all other species were collected and assigned a unique collection number to facilitate tracking. All specimens collected during the field assessment were dried and processed in accordance with the requirements of the WA Herbarium. Species were identified by a consultative taxonomist at the herbarium using taxonomic literature, electronic keys and online electronic databases.

The conservation status of all recorded flora was compared against the current lists available on FloraBase (WA Herbarium 1998–) and the EPBC Act Threatened species database provided by DEE (2018b).

Nomenclature used in this report follows that used by the WA Herbarium as reported on FloraBase (WA Herbarium 1998–).

Surveys for conservation significant flora

Prior to the field survey, information obtained from the desktop assessments (e.g. aerial photography, geology, soils and topography data, EPBC Act PMST, TPFL, NatureMap and the WAHERB databases search results) was reviewed to determine conservation significant flora species potentially present within the study area and locations. Additionally, ecological information (e.g. habitat, associated flora species and phenology) was sourced from FloraBase (WA Herbarium 1998–) to provide further details.

Potential habitats and locations of previous records were searched by opportunistic sampling. Locations within the survey area with differing hydrology, fire or disturbance history to the surrounding areas were also searched where identified. Where individuals were identified, the location and number of plants present were recorded using handheld GPS units.

***Diuris drummondii* survey**

A targeted survey was completed for *Diuris drummondii*. The field survey was undertaken in reference to the Commonwealth of Australia - Draft Orchid Survey Guidelines (2013) and the methodology was discussed with Mr Andrew Webb (DBCA Flora Officer) prior to commencing the field work. The methodology employed involved:

- Identification of potential habitat – this was based on the vegetation mapping and field observations during the spring surveys. Sites selected were within swamps / dampland areas within the PDE (Figure 1, Appendix A). Areas that had been completely cleared, heavily grazed paddocks that did not contain remnant vegetation were excluded from the survey
- Prior to the field survey, Mr Andrew Webb confirmed that *D. drummondii* was flowering in the Bunbury region and one of the known sites (outside of the survey area) was visited to confirm that the species was in flower
- Surveys involved two senior botanists and a field ecologist, sites were traversed on foot with:
  - Higher quality habitat (sites that retained structure (had a upper / mid or ground layer that comprised native species) traversed on a parallel grid (at a 5-10 m intervals)
  - Lower quality sites (sites that were almost completed cleared / or contained scattered native sedged (such as *Juncus pallidus*) but were grazed and had high visibility through the ground layer were traversed via meander surveys
- In total, 72 person hours were spent surveying for *D. drummondii*.

Figure 2, Appendix A shows the survey sites assessed.

2.3 Desktop and field assessment limitations

2.3.1 Desktop

The EPBC Act PMST is based on bioclimatic modelling for the potential presence of species. As such, this does not represent actual records of the species within the area. The records from the DBCA searches of Threatened and Priority Flora provide more accurate information for the general area. However, some records of collections cannot be dated or are plain text interpretations of locations which can misrepresent the current range of Threatened or Priority species.

2.3.2 Field

The EPA (2016) Technical Guide states flora survey reports for environmental impact assessment in WA should contain a section describing the limitations of the survey methods used. The limitations and constraints associated with this field survey are discussed in Table 2-4. Based on this assessment, the present survey effort has not been subject to any constraints which affect the thoroughness of the assessment and the conclusions which have been formed.

Table 2-4 Field survey limitations

Aspect	Constraint	Comment
Sources of information and availability of contextual information.	Nil	Adequate information is available for the survey area, this includes: • Broad scale (1:250,000) mapping by Beard (1979), Heddle *et al*. (1980) and Webb *et al*. (2016) • Regional biogeography (Mitchell *et al*. 2002) • Previous flora surveys within and adjacent to the survey area (see section 4).
Scope (what life forms were sampled etc.)	Nil	Vascular flora was sampled during the survey. Non-vascular flora were not surveyed.
Proportion of flora collected and identified (based on sampling, timing and intensity)	Minor	The detailed vegetation and flora survey was undertaken from 20 August 2018 to 19 December 2018. The survey included early spring, mid-spring, late spring and summer survey periods. The flora recorded from the field survey is detailed in section 5.5 and a full flora species list is provided in Appendix F. The portion of flora collected and identified was considered moderate to high, based on survey effort and timing.
Flora determination	Minor	Flora determination was undertaken by the GHD botanists in the field and consulting taxonomist at the WA Herbarium. 87% of species were identified to a species level. One species could only be identified as a moncot, 30 species could be identified / tentatively identified to genus level only (eight of these were weeds) and 16 species could be tentatively identified to species level, due to lack of flowering and/or fruiting material required for identification. Five of the orchid records could not be confirmed to species level due to a lack of key diagnostic features (flowering parts). It is likely this group is under-represented as they are cryptic, perennial species and not all known species would have been flowering during the survey period. The taxonomy and conservation status of the WA flora is dynamic. This report was prepared with reliance on taxonomy and conservation status current at the time of the report development, but it should be noted that this may change in response to ongoing research and review of International Union for Conservation Nature criteria.
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	Minor	Access to the survey area was made by vehicle tracks which extended along the site. The majority of vegetated areas within the survey area were traversed on foot. Information gained from the survey was extrapolated across those small sections of the survey area not accessed on foot during the field survey to assist with determining the vegetation units and condition.

Aspect	Constraint	Comment
Mapping reliability	Minor	The vegetation was mapped using high-resolution ESRI aerial imagery obtained from Landgate, topographical features, previous broad scale mapping and field data. Data was recorded in the field using hand-held GPS tools (e.g. Samsung tablets with ArcGIS collector and Garmin GPS). Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. The Garmin GPS units used for this survey are accurate to within ±5 metres on average. Therefore the data points consisting of coordinates recorded from the GPS may contain inaccuracies.
Timing/weather/ season/cycle	Nil	The field surveys were conducted between 20 August and 19 December 2018. The closest weather recording station to the survey area is Bunbury (No. 9965) (Bureau of Meteorology (BoM) 2019). As shown in Plate 1, section 3.1, the long-term average (LTA) rainfall is lower than the 2018 period for June and July, with the 2018 period recording lower rainfall averages in September, November and December. The temperature statistics indicate that the 2018 minimum and maximum temperatures were consistent with the LTAs. The weather conditions recorded during the survey periods are considered unlikely to have impacted upon the vegetation and flora survey. The survey timing was considered appropriate for the flora field survey.
Disturbances (e.g. fire, flood, accidental human intervention)	Nil	The survey area is largely located in an agricultural setting and as such has had previous land clearing. At the time of the survey no other disturbance such as fire / flooding etc. were present.
Intensity (in retrospect, was the intensity adequate)	Nil	The vascular flora of the survey area was sampled in accordance with EPA (2016); a minimum of three quadrats per vegetation type were established (where possible) along with PPs to supplement the data. The survey area was sufficiently covered by the botanists during the survey.
Resources	Nil	Adequate resources were employed during the field survey. Field survey teams consisted of one senior botanist (more than 10 years' experience) and a field ecologist (2+ years' field experience). In total, 12 field survey team days were spent undertaking vegetation and flora surveys. An additional three days by two senior botanists and one field ecologist were deployed for the targeted *Diuris drummondii* survey.
Access restrictions	Nil	The survey area included private properties, the BORR IPT arranged site access. However, not all properties were accessed for the survey. In some instances, access within and across properties was restricted due to biosecurity, electric fences and cattle. In these instances vegetation types and conditions were extrapolated from aerial photography / soil and landscape information and nearby survey points.
Experience levels	Nil	The botanists who executed the survey are practitioners suitably qualified and experienced in their respective fields. Senior Botanists have over 10 years' experience undertaking

Aspect	Constraint	Comment
		flora surveys within WA, including the south-west. Field ecologists/ field support staff have 2 – 4 years field experience.

3 DESKTOP ASSESSMENT

3.1 Climate

The Bunbury area experiences a Mediterranean climate and is characterised by warm, dry summers and cool, wet winters. Rainfall is largely received during the winter months as a result of cold fronts that regularly cross the South West coast. The closest BoM weather station is Bunbury (site number 009965) (BoM 2019). Climate statistics for the Bunbury weather station have been presented in Plate 1.

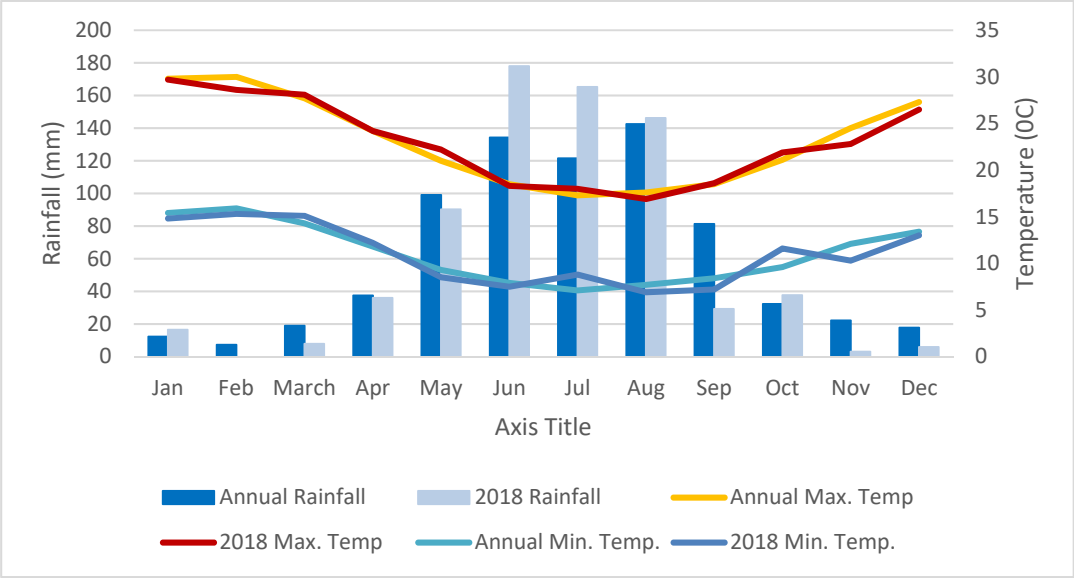

Plate 1 Climate statistics for Bunbury Weather Station (No. 9965) Annual and 2018

Note: April and May data for Bunbury Weather Station not available at time of writing therefore data from Australind weather station (No. 9273) has been used instead. Annual climate statistics are from November 1995 to current.

3.2 Province

The study area is located in the South West Botanical Province of WA (Beard 1990). The study area is located in the Swan Coastal Plain Bioregion and Perth (SWA2) subregion as described by the Interim Biogeographic Region of Australia (IBRA) (Department of the Environment 2012).

The Perth subregion is composed of colluvial and aeolian sands, alluvial river flats and coastal limestone. Heath and/or Tuart woodlands occur on limestone, Banksia and Jarrah-Banksia woodlands on Quaternary marine dunes of various ages and Marri on colluvial and alluvial soils. The subregion also includes a complex series of seasonal wetlands (Mitchell *et al.* 2002).

3.3 Landform and soils

The Swan Coastal Plain is comprised of five major geomorphological units, which lie more or less parallel to the coast, being the Quindalup, Spearwood and Bassendean Dunes, the Pinjarra Plain and the Ridge Hill Shelf (McArthur and Bettenay 1960, Churchwood and McArthur 1980). The survey area lies within the Bassendean Dune and Pinjarra Plain elements, which are broadly described as:

- Bassendean dune and sandplain system: Pleistocene sand dunes with very low relief, leached grey siliceous sand intervening sandy and clayey swamps and gently undulating plains. These occur immediately west of, and partly overlie, the Pinjarra Plain

- Pinjarra Plain: Broad low relief plain west of the foothills, comprising predominantly Pleistocene fluvial sediments and some Holocene alluvium associated with major current drainage systems. Major soils are naturally poorly drained with many swamps.

Desktop assessment of broad geological formations indicates that the survey area occurs within three broad formations in addition to rivers and wetland areas, which are outlined in Table 3-1.

Table 3-1 Geology and landform information for the survey area (Geological Survey of WA 2009)

Formation	Geological Type	Geological Description/ Landform
Guildford Formation	Qpa	Mainly alluvial sandy clay
Bassendean Sand	Qpb	Low rounded sand dunes
	Qpb/Qpa	Thin Bassendean Sand over Guildford Formation
Rivers	Qhay	Alluvium, younger river terraces
	Qhao	Alluvium older river terraces

The Department of Primary Industries and Regional Development soil-landscape mapping of the South West of WA (Government of Western Australia (GoWA) 2018a) provides soil and landform data compiled from various sources. This mapping identifies 28 different soil types within the survey area. In total, over 70 % of the mapped soil types occur within the Pinjarra Plain and 30 % within the Bassendean Dune system (Figure 3, Appendix A). The dominant soil types (greater than 100 ha / more than 12 % of the survey area each) are the:

- Bassendean B1a Phase (212Bs_B1a): Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands with an intensely coloured yellow B horizon occurring within 1 m of the surface; marri and jarrah dominant
- Pinjarra P1d Phase (213Pj_P1d): Flat to very gently undulating plain with deep acidic mottled yellow duplex soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and moderately susceptible to salinity
- Pinjarra P3 Phase (213Pj_P3): Flat to very gently undulating plain with deep, imperfect to poorly drained acidic gradational yellow or grey-brown earths and mottled yellow duplex soils, with loam to clay loam surface horizons
- Pinjarra P1b Phase (213Pj_P1b): Flat to very gently undulating plain with deep acidic mottled yellow duplex soils. Moderately deep pale sand to loamy sand over clay: imperfectly drained and moderately susceptible to salinity in limited areas.

3.4 Hydrology

3.4.1 Watercourses

There are four main watercourses within the survey area (Figure 4, Appendix A):

- Brunswick River – occurs immediately north of the survey area
- Collie River – occurs near Raymond Road
- Ferguson River – occurs near South West Highway and the railway line
- Preston River – occurs at the southern end of the survey area.

In addition, a number of small drainage lines and man-made drains occur throughout the survey area. Large parts of the survey area have been extensively modified for agricultural irrigation / drainage. For the purposes of this report, these irrigation channels are considered part of the agricultural areas and are not mapped as waterways.

3.4.2 Wetlands

The survey area occurs extensively within a low-lying palusplain, which is seasonally inundated or has a high water table during winter. The EPBC Act PMST did not identify any wetlands of international importance (Ramsar wetland) or Nationally Important Wetlands within a 5 km buffer of the survey area.

The Geomorphic Wetlands Swan Coastal Plain dataset (Hill *et al.* 1996) identified 36 wetlands within the survey area (Figure 4, Appendix A). These included seven Conservation Category Wetlands (CCW), 26 Multiple Use Wetlands (MUW) and two Resource Enhancement Wetlands (REW) and one Not Assessed wetland (Artificial Lake). Approximately 87 % of the survey area is mapped as geomorphic wetlands.

A separate wetland assessment has been completed (BORR IPT 2019) which provides further information on the geomorphic wetlands and an evaluation of their classification.

3.5 Vegetation and flora

3.5.1 Broad vegetation mapping and extents

Broad scale (1:250,000) pre-European vegetation mapping of the area has been completed by Beard (1979) at an association level. The mapping (Figure 5, Appendix A) indicates that the survey area intersects three vegetation associations:

- Mosaic: Medium forest; Jarrah-Marri / Low woodland; *Banksia* / Low forest; Teatree (*Melaleuca* spp.) (association 1000) – occurs in the northern and southern extent of the survey area
- Medium woodland; *Eucalyptus rudis* & *Melaleuca rhaphiophylla* (association 1182) – occurs near the Collie River in the northern section of the survey area
- Medium Woodland; Jarrah, Marri and Wandoo (association 968) – occurs throughout the central section of the survey area.

The pre-European mapping has been adapted and digitised by Shepherd *et al*. (2002). The extent of the vegetation associations have been determined by the state-wide vegetation remaining extent calculations maintained by the DBCA (latest update December 2017 – GoWA 2018b). As shown in Table 3-2, the current extents of vegetation associations 1000 and 1182 are less than 30 % of their pre-European extent at the IBRA Bioregion, IBRA subregion and within some of the Local Government Authority (LGA) levels. The current extent of vegetation association 968 is less than 10 % of its pre-European extent at the State, IBRA Bioregion, IBRA subregion and within some of the LGA levels.

Regional vegetation for the Swan Coastal Plain (at vegetation complex level) was mapped by Heddle *et al*. (1980) and updated and extended by Webb *et al*. (2016). The mapping (Figure 6, Appendix A) indicates that four vegetation complexes on Aeolian deposits of the Swan Coastal Plain are present within the survey area:

- Bassendean Complex – Central and South: Vegetation ranges from woodland of *Eucalyptus marginata* (Jarrah) – *Allocasuarina fraseriana* (Sheoak) – *Banksia* species to low woodland of *Melaleuca* species, and sedgelands on the moister sites. Occurs in the northern extent of the survey area to Raymond Road
- Southern River Complex – Open woodland of *Corymbia calophylla* (Marri) – *Eucalyptus marginata* (Jarrah) – *Banksia* species on elevated areas and a fringing woodland of *Eucalyptus rudis* (Flooded Gum) – *Melaleuca rhaphiophylla* (Swamp Paperbark) along streams. South of the Murray River *Agonis flexuosa* (Peppermint) occurs in association with the Flooded Gum and Swamp Paperbark. Occurs in the northern and southern extent of the survey area along the eastern margin
- Swan Complex – Fringing woodland of *Eucalyptus rudis* (Flooded Gum) – *Melaleuca rhaphiophylla* (Swamp Paperbark) with localised occurrence of low open forest of *Casuarina obesa* (Swamp

Sheoak) and *Melaleuca cuticularis* (Saltwater Paperbark). Occurs in a band near the Collie River and Preston River

- Guilford Complex – A mixture of open forest to tall open forest of *Corymbia calophylla* (Marri) - *Eucalyptus wandoo* (Wandoo) – *Eucalyptus marginata* (Jarrah) and woodland of *Eucalyptus wandoo* (Wandoo) (with rare occurrences of *Eucalyptus lane-poolei* (Salmon White Gum)). Minor components include *Eucalyptus rudis* (Flooded Gum) – *Melaleuca rhaphiophylla* (Swamp Paperbark). Occurs through the central section of the survey area.

GoWA (2018c) has assessed the vegetation complexes against presumed pre-European extents within the SWA IBRA Bioregion (Table 3-4) and LGA levels (Table 3-5). The current extents of all four complexes occurring within the survey area are less than 30 % of their pre-European distribution within the SWA IBRA Bioregion and LGAs.

Table 3-2 Extents of vegetation associations mapped within the survey area (GoWA 2018b)

VEGETATION ASSOCIATION	SCALE		PRE-EUROPEAN EXTENT (HA)	CURRENT EXTENT (HA)	REMAINING (%)	REMAINING WITHIN DBCA MANAGED LANDS (%)
Swan Coastal Plain IBRA Bioregion			1,501,221.93	578,997.37	38.57	38.47
968	State: WA		296,877.84	94,970.94	31.99	57.68
	IBRA Bioregion: Swan Coastal Plain		136,188.20	8,938.45	6.56	21.78
	Sub-region: Perth		136,188.20	8,938.45	6.56	21.78
	LGA	City of Bunbury	4.51	1.11	24.52	NA
		Shire of Capel	6,657.26	660.36	9.92	3.49
		Shire of Dardanup	9,655.06	641.32	6.64	11.67
		Shire of Harvey	23,465.19	1,260.92	5.37	36.80
1000	State: WA		99,835.86	27,705.61	27.75	18.67
	IBRA Bioregion: Swan Coastal Plain		94,175.31	24,805.96	26.34	19.21
	Sub-region: Perth		94,175.31	24,805.96	26.34	19.21
	LGA	City of Bunbury	2,171.67	621.00	28.60	2.12
		Shire of Capel	15,173.76	3,189.87	21.02	7.27
		Shire of Dardanup	3,375.44	820.85	24.32	NA
		Shire of Harvey	20,121.61	8,209.83	40.80	30.38
1182	State: WA		23,437.06	6,133.59	26.17	55.33
	IBRA Bioregion: Swan Coastal Plain		12,309.34	1,400.60	11.38	6.10
	Sub-region: Perth		12,309.34	1,400.60	11.38	6.10
	LGA	City of Bunbury	280.10	86.93	31.03	NA
		Shire of Capel	4,028.76	1,132.73	28.12	33.11
		Shire of Dardanup	4,267.32	1,096.72	25.70	57.92

VEGETATION ASSOCIATION	SCALE		PRE-EUROPEAN EXTENT (HA)	CURRENT EXTENT (HA)	REMAINING (%)	REMAINING WITHIN DBCA MANAGED LANDS (%)
		Shire of Harvey	7,311.54	598.45	8.19	6.85

Table 3-3 Extent of vegetation complexes on the Swan Coastal Plain mapped within the survey area (GoWA 2018c)

VEGETATION COMPLEX	PRE-EUROPEAN EXTENT (HA)	CURRENT EXTENT (HA)	REMAINING EXTENT (%)	CURRENT EXTENT REMAINING WITHIN ALL DBCA MANAGED LAND (%)
Bassendean Complex – Central and South	87,476.25	23,533.09	26.90	4.99
Guildford Complex	90,513.13	4,522.01	5.00	0.30
Southern River Complex	58,781.48	10,828.04	18.42	1.59
Swan Complex	15,194.13	2,055.56	13.53	0.92

Table 3-4 Extent of vegetation complexes within Local Government Areas mapped within the survey area (GoWA 2018c)

VEGETATION COMPLEX	LGA	PRE-EUROPEAN EXTENT (HA)	CURRENT EXTENT (%)	REMAINING EXTENT (%)	PROPORTION OF THE VEGETATION COMPLEX WITHIN THE LGA (%)
Bassendean Complex – Central and South	City Bunbury	0.00	0.00	0.00	0.00
	Shire Capel	4,946.61	1,162.16	23.49	5.65
	Shire Dardanup	2.59	0.43	16.73	0.00
	Shire Harvey	19,017.49	8,155.02	42.88	21.74
Guildford Complex	City Bunbury	10.25	1.68	16.36	0.01
	Shire Capel	6,508.42	540.53	8.31	7.19
	Shire Dardanup	8,582.35	453.87	5.29	9.48
	Shire Harvey	16,378.82	534.93	3.27	18.10
Southern River Complex	City Bunbury	2,205.16	635.67	28.83	3.75
	Shire Capel	7,876.12	1,794.33	22.78	13.40
	Shire Dardanup	3,331.04	811.88	24.37	5.67
	Shire Harvey	798.38	75.66	9.48	1.36
Swan Complex	City Bunbury	305.61	88.07	28.82	2.01
	Shire Capel	2,047.08	417.46	20.39	13.47
	Shire Dardanup	1,267.78	151.18	11.92	8.34

VEGETATION COMPLEX	LGA	PRE-EUROPEAN EXTENT (HA)	CURRENT EXTENT (%)	REMAINING EXTENT (%)	PROPORTION OF THE VEGETATION COMPLEX WITHIN THE LGA (%)
	Shire Harvey	1,512.04	259.38	17.15	9.95

Note: red and orange indicate that less than 10 % and 30 %, respectively, of the pre-European extent is remains.

Swan Coastal Plain Floristic Studies

Floristic studies on the Swan Coastal Plain include those completed by Gibson *et al.* (1994) and other unpublished data collected as part of the System 6 and Part System 1 Update program and from various sources (e.g. Weston *et al.* 1993, Griffin 1994, DEP 1996 and Keighery 1996). This data has been compiled into a dataset, referred to in this report as the SWA dataset. A search of the SWA dataset identified 17 FCTs that are known to occur within a 5 km buffer of the survey area (Table 3-5).

Table 3-5 SWA dataset FCTs within 5 km of the survey area

FCT	Description and status
Foothills / Pinjarra Plain	
1b	Southern *Corymbia calophylla* woodlands on heavy soils.
3c	*Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands
Seasonal wetlands	
4	*Melaleuca preissiana* damplands
5	Mixed shrub damplands
6	Weed dominated wetlands on heavy soils
7	Herb rich saline shrublands in clay pans
8	Herb rich shrublands in clay pans
9	Dense shrublands on clay flats
11	Wet forests and woodlands
13	Deeper wetlands on heavy soils
17	*Melaleuca rhaphiophylla – Gahnia trifida* seasonal wetlands
18	Shrublands on calcareous silts
S01	*Astartea* aff. *fascicularis* / *Melaleuca* species dense shrublands
S05	*Acacia saligna* wetlands
Uplands centred on Bassendean dunes and Dandaragan Plateau	
21a	Central *Banksia attenuata – Eucalyptus marginata* woodlands
21b	Southern *Banksia attenuata* woodlands
Uplands centred on Spearwood and Quindalup Dunes	
25	Southern *E. gomphocephala – Agonis flexuosa* woodlands

3.5.2 Conservation significant ecological communities

A search of the EPBC Act PMST identified four EPBC Act-listed TECs potentially occurring within the survey area. These TECs were also identified in a search of the DBCA TEC/PEC database as well as 6 PECs. There are multiple occurrences where TECs and PECs intersected the survey area (Table 3-6 and Figure 7, Appendix A). Much of the northern and southern extent of the survey area is mapped as the Banksia Woodlands (TEC/PEC) or its buffer area (which is typically a 500 m area surrounding this community). The remaining three TECs are restricted to scattered patches in the central (near the intersection with South Western Highway and Wireless Road) and southern extent of the survey area.

Table 3-6 Threatened and Priority Ecological Communities identified in the desktop searches

Floristic Community Type Name & ID	EPBC Act	DBCA / BC Act	Description	Location
Herb rich shrublands in clay pans (FCT - SCP08)	Critically Endangered	TEC - Endangered	This vegetation community type occurs in low lying flats with a clay impeding layer allowing seasonal inundation. This vegetation community type is dominated by one or more of the shrubs: *Viminaria juncea, Melaleuca viminea, M. lateritia*, *Kunzea micrantha* or *K. recurva* with occasional emergent of *Eucalyptus wandoo*. Species such as *Hypocalymma angustifolium*, *Acacia lasiocarpa* var. *bracteolata* long peduncle variant (G. J. Keighery 5026) (P1) and *Verticordia huegelii* occur at moderate frequencies. This vegetation community type has a high percentage of weeds and appears to be the clay pan vegetation community type that has the greatest disturbance (Threatened Species Scientific Committee (TSSC) 2012).	Four occurrences within the survey area: One at the intersection with South Western Hwy One at the South Western Hwy and Wireless Road One occurrence at the southern extent of the survey area at the termination of the existing BORR. One occurrence at the Davenport Link. Five occurrences within the 5 km buffer.
Dense shrublands on clay flats (FCT – SCP09)	Critically Endangered	TEC - Vulnerable	This vegetation community type is shrublands or low open woodlands on clay flats that are inundated for long periods because it usually occurs very low in the landscape. Sedges are more apparent in this ecological community and include *Chorizandra enodis*, *Cyathochaeta avenacea, Lepidosperma longitudinale* and *Meeboldina coangustata*. Shrubs include *Hakea varia* and *Melaleuca viminea* and occasionally *Xanthorrhoea preissii, X. drummondii* and *Kingia australis*. This vegetation community type has a lower species richness and weed frequency than in the other clay pan	Two occurrences within the survey area: One at the intersection with South Western Hwy One at the intersection of South Western Hwy and Wireless Road. Four occurrences within the 5 km buffer.

Floristic Community Type Name & ID	EPBC Act	DBCA / BC Act	Description	Location
			community types, presumably because of the longer inundation times (TSSC 2012).	
Corymbia calophylla – *Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain (SCP 3c)	Critically Endangered	TEC - Vulnerable	The *Corymbia calophylla* - *Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain ecological community is one of three *Corymbia calophylla* dominated plant communities, which were historically probably some of the most common vegetation types on heavy soils on the eastern side of the Swan Coastal Plain. Gibson *et al.* (1994) recognised three distinct communities in this group. The floristic composition of these communities varies with water regime, with this driest type dominated by *Corymbia calophylla* and *Xanthorrhoea preissii*. This ecological community aligns with the Gibson *et al*. (1994) community type 3c (Endangered Species Scientific Subcommittee 2000).	Two occurrences within the survey area at South Western Hwy and Wireless Road
Banksia woodlands of the Swan Coastal Plain (TEC) *Banksia* dominated woodlands of the Swan Coastal Plain IBRA region (PEC)	Endangered	Priority 3	The ecological community is a woodland associated with the Swan Coastal Plain. A key diagnostic feature is a prominent tree layer of *Banksia*, with scattered eucalypts and other tree species often present among or emerging above the *Banksia* canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range (TSSC 2016).	77 occurrences of mapped within the survey area. These occur in the northern extent (Brunswick River to Collie River), at the northern extent of the existing BORR near Moore Road to the south extent of the survey area at the Preston River). 986 occurrences within the 5 km buffer.

Floristic Community Type Name & ID	EPBC Act	DBCA / BC Act	Description	Location
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Priority 3	Consists of the assemblage of plants, animals and micro-organisms associated with saltmarsh in coastal regions of sub-tropical and temperate Australia. The habitat is tidal areas under tidal influence. It is typically restricted to the upper intertidal environment, generally between the elevation of the mean high tide, and the mean spring tide (TSSC 2013).	5 occurrences within the 5 km buffer of the survey area.
SCP07 - Herb rich saline shrublands in clay pans (a component of the Critically Endangered Clay Pans of the Swan Coastal Plain TEC).	Critically Endangered	TEC - Vulnerable	This vegetation community type occurs on heavy clay soils that are generally inundated from winter to mid-summer. Structurally this vegetation community type is quite variable ranging from woodlands to herblands, the most common overstorey species being *Melaleuca viminea, M. uncinata, M. cuticularis* or *Casuarina obesa*. Typical species in the understorey include the common herbs *Brachyscome bellidioides, Centrolepis polygyna, Pogonolepis stricta* and *Cotula coronopifolia*. In addition, species such as *Angianthus* aff. *drummondii*, *Eryngium pinnatifidum* subsp. Palustre (G.J. Keighery 13459) and *Blennospora drummondii* occur in low frequency (<50%) and are absent from the other four vegetation community types (SCP08, SCP09, SCP10a and 117) (TSSC 2012).	2 occurrences in the 5 km buffer.
SCP10a - Shrublands on dry clay flats (a component of the Critically Endangered Clay Pans of the Swan Coastal Plain TEC).	Critically Endangered	TEC - Endangered	This is the most rapidly drying of the clay flats vegetation community types. This vegetation community type has a high species richness and includes the aquatic annuals and geophytes typical of other clay pan and clay flat vegetation community types. The shrub layer is dominated by species of *Hakea*	One occurrence within the 5 km buffer.

Floristic Community Type Name & ID	EPBC Act	DBCA / BC Act	Description	Location
			(*H. varia* and *H. sulcata*) which, along with *Pericalymma ellipticum,* is indicative of a short inundation period (TSSC 2012).	
SCP18 - Shrublands on calcareous silts of the Swan Coastal Plain		TEC - Vulnerable	Shrublands on calcareous silts of the Swan Coastal Plain	One occurrence within the 5 km buffer.
SCP1b - *Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain		TEC - Vulnerable	*Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain	One occurrence within the 5 km buffer.
SCP21b - Southern *Banksia attenuata* woodlands (a component of the Endangered Banksia Woodland TEC).	Endangered	Priority 3	This community is restricted to the sand sheets at the base of the Whicher Scarp, the sand sheets on elevated ridges or the sand plain south of Bunbury. Structurally, this community type is normally *Banksia attenuata* or *Eucalyptus marginata – B. attenuata* woodlands. Common species include *Acacia extensa*, *Jacksonia* sp. Busselton, *Laxmannia sessiliflora*, *Lysinema ciliatum* and *Johnsonia acaulis* (DBCA 2019).	Five occurrences in the 5 km buffer.
SCP21c - Low lying *Banksia attenuata* woodlands or shrublands (a component of the Banksia Woodlands TEC).	Endangered	Priority 3	This type occurs sporadically between Gingin and Bunbury, and is largely restricted to the Bassendean system. The type tends to occupy lower lying wetter sites and is variously dominated by *Melaleuca preissiana*, *Banksia attenuata*, *B. menziesii*, *Regalia ciliata*, *Eucalyptus marginata* or *Corymbia calophylla*. Structurally, this community type may either be a woodland or occasionally shrubland (DBCA 2019).	One occurrence within the 5 km buffer.
SCP25 - Southern *Eucalyptus gomphocephala - Agonis*	Endangered	Priority 3	Woodlands of *E. gomphocephala – A. flexuosa* south of Woodman Point. Recorded from the Karrakatta,	Eight occurrences in the 5 km buffer.

Floristic Community Type Name & ID	EPBC Act	DBCA / BC Act	Description	Location
flexuosa woodlands (can form a component of the Banksia Woodlands TEC or the Tuart Woodlands of the SCP PEC).			Cottesloe and Vasse units. Dominants other than Tuart were occasionally recorded (including *Corymbia calophylla* and *E. decipiens*) however Tuart was emergent nearby (DBCA 2019).	
SCP30b - Quindalup *Eucalyptus gomphocephala* and/or *Agonis flexuosa* woodlands (can form a component of the Tuart Woodlands of the Swan Coastal Plain PEC).		Priority 3	This community is dominated by either Tuart or *Agonis flexuosa*. The presence of *Hibbertia cuneiformis*, *Geranium retrorsum* and *Dichondra repens* differentiate this group from other Quindalup community types. This type is found from the Leschenault Peninsular south to Busselton (DBCA 2019).	One occurrence within the 5 km buffer.

3.5.3 Flora diversity

The NatureMap database search identified 656 plant species, representing 90 families recorded within the study area. This total comprised 522 native flora species and 134 introduced flora species. Dominant families recorded within the study area included Fabaceae (79 species), Orchidaceae (51 species), Poaceae (48 species), Cyperaceae (42 species) and Myrtaceae (37 species). The NatureMap database search is provided in Appendix C.

3.5.4 Conservation significant flora

Desktop searches of the EPBC Act PMST, NatureMap, DBCA TPFL and WAHERB databases identified the presence/potential presence of 48 conservation significant flora species within the study area. The desktop searches recorded 18 species listed under the EPBC Act and/or as Threatened under the BC Act and 30 listed as Priority species by the DBCA.

The locations of conservation significant flora registered on the DBCA databases are mapped in Figure 7, Appendix A.

4 SUMMARY OF PREVIOUS VEGETATION AND FLORA SURVEYS

4.1 Survey areas and methodology

Several studies have previously been undertaken over sections of the survey area. An overview of previous survey effort is included in Table 4-1 and the location of these surveys is provided in Figure 8, Appendix A. A summary of the key findings of these previous surveys is provided in Table 4-2.

Table 4-1 Summary of Previous Surveys

Study name	Location / extent in survey area	Methodology
GHD (2010) – Bunbury Port Access Road Project Stage 2 – Flora and Vegetation Survey	Near Boyanup Picton Road to South Western Highway.	Survey completed on the 13, 14 and 17 October and the 4 – 5 November 2009. The survey included vegetation type and condition mapping.
GHD (2014) – Lot 1 Ducane Road, Environmental Values Assessment	Survey of Lot 1 Ducane Road (40.5 ha) – which is located south of the BORR North survey area.	Survey on the 13 June 2013. This survey included vegetation mapping and quadrat based sampling.
GHD (2015a) – Dardanup Structure Plan	Approximately 2,700 ha between Collie River and approximately Boyanup Picton Road.	Two season flora survey in accordance with EPA (2004). Late winter (13 – 14 August 2014 and mid-spring (30 – 31 October 2014). Vegetation type and condition mapping based on quadrats and opportunistic records. Searches for conservation significant flora.
GHD (2015b) – BORR South Flora Survey	Survey for the BORR South project area. This occurs immediately south of the current survey area and is used to provide context.	Survey completed on 21 – 23 September 2011 and 16 – 18 June 2014. Level 2 flora and vegetation survey including quadrat sampling, targeted searches and vegetation type / condition mapping.
Biota (2016) – Reassessment of Floristic Communities.	Target areas within the BORR South alignment. Two quadrats within the current survey area.	Additional quadrats and re-analysis of the FCTs presented in GHD (2015). Surveys carried out in September 2016.
Biota (2018) – Banksia TEC Assessment for BORR South	24 target areas within the BORR South area and surrounds. This report also provides context for the Banksia TEC assessment. One target site (Site 1) occurred within the current survey area.	Walking transects and quadrats within the target sites, surveys carried out in November 2017.
Ecoedge (2018) – A Flora and Vegetation survey	Survey of the 83.3 ha within Lot 104 (North east of the Preston River.	Survey carried out on 30 October and 2 and 3 November 2017. Vegetation

Study name	Location / extent in survey area	Methodology
on Lot 104 Willinge Drive Davenport.		type and condition mapping and species lists presented.

Table 4-2 Summary of the key findings of previous flora surveys

Study name	Summary of vegetation types and condition	Species diversity	Conservation significant community / species
GHD (2010)	Three vegetation types: including *Corymbia calophylla* woodland, *Melaleuca rhaphiophylla* woodland and *Eucalyptus rudis* woodland. Condition ranged from Good (3) to Completed Degraded (6).	128 plant species, 31 introduced species.	None.
GHD (2014)	Five vegetation types; Jarrah / Marri / Banksia Woodland, Jarrah / Peppermint Woodland, Flooded Gum Woodland and *Astartea* closed heath. Previous disturbances by grazing and weeds present.	104 plant species, 23 introduced species.	No TECs or PECs – this survey was prior to the Banksia Woodland TEC being formally recognised. It is likely that some of the vegetation on site may meet this TEC. One conservation significant species recorded (*Acacia semitrullata* P4).
GHD (2015a)	Twelve vegetation types; it was noted that majority of the project area had been cleared for agriculture and consisted of paddocks used for dairy farming. Within the project area remnant vegetation occurred along the road reserves, rivers and creeklines, in small patches on private land and as scattered trees in paddocks, including *Melaleuca rhaphiophylla*, *Corymbia calophylla* and *Eucalyptus rudis*. Scattered clay pans occur throughout the project area. The majority of these had been cleared but the small patches that remain support seasonally-inundated shrublands and herblands. 91.7 % of the project area was in Completely Degraded condition.	201 flora species from 64 families and 151 genera within their project area. This included 102 native species and 99 introduced species. The species richness recorded in quadrats ranged from 7 to 32 species per 100 square metres.	Possible – Clay pans TEC. GHD identified two DBCA conservation species and a potential third within project area • *Chamaescilla gibsonii* (P3) • *Aponogeton hexatepalus* (P4) • *Schoenus ? capillifolius* (P3) – tentative identification due to insufficient flowering material. Potential for *Eucalyptus rudis* subsp. *cratyantha* (P4) to occur within the project area
GHD (2015b)	Eleven vegetation types; two types mapped within the BORR North survey area: *Melaleuca* woodland and scattered remnant vegetation. Both types in Degraded to Completely Degraded condition.	198 species from 48 families and 118 genera within the project area. This included 145 native	Potential TEC and PECs present. Two conservation significant – *Caladenia speciosa* (P4) and *Acacia semitrullata* (P4).

Study name	Summary of vegetation types and condition	Species diversity	Conservation significant community / species
		species and 53 introduced species.	
Ecoedge (2018)	Seven vegetation types including *Eucalyptus marginata / Corymbia calophylla* and *Agonis flexuosa* woodlands, *Eucalyptus rudis* woodlands, *Melaleuca rhaphiophylla* woodlands and pasture / plantation. 78% (65.4 ha) in Completely Degraded condition, 16.1 % (13.3 ha) in Degraded condition and 5.1 % (4.2 ha) in Good condition.	96 species, 38 introduced species	No conservation significant flora. No TECs –two units appear to be degraded examples of the Central *E. marginata – B. attenuata* woodlands (FCT21a). This forms part of the Endangered Banksia Woodlands TEC. However, the patches do not meet the condition and size criteria for the TEC. The fringe vegetation along the Preston River is similar to the TEC – Southern *Corymbia calophylla* Woodlands on Heavy Soils (FCT01b) – but may be an example of a riverine vegetation unit not sampled by Gibson *et al.* (1994). It is an example of a riverine community that has largely disappeared from the southern Swan Coastal Plain and is regionally significant.

5 VEGETATION AND FLORA FIELD SURVEY RESULTS

5.1 Vegetation types

The survey area has been extensively cleared for agriculture and consists of paddocks used for dairy farming / grazing. Areas of native vegetation occur within road reserves, along rivers and creeklines, in patches on private land and as scattered trees in paddocks.

The survey area occurs on the Bassendean Dunes and Pinjarra Plain, and is mostly low relief, flat to undulating plains with low-lying seasonally inundated depressions. Prior to clearing vegetation would have comprised *Eucalyptus* / *Corymbia* / *Banksia* woodlands in higher relief areas with *Eucalyptus rudis / Melaleuca* woodlands in the low, seasonally inundated areas.

Remnant tracts of vegetation within the survey area that retain native structure / overstorey density are mostly restricted to patches within paddocks and sections of road reserves. Elsewhere, only scattered trees including *Melaleuca rhaphiophylla, M. preissiana, Agonis flexuosa, Corymbia calophylla, Eucalyptus marginata* and *E. rudis* remain over introduced pasture species.

The survey identified 17 vegetation types as well as cleared areas, planted vegetation and rehabilitated areas. The vegetation types include *Eucalyptus* and *Melaleuca* swamps / damplands, riverine / creekline vegetation, shrublands, *Eucalyptus* woodlands and *Eucalyptus* / *Banksia* woodlands as well as scattered remnant trees within road reserves and paddocks. Table 5-1 provides a summary of the vegetation types and mapping is provided in Figure 9, Appendix A.

5.1.1 Floristic analysis

The similarity between BORR IPT sites was examined using PRIMER. Analysis was run using three scenarios:

- All species (base quadrat data)
- Native species only (weed species removed from each quadrat)
- Species that occur only once (singles) removed from each quadrat.

Of these three scenario's the native species only had the lowest stress value (0.12), indicating a reasonable representation. Using this scenario the cluster analysis and resulting dendrogram (Appendix E) and two dimensional MDS scatter plot (Plate 2) showed general groupings of quadrats that broadly aligned with vegetation types.

Those vegetation units that most closely grouped were:

- VT12 – *Melaleuca rhaphiophylla* and *M. lateritia* shrublands
- VT19 and VT20 – representing the *Eucalyptus* and *Banksia* Woodlands
- VT15 – *Corymbia calophylla* woodlands.

Those vegetation types that largely occurred in Degraded or worse condition and have experienced historical disturbance occurred on multiple clades and showed limited similarity.

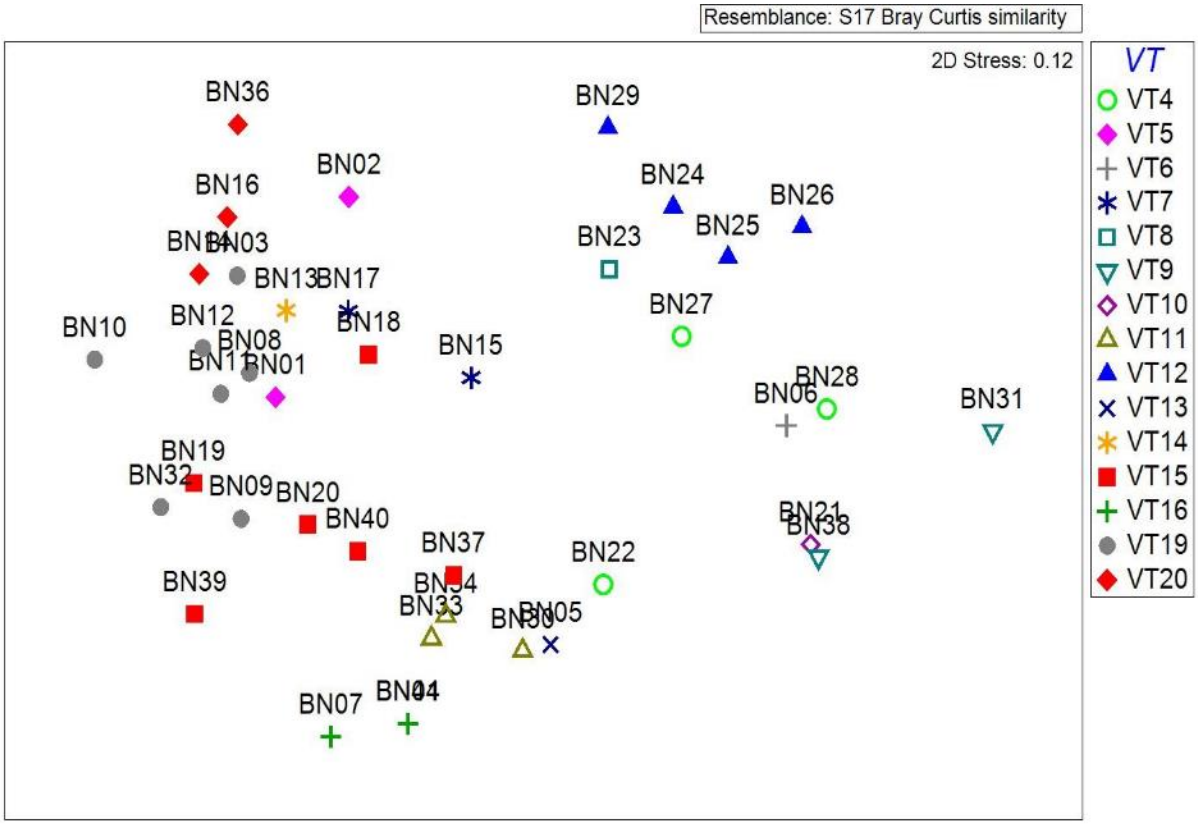

Plate 2 MDS showing general clustering of quadrats

The BORR IPT quadrats were compared to the FCT sites (see section 2.3). The cluster analysis and resulting dendrogram (Appendix E) showed little similarities between the BORR IPT quadrats and the SWA FCTs, with the BORR IPT quadrats clustered together. A two dimensional MDS scatted plot was also produced (Plate 3) and indicated that the BORR IPT quadrats have affinities to some FCTs. However, there was no strong statistical alignment with any of the FCTs, and the stress value of 0.22 indicated a poor/random representation. Overall the BORR IPT quadrats showed limited similarity to FCT quadrats in the SWA dataset, and the analysis indicates that, statistically, the vegetation recorded in the quadrats does not have strong affinities to any FCTs previously defined from the area (eg Gibson *et al.* 1994).

Given the results of the statisitical analyses, possibly due to the degraded nature of much of the survey area, it was difficult to make firm conclusions regarding the appropriate FCT to assign to each vegetation type. Best matches were drawn from a combination of the statistical analysis and interpretation of FCT descriptions.

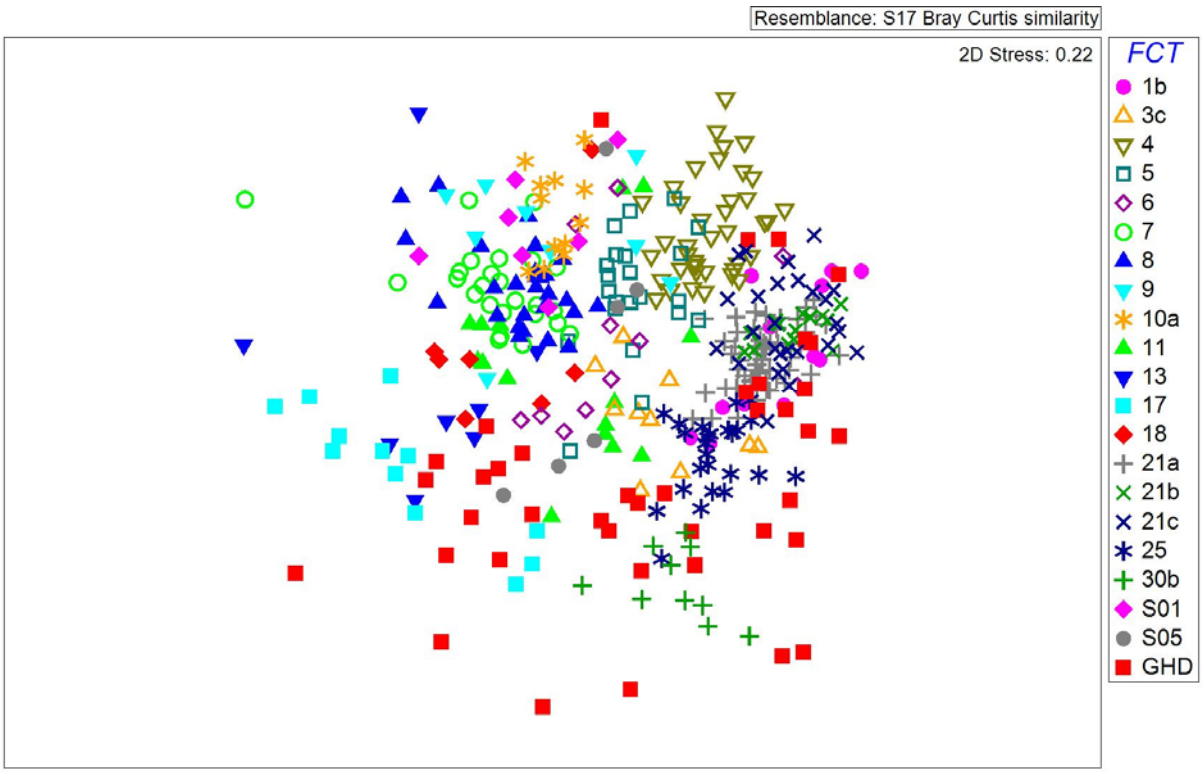

Plate 3 MDS showing showing BORR IPT quadrats compared to the SWA dataset

Table 5-1 Recorded vegetation types

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
Highly Modified / Cleared / Non-Native and Revegetation			
Highly Modified (HM –VT1) This includes areas such as existing roads, firebreaks and tracks, buildings, yards and agricultural paddocks. These areas are either devoid of vegetation or are dominated by introduced grasses and herbs. Paddocks include of mixture introduced grasses (**Avena* spp., **Bromus* sp. and **Cenchrus clandestinus*) with a mixed herbland of **Arctotheca calendula, *Cotula turbinata, *Trifolium* species and **Lotus* species with occasional patches of *Pteridium esculentum* and **Lotus cosentinii.* The lower lying areas (that would be seasonally inundated) and along the man made drains and dams may also contain *Juncus pallidus*, *J. kraussii*, **Typha orientalis* **Rumex crispus,***Watsonia meriana* and **Polypogon monspeliensis.* Some areas of open water had aquatic species including **Callitriche stagnalis*, *Azolla rubra* and *Cycnogeton lineare*. There are occasional scattered native and non-native trees and shrubs present.	 	Occurs throughout the survey area. **Extent:** 786.18 ha. **Condition**: Completely Degraded (7).	**Photo-points**: PP28, BNA21, BNA26, BNA29, BNC5 and BNC7. **FCT**: N/A.
Non Native Vegetation (NN – VT2) Non-native planted vegetation, including planted *Eucalyptus* species along internal fence lines and driveways, Blue gum plantations and land-scaping.	 Showing a recently felled area of Blue gums.	**Extent**: 123.34 ha. **Condition**: Completely Degraded (7).	**Photo-points**: PP4, PP5, PP7, PP10, BNB06 and BNB28. **FCT**: N/A.

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
Revegetation / Regrowth/ Planted (R/P – VT3) This includes revegetation as well as areas planted with a mixture of native and non-native vegetation. There are scattered remnant trees occasionally present (including *Corymbia calophylla, Eucalyptus marginata, E. rudis*, *E. gomphocephala* (uncommon), *Agonis flexuosa*, *Casuarina obesa* and *Melaleuca* species). Common shrubs include *Melaleuca nesophila, M. lanceolata*, *Kunzea glabrescens* and *Acacia saligna*. Non-endemic species present include: **Corymbia citriodora, *Eucalyptus cladocalyx, *E. botryoides* and *E. lane-poolei* (native to South West but not naturally occurring in study area). The understorey was mostly dominated by introduced grasses and herbs. The area along the existing BORR central contains more recent revegetation works (typically less than 1 m in height) and has been mapped at VT3A.	 	Along existing sections of BORR Central, Forrest Highway and in road reserves throughout the survey area. **Extent**: 3 – 16.82 ha 3A – 17.41. **Condition**: ranged from Good to Degraded (4 – 6).	**Photo-points**: BNB02, BNB03, BNB04, BNA27, BNA30, BNA31, BNA32, BNA33, BNA34, BNA45, BNA55 and BNC8. **FCT**: N/A.
***Eucalyptus* and *Melaleuca* Swamps / Damplands**			
Low woodland of *Eucalyptus rudis* and *Melaleuca rhaphiophylla* (ErMr – VT4) Woodland to very open woodland of *Eucalyptus rudis* and *Melaleuca rhaphiophylla* (occasionally *M. preissiana)* over mixed sedgeland over introduced grasses and herbs. Along St Helena Road *Xanthorrhoea preissii* and *Melaleuca viminea* form a shrubland with *Eucalyptus rudis* and *M. rhaphiophylla* dominant in the upper layer.		Scattered throughout the survey area in drainage lines and low lying / seasonally wet areas. On brown to black sandy clay. **Extent**: 21.85 ha.	**Quadrats**: BN22, BN27 and BN28. **Photo-points**: BNB09, BNB10, BNB16, BNB20, BNB23, BNB29, BNB30, BNB33, BNB34, BNB35, BNA35, BNA36, BNA37, BNC4 and BNC11. **FCT**: Difficult to assign FCT due to degraded nature.

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
	 ErMr at Quadrat BN27 – showing *X. preissii* and *M. viminea* in the shrub (mid) layer	**Condition**: Degraded to Completely Degraded (6-7).	Likely to be FCT11. Mapped in Guildford Complex of which a minor component is noted as being *E.rudis* and *M. rhaphiophylla.*
Woodland of Melaleuca *preissiana* / *Kunzea glabrescens* over mixed sedgeland (MpKgS– VT5) Woodland of *Melaleuca preissiana* with scattered *Corymbia calophylla* in higher elevation areas. The shrubland to open shrubland is dominated by *Kunzea glabrescens, Xanthorrhoea brunonis* and *Acacia pulchella* var. *glaberrima* over sedgeland of *Lepidosperma longitudinale, L. pubisquameum* and *Schoenus efoliatus*. This unit transitions into a *Corymbia* woodland (14) with *Banksia attenuata* and *Nuytsia floribunda* present (near Quadrat BN01).		Occurs in one location in the southern extent of the survey area. On a low lying plain that would be seasonally wet with sand / clay substrates. **Extent**: 2.09 ha. **Condition**: Very Good to Degarded (3 – 6).	**Quadrats**: BN01 and BN02. **Photo-points**: BNA01, BNA02, BNA03, BNA04, BNA06, BNA07 and BNC18. **FCT**: Affinity to FCT4 – This vegetation type occurs on the Southern River Complex and has *M. preissiana* as dominant in the overstorey.

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
Very open woodland of *Melaleuca rhaphiophylla* over introduced grasses and herbs in paddocks and road reserves (Mr – VT6) Woodland to very open woodland of *Melaleuca rhaphiophylla* (occasionally *M. preissiana*) over introduced grasses and herbs including **Briza maxima* and **Cynodon dactylon* over herbland of **Cyperus eragrostis, *Cotula coronopifolia* and **Callitriche stagnalis* with occasional **Watsonia meriana* var. *bulbillifera*. Often present as scattered trees of *M. rhaphiophylla*. In some locations native sedges were present in the understorey including *Juncus pallidus* and *Lepidosperma longitudinale*. At Quadrat BN06 the vegetation was in Good to Degraded condition and included *M. teretifolia* in the upper layer with *J. pallidus* and introduced grasses and herbs in the ground layer.	 	Occurs throughout the survey area, often as scattered *M. rhaphiophylla* trees. **Extent**: 25.16 ha. **Condition**: Good – Completely Degraded (4-7).	**Quadrats**: BN06 (only one quadrat in Good-Degraded site). Remainder of locations in Degraded condition and surveyed via photo points. **Photo-points**: PP8, PP9, PP31, BNB14, BNB15, BNB19, BNB25, BNB26, BNC3, BNC9, BNC13, BNC14 and BNC15. **FCT**: It is difficult to assign this vegetation type to a FCT due to its Degraded to Completely Degraded condition. Likely to be degraded form of FCT11.

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
Woodland of *Melaleuca preissiana* and *Kunzea glabrescens* in damplands (MpKg – VT7) Woodland to closed woodland of *Melaleuca preissiana* and *Kunzea glabrescens* over an open grassland / sedgeland of **Ehrharta calycina*, *Lyginia imberbis* and **Oxalis pes-caprae* and an open herbland of *Dasypogon bromeliifolius, Hypochaeris glabra* and *Daucus glochidiatus*. It is noted that at both locations there was no water present and tree death was evident.		Occurs in two locations in the northern extent of the survey area. **Extent**: 4.62 ha. **Condition**: Good – Degraded (4 - 6).	**Quadrats**: BN15 and BN17. **Photo-points**: PP24, BNA43, BNA40, BNA44, BNA57 and BNA58. **FCT**: This community lacked native species in the mid and ground layers. It may align with FCT4 based on the dominance of *M. preissiana* and *D. bromellifolius*.
Mosaic of *Melaleuca rhaphiophylla, Corymbia calophylla* and *Eucalyptus rudis* woodland (MrCcEr – VT8) Mosaic of vegetation types VT4 and VT17. This vegetation type occurs in road reserves where a mosaic of scattered trees of *Melaleuca rhaphiophylla, Corymbia calophylla* and *Eucalyptus rudis* occur over a ground-layer dominated by introduced grasses.		**Extent**: 3.72 ha. **Condition**: Degraded – Completely Degraded (6 - 7).	**Quadrats**: BN23 **Photo-points**: BNB13, BNB17, BNB18, BNC10 and BNC12. **FCT**: possibly forms part of FCT11 (based on presence of *E. rudis* and *M. rhaphiophylla*). However, only present in Degraded or worse condition in narrow road reserves making assigning an FCT difficult.

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
River / Creekline vegetation			
Woodland of *Eucalyptus rudis* and *Corymbia calophylla* over *Melaleuca rhaphiophylla* (ErCcMr – VT9) Woodland of *Eucalyptus rudis* and *Corymbia calophylla* over *Melaleuca rhaphiophylla* over grassland of **Cenchrus clandestina*, * *Briza minor* and **Bromus diandrus* and a herbland of **Geranium molle*, **Stellaria media* and **Alisma lanceolatum* on red-brown clay loams.		Occurs in a main tributary leading into Preston River. **Extent**: 5.88 ha. **Condition**: Degraded – Completely Degraded (6 - 7).	**Quadrats**: BN31 and BN38. **FCT**: Degraded form of FCT11 (based on presence of *E. rudis* and *M. rhaphiophylla*). However, only present in Degraded or worse condition in narrow road reserves making assigning an FCT difficult.
Woodland of *Melaleuca rhaphiophylla, Eucalyptus rudis* and *Casuarina obesa*; fringing vegetation along Collie River (ErMrCo – VT10) Woodland of *Melaleuca rhaphiophylla, Eucalyptus rudis* and *Casuarina obesa* over sedgeland of *Juncus* species over grassland of introduced species including: **Cynodon dactylon, *Lolium rigidum, *Avena barbata* and *Bromus diandrus.*		Located along the Collie River. **Extent**: 2.32 ha. **Condition**: Good – Degraded (4 - 6).	**Quadrats**: BN21. **Photo-points**: BNB07. **FCT**: Form of FCT11 (based on presence of *E. rudis* and *M. rhaphiophylla*). However, Gibson *et al*. (1994) notes that further information on riverine communities was needed.
Open forest of *Corymbia calophylla* and *Eucalyptus rudis* over *Agonis flexuosa* along the Preston River (CcErAf – VT11) Open forest of *Corymbia calophylla* and *Eucalyptus rudis* over *Agonis flexuosa* over scattered shrubs of *Acacia pulchella*, *Hardenbergia comptoniana* and *Macrozamia riedlei* over herbland of **Oxalis pes-caprae* and *Pteridium esculentum* and open grassland of **Ehrharta longiflora* on grey-brown sandy loam.		Occurs along the Preston River. **Extent**: 21.63 ha. **Condition**: Good – Completely Degraded (4 - 7).	**Quadrats**: BN30, BN33 and BN34. **Photo-points**: PP2, PP3, PP6, PP11, BNC16 and BNC17. **FCT**: undescribed, affinity to FCT1b (see notes in section 5.3.6).

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
Open forest of *Eucalyptus rudis* on the floodplain / upper banks of the Brunswick River (VT11a) Open forest of *Eucalyptus rudis* over introduced grasses on the upper banks / floodplain of the Brunswick River.		Occurs adjacent to the Bruswick River. Extent: 0.25 ha. Condition: Good – Degraded (4 - 6).	Photo-points: BNA54. FCT: N/A, only occurred as emergent trees over weeds.

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
Shrublands			
***Melaleuca rhaphiophylla* and *Melaleuca lateritia* shrubland (MrMl – VT12)** Open woodland of *Melaleuca rhaphiophylla* over tall shrubland of *M. lateritia, Viminaria juncea and Acacia pulchella* var. *glaberrima* over mixed sedgeland / grassland of *Lepyrodia glauca, *Ehrharta longifolia* and **Cynodon dactylon*.	 	**Extent**: 1.33 ha. **Condition**: Good – Degraded (4 - 6).	**Quadrats**: BN24, BN25, BN26 and BN29. **Photo-points**: BNB12. **FCT**: Statistically these communities did not have a strong grouping with any of the FCTs. Given the presence of *M. lateritia* and *V. juncea* this is likely to form a disturbed occurrence of FCT08.
***Astartea scoparia* shrubland (As – VT13)** Shrubland of *Astartea scoparia* over open sedgeland of *Juncus pallidus*, **Isolepis marginata* and *Isolepis ? stellata* over grassland of **Avena barbata*, **Lotus subbiflorus* and **Cynodon dactylon*. Occurs in a low lying / seasonally inundated area adjacent to cleared agricultural land. Scattered *Melaleuca rhaphiophylla* and *Agonis flexuosa* woodlands occur nearby.		Occurs in one location in the northern extent of the survey area. **Extent**: 0.22 ha. **Condition**: Good (4).	**Quadrats**: BN05. **FCT**: N/A, likely to have formed part of a broader *Melaleuca rhaphiophylla* dampland given the small extent and surrounding distured landscape. An FCT cannot be drawn.

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
Woodlands			
Woodland of *Corymbia calophylla* and *Agonis flexuosa* over weedy grass and herbland (CcAf – VT 14) Woodland of *Corymbia calophylla* and *Agonis flexuosa* with occasional *Eucalyptus marginata* typically over introduced grasses and herbs. At quadrat BN13 native structure remains with woodland *C. calophylla, E. marginata* and *A. flexuosa* over *Jacksonia furcellata, Xanthorrhoea brunonis* and *Hypocalymma angustifolium* over a herbland / sedgeland of *Opercularia hispidula, Dasypogon bromeliifolius* and *Lepidosperma pubisquameum*.		Occurs throughout the survey area, mostly within road reserves. **Extent**: 6.85 ha. **Condition**: Good – Completely Degraded (4 - 7).	**Quadrats**: BN13 , BN37. BN39 and BN40 **Photo-points**: BNA38, BNA39, BNA52 and BNA63. **FCT**: affinity to 25. However, *C. calophylla* is dominant and Tuart was not observed.
Open woodland of *Corymbia calophylla* and *Eucalyptus marginata* over introduced grasses in road reserves and paddocks (CcEm – VT15) Woodland of *Corymbia calophylla* and *Eucalyptus marginata* with occasionally a lower tree layer of *Agonis flexuosa* over a shrubland of *Kunzea glabrescens, Xylomelum occidentale* and *Xanthorrhoea brunonis* over a grassland of introduced grasses including **Ehrharta calycina., *Lolium perenne* and *Avena barbata.* Similar to VT 14 – with *A. flexuosa* less dominant in the overstorey. Often in the road reserves this occurs as *C. calophylla / E. marginata* over introduced grasses.		**Extent**: 24.98 ha. **Condition**: Good – Completely Degraded (4 - 7).	**Quadrats**: BN18, BN19 and BN20. **Photo-points**: BNB05, BNB7_2, BNB08, BNB11, BNB22, BNB24, BNB31, BNA08, BNA09, BNC6 and BNC19. **FCT**: affinity to 25. However, *C. calophylla/ E. margianta* are dominant and Tuart was not observed.

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
***Agonis flexuosa* closed woodland over pasture grasses (Af – VT16)** This unit occurs as *Agonis flexuosa* woodland to closed woodland over introduced grasses. It occurs throughout the survey area, with stands of this community occurring near Clifton Road in the northern extent of the survey area.		**Extent**: 25.78 ha. **Condition**: Good – Completely Degraded (4 - 7).	**Quadrats**: BN04, BN07 and BN35. **Photo-points**: PP20, PP32, PP39, PP40, BNB21, BNA11, BNA13, BNA14, BNA15, BNA16, BNA18, BNA19, BNA20, BNA22, BNA24, BNA25, BNA41, BNA51 and BNA64. **FTC**: affinity to FCT25. However, *A. flexuosa* is dominant and Tuart was not observed.
Scattered / Isolated Trees			
Scattered *Eucalyptus rudis* (Er – VT 17) Scattered trees of *Eucalyptus rudis* over grassland of introduced grasses, **Cynodon dactylon* and **Briza maxima*.		**Extent**: 1.36 ha. **Condition**: Degraded – Completely Degraded (6 - 7).	**Photo-points**: BNB27 and BNB36. **FCT**: N/A, scattered trees, insufficient structure / asssemblages to align with FCT.

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
Isolated trees of *Eucalyptus* species / *Agonis flexuosa* and *Melaleuca* species in paddocks (EspAfMsp – VT18) Isolated trees of *Eucalyptus* (*E. marginata / E. rudis* and *Corymbia calophylla*), *Agonis flexuosa* or *Melaleuca rhaphiophylla* in paddocks or road reserves.		**Extent**: 10.66 ha. **Condition**: Degraded – Completely Degraded (6 - 7).	**Photo-points**: BNC18. **FCT**: N/A, scattered trees; insufficient strucutre / asssemblages to align with FCT.
Eucalyptus and Banksia Woodlands			
Woodland of *Eucalyptus marginata* over *Agonis flexuosa*, *Banksia attenuata* and *B. ilicifolia* (EmAfBaBi – VT19) Woodland of *Eucalyptus marginata* and *Corymbia calophylla* with lower tree layer of *Agonis flexuosa*, *Banksia attenuata* and *B. ilicifolia*. The diverse shrubland (when present) was dominated by *Hibbertia racemosa, Macrozamia riedlei* and *Xanthorrhoea brunonis* over herbland / sedgeland including *Desmocladus fasciculatus, Lomandra* species and *Dasypogon bromeliifolius*. Introduced grass species were common including **Briza maxima* and **Ehrharta* species on grey sand. This was often in a Degraded condition, with only the tree layer present.	 BN03 in Very Good condition  BN08 in Degraded condition	**Extent**: 23.10 ha. **Condition**: Very Good – Completely Degraded (3 - 7).	**Quadrats**: BN03, BN08, BN09, BN10, BN11, BN12 and BN32. **Photo-points**: PP1, PP25, PP27, PP30, PP36, PP37, PP38, PP50, PP52, BNA10, BNA17, BNA17, BNA28, BNA56, BNA59, BNA60, BNA61, BNA62 and BNA65. **FCT**: FCT21a.

Vegetation type description	Photograph	Location, Condition and extent	Sample locations and FCT comparison
Woodland of *Eucalyptus marginata, Banksia* spp., *Kunzea glabrescens* (EmBKg – VT20) *Eucalyptus marginata* woodland with *Banksia ilicifolia* and *Banksia attenuata* low woodland over *Kunzea glabrescens, Xanthorrhoea brunonis and Acacia pulchella* var. *glaberrima* over sedgeland / herbland of *Lomandra caespitosa, Hypolaena exsulca* and *Lyginia barbata*. Introduced grass species including **Ehrharta* species and **Briza maxima*. This community was noted by Great Southern Biologic (GS Biologic) (2018) as being Dieback infested. The density of *Banksia* and other Proteaceae species varied throughout the community but generally was between 2 and 30 %.		**Extent**: 2.97 ha. **Condition**: Good - Degraded (4 - 6).	**Quadrats**: BN14, BN16 and BN36. **Photo-points**: BNA10, BNA42, BNA46, BNA47, BNA48, BNA50, BNC1 and BNC2. **FCT**: FCT21a.

5.2 Vegetation condition

The vegetation condition within the survey area was rated from Excellent to Completely Degraded. The majority of the survey area was rated as Completely Degraded (81.02 %), this included pasture, plantations and existing infrastructure corridors (roads, tracks and power corridors). Areas of remnant vegetation within the agricultural areas were mostly in Degraded to Completely Degraded condition. These were typically small, disjunct patches within paddocks that had scattered trees but lacked structure and were dominated by introduced grasses and herbs in the ground layer.

Some larger patches of native vegetation within agricultural areas were present, particularly in the northern and southern extent of the survey area (along Preston River and adjacent to Clifton Road). These areas have historically been / are currently grazed and were often devoid of native mid and ground layers, with a remnant overstorey of species such as Marri, Jarrah, Peppermint and Banksia present. Vegetation was rated as Degraded where a native overstorey was retained but no native mid or ground layers were present. When these patches had native species in the mid / ground layers and an intact native overstorey, they were rated as Good condition.

The road reserves and patches of vegetation within private land holdings had some areas rated as Good to Very Good (10.61 ha / 1.88 % of the survey area). Vegetation rated as Good to Very Good had few weed species, structural layers present and showed few signs of disturbance. Areas in these condition classes occurred in the northern extent along sections of Forrest Highway and also on the South Western Highway near the current BORR Central termination. The remainder of the road reserves were rated as Degraded to Completely Degraded.

A dieback survey for the survey area was completed (GS Biologic 2018) and identified dieback within most low lying wetlands areas with some limited spread into elevated areas. Several areas of vegetation were classified as un-infested and these were typically associated with elevated areas where public access is limited or restricted. Significant areas of vegetation were also classified as uninterpretable, as the vegetation communities did not contain suitable numbers of disease indicator species.

A summary of the vegetation condition is provided in Table 5-2 and vegetation condition mapping is shown in Figure 10, Appendix A.

Table 5-2 Extent of vegetation condition ratings mapped within the survey area

Vegetation condition and extent in survey area (ha)	Photograph and description
Excellent (2) to Very Good (3): 1.02 ha (0.09 % of the survey area)	 Showing minor disturbances and very few weeds. Vegetation structure is intact, native shrubs, herbs, sedges and rushes present.
Very Good (3): 1.62 ha (0.14 % of the survey area)	Showing on minor disturbances (e.g. weeds / dieback/ edge effect from nearby roads and land uses). Vegetation structure is intact, native shrubs, herbs, sedges and rushes present.

Vegetation condition and extent in survey area (ha)	Photograph and description	
Good (4): 18.57 ha (1.64 % of the survey area)		Showing native vegetation in the upper, mid and ground layers resembling native structure. Obvious disturbances including weeds and dieback (rated Good).
Good (4) to Degraded (6): 57.43 ha (5.09 % of the survey area)		Good – Degraded was assigned when some structure and native species remained in the mid and ground layers but introduced species were dominant.
Degraded (6): 90.34 ha (8.01 % of the survey area)	 Showing vegetation that is highly disturbed, structure altered or absent. Dominance of weeds in the understorey and no mid storey.	 Showing a woodland with a tree layer but absence of any mid storey and a ground layer dominated by introduced grasses and herbs.
Degraded (6) - Completely Degraded (7): 45.25 ha (4.01 % of the survey area)		Assigned to vegetation that occurs as scattered trees with very limited connectivity.
Completely Degraded (7): 914.25 ha (81.02 % of the survey area)		Paddock – cleared of native vegetation and dominated by pasture grasses. Isolated trees occasionally present.

5.3 Threatened and Priority Ecological Communities

Threatened and Priority Ecological Communities were identified by assessing the vegetation types, landform features and field observations, coupled with the statistical analyses. Two TECs and one PEC were identified within the Survey Area (Table 5-3).

Table 5-3 Diagnostic characteristics and condition thresholds to determine Banksia Woodlands TEC (TSSC 2016)

TEC / PEC	Status	Extent in survey area
Banksia Woodlands of the Swan Coastal Plain TEC	Threatened TEC – EPBC Act	7.87 ha
Banksia dominated woodlands of the Swan Coastal Plain IBRA region PEC	Priority PEC*	26.08 ha
Herb rich shrublands in clay pans (FCT08) TEC.	Critically Endangered TEC – EPBC Act and Vulnerable TEC – BC Act	1.33 ha

A discussion is also provided on other TECs / PECs considered to show affinities to vegetation but were deemed to not meet the descriptions / criteria for TEC or PEC determination.

The spatial distribution of these TECs and PECs are presented in Figure 11, Appendix A.

5.3.1 Banksia dominated woodlands of the Swan Coastal Plain IBRA region PEC

The field assessment also confirmed the presence of the Banksia dominated woodlands of the Swan Coastal Plain IBRA region PEC, listed as Priority 3 by DBCA. This PEC differs from the TEC in that it has no minimum condition and patch size thresholds. Vegetation types VT19 and VT20 are representative of the Banksia dominated woodlands of the Swan Coastal Plain IBRA region PEC.

There is 26.08 ha of the Banksia dominated woodlands of the Swan Coastal Plain IBRA region PEC present within the survey area, ranging from Excellent to Degraded in condition (this total includes 7.87 ha which also aligns with the Banksia Woodlands of the Swan Coastal Plain EPBC Act TEC).

5.3.2 Banksia Woodlands of the Swan Coastal Plain TEC

The Banksia Woodlands of the Swan Coastal Plain was listed in September 2016 as an Endangered TEC under the EPBC Act. The Commonwealth TEC encompasses a number of FCTs, some of which area also listed as State TECs/PECs.

The TSSC (2016) describes the key structural features of the community as:

- A prominent tree layer of Banksia, with scattered eucalypts and other tree species often present among, or emerging above, the canopy
- The understorey is a species rich mix of sclerophyllous shrubs, graminoides and forbs
- High endemism and considerable localised variation in species composition across its range.

The TSSC (2016) provides guidance for determining whether the TEC is present. These criteria are summarised in Table 5-4.

Table 5-4 Diagnostic characteristics and condition thresholds to determine Banksia Woodlands TEC (TSSC 2016)

Diagnostics characteristics / condition thresholds	Criteria
Floristic Community Type	Location and physical environment: • Occurs in the SCP IBRA Bioregion Soil and landform: • Typically occurs on well drained, low nutrient soils on sandplain landforms, particularly in deep Bassendean and Spearwood sands and occasionally on Quindalup sands. Structure: • The community is a low woodland to forest, but may also include shrubland, open woodland or forest under some classification systems. The percentage canopy cover is more than 2% and typically less than 50%. The structure and appearance may also vary due to disturbance history. Composition: • The canopy is commonly dominated by *Banksia attenuata* and or *B. menziesii*. Other *Banksia* species that dominate include *B. prionotes* or *B. ilicifolia*. The patch must include at least one of these diagnostic species.
Vegetation condition[1] and minimum patch size	• Pristine – no minimum • Excellent – 0.5 ha • Very Good – 1 ha • Good – 2 ha.
Surrounding context	A patch is a discrete and mostly continuous area of ecological community. A patch may include small scale (<30 m) variations, gaps and disturbances, such as tracks, that do not significantly alter the overall functionality of the ecological community. Such breaks are generally included in patch size calculations. The landscape and position of the patch including its position relative to surrounding vegetation also influences how important it is in the broader landscape.
Additional information – patch	Average canopy cover and quality across the broadest area that meets the general description of the ecological community should be used initially in determining overall canopy cover and vegetation condition. Also note any areas that are either significantly higher or lower in quality, gaps in canopy cover and the condition categories that would apply across different parts of the site respectively. Where the average canopy cover or quality falls below the minimum thresholds, the next largest area or areas that meet key diagnostics (including minimum canopy cover requirements) and minimum condition thresholds should be specified and protected. This may result in multiple patches being identified within the overall area first considered.

[1] As per the Keighery (1994) condition scale presented in Bush Forever (Government of Western Australia 2000).

Areas of potential TEC were identified through the desktop review (including soils mapping), previous surveys in the area (GHD 2015a, Biota 2018, Ecoedge 2018), initial site reconnaissance visit and aerial photography. These areas were assessed (using quadrats and traverses) during the 2018 survey.

Vegetation types 19 and 20 were considered to be potentially representative of the Banksia woodland TEC. However, not all occurrences of these vegetation types are considered to be the Commonwealth TEC, as many do not meet the patch size / condition thresholds. Table 5-5 provides a summary of the Commonwealth Banksia Woodland TEC assessment. In total, 7.87 ha of vegetation types 19 and 20 met the criteria for the Banksia TEC. These were all in the northern extent of the survey area, near the Forrest Highway and Clifton Road intersections.

Table 5-5 Summary of field assessment for Banksia Woodland TEC

Site	Mapped VT and survey sites	Condition and Size	TEC notes	Photograph	Outcome (Yes / No)
Site 1 - Forrest Highway road reserve (eastern side) (north of Clifton Road).	VT 20 – EmBKg. Quadrat BN16.	Good within the survey area. Not assessed in the adjacent private land. Patch size in survey area: 0.48 ha.	*Eucalyptus marginata* over *Banksia ilicifolia* and *B. attenuata* over mixed shrubs and herbs. *Banksia ilicifolia* and *B. attenuata* present in patch at 2 – 10 % cover. Private land to the east also contains similar vegetation but was not assessed – using the precautionary principle if the adjacent vegetation is included the patch size would exceed the 2 ha extent. Dieback survey (GS Biologic 2018) identifies that area as dieback infested.		Yes – including broader patch in adjacent private land.
Site 2 – Forrest Hwy road reserve (western side – North of Paris Road).	VT 20 – EmBKg. Quadrats BN36 and BN14. Photo-points: PPMT50, SRU, 49, 48, 47, 46, SPT.	Good to Degraded. Patch size: 1.20 ha in Good Condition. 1.29 ha in Good to Degraded condition.	*Eucalyptus marginata* over *Banksia ilicifolia* and *B. attenuata* over mixed shrubs and herbs. *Banksia ilicifolia* and *B. attenuata* present in patch at 2 – 30 % cover. In some areas, tree death and an absence of dieback susceptible species was more evident. Banksia cover reduced to less than 2 % in sections. These sections were assigned a score of Degraded. As the condition occurred in a mosaic pattern (with small sections grading into each other) the overall patch was assigned the Good and Degraded. It is considered that given the overall patch size is 2.49 ha (and gaps of degraded vegetation were less than the 30 m distance criteria) that the overall patch meets the TEC requirements.		Yes

Site	Mapped VT and survey sites	Condition and Size	TEC notes	Photograph	Outcome (Yes / No)
			Dieback survey (GS Biologic 2018) identifies that area as dieback infested.		
Site 3 - Paris Road / Forrest Hwy intersection.	VT19 – EmAfBaBi. Quadrat BN03. Photo-points PPMT42 and PPMT10.	Patch (1.02 ha) in Excellent Condition.	Small patch in Excellent condition meets floristic, condition and size thresholds. Dieback survey (GS Biologic) – Un-infested then into infested.	 BN03	Yes
Site 4 Forrest Highway road reserve south of Clifton Road (eastern side) / Raymond Road.	VT19 – EmAfBaBi. Quadrat: BN12 BN11. Photo points: mt29, mt28, mt59, pp30, pp27, WPP27, PPMT60, PPMT61, WPP25, PPMT65.	Mosiac of Good and Degraded condition. Three patches in Good condition (2.73 ha, 1.18 ha and 1.63 ha) with a total of 5.54 ha in Good. Remaining 5.34 ha in Degraded condition.	Patch is 10.88 ha in size with more than 50% in Good (4) condition (5.34 ha). Edge effects from adjacent agricultural land (weeds) and evidence of dieback. *Eucalyptus marginata* (2 – 10 %, 10-20 m) over *Agonis flexuosa, Banksia attenuata* and *B. ilicifolia* (10 – 30 %, 6 – 10 m) over *Xanthorrhoea brunonis, Hibbertia hypericoides, Dasypogon bromeliifolius* and *Lyginia barbata* (30 %, 0.5 m). Introduced grasses dominant dominate the ground layer. Meets floristic and condition criteria for part of the site. As per guidance statement patch requirements the whole patch forms part of the TEC as over 50% meets the requirements.		Yes

Site	Mapped VT and survey sites	Condition and Size	TEC notes	Photograph	Outcome (Yes / No)
Site 5 Lot 104 and Lot 5 Clifton Road.	VT19 – EmAfBaBi. Quadrats: BN08, BN09 and BN10.	Patch size: 1.74 ha patch in Good condition. Surrounding 6.04 ha in Degraded condition.	Does not meet patch size criteria for the TEC. Dieback survey – un-infested and Infested.		No
Site 6 Lot 104 – near Preston River.	VT19 – EmAfBaBi. Quadrat : BN32.	Patch size: 3.02 ha in Degraded Condition.	Does not meet condition threshold for the TEC. Dieback survey – un-infested.		No

5.3.3 Clay pans of the Swan Coastal Plain TEC

The clay pans of the Swan Coastal Plain ecological community occurs where clay soils form an impermeable layer close to the ground surface, and wetlands form that rely solely on rainfall to fill and then dry to impervious pans in summers (TSSC 2012).

A distinctive feature of the clay pan wetlands is the suite of geophytes and annual flora that germinates, grows and flowers sequentially as these areas dry over summer. The clay pans have a high species richness, a number of local endemics and are the most floristically diverse of the SCP wetlands.

The clay pans Commonwealth TEC (Critically Endangered) corresponds to five separate FCTs, which are also State TECs / PEC, these being:

- Herb rich saline shrublands in clay pans (FCT07) – State Vulnerable TEC
- Herb rich shrublands in clay pans (FCT08) – State Vulnerable TEC
- Dense shrublands on clay flats (FCT09) – State Vulnerable TEC
- Shrublands on dry clay flats (FCT10a) – State Endangered TEC
- Clay plans with shrubs over herbs (community 117) – State Priority 1 PEC.

Although not supported by the statistical analysis, VT12 – *Melaleuca rhaphiophylla* and *M. lateritia* shrubland shows affinities with FCT08 based on key species present.

For a community to be considered a claypan TEC under the EPBC Act it should have a functioning hydrological regime and meet at least the Good condition category (TSSC 2012). Given the ecological community occurs in very loccalised locations that can be very small, no mimium patch size is recommended in the TSSC (2012).

In the survey area there is 1.33 ha of VT12 that was assigned a condition rating of Good to Degraded. The vegetation type occurred adjacent to existing roads with modified drainage and a dominance of introduced species in the ground layer. Additional surveys are recommended to further assess the condition, hydrology and species diversity (in differing seasons and periods of wet/dry) of these patches to confirm whether they meet the floristic and condition thresholds of the claypan TEC.

It is considered that this vegetation type may represent a degraded form of this TEC. There is 1.33 ha of this vegetation type within the survey area in a Good to Degraded condition.

5.3.4 Tuart (*Eucalyptus gomphocephala*) woodlands of the Swan Coastal Plain PEC

Mostly confined to Quindalup Dunes and Spearwood Dunes from Jurien Bay to the Sabina River, with outliers along some rivers. Tuart is the key dominant canopy species, however; Tuart communities comprise a variety of flora and fauna assemblages. Flora commonly occurring with Tuart include *Agonis flexuosa, Banksia attenuata, B. grandis, Allocasuarina fraseriana, Xylomelum occidentale, Macrozamia riedlei, Xanthorrhoea preissii, Spyridium globulosum, Templetonia retusa* and *Diplolaena dampieri*.

In the survey area, Tuart occurred in scattered locations but did not form continuous canopy cover and was not the dominant overstorey in any of the vegetation types described. The FCT analysis / comparison identified several vegetation types that had affinities to FCT25 – Southern Swan Coastal Plain *E. gomphocephala – A. flexuosa* woodlands. However, given that Tuart was not present and that the vegetation units were mostly in Degraded or worse condition it is not considered that they are representative of this PEC.

5.3.5 *Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain (FCT 1b) TEC

Vegetation type 11 (Open forest of *Corymbia calophylla* and *Eucalyptus rudis* over *Agonis flexuosa*) which occurs as a fringe along the Preston River is similar to FCT1b. However, even though it was rated as Good in condition, it has a depauperate understorey and lacks many of the species characteristic of FCT1b TEC (Ecoedge 2018). This may be a different community altogether and be an example of a riverine vegetation type not sampled by the survey of Gibson *et al.* (1994), which acknowledged it had not covered riverine

communities sufficiently, mainly because examples in good or better condition are rare. Smith (2002) found a similar community in a survey of riverine and alluvial plain communities. His Community III, the '*Eucalyptus rudis – Corymbia calophylla – Agonis flexuosa* Community' had low numbers of understorey species and all examples had been impacted by livestock grazing (Ecoedge 2018). The vegetation along the Preston River is not considered to be the FCT1b TEC.

Ecoedge (2018) noted that the vegetation unit along the Preston River is an example of a riverine community that has largely disappeared on the southern Swan Coastal Plain and is regionally significant. There is 21.63 ha of riverine vegetation associated with the Preston River present within the survey area.

5.3.6 *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain (FCT 3c) TEC

The *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands of the Swan Coastal Plain ecological community is one of three Marri dominated plant communities, which historically were probably some of the most common vegetation types on heavy soils on the eastern side of the Swan Coastal Plain. Gibson *et al.* (1994) recognised three distinct communities in this group. The floristic composition of these communities varies with water regime, with this driest type dominated by *Corymbia calophylla* and *Xanthorrhoea preissii*. This ecological community aligns with the Gibson *et al.* (1994) FCT 3c (ESSS 2000).

The *Corymbia calophylla* dominated vegetation types (VT15) on the heavier soils through the central section of the survey area (that overlaps with the Guildford Complex) may align with this community. However, a review of the key species recorded in the three quadrats within the VT15 indicates that very few of the common species recorded in this community were present within quadrats. Key species, including *Xanthorrhoea preissii,* were not recorded.

VT 15 was largely in a Degraded to Completely Degraded condition and did not contain native structure, and was often present as tree species only over introduced grasses. This vegetation type was not considered to be representative of this TEC.

5.4 Other significant vegetation

The survey area traverses a number of rivers, small drainage lines, as well as seasonally inundated areas (wetlands) that support riparian vegetation. The majority of the vegetation (over 80 %) in these areas was rated as Degraded to Completely Degraded in condition with scattered trees over introduced grasses.

Excluding vegetation associated with the Preston River (see section 5.3.5), the survey mapped 10.27 ha of riparian vegetation in Good – Degraded or better condition. This vegetation was considered to be representative of 'other significant vegetation', and includes:

- Very Good (3): 1.62 ha
- Good: 1.81 ha
- Good to Degraded: 6.84 ha.

5.5 Flora diversity

Three hundred and fifty four flora species (including subspecies and varieties) representing 69 families and 198 genera were recorded from the survey area during the field survey. This total comprised 241 native species and 113 introduced / planted flora species.

Dominant families recorded from the survey area included:

- Fabaceae (41 species including 16 introduced species)
- Myrtaceae (35 species including 10 planted species)
- Orchidaceae (25 species including one introduced species)
- Poaceae (24 species including 19 introduced species)

- Cyperaceae (23 species including 3 introduced).

A flora species list for the survey area is provided in Appendix F.

A species accumulation curve was generated using PRIMER to assess adequacy of sampling effort within the survey area. The species accumulation curve for the survey area, based on flora recorded within quadrats, is approaching an asymptote, which suggests that the current survey effort is sufficient. Furthermore, the bootstrap estimate of species richness generated from this data indicates that 216.28 species could be expected from the survey area based on the diversity recorded within quadrats. The total species recorded from the survey area was 354 flora species, which is substantially above the predicted species diversity estimate. The survey area is considered representative of the floristic diversity in the area.

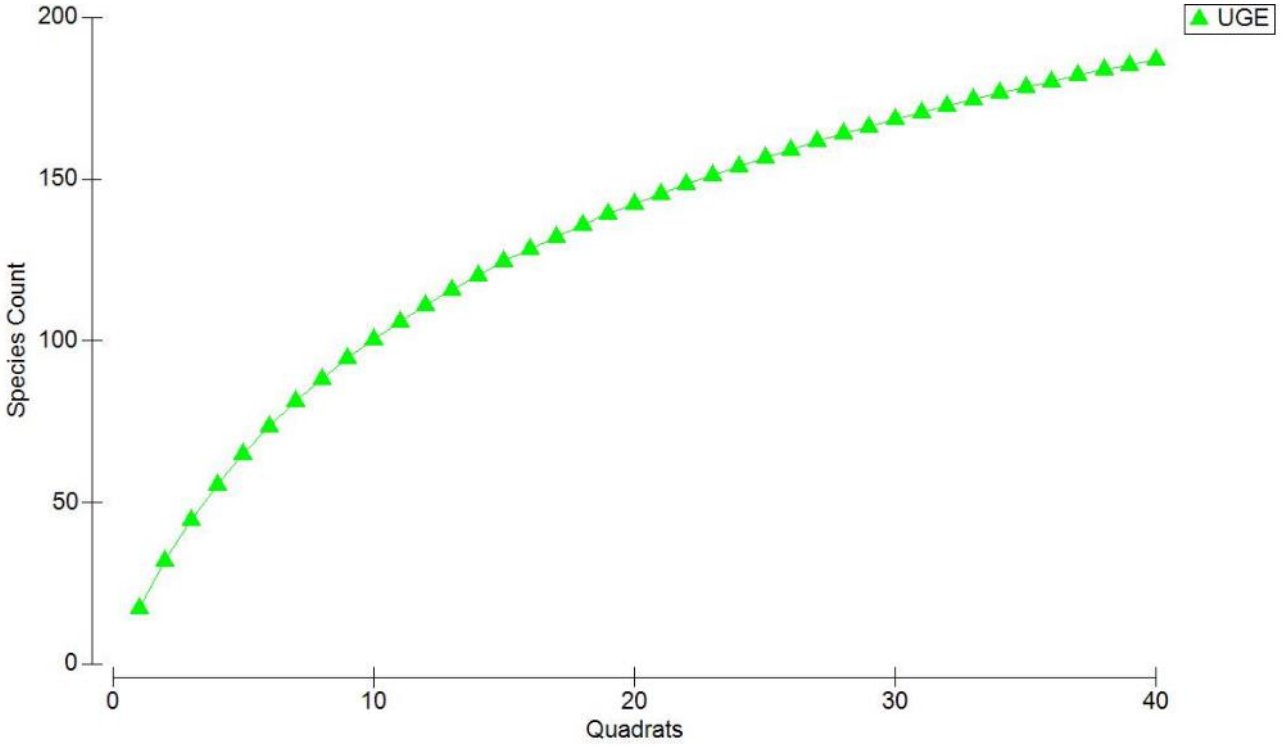

Plate 4 Species accumulation curve

5.6 Conservation significant flora

No EPBC Act or BC Act listed flora were recorded within the survey area. Four DBCA Priority-listed flora species were recorded within the survey area during the field survey.

The locations of the recorded DBCA Priority-listed flora recorded within the survey area are mapped in Figure 11, Appendix A.

***Acacia semitrullata* – Priority 4 (**Plate 4**)**

Acacia semitrullata is an erect, pungent shrub to about 0.5 m high with cream-white flowers. The species grows in white to grey sand on sand plains and is recorded from the Jarrah Forrest, Swan Coastal Plain and Warren IBRA Bioregions (WA Herbarium 1998–). *Acacia semitrullata* was recorded from five locations (eight plants) within the survey area. It was recorded from *Eucalyptus* woodlands and *Eucalyptus* / *Banksia* woodlands (VT19 and VT20) and within the *Melaleuca preissiana* and *Kunzea glabrescens* damplands (VT5). All records were from the norther extent of the survey area, in the vicinity of Forrest Highway and Clifton Road.

It is likely this plant would be scattered throughout these vegetation types where they are in Good or better condition.

***Chamaescilla gibsonii* – Priority 3 (**Plate 5**)**

Chamaescilla gibsonii is a clumped tuberous herb with blue flowers. It occurs on clay to sandy clay in winter wet flats and shallow water filled claypans. Plants of this species were recorded from two locations within the survey area (as a less than 2% component of the vegetation). It was recorded from low lying sites that would be seasonally inundated. One record was within the *Melaleuca rhaphiophylla* and *Melaleuca lateritia* Shrubland (VT12) and the other from *Melaleuca preissiana / Kunzea glabrescens* dampland (VT7).

***Caladenia speciosa* – Priority 4 (**Plate 6 **and** Plate 7**)**

The Sandplain White Spider Orchid (*Caladenia speciosa*) is a tuberous, perennial herb approximately 0.35 to 0.6 m high, with white to pink flowers. This species is reported to flower in September to October. It grows in white, grey or black sands and is recorded from the Jarrah Forest and Swan Coastal Plain IBRA Bioregions (WA Herbarium 1998–). *C. speciosa* was recorded at one location within the survey area in *Eucalyptus* / *Banksia* woodland along the western side of Forrest Highway. The survey period was towards the end of this species flowering season, and it is likely this species would occur at more locations within the *Eucalyptus* / *Banksia* woodlands.

Plate 4 *Acacia semitrullata*

Plate 5 *Chamaescilla gibsonii*

Plate 6 *Caladenia speciosa*

Plate 7 *Caladenia speciosa*

Targeted search results

***Drakaea elastica* – Endangered under EPBC Act and Critically Endangered under the BC Act**

Drakaea elastica was historically recorded from one location, at the northern extent near the Brunswick River within the Forrest Highway road reserve.

The section of road reserve was also searched for *D. elastica* by a Main Roads environmental scientist familiar with the species on 28 August 2017. This search did not identify *D. elastica* present within the recorded location.

***Diuris drummondii* –Vulnerable under the EPBC Act and Vulnerable under the BC Act**

A targeted survey was carried out in December 2018 of 20 sites within the PDE. Prior to completing the search a nearby known location of *Diuris drummondii* was visited, and the species was confirmed to be flowering.

Grid and meander searches of the 20 sites were carried out by two senior botanist and a support ecologist over of three days. Mapping showing the location of the search sites is shown in Figure 2 (Appendix A) and a description of each search site is provided in Appendix D.

No *D. drummondii* were observed from any of the search areas. Many of the sites are highly disturbed with limited native species remaining and / or grazed by cattle.

5.6.1 Likelihood of occurrence

A likelihood of occurrence assessment was conducted post-field survey for all conservation significant flora species identified in the desktop assessment, including TPFL and WAHERB database records (Appendix G). This assessment took into account previous records, habitat requirements, efficacy of the survey, intensity of the survey, flowering times and the cryptic nature of species.

The likelihood of occurrence assessment post-field survey concluded that three species are known to occur (including one species not identified in the desktop assessment), three species are likely to occur, 27 species possibly occur and the remaining 16 species are unlikely to occur within the survey area. A summary of conservation significant species which are known, likely or possibly occur within the survey area has been included in Table 5-6.

Table 5-6 Summary of conservation significant species recorded as occuring or potentially occuring within or near the survey area

Species	EPBC Act Status	BC Act / DBCA Status	Likelihood of Occurrence
Austrostipa jacobsiana	CE	CE	Possible
Austrostipa bronwenae	E	EN	Possible
Caladenia huegelii	E	CE	Possible
Drakaea elastica	E	CE	Unlikely
Diuris drummondii	VU	VU	Possible
Diuris micrantha	VU	VU	Possible
Drakaea micrantha	VU	EN	Possible
Eleocharis keigheryi	VU	VU	Possible
Synaphea odocoileops	-	P1	Possible
Craspedia sp. Waterloo (G.J. Keighery 13724)	-	P2	Possible
Grevillea rosieri	-	P2	Possible
Leptomeria furtiva	-	P2	Possible
Leucopogon sp. Busselton (D. Cooper 243)	-	P2	Possible
Schoenus loliaceus	-	P2	Possible

Species	EPBC Act Status	BC Act / DBCA Status	Likelihood of Occurrence
Angianthus drummondii	-	P3	Possible
Boronia tetragona	-	P3	Possible
Carex tereticaulis	-	P3	Possible
Chamaescilla gibsonii	-	P3	Known
Dillwynia dillwynioides	-	P3	Possible
Lasiopetalum membranaceum	-	P3	Possible
Platysace ramosissima	-	P3	Possible
Schoenus benthamii	-	P3	Possible
Schoenus capillifolius	-	P3	Likely
Verticordia attenuata	-	P3	Possible
Acacia flagelliformis	-	P4	Possible
Acacia semitrullata	-	P4	Known
Aponogeton hexatepalus (Stalked Water Ribbons)	-	P4	Likely
Caladenia speciosa	-	P4	Known
Eucalyptus rudis subsp. *cratyantha*	-	P4	Possible
Ornduffia submersa	-	P4	Possible
Pultenaea skinneri	-	P4	Possible
Rumex drummondii	-	P4	Possible
Stylidium longitubum (Jumping Jacks)	-	P4	Likely

Note: CE: Critically Endangered, E: Endangered, V: Vulnerable, P: Priority.

5.7 Introduced flora

One hundred and thirteen introduced flora species were recorded in the survey area. Of the introduced species, four are listed as Declared Pests under the *Biosecurity and Management Act 2007* and/or as a Weed of National Significance (WONS):

- * *Gomphocarpus fruticosus* (Narrowleaf Cottonbush) – Declared Pest
- * *Asparagus asparagoides* (Bridal Creeper) – Declared Pest and WONS
- * *Zantedeschia aethiopica* (Arum lily) – Declared Pest
- * *Solanum linnaeanum* (Apple of Sodom) – Declared Pest.

The remaining introduced species are considered environmental weeds and all have been previously recorded on the Swan Coastal Plain. The locations of the declared weeds is shown in Figure 9, Appendix A.

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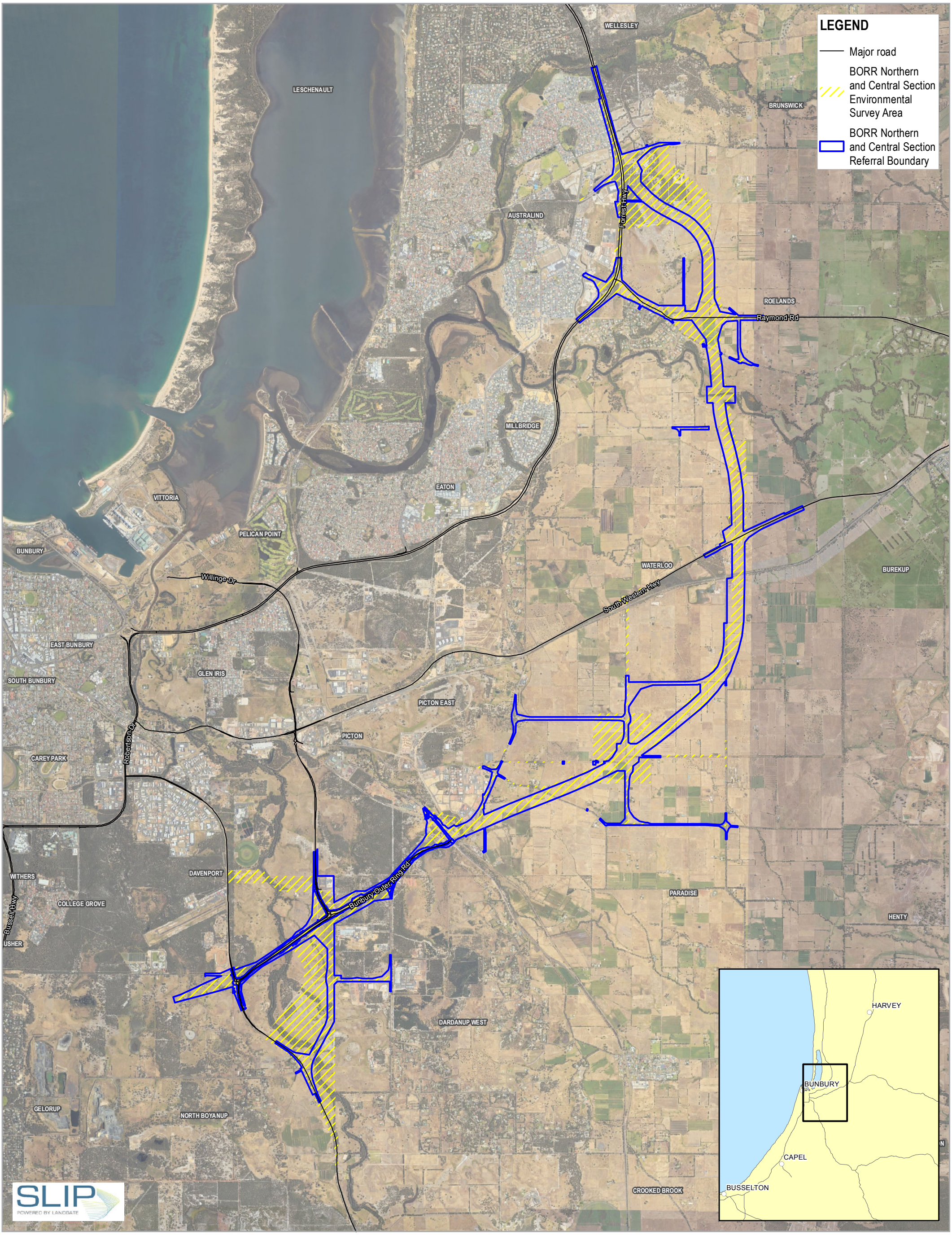
APPENDIX D

BORR Northern and Central Sections Vegetation and Flora Assessment (BORR IPT 2019c) – Part 2a (part 2 of 8)

APPENDIX A FIGURES



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Project Location

Project No. **61-37041**
Revision No. **0**
Date **20 May 2019**

FIGURE 1

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Created by: mmikkonen

APPENDIX D

BORR Northern and Central Sections Vegetation and Flora Assessment (BORR IPT 2019c) – Part 2b (part 3 of 8)

LEGEND

- Road Network
- BORR Northern and Central Section Environmental Survey Area
- BORR Northern and Central Section Referral Boundary
- Map sheet

Map 1
Map 2
Map 3
Map 4
Map 5
Map 6

Paris Rd
Raymond Rd
Clifton Rd
Forrest Hwy
Willinge Dr
South Western Hwy
Railway Rd
Wireless Rd
Martin-Pelusey Rd
Golding Cr
Boyanup-Picton Rd

Paper Size ISO A3

0 420 840 1,260 1,680

Metres

Map Projection: Transverse Mercator
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Revision No. **0**
Date **09/05/2019**

OVERVIEW

FIGURE 2

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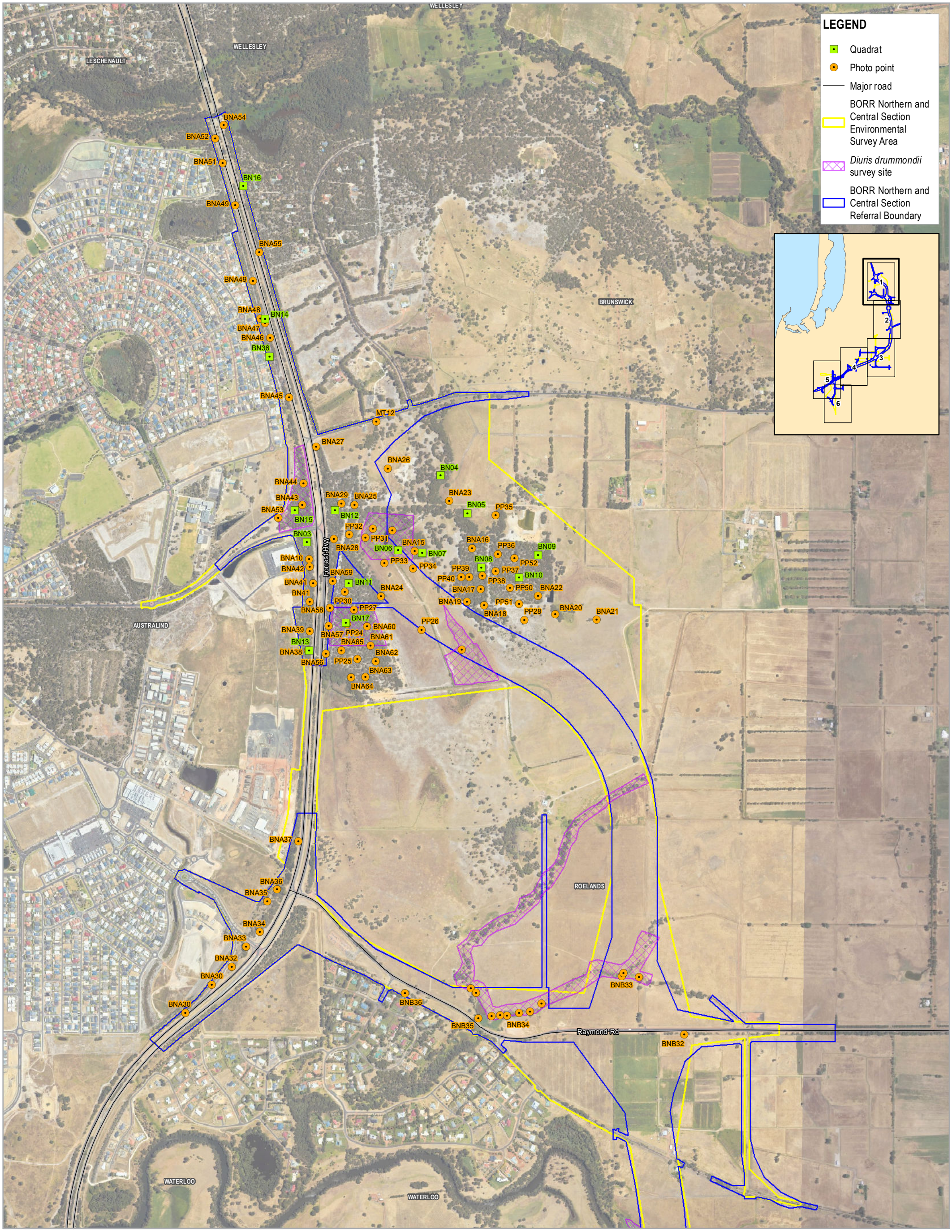

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FIGURE 2

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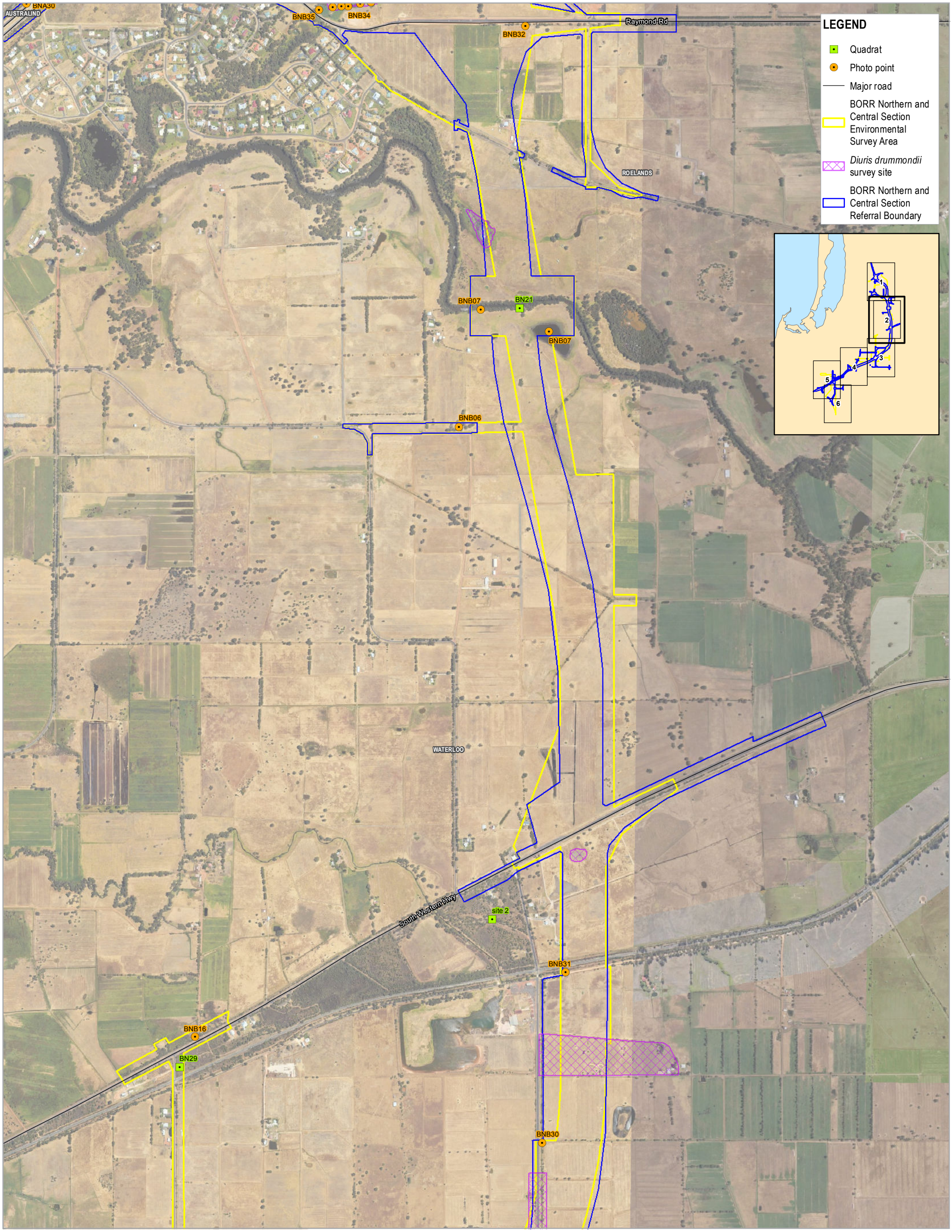

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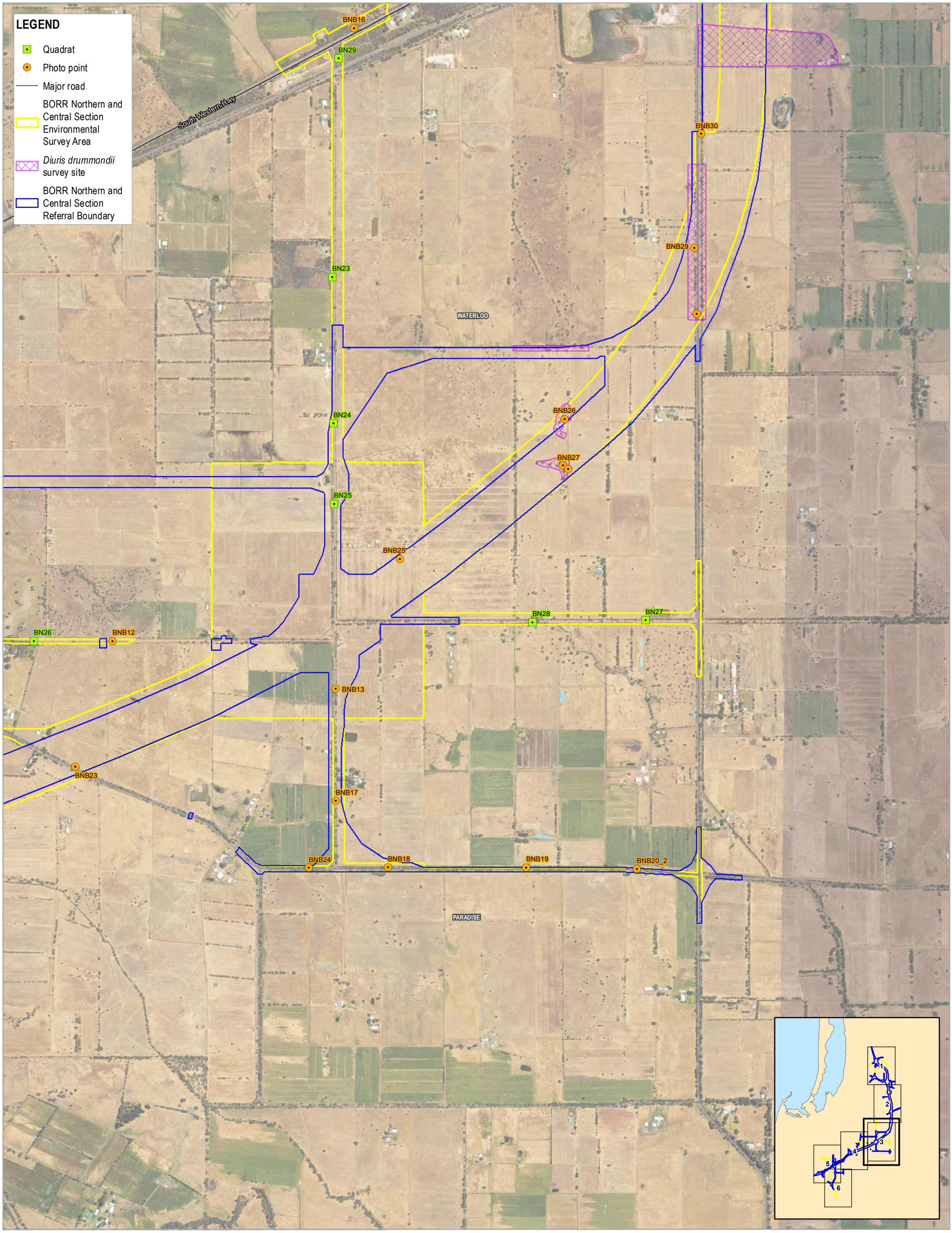

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FIGURE 2

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LEGEND

- Quadrat
- Photo point
- Major road
- BORR Northern and Central Section Environmental Survey Area
- *Diuris drummondii* survey site
- BORR Northern and Central Section Referral Boundary

South Western Hwy
PICTON
PICTON EAST
WATERLOO
PARADISE
DARDANUP WEST
Bunbury Outer Ring Rd

BNB11
BNB15
BNB14
BN26
BNB12
BNB20_2
BNB21
BNB22
BNB23
BNB10
BNB09
BNB05
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BNB02
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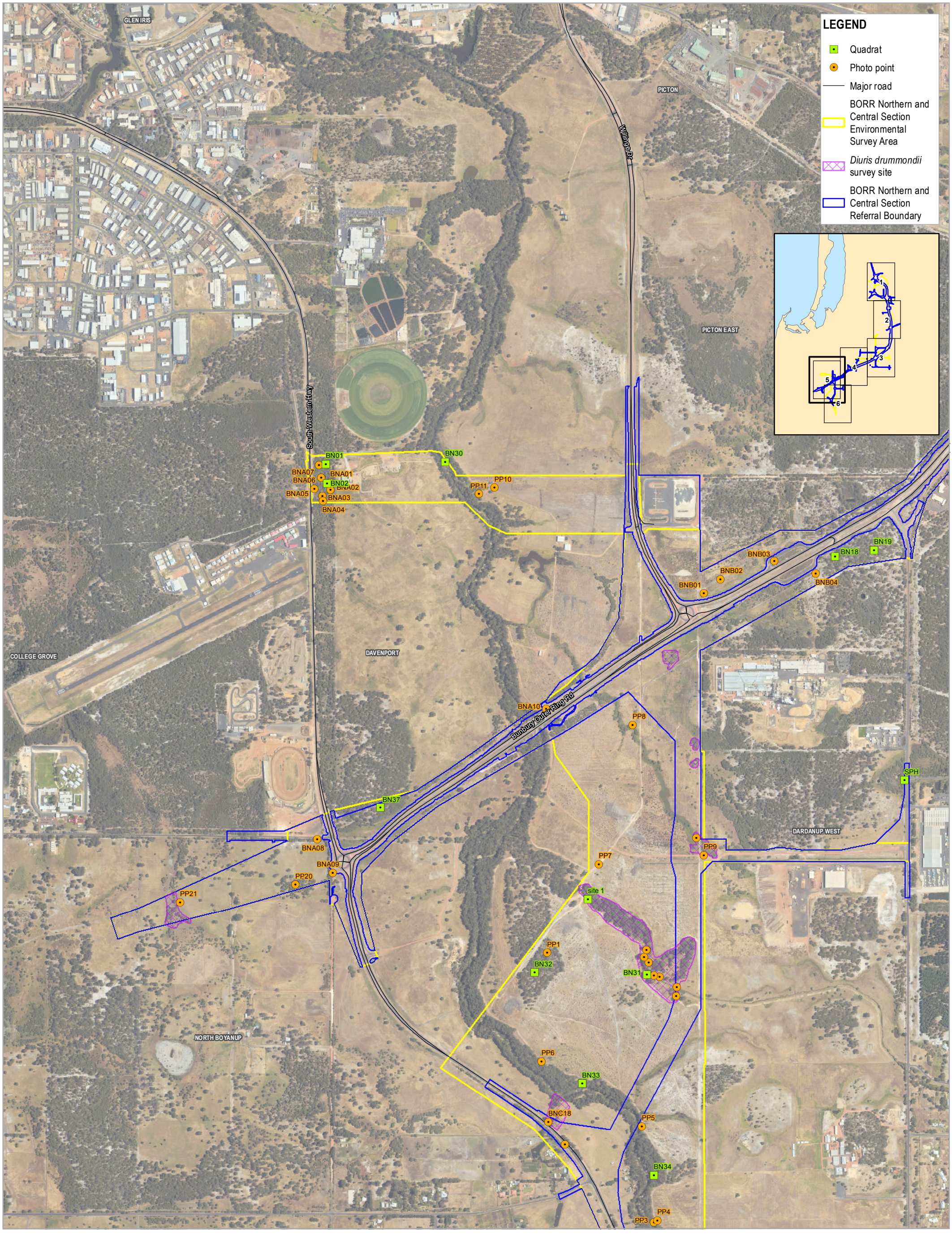

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Revision No.	**0**
Date	**21 May 2019**

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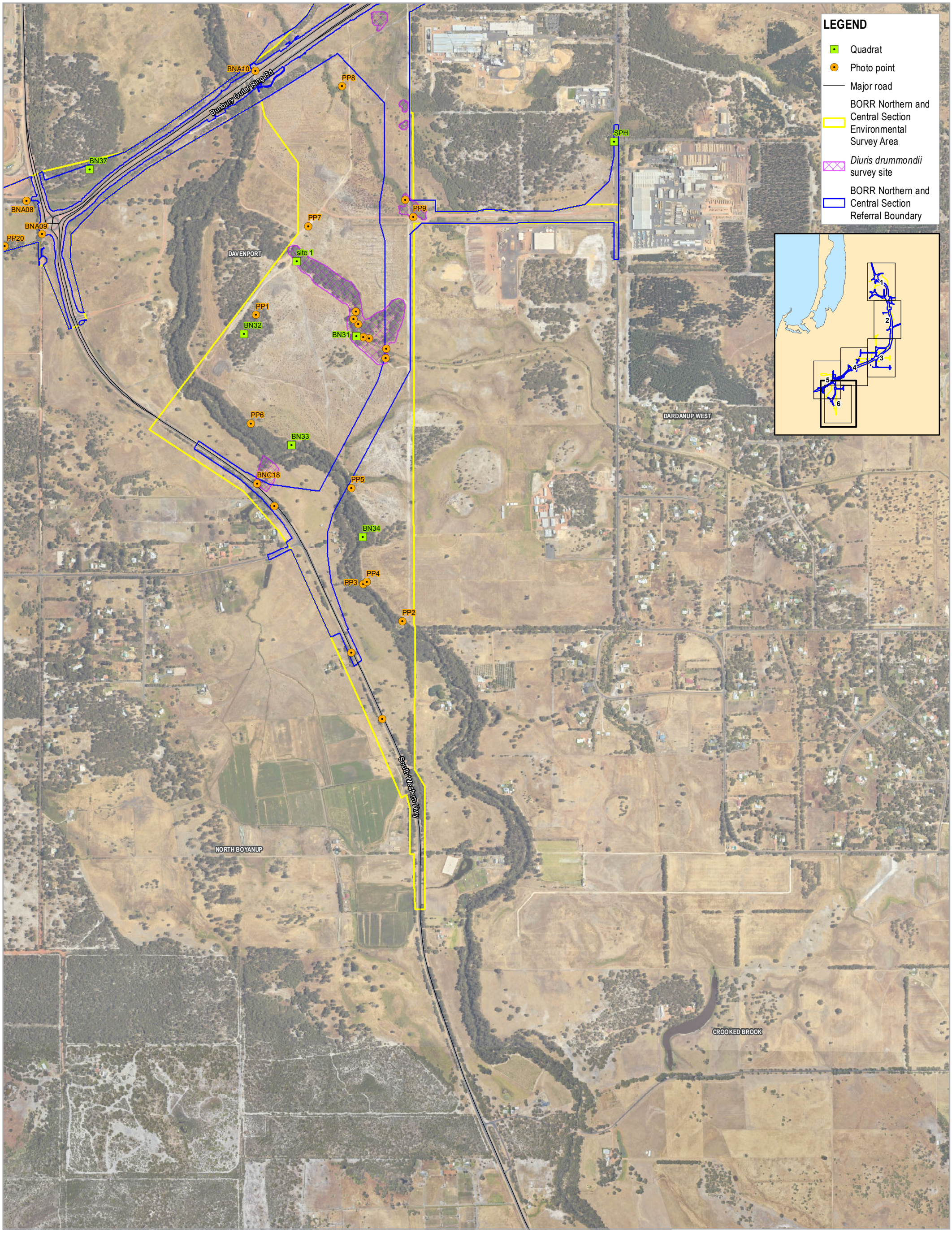

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