

Vegetation, Flora and Wetland Survey at the Wonnerup South Mineral Sands Deposit

For

Cristal Mining Australia

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Russell Smith MPhil (Plant Ecology) BSc (Hons)



Ekologica Pty Ltd
PO Box 207 Bunbury
WA 6230
Ph: (08) 9725 4014

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Summary

Ekologica Pty Ltd was commissioned by Ennovate Consulting on behalf of Cristal Mining Australia Resources Incorporating Cable Sands (Cristal Mining Australia Resources) to review flora and vegetation values at native remnants occurring on privately owned farmland (Lot 3819), Wonnerup South. The study area, comprising 233.8 ha, is situated 6 km east south east of the town of Busselton.

All remnant native vegetation and several areas of wetland, comprised almost exclusively of introduced species, was surveyed on 27th October 2012. Only forty species of flora were identified within the study area, of which thirty were introduced species.

No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the Western Australian *Wildlife Conservation Act (1950)* or listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* were located. Additionally, no Priority Flora as defined by the Department of Environment and Conservation were located within the study area.

Four plant communities were recognized in the study area, all of which consisted of an overstorey of natives trees and an understorey of introduced species (pasture species and agricultural weeds). Although one of the communities (*Corymbia calophylla* and *Eucalyptus marginata* woodland) probably was once an occurrence of the threatened ecological community “*Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain” (SCP01b), the only resemblance now is in the overstorey species and because of the absence of native understorey taxa it could not be considered an occurrence of the TEC.

Due to their small size (< 2 ha) and ongoing grazing all of the remnants lack a native understorey component and there was no regeneration of the native overstorey species. All were assessed as “completely degraded” using the definition of Keighery (1994).

Some of the remnants of native vegetation in the study area occur on the Abba Plains soil-landscape system, of which only 5% of the pre-European extent remains uncleared and none is contained in secure reserves (Molloy *et al.*, 2007). Both of the vegetation complexes represented by the study area remnants are considered to be poorly reserved, with less than the target 15% in secure conservation reserves (EPA, 2006).

However, because of their absence of native understorey species and of regeneration by the native overstorey species the study area remnants are considered to have little or no conservation value as representatives of Abba Plains vegetation.

1. Introduction

Cristal Mining Australia Resources Ltd are preparing the necessary approvals for the development of the Wonnerup South mineral sands deposit. As part of this process, Cristal Mining Australia had vegetation survey work conducted by Onshore Environmental Consultants on Lot 7 to the east of Sues Road and part Lot 3819 in 2006, and on Lot 7 only in 2009. Ekologica Pty Ltd was contracted to carry out a further Spring survey of part Lot 3819 to finalize the vegetation survey and to prepare a report that presented the results of this survey and to summarize previous findings with regard to vegetation and flora in the Study Area. The Study Area on Lot 3819 covers 233.8 ha (Fig. 1). In addition, a specific wetland buffer study was required of the Study Area to support an application to clear native vegetation under the *Environmental Protection Act 1986*.

2. Location, Landscape and Soils

The Study Area is located on the Swan Coastal Plain 6 km east south east of the town of Busselton. It is flanked to the east by Sues Road and by Bussell Highway to the north. Soils and landforms have been mapped by Tille and Lantzke (1990). This mapping shows that the Study Area is situated on the Abba Plain land system, a depositional feature formed of Quaternary alluvium, lying between 10 – 40 m above sea level and containing extensive areas of poor drainage.

The dominant landform pattern is an intricate patchwork of slight depressions and slight rises. The deeper depressions may become inundated in winter, while the rises tend to suffer subsoil waterlogging. The northern third of the Study Area has soils belonging to the Cokelup wet clayey flats mapping unit, a narrow band of sandy soil belonging to the Bassendean soil-landscape system (overlying the Abba Plain system) traverses the Study Area on a south-west to north-east axis and the southern portion has sandy grey brown duplex (Abba) and gradational (Busselton) soils of the Abba wet flats and Abba flats mapping units. A narrow band of recent alluvial soils lies along the Abba River on the eastern boundary of the Study Area (Tille and Lantzke 1990).

3. Vegetation and Flora

3.1. *Broadscale Vegetation Mapping*

The study area occurs in the Drummond Subdistrict of the Darling Botanical District, in the Southwest Botanical Province (Beard 1981). Before clearing for agriculture over the last 150 years the original vegetation of the Abba Plain was an open woodland dominated by marri (*Corymbia calophylla*), jarrah (*Eucalyptus marginata*) and banksia (*Banksia grandis*). The Bassendean Dune system carried woodland dominated by jarrah, *Agonis flexuosa* and *Banksia attenuata*. Along the drainage lines and on flats and depressions *Eucalyptus rudis* occurred with *Melaleuca raphiophylla*, or on some waterlogged flats a myrtaceous scrub dominated.

The vegetation of the southern Swan Coastal Plain was mapped at a broad scale (1: 250,000) by Smith (1973) and this mapping was digitized by Shepherd *et al.* (2002). The original vegetation of the northern portion of the Study Area (on the Cokelup wet clayey flats) is mapped as “Low forest: peppermint (*Agonis flexuosa*)”, which is unlikely considering the clayey soil. The narrow band of Bassendean Dune sand running through the Study Area was mapped by Shepherd *et al.* (2002) as “Low woodland; banksia” and the southern portion, on sandy grey brown duplex (Abba) and gradational (Busselton) soils is shown as “Medium woodland; marri with some jarrah, wandoo, river gum and casuarina”

The vegetation complex mapping by Mattiske and Havel (1998) did not include the part of the Swan Coastal Plain where the Study Area is situated, however vegetation complex mapping has since been extended to include the study area (SWBP, 2007). This mapping shows the remnants in the northern part of the study area and along the Sabina River as belonging to the Ludlow (Lw) vegetation complex, and the remnants on the central sandy ridge as being Abba (Ad) vegetation complex.

3.2. Previous Vegetation Survey of the Study Area

A survey of the remnants of native vegetation in the Study Area (as well as the adjacent Lot 7) was carried out by Onshore Environmental in April 2006. Four plots were established within the remnants, all rated as “Completely Degraded”, and the following communities were described;

- *Agonis flexuosa* Low Forest A over **Lolium rigidum* Dense Low Grass
- *Corymbia calophylla*/*Agonis flexuosa* Forest A over **Lolium rigidum* Low Grass
- *Melaleuca raphiophylla* Low Forest A over **Zantedeschia aethiopica*/**Rumex pulcher* Open Dwarf Scrub D over **Lolium rigidum* Low Grass
- *Corymbia calophylla* Woodland over **Rumex pulcher* Open Dwarf Scrub D over **Lolium rigidum* Low Grass

On the sandy rise, where most of the remnants occur they were comprised of a sparse canopy of *Corymbia calophylla* and *Agonis flexuosa*, with scattered trees of *Eucalyptus marginata* ssp. *marginata* and *Banksia attenuata*. Native understorey taxa were virtually absent, due mainly to ongoing livestock grazing.

Ninety four plant taxa (including varieties and sub-species) were recognized in Lots 7 and 3819, of which 37 were introduced species (Onshore Environmental, 2006). No breakdown in numbers occurring on the separate lots was provided but it is assumed that most of them occurred on Lot 7 where the remnants were larger and marginally less degraded. No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act* (1950) were located. Additionally, no Priority Flora as defined by the Department of Environment and Conservation (2012a) were located within the Lot 7 and Lot 3819 survey areas (Onshore Environmental, 2006).

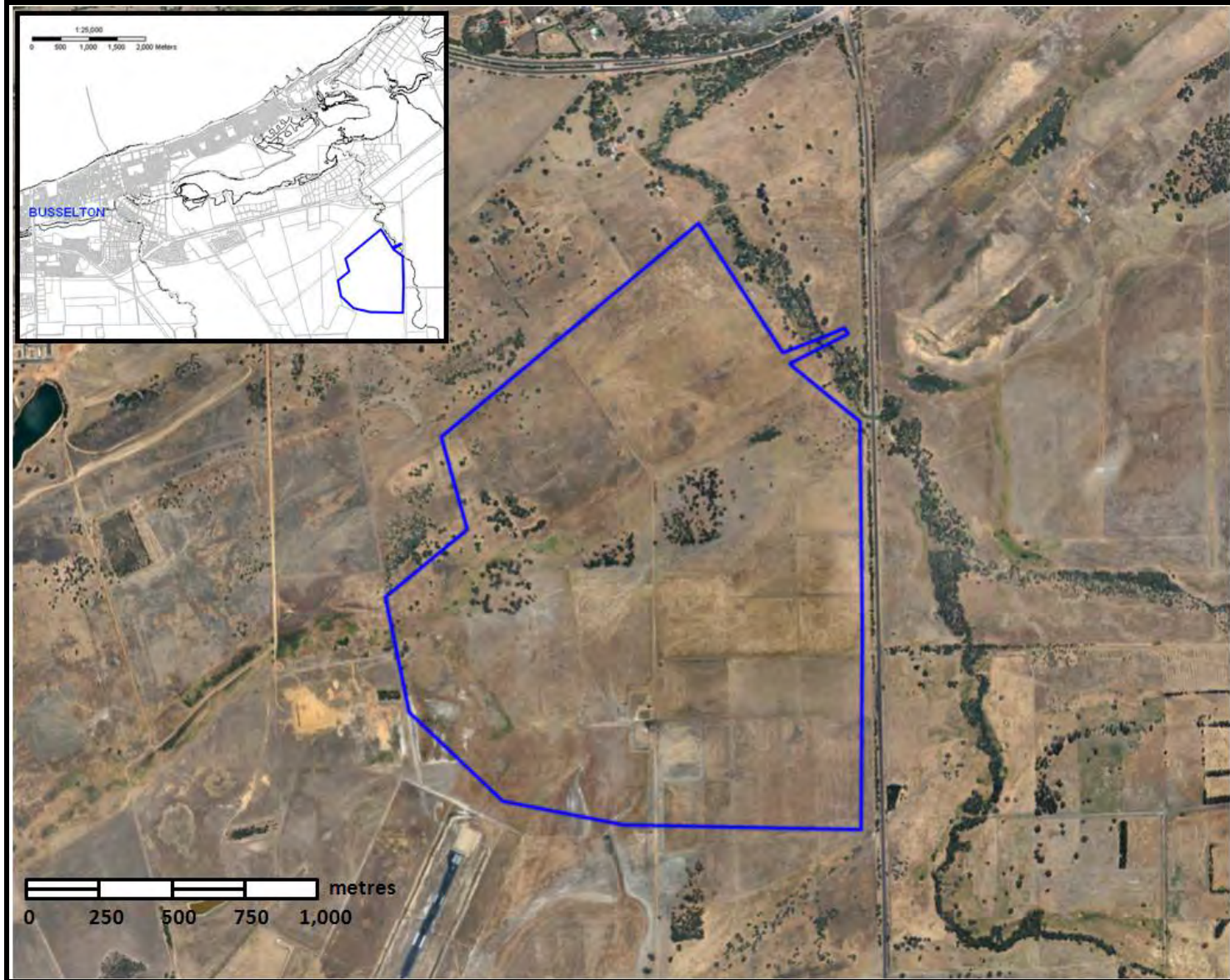


Figure 1. Location of Study Area on Lot 3819, Wonnerup South.

4. Regulatory Context

4.1. *Threatened and Priority Flora*

Species of flora and fauna are defined as Declared Rare or Priority conservation status where their populations are restricted geographically or threatened by local processes. The Department of Environment and Conservation (DEC) recognises these threats of extinction and consequently applies regulations towards population and species protection.

Rare Flora species are gazetted under Subsection 2 of Section 23F of the *Wildlife Conservation Act 1950* and therefore it is an offence to “take” or damage rare flora without Ministerial approval. Section 23F of the *Wildlife Conservation Act 1950-1980* defines “to take” as “... to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means.”

Priority Flora are under consideration for declaration as ‘rare flora’, but are in need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four). Table 1 presents the categories of Declared Rare and Priority Flora as defined by the *Wildlife Conservation Act 1950* (Department of Environment and Conservation 2012a).

Threats of extinction of species are also recognised at a Federal Government level and are categorized according to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), (Department of Sustainability, Environment, Water, Population and Communities, 2012a).

A search was made of Naturemap (DEC, 2012b) for Declared Rare Flora and Priority Flora occurring within 10 km of the Survey Area. The sixty taxa of DRF and PF occurring within this area are shown in Table 2. All of the DRF species are also listed as Endangered under the EPBC Act. All of the taxa would have been flowering, or at least have been identifiable at the time of survey.

4.2. *Threatened and Priority Ecological Communities*

Threatened Ecological Communities (TECs) are communities afforded special protection under the *Wildlife Conservation Act 1950* because they are subject to processes that threaten to destroy or significantly modify them across much of its range. TECs are categorized as presumed totally destroyed, critically endangered, endangered or vulnerable (DEC, 2012a). Some TECs are also listed as matters of national significance under the Commonwealth EPBC Act (Department of Sustainability, Environment, Water, Population and Communities, 2012b). Potential TECs that do not meet the survey criteria or that are not adequately defined, are added to a Priority Ecological Community (PEC) list under priority categories of 1, 2, 3 or 4 (DEC, 2012c).

Three occurrences of threatened ecological communities occur within 10 km of the Study Area, these being “*Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain” (SCP01b),

“Herb rich saline shrublands in clay pans” (SCP07) and “Shrublands on dry clay flats” (SCP10a) (FCT07) all of which are listed as “Vulnerable” (Department of Environment and Conservation, 2012b).

Several priority ecological communities are known from within a 10 km radius of the study area (DEC, 2012d), including ;

- *Eucalyptus cornuta*, *Agonis flexuosa* and *Eucalyptus decipiens* forest on deep yellow-brown siliceous sands over limestone (‘Busselton Yate community’) - Priority 1
- *Eucalyptus rudis*, *Corymbia calophylla*, *Agonis flexuosa* Closed Low Forest (near Busselton) – Priority 1
- *Eucalyptus patens*, *Corymbia calophylla*, *Agonis flexuosa* Closed Low Forest (near Busselton)

Table 1. Categories of Declared Rare and Priority Flora as defined by the *Wildlife Conservation Act 1950*

CATEGORY	CATEGORY
R	“Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such.”
P1	“Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. Such taxa are under consideration for declaration as ‘rare flora’, but are in urgent need of further survey.”
P2	Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat. Such taxa are under consideration for declaration as ‘rare flora’, but are in urgent need of further survey.”
P3	“Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as ‘rare flora’, but are in need of further survey.”
P4	“Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.”

SPECIES	STATUS	FLOWERING	SPECIES	STATUS	FLOWERING
<i>Acacia flagelliformis</i>	P4	May-Sep	<i>Isopogon formosus</i> subsp. <i>dasylepis</i>	P3	Jun-Dec
<i>Acacia semitrullata</i>	P4	May-Oct	<i>Jacksonia gracillima</i>	P3	Oct-Nov
<i>Actinotus whicheranus</i>	P2	Dec-Mar	<i>Johnsonia inconspicua</i>	P3	Oct-Nov
<i>Amperea micrantha</i>	P2	Oct-Nov	<i>Kennedia lateritia</i>	DRF	Oct
<i>Angianthus drummondii</i>	P3	Oct-Dec	<i>Lambertia echinata</i> subsp. <i>occidentalis</i>	DRF	Feb-Dec
<i>Aponogeton hexatepalus</i>	P4	Jul-Oct	<i>Lambertia orbifolia</i> subsp. Scott River Plains (L.W. Sage 684)	DRF	Oct-Jan
<i>Banksia meisneri</i> subsp. <i>ascendens</i>	P4	Apr-Sep	<i>Lasiopetalum membranaceum</i>	P3	Sep-Dec
<i>Banksia nivea</i> subsp. <i>uliginosa</i>	DRF	Aug-Sep	<i>Laxmannia jamesii</i>	P4	May-Jul
<i>Banksia squarrosa</i> subsp. <i>argillacea</i>	DRF	Jun-Nov	<i>Leptomeria furtiva</i>	P2	Aug-Oct
<i>Blennospora doliiformis</i>	P3	Oct-Nov	<i>Lepyrodia heleocharoides</i>	P3	Dec
<i>Caladenia huegelii</i>	DRF	Sep-Oct	<i>Loxocarya magna</i>	P3	Sep-Nov
<i>Caladenia procera</i>	DRF	Sep-Oct	<i>Myriophyllum echinatum</i>	P3	Nov
<i>Calothamnus quadrifidus</i> subsp. <i>teretifolius</i> ms	P4	Nov-Dec	<i>Ornduffia submersa</i>	P4	Sep-Oct
<i>Cardamine paucijuga</i>	P2	Sep-Oct	<i>Pimelea ciliata</i> subsp. <i>longituba</i>	P3	Oct-Dec
<i>Caustis</i> sp. Boyanup (G.S. McCutcheon 1706)	P3	Dec-Jan	<i>Puccinellia vassica</i>	P1	Sep-Nov
<i>Chamaescilla gibsonii</i>	P3	Sep	<i>Pultenaea pinifolia</i>	P3	Oct-Nov
<i>Chamelaucium</i> sp. Yoongarillup (G.J. Keighery 3635)	P4	Nov-Feb	<i>Schoenus benthamii</i>	P3	Oct-Nov
<i>Chordifex gracilior</i>	P3	Sep-Dec	<i>Schoenus natans</i>	P4	Oct
<i>Chorizema carinatum</i>	P3	Oct-Dec	<i>Schoenus pennisetis</i>	P1	Aug-Sep
<i>Conospermum paniculatum</i>	P3	Jul-Nov	<i>Stylidium longitubum</i>	P3	Oct-Dec
<i>Drakaea elastica</i>	DRF	Oct-Nov	<i>Synaphea hians</i>	P3	Jul-Nov
<i>Eryngium</i> sp. Ferox (G.J. Keighery 16034)	P3	Nov	<i>Synaphea petiolaris</i> subsp. <i>simplex</i>	P2	Sep-Oct
<i>Eryngium</i> sp. Subdecumbens (G.J. Keighery 5390)	P3	Nov	<i>Thomasia laxiflora</i>	P3	Oct-Nov
<i>Eucalyptus rudis</i> subsp. <i>cratyantha</i>	P4	Jul-Sep	<i>Thysanotus glaucus</i>	P4	Oct-Nov
<i>Franklandia triaristata</i>	P4	Aug-Oct	<i>Trichocline</i> sp. Treeton (B.J. Keighery & N. Gibson 564)	P2	Nov-Jan
<i>Gastrobium</i> sp. Yoongarillup (S. Dilkes s.n. 1/9/1969)	P1	Aug-Oct	<i>Verticordia attenuata</i>	P3	Dec-May
<i>Grevillea brachystylis</i> subsp. <i>brachystylis</i>	DRF	Aug-Nov	<i>Verticordia densiflora</i> var. <i>pedunculata</i>	DRF	Dec-Jan
<i>Grevillea bronwenae</i>	P2	Jun-Dec	<i>Verticordia lehmannii</i>	P4	Aug-Apr
<i>Grevillea elongata</i>	DRF	Oct	<i>Verticordia plumosa</i> var. <i>ananeotes</i>	DRF	Nov-Dec
<i>Hakea oldfieldii</i>	P3	Aug-Oct	<i>Verticordia plumosa</i> var. <i>vassensis</i>	DRF	Sep-Feb

Table 2. Declared Rare Flora and Priority Flora occurring within 10 km of the Survey Area.

5. Methods

The Wonnerup South Study Area was surveyed on 27th October 2012; all areas of remnant vegetation as well as several wetland areas comprised almost exclusively of introduced taxa were searched. Vegetation structure and condition (method of Keighery, 1994) and species data were collected from nine relevés approximately 10 m in diameter sited within bushland remnants (seven relevés) and wetlands with no native overstorey species (two relevés). Description of vegetation structure follows the height, life form and density classes based on those of Muir (1977) and Aplin (1979). A comprehensive list of vascular flora occurring within the Study Area was compiled, with species not able to be identified in the field being collected or photographed for later identification. Nomenclature follows that of the Western Australian Herbarium (DEC, 2012d, 2012e).

6. Results and Discussion

6.1. *Flora including Rare Flora*

Forty species of flora were identified within the study area, of which thirty were introduced species (Appendix 1). Species representation was highest amongst the Poaceae (11 species) and Myrtaceae (7 species). Species lists for each of the releve sites is presented in Appendix 2.

No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* or listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* were located. Additionally, no Priority Flora as defined by the Department of Environment and Conservation (2012a) were located within the study area.

6.2. *Plant Communities*

The total area of “remnant vegetation” in the study area, defined as clumps of five or more trees within 20 m of each other, is about 8.5 ha comprised of twelve separate areas (Fig. 2). Other individual trees, or small groups of trees occur outside these areas of remnant vegetation. None of the remnants are fenced to exclude livestock. Four plant communities were recognized in these areas of remnant vegetation (photos of the communities are presented in Appendix 3);

- A. *Eucalyptus rudis* and *Agonis flexuosa* woodland over grassland/herbland of introduced taxa including **Pennisetum clandestinum*
- B. *Corymbia calophylla* and *Eucalyptus marginata* woodland over *Agonis flexuosa*, *Nuytsia floribunda* low woodland over grassland/herbland of **Lolium rigidum*, **Hordeum leporinum*, **Arctotheca calendula* and other introduced species
- C. *Melaleuca raphiophylla* low woodland over grassland/herbland of **Lolium rigidum*, **Hordeum leporinum*, **Arctotheca calendula* and other introduced species

D. *Melaleuca raphiophylla* low forest over **Zantedeschia aethiopica* and **Rumex pulcher* herbland

In addition there were areas of wetland or dampland vegetation, too small to map, where the native rush *Juncus pallidus* occurred along with the introduced rush **J. microcephalus* and other non-native species such as **Cotula coronopifolia*, **C. turbinata* and **Trifolium hirtum*.

6.3. *Vegetation Condition*

All of the areas of remnant native vegetation were assessed as “completely degraded” using the method of Keighery (1994). This condition rating is defined as:

“The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as ‘parkland cleared’ with the flora comprising weed or crop species with isolated native trees or shrubs”

None of the areas of remnant vegetation in the study area had evidence of regeneration of native species. This is probably because of vigorous competition from established non-native species and the effects of grazing. The study area is situated in one of the earliest-settled parts of the State where livestock grazing has occurred for more than 150 years.

6.4. *Conservation Significance of the Vegetation*

It is likely that the *Corymbia calophylla* and *Eucalyptus marginata* woodland community described in section 6.2 (Community A) would once have had affinities with the “*Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain” (SCP01b) floristic community type, which is a threatened ecological community. However, apart from the tree overstorey the remnants bear no resemblance to this or any other threatened or priority ecological community. Without intensive restoration works it is unlikely that any of the remnants in the study area will again function as a native ecosystem.

Some of the plant communities in the study area (communities A, C, D) occur on the Abba Plains soil-landscape system, of which only 5% of the pre-European extent remains uncleared and none in secure reserves (Molloy *et al.*, 2007). The two vegetation complexes represented in the study area, Ludlow (Lw) and Abba (Ad) have 24% and 14% of their pre-European area remaining respectively (Mattiske Consulting and Havel, 2002, Webb *et al.*, 2009). There is 9% of Ludlow (Lw) and none of the Abba (Ad) in secure conservation reserves. Despite the figure of 24% remaining given for the Ludlow (Lw) complex it is likely that much of this is in less than “good” condition, particularly the remnants on private property and the Pinjarra (Abba) Plain/ Spearwood Dunes interface wetlands, such as occurs in the northern part of the study area (Webb *et al.*, 2009).

Because of their high level of degradation the areas of remnant vegetation in the study area have little value with regard to floristic values, having no native species in the understorey and no more than three or four native species in any one remnant. The likelihood of natural regeneration within these remnants is very low because of grazing by livestock and the competition from established pasture species and therefore they are not self-sustaining (Spooner *et al.*, 2002, Duncan *et al.*, 2007).

7. Conclusions

A spring survey of remnant native vegetation and areas of wetland comprised almost exclusively of introduced species was carried out within a 234 ha area of Lot 3819, Wonnerup, proposed for mineral sands extraction. Only forty species of flora were identified within the study area, of which thirty were introduced species.

No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the Western Australian *Wildlife Conservation Act (1950)* or listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* were located. Additionally, no Priority Flora as defined by the Department of Environment and Conservation were located within the study area.

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Due to their small size (< 2 ha) and ongoing grazing all of the remnants lack a native understorey component and there was no regeneration of the native overstorey species. All were assessed as “completely degraded” using the definition of Keighery (1994).

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However, because of their absence of native understorey species and of regeneration by the native overstorey species the study area remnants are considered to have little or no conservation value as representatives of Abba Plains vegetation.

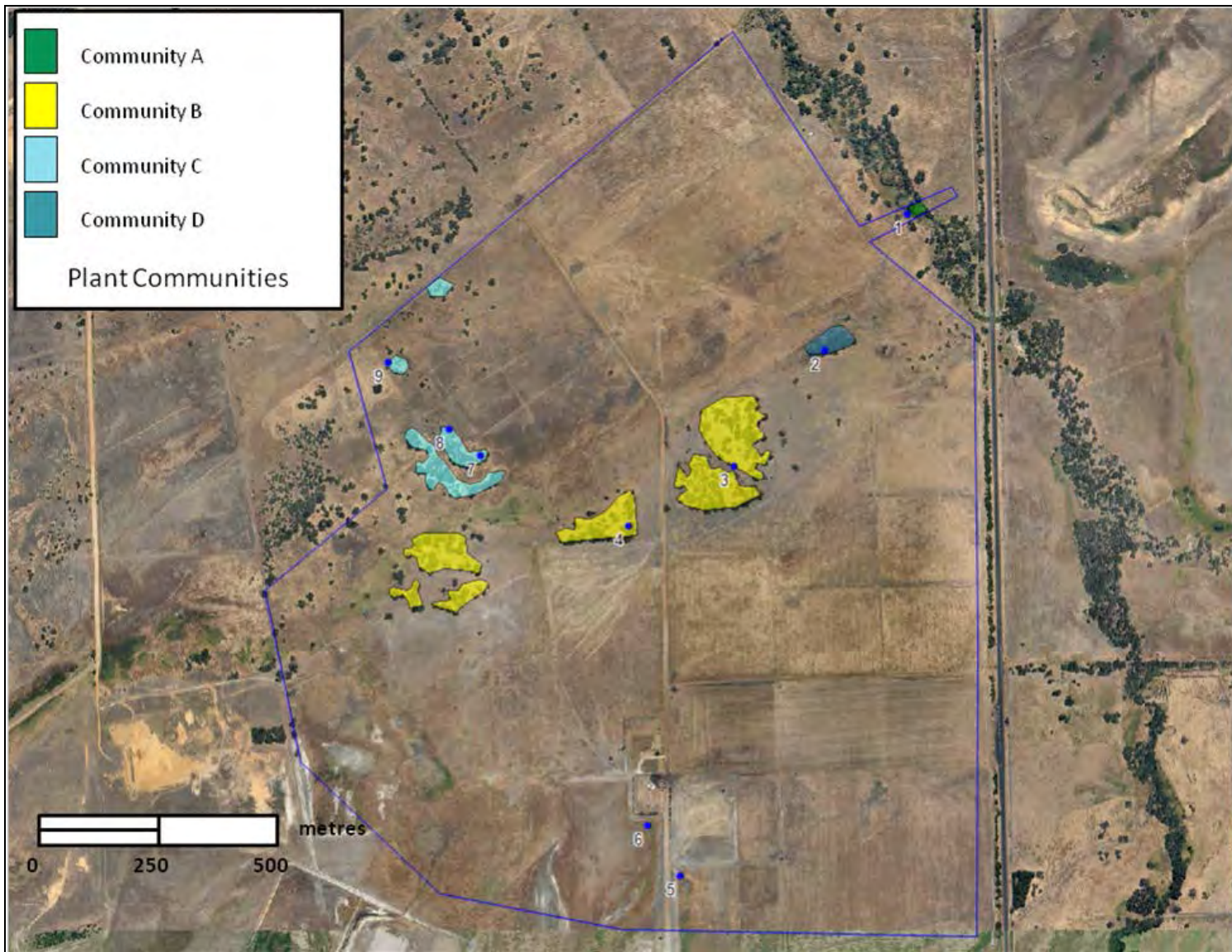


Figure 2. Plant communities in the study area with releve sites indicated.

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Appendix 1. List of vascular flora found in the study area.

FAMILY	LATIN NAME	VERNACULAR	NATURALISED
Araceae	<i>Zantedeschia aethiopica</i>	Arum Lily	*
Asteraceae	<i>Arctotheca calendula</i>	Cape Weed	*
	<i>Cotula coronopifolia</i>	Waterbuttons	*
	<i>Cotula turbinata</i>	Funnel Weed	*
	<i>Hypochaeris glabra</i>	Smooth Catsear	*
	<i>Sonchus oleraceus</i>	Common Sowthistle	*
Boraginaceae	<i>Echium plantagineum</i>	Paterson's Curse	*
Fabaceae	<i>Lotus subbiflorus</i>		*
	<i>Trifolium hirtum</i>	Rose Clover	*
Geraniaceae	<i>Erodium botrys</i>	Long Storksbill	*
	<i>Pelargonium capitatum</i>	Rose Pelargonium	*
Juncaceae	<i>Juncus microcephalus</i>		*
	<i>Juncus pallidus</i>	Pale Rush	
Loranthaceae	<i>Nuytsia floribunda</i>	Christmas Tree	
Lythraceae	<i>Lythrum hyssopifolia</i>	Lesser Loosestrife	*
Malvaceae	<i>Malva parviflora</i>	Marshmallow	*
Myrtaceae	<i>Agonis flexuosa</i>	Peppermint	
	<i>Corymbia calophylla</i>	Marri	
	<i>Eucalyptus marginata</i> subsp. <i>marginata</i>	Jarrah	
	<i>Eucalyptus rudis</i>	Flooded Gum	
	<i>Melaleuca preissiana</i>	Moonah	
	<i>Melaleuca raphiophylla</i>	Swamp Paperbark	
	<i>Melaleuca viminea</i>	Mohan	planted
Orobanchaceae	<i>Orobanche minor</i>	Lesser Broomrape	*
Poaceae	<i>Anthoxanthum odoratum</i>	Sweet Vernal Grass	*
	<i>Avena barbata</i>	Bearded Oat	*
	<i>Bromus diandrus</i>	Great Brome	*
	<i>Cynodon dactylon</i>	Couch	*
	<i>Ehrharta longiflora</i>	Annual Veldt Grass	*
	<i>Holcus lanatus</i>	Yorkshire Fog	*
	<i>Hordeum leporinum</i>	Barley Grass	*
	<i>Lolium perenne</i>	Perennial Ryegrass	*
	<i>Lolium rigidum</i>	Wimmera Ryegrass	*
	<i>Pennisetum clandestinum</i>	Kikuyu Grass	*
	<i>Poa annua</i>	Winter Grass	*
Polygonaceae	<i>Rumex brownii</i>		*
	<i>Rumex crispus</i>	Curled Dock	*
	<i>Rumex pulcher</i>	Fiddle Dock	*
Ranunculaceae	<i>Ranunculus muricatus</i>	Sharp Buttercup	*
Solanaceae	<i>Solanum linnaeanum</i>		*
	<i>Solanum nigrum</i>		*

Appendix 2. Species Lists at Releve Sites

LATIN NAME	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
<i>Agonis flexuosa</i>	x		x				x		
<i>Arctotheca calendula</i>			x	x	x			x	x
<i>Bromus diandrus</i>	x		x			x			
<i>Corymbia calophylla</i>			x	x			x		
<i>Cotula coronopifolia</i>					x			x	
<i>Cotula turbinata</i>						x		x	
<i>Cynodon dactylon</i>	x								
<i>Echium plantagineum</i>									x
<i>Ehrharta longiflora</i>	x	x							
<i>Eucalyptus marginata</i>			x						
<i>Eucalyptus rudis</i>	x								
<i>Hordeum leporinum</i>		x	x	x	x		x	x	x
<i>Hypochaeris glabra</i>									x
<i>Juncus microcephalus</i>						x			
<i>Juncus pallidus</i>						x			
<i>Lolium perenne</i>									
<i>Lolium rigidum</i>				x		x		x	x
<i>Lotus subbiflorus</i>		x				x			
<i>Lythrum hyssopifolia</i>						x			
<i>Melaleuca raphiophylla</i>		x						x	x
<i>Melaleuca viminea</i>	x								
<i>Nuytsia floribunda</i>			x						
<i>Pelargonium capitatum</i>				x					
<i>Pennisetum clandestinum</i>	x				x	x			
<i>Poa annua</i>						x			
<i>Ranunculus muricatus</i>								x	
<i>Rumex brownii</i>					x				
<i>Rumex crispus</i>				x					x
<i>Solanum linnaeanum</i>		x							
<i>Solanum nigrum</i>							x		
<i>Rumex pulcher</i>							x	x	
<i>Solanum nigrum</i>							x		
<i>Trifolium hirtum</i>					x	x			
<i>Zantedeschia aethiopica</i>		x					x	x	

Appendix 3. Pictures of the Study Area Plant Communities.



Plant Community A: *Eucalyptus rudis* and *Agonis flexuosa* woodland over grassland/herbland of introduced taxa including **Pennisetum clandestinum*



Plant Community B: *Corymbia calophylla* and *Eucalyptus marginata* woodland over *Agonis flexuosa*, *Nuytsia floribunda* low woodland over grassland/herbland of **Lolium rigidum*, **Hordeum leporinum*, **Arctotheca calendula* and other introduced species



Plant Community C: *Melaleuca raphiophylla* low woodland over grassland/herbland of **Lolium rigidum*, **Hordeum leporinum*, **Arctotheca calendula* and other introduced species



Plant Community D: *Melaleuca raphiophylla* low forest over **Zantedeschia aethiopica* and **Rumex pulcher* herbland