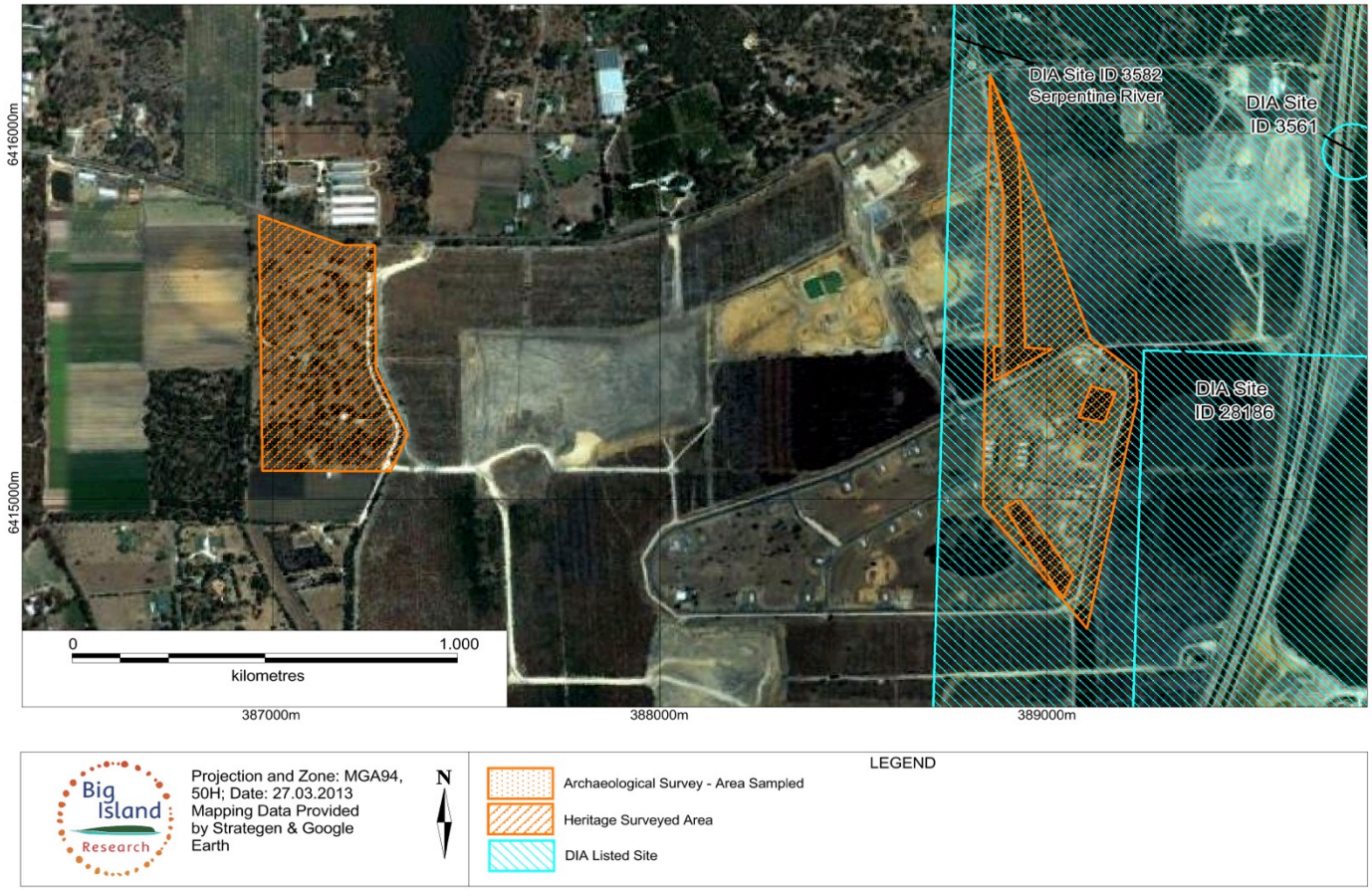
Map 1. Location of the survey areas

Map 2. Location of DIA sites in the vicinity of the survey areas

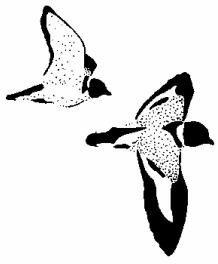


Fauna Values of the Wetland and Bushland Remnants within the Pine Plantation south of Stakehill Road, Karnup

Prepared for: Strategen
Suite 7, 643 Newcastle Street
LEEDERVILLE WA 6007

Prepared by: **Wes Bancroft and Mike Bamford**

M.J. & A.R. BAMFORD
CONSULTING ECOLOGISTS
23 Plover Way
KINGSLEY WA 6026



15th September 2006

CONTENTS

INTRODUCTION

As part of the control program for the European House Borer (EHB, *Hylotrupes bajulus*) the Forest Products Commission (FPC) plans to log the pine plantation south of Stakehill Road, Karnup (surrounding the Baldivis Explosives Reserve). The wood stock and debris that remain after the logging program will be burnt to help ensure eradication of the EHB from the site. It is proposed that the land encompassing the pine plantation and explosives reserve will then be transferred to Landcorp. Part of this land is flagged for sand mining and housing development, with the remainder vested as parks and recreation reserve. There are several small, remnant wetlands within the pine plantation (within the boundary of the vested parks and recreation reserve) and explosives reserve. Several small areas of native bushland, including Tuart woodland, also persist within the site boundary. Bamford Consulting Ecologists was commissioned to conduct a site inspection to assess the potential value of the wetland and bushland remnants to terrestrial fauna.

METHODS

Level of assessment

The fauna assessment and report preparation were carried out with reference to guidance and position statements published by the WA Environmental Protection Authority (EPA) on fauna surveys and environmental protection, and Commonwealth Biodiversity Legislation (e.g. EPA 2002; e.g. EPA 2004). The report synthesises the results of a brief literature review and site inspection.

Personnel

The following personnel were involved in the preparation of this report:

- Dr Mike Bamford *BSc(Biol.), Hons(Biol.), PhD(Biol.*)
- Dr Wes Bancroft *BSc(Zool./Microbiol.), Hons(Zool.), PhD(Zool.)*

The site inspection was undertaken by Wes Bancroft. The report was prepared by Wes Bancroft and Mike Bamford.

Licences and permits

No licences or permits were required for the site inspection and preparation of the report.

Literature search/Sources of information

A list of conservation significant fauna that would be expected to occur in the vicinity of the Karnup pine plantation was generated by searching available databases and literature. These include:

- the Western Australian Museum's 'Faunabase'.
- Birds Australia's database for the second Atlas of Australian Birds.
- the information and species distribution maps provided by Tyler *et al*. (2000), Storr *et al*. (1983; 1990; 1999), Wilson and Swan (2003), Cogger (2000), Johnstone and Storr (1998), Strahan (1995), Menkhorst and Knight (2004) and Churchill (1998).
- A list of the declared threatened fauna and occurrence in Department of Environment and Conservation (DEC) regions.

- Burbidge (2004).
- DEP (2000).
- Listings under the EPBC Act 1999 and WA Wildlife Conservation Act 1950 (see 'Assessment of conservation significance' below).

Site inspection

The site inspection was carried out on 22nd August 2006. The intention of the site inspection was to familiarise the consultant with the environment and fauna habitats of the study area. During the inspection, most areas of remnant bushland or wetland within the pin plantation boundary were visited. Notes were made on habitats and opportunistic observations were made on fauna.

Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's *Checklist of the Vertebrates of Western Australia*. The authorities used for each vertebrate group are: amphibians and reptiles (Aplin and Smith 2001), birds (Christidis and Boles 1994; Johnstone 2001), and mammals (How *et al.* 2001).

Assessment of conservation significance

The conservation status of fauna species is assessed under Commonwealth and State Acts such as the *Commonwealth Environment Protection and Biodiversity Conservation Act* (EPBC Act) 1999 and the *Western Australian Wildlife Conservation Act* 1950. The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN 2001). The *WA Wildlife Conservation Act* 1950 uses a set of Schedules but also classifies species using some of the IUCN categories. These categories and Schedules are described in Appendix 1.

The EPBC Act also has lists of migratory species that are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). The list of migratory species under the EPBC Act has been revised to include species only, thus excluding family listings (DEH, pers. comm.). Those species listed in JAMBA are also protected under Schedule 3 of the *WA Wildlife Conservation Act*. There is a separate list of marine species under the EPBC Act, but this only applies to land and waters under Commonwealth management. Therefore, marine listings are not included in this report.

The Department of the Environment and Heritage (DEH, formerly Environment Australia) has also supported the publication of reports on the conservation status of most vertebrate fauna species: reptiles (Cogger *et al.* 1993), birds (Garnett and Crowley 2000), monotremes and marsupials (Maxwell *et al.* 1996), rodents (Lee 1995) and bats (Duncan *et al.* 1999). The Threatened Species and Communities Section of Environment Australia has also produced a list of Threatened Australian Fauna, although this list is effectively a precursor to the list produced under the EPBC Act. These publications also use the IUCN categories, although those used by Cogger *et al.* (1993) differ in some respects because this report pre-dates categories reviewed

by Mace and Stuart (1994) and revisited since by IUCN (2001).

In Western Australia, the Department of Environment and Conservation (DEC) has produced a supplementary list of Priority Fauna, being species that are not considered Threatened under the WA Act but for which the Department feels there is cause for concern. Some Priority species, however, are also assigned to the IUCN Conservation Dependent category. Levels of Priority are described in Appendix 1. Assessments in this report are based on the most recent version of the DEC priority list (June 2005).

Fauna species included under conservation acts and/or agreements are formally recognised as of conservation significance under state or federal legislation. Species listed only as Priority by DEC, or that are included in publications such as Garnett and Crowley (2000) and Cogger *et al.* (1993), but not in State or Commonwealth Acts, are also of recognised conservation significance. In addition, species that are at the limit of their distribution, those that have a very restricted range and those that occur in breeding colonies, such as some waterbirds, can be considered of conservation significance, although this level of significance has no legislative or published recognition and is based on interpretation of distribution information. The WA Department of Environment (formerly the Department of Environmental Protection, DEP) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Perth Bushplan (DEP 2000).

On the basis of the above comments, three levels of conservation significance are recognised in this report:

- *Conservation Significance (CS) 1*: Species listed under State or Commonwealth Acts.
- *Conservation Significance (CS) 2*: Species not listed under State or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by DEC.
- *Conservation Significance (CS) 3*: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution. This level may have links to preserving biodiversity at the genetic level (EPA Position Statement No. 3, EPA 2002). For example, if a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3.

Acknowledgements

The authors thank Ron Johnstone and Tony Kirby, of the Western Australian Museum, for their advice and for the provision of bird records from the Baldivis and Stakehill Road area.

RESULTS AND DISCUSSION

Site inspection

All of the wetlands visited were small (0.3 to 3.1 ha), remnant paperbark wetlands that have been isolated from one another (and surrounding native vegetation) by pine plantation or clearing. All were apparently seasonal. All were degraded (at least in part) and had been substantially invaded by weeds. As part of their control program for the EHB, the FPC had already cleared the pines surrounding all but one of the wetlands (Wetland 5, see below) outside the explosives compound (Wetland 1 and the Tuart patch within this compound were also surrounded by clear ground). Burning of the logging debris had already been conducted around two of the wetlands (Wetlands 2 and 4). Nonetheless, some fauna was observed on or around some of the wetlands. The following provides a brief overview of the individual wetlands/remnants and their fauna values.

Note that wetlands were numbered arbitrarily, in the order in which they were visited.

Wetland 1. 389171E, 6415189N (WGS84). Within the Baldivis Explosives Reserve. 0.3 ha. A ring of freshwater paperbarks (*Melaleuca rhaphiophylla*) around a small body of standing water (water depth to *c*. 20cm). A small area (*c*. 15m by 5m) of open water in the centre of the wetland. Some rushes and a small patch of *Typha* sp. Very weedy throughout. Listed as a conservation category wetland (see Appendix 2 for details) by Hill *et al*. (1996).

Many Squelching Froglets (*Crinia insignifera*) calling around the rim of the wetland. White-browed Scrubwren, Golden Whistler and Grey Fantail. One Carnaby's Cockatoo flew overhead. Western Grey Kangaroo (*Macropus fuliginosus*) droppings and tracks. Some possible Quenda (*Isoodon obesulus*) diggings.

Tuarts and bridal trail. 388984E, 6414841N. Within the Baldivis Explosives Reserve. A small patch of remnant Tuart (*Eucalyptus gomphocephala*) over She-oak (*Allocasuarina* sp.) and mixed *Banksia* spp. woodland. Grassy understorey with some native sedges (*Mesomelena* sp.). The bridal trail was a narrow (*c*. 5-10m) strip of Jarrah (*E. marginata*) and *Banksia* spp. woodland.

Galah, Australian Ringneck, Laughing Kookaburra, Western Gerygone, Inland Thornbill, Grey Fantail and Silvereye. Several large warrens under the Tuarts (possibly Rabbit, *Oryctolagus cuniculus* or Fox, *Vulpes vulpes*). There were several Tuart tree hollows that may be potential nest sites for Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*) or Carnaby's Cockatoo.

Wetland 2. 389105E, 6416018N. In logged and burnt area. 0.5 ha. Very open, mostly dry depression. Freshwater paperbarks with virtually no native understorey. Weeds throughout. A small fire-pit at the northern end with some rushes. Listed as a conservation category wetland by Hill *et al*. (1996).

Some Squelching Froglets calling around the rim of the fire pit. Large tadpoles (unlikely to be Squelching Froglet tadpoles), possibly *Heleioporus* sp. Western Grey Kangaroos (12).

Wetland 3. 389361E, 6414996N. In logged area. 3.1 ha. A dense ring of freshwater paperbarks around a moderate body of standing water (water depth to *c*. 30 cm). A moderate area (*c*. 30m by 20m) of open water in the centre of the wetland. Many rushes and a small patch of *Typha* sp. A fire-pit at the northern end. Listed as a resource enhancement wetland (see Appendix 2 for details) by Hill *et al*. (1996).

A large number of Slender Tree Frogs (*Litoria adelaidensis*) and Squelching Froglets calling around the wetland. Laughing Kookaburra, White-browed Scrubwren, Weebill, Western Gerygone, Inland Thornbill, Brown Honeyeater, Western Spinebill, Scarlet Robin, Golden Whistler, Grey Fantail and Australian Magpie. Two Carnaby's Cockatoos calling nearby. Western Grey Kangaroo droppings and tracks.

Wetland 4. 389314E, 6415554N. 0.4 ha. A small number of freshwater paperbarks and at least one *Banskia littoralis* in a dry depression. No understorey. Weedy ground cover. Listed as a resource enhancement wetland by Hill *et al*. (1996).

Common Bronzewing. Western Grey Kangaroo droppings.

Wetland 5. 389455E, 6415404N. 0.4 ha. A dense patch of freshwater paperbarks wit a very small body (*c*. 1 m diameter) of standing water (water depth to *c*. 5 cm). Listed as a resource enhancement wetland by Hill *et al*. (1996).

Western Grey Kangaroo droppings.

No fish, tortoises or waterfowl were observed using any of the wetlands inspected.

A summary of the birds recorded during the site inspection is presented in Table 1.

Conservation significant fauna

A number of conservation significant vertebrates may occur in the vicinity of the site, and future management regimes may need to consider these species. Those that are most likely to occur in the general region of the site are listed in Table 2. Species accounts that provide basic information on the vertebrate species of conservation significance (including their conservation status, the reason for their significance, aspects of their ecology, potential threatening processes and the inferred status of the species at the study site) are presented in Appendix 3.

The Karnup pine plantation site is unlikely to support conservation significant waterbirds (see Table 2, Appendix 3) due to the small size and temporary nature of the wetlands. Similarly, the small and fragmented nature of bushland remnants on the site is unlikely to support resident populations of most conservation significant mammals with the exception, perhaps, of Quenda.

A lage number of the conservation significant vertebrates (particularly bird species) that may occur in the vicinity of the site are significant because habitat clearing on the Swan Coastal Plain has greatly reduced their population sizes or distribution (see DEP 2000). Several of these species were recorded during the site inspection: Common Bronzewing, White-browed Scrubwren, Weebill, Inland Thornbill, Scarlet Robin and Golden Whistler. It is interesting that these species persist in the fragmented remnants, because they are generally regarded as species that are susceptible to habitat fragmentation (see DEP 2000; Gole 2004).

The assessment of the conservation significant species in Appendix 3 highlights several species that are most likely to occur at the site and, hence, those species which future management regimes should embrace. The species are: Quenda, the Common Bronzewing and small passerines listed above, several honeyeaters (not recorded during the site inspection), Forest Red-tailed Black-Cockatoo, Carnaby's Cockatoo, and the lizards the Western Ctenotus and *Ctenotus gemmula*.

Of highest priority are the two cockatoo species. Both species have been recently recorded breeding in the Baldivis area (R. Johnstone, pers. comm.). Forest Red-tailed Black-Cockatoo nests were mostly recorded in Marri (*Corymbia calophylla*). A male Carnaby's Cockatoo was observed feeding a female (an indication of a breeding pair) on the edge of the Baldivis Explosives Reserve (R. Johnstone, pers. comm.). Breeding by black-cockatoos is an unusual occurrence on the Swan Coastal Plain, but perhaps it reflects a change in reproductive behaviour in response to poor breeding success at Darling Range and inland sites.

The bronzewing, small passerines and honeyeaters are all generally dependent on good quality native vegetation, particularly that with a healthy understorey. It is doubtful that the wetland remnants alone, with the possible exception of Wetland 3, provide enough suitable habitat to sustain these species. Restoration of the vegetation would improve the chance of species persistence. Quenda were almost certainly abundant in the area prior to urbanisation, and small populations may continue to survive (particularly at Wetlands 1 and 3). The highly fragmented landscape will restrict the size of, and genetic exchange between, any existing populations. The two *Ctenotus* species may occur in the remnant patches of Banksia (e.g. the bridal trail).

In addition to the species of conservation significance, the wetlands are used as breeding sites for frogs. Some of these species are likely to be resident in and around the wetlands, but other species (such as the burrowing frogs of the genus *Heleioporus*) are likely to migrate to and from the wetlands. The passage of these animals should be considered in the site management.

Summary

The remnant bushland and wetlands within the Karnup pine plantation are small, partly degraded (most remnants), have considerable weed invasion and are very poorly connected to one another or surrounding areas (some are completely surrounded by cleared pine forest). Their current value to vertebrate fauna is, therefore, limited. Despite this, several bird species that are known to be highly susceptible to habitat fragmentation, degradation or clearing were recorded during the site inspection. These were around Wetlands 1 and 3. This may indicate:

- sufficient ecological resources associated with these wetlands to support small populations of these sensitive species;
- that these populations are able to persist using a network of sites (despite the poor connectivity between sites);
- that these populations are destined for local extinction.

The isolation of the remnant wetlands and bushland has been, and will continue to be, exaggerated by the logging of the pine plantation. This process leaves tree stumps and cleared ground around the remnants (with tens to hundreds of metres between vegetation patches). Areas of pines that had been harvested prior to the site inspection had been heavily invaded by weeds. This situation will strongly hamper the immigration or emigration of fauna to and from the remnants. Clearing of the surrounding tress will also expose the small remnants to the very strong winds common in this area (particularly summer easterlies). Erosion and vegetation damage may result.

The bushland and wetland remnants will be further isolated on the eastern side by the construction of the Perth to Bunbury highway along the plantation boundary. This will sever the (already tentative) connection to areas of riparian vegetation associated with the Serpentine River.

Remnants are further threatened by fire. As part of the control process for the European House Borer, the wood stock and debris that remain after logging are burnt. Where this process has already been undertaken, the fires have also burnt through Wetlands 2 and 4. Only one species of bird was recorded from one of these two sites (c.f. to an average of 5.25 species at the unburnt sites). Fire would pose a major threat to the survival of the persisting species through the removal of food and shelter resources.

Table 2 and Appendix 3 highlight the vertebrate species of conservation significance that are most likely to be associated with this area, and therefore should be considered when making planning and management decisions.

For most remnants and wetlands inspected, their current value to fauna is low. Wetland 3, the area of Tuarts and the remnant strips of Banksia woodland are the highest quality and highest value sub-sites. The long-term persistence of the wetlands and remnants should be assessed. If they are to be preserved, then a restoration process should be undertaken. To conserve and improve the habitat for terrestrial fauna the management process may include:

- Protecting the wetlands from fire (i.e. Wetlands 1, 3 and 5 that have yet to be burnt);
- Protecting the Tuarts as potential nesting sites for black-cockatoos;
- Revegetating areas around the wetlands and remnants;
- Establishing native vegetation corridors between wetlands and remnants;
- Establishing native vegetation corridors to surrounding native vegetation (e.g. that associated with the Serpentine River to the east); and
- Protecting the wetlands from further rubbish dumping and degradation by the public.

There is potential for the existing wetlands to be protected, restored or enhanced, and integrated into conservation network through open space. This would help to conserve current fauna values and would be likely to aid the passage of native fauna through the broader area (akin to 'stepping stones' between larger or more intact bushland and wetland remnants).

REFERENCES

Adams, M., Reardon, T. R., Baverstock, P. R. and Watts, C. H. S. (1988). Electrophoretic resolution of species boundaries in Australian Microchiroptera. IV. The Molossidae (Chirpotera). *Australian Journal of Biological Science* **41**: 315-326.

Allen, G. R., Midgley, S. H. and Allen, M. (2003). *Field Guide to the Freshwater Fishes of Australia*. Western Australian Museum, Perth, Western Australia.

Aplin, K. and Smith, L. A. (2001). Checklist of the frogs and reptiles of Western Australia. *Records of the Western Australian Museum* **Suppl. No. 63**: 51-74.

Burbidge, A. A. (2004). *Threatened Animals of Western Australia*. Department of Conservation and Land Management, Kensington, Western Australia.

Christidis, L. and Boles, W. E. (1994). The taxonomy and species of birds of Australia and its territories. Royal Australasian Ornithologists' Union, Hawthorn East, Victoria, Australia.

Churchill, S. (1998). *Australian Bats*. Reed New Holland, Sydney, NSW.

Cogger, H. G. (2000). *Reptiles and Amphibians of Australia*. Reed New Holland, Sydney, Australia.

Cogger, H. G., Cameron, E. E., Sadlier, R. A. and Eggler, P. (1993). *The Action Plan for Australian Reptiles*. Environment Australia, Canberra, ACT.

Debus, S. (1998). *The Birds of Prey of Australia: A Field Guide*. Oxford University Press Australia, Melbourne, Australia.

DEH. (2006). SpeciesBank. Department of the Environment and Heritage. http://www.deh.gov.au/biodiversity/abrs/online-resources/species-bank/index.html

DEP. (2000). *Bush Forever*. Department of Environmental Protection, Perth, Western Australia.

Duncan, A., Baker, G. B. and Montgomery, N. (1999). *The Action Plan for Australian Bats*. Environment Australia, Canberra, ACT.

EPA. (1990). A Guide to Wetland Management in Perth (Bulletin 374). Environmental Protection Authority, Perth, Western Australia.

EPA. (1993). A Guide to Wetland Management in the Perth and near perth Swan Coastal Plain Area (Bulletin 686). Environmental Protection Authority, Perth, Western Australia.

EPA. (2002). Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3. Environmental Protection Authority, Perth, Western Australia.

EPA. (2004). Guidance for the assessment of environmental factors: Terrestrial fauna surveys for environmental impact assessment in Western Australia. No. 56. Environmental Protection Authority, Perth, Western Australia.

Garnett, S. T. and Crowley, G. M. (2000). *The Action Plan for Australian Birds*. Environment Australia, Canberra, ACT.

Gole, C. A. (2004). Bird surveys in selected Perth metropolitan reserves: Rounds 1 and 2 survey reports. Birds Australia Western Australia and the Perth Biodiversity Project, Floreat Park and West Perth, Western Australia.

Higgins, P. J. (Ed.) (1999). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird*. Oxford University Press, Melbourne, Australia.

Higgins, P. J. and Davies, S. J. J. F. (Eds). (1996). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipe to pigeons*. Oxford University Press, Melbourne, Australia.

Hill, A. L., Semeniuk, C. A. and Semeniuk, V. (1996). Wetlands of the Swan Coastal Plain. Volume 2: Wetland Mapping, Classification and Evaluation - Wetland Atlas. Prepared for the Water and Rivers Commission and the Department of Environmental Protection, Perth, Western Australia.

How, R. A., Cooper, N. K. and Bannister, J. L. (2001). Checklist of the mammals of Western Australia. *Records of the Western Australian Museum* **Suppl. No. 63**: 91-98.

IUCN. (2001). *IUCN Red List Categories and Criteria, Version 3.1*. IUCN Species Survival Commission, IUCN, Gland, Switzerland and Cambridge, UK.

Johnstone, R. E. (2001). Checklist of the birds of Western Australia. *Records of the Western Australian Museum* **Suppl. No. 63**.

Johnstone, R. E. and Storr, G. M. (1998). *Handbook of Western Australian birds. Volume 1: Non-passerines (Emu to Dollarbird)*. Western Australian Museum, Perth, Western Australia.

Johnstone, R. E. and Storr, G. M. (2005). *Handbook of Western Australian birds. Volume 2: Passerines (Blue-winged Pitta to Goldfinch)*. Western Australian Museum, Perth, Western Australia.

Lee, A. K. (1995). *The Action Plan for Australian Rodents*. Environment Australia, Canberra, ACT.

Mace, G. and Stuart, S. (1994). Draft IUCN Red List Categories, Version 2.2. *Species; Newsletter of the Species Survival Commission. IUCN - The World Conservation Union.* **21-22**: 13-24.

Marchant, S. and Higgins, P. J. (Eds). (1990). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 1: Ratites to Ducks*. Oxford University Press, Melbourne, Australia.

Marchant, S. and Higgins, P. J. (Eds). (1993). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2: Raptors to Lapwings*. Oxford University Press, Melbourne, Australia.

Maxwell, S., Burbidge, A. A. and Morris, K. (1996). *Action Plan for Australian Marsupials and Monotremes*. Environment Australia, Canberra, ACT.

Menkhorst, P. and Knight, F. (2004). *A Field Guide to the Mammals of Australia*. Oxford University Press, South Melbourne.

Morgan, D. L., Gill, H. S. and Potter, I. C. (1998). Distribution, identification and biology of freshwater fish in south-western Australia. *Records of the Western Australian Museum* **Suppl. No. 56**.

Storr, G. M., Smith, L. A. and Johnstone, R. E. (1983). *Lizards of Western Australia. II. Dragons and Monitors*. Western Australian Museum, Perth, Western Australia.

Storr, G. M., Smith, L. A. and Johnstone, R. E. (1990). *Lizards of Western Australia. III. Geckos and Pygopods*. Western Australian Museum, Perth, Western Australia.

Storr, G. M., Smith, L. A. and Johnstone, R. E. (1999). *Lizards of Western Australia. I. Skinks*. Western Australian Museum, Perth, Western Australia.
Storr, G. M., Smith, L. A. and Johnstone, R. E. (2002). *Snakes of Western Australia*. Western Australian Museum, Perth, Western Australia.
Strahan, R. (Ed.) (1995). *The Mammals of Australia*. Reed Books, Chatswood, New South Wales, Australia.
Tyler, M. J., Smith, L. A. and Johnstone, R. E. (2000). *Frogs of Western Australia*. Western Australian Museum, Perth, Western Australia.
Wilson, S. and Swann, G. (2003). *Reptiles of Australia*. Princeton University Press, Australia.

TABLES

Table 1. Birds recorded during the site inspection. Status is assigned as described in Methods. 'X' indicates species present, 'OH' indicates species flew overhead.

Species		Status	Wetland 1	Tuarts and bridal trail	Wetland 2	Wetland 3	Wetland 4	Wetland 5
COLUMBIDAE (Pigeons and doves)								
Phaps chalcoptera	Common Bronzewing	CS3					X	
CACATUIDAE (Cockatoos)								
Calyptorhynchus latirostris	Carnaby`s Cockatoo	CS1	OH			OH		
Eolophus roseicapilla	Galah			X				
PSITTACIDAE (Parrots)								
Barnardius zonarius	Australian Ringneck			X				
HALCYONIDAE (Kingfishers)								
Dacelo novaeguineae	Laughing Kookaburra			X		X		
PARDALOTIDAE (Pardalotes, scrubwrens, thornbills and allies)								
Sericornis frontalis	White-browed Scrubwren	CS3	X			X		
Smicrornis brevirostris	Weebill	CS3				X		
Gerygone fusca	Western Gerygone			X		X		
Acanthiza apicalis	Inland Thornbill	CS3		X		X		
MELIPHAGIDAE (Honeyeaters)								
Lichmera indistincta	Brown Honeyeater					X		
Acanthorhynchus superciliosus	Western Spinebill					X		
PETROICIDAE (Robins)								
Petroica multicolor	Scarlet Robin	CS3				X		
PACHYCEPHALIDAE (Whistlers, shrike-thrushes and allies)								
Pachycephala pectoralis	Golden Whistler	CS3	X			X		
DICRURIDAE (Monarchs, fantails and drongos)								
Rhipidura fuliginosa	Grey Fantail		X	X		X		
ARTAMIDAE (Woodswallows, butcherbirds and currawongs)								
Gymnorhina tibicen	Australian Magpie					X		
ZOSTEROPIDAE (White-eyes)								
Zosterops lateralis	Silvereye			X				

Table 2. Conservation significant species that are likely to occur in the vicinity of the Karnup pine plantation. An assessment of these species (including the likelihood of their occurrence within remnant bushland of the pine plantation site) is provided in Appendix 3.
Species marked with a superscript 'w' are generally dependent on wetlands.

Species		Status
Scincidae (skink lizards)		
Western Ctenotus	*Ctenotus australis*	CS3
	Ctenotus gemmula	CS2
Red-legged Skink	*Ctenotus labillardieri*	CS3
Mourning Skink	*Egernia luctuosa*	CS3
Perth Lined Lerista	*Lerista lineata*	CS2
Boidae (pythons)		
South-West Carpet Python	*Morelia spilota imbricata*	CS1
Elapidae (front-fanged snakes)		
Black-striped Snake	*Neelaps calonotos*	CS2
Casuariidae (emus and cassowaries)		
Emu	*Dromaius novaehollandiae*	CS3
Anatidae (ducks, geese and swans)		
Blue-billed Duck	*Oxyura australis* [w]	CS3
Musk Duck	*Biziura lobata* [w]	CS3
Freckled Duck	*Stictonetta naevosa* [w]	CS3
Australasian Shoveler	*Anas rhynchotis* [w]	CS3
Pink-eared Duck	*Malacorhynchus membranaceus* [w]	CS3
Hardhead	*Aythya australis* [w]	CS3
Ardeidae (herons and egrets)		
Great Egret	*Egretta alba* [w]	CS1
Cattle Egret	*Ardeola ibis* [w]	CS1
Little Bittern	*Ixobrychus minutus* [w]	CS2
Black Bittern	*Ixobrychus flavicollis* [w]	CS3
Australasian Bittern	*Botaurus poiciloptilus* [w]	CS1
Accipitridae (kites, hawks and eagles)		
Square-tailed Kite	*Lophoictinia isura*	CS3
Whistling Kite	*Haliastur sphenurus*	CS3
Brown Goshawk	*Accipiter fasciatus*	CS3
Collared Sparrowhawk	*Accipiter cirrhocephalus*	CS3
Wedge-tailed Eagle	*Aquila audax*	CS3
Little Eagle	*Hieraaetus morphnoides*	CS3
Falconidae (falcons)		
Peregrine Falcon	*Falco peregrinus*	CS1
Rallidae (Rails, gallinules and coots)		
Dusky Moorhen	*Gallinula tenebrosa* [w]	CS3
Scolopacidae (sandpipers)		
Common Greenshank	*Tringa nebularia* [w]	CS1
Common Sandpiper	*Tringa hypoleucos* [w]	CS1
Columbidae (Pigeons and doves)		
Common Bronzewing	*Phaps chalcoptera*	CS3

Table 2. Continued.

Species		Status
Cacatuidae (cockatoos)		
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	CS1
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	CS1
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	CS1
Psittacidae (lorikeets and parrots)		
Regent Parrot	*Polytelis anthopeplus*	CS3
Western Rosella	*Platycercus icterotis*	CS3
Strigidae (hawk-owls)		
Barking Owl	*Ninox connivens*	CS2
Meropidae (bee-eaters)		
Rainbow Bee-eater	*Merops ornatus*	CS1
Maluridae (Fairy-wrens, emu-wrens and grasswrens)		
Splendid Fairy-wren	*Malurus splendens*	CS3
Pardalotidae (Pardalotes, scrubwrens, thornbills and allies)		
White-browed Scrubwren	*Sericornis frontalis*	CS3
Weebill	*Smicrornis brevirostris*	CS3
Inland Thornbill	*Acanthiza apicalis*	CS3
Western Thornbill	*Acanthiza inornata*	CS3
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	CS3
Meliphagidae (Honeyeaters)		
Western Wattlebird	*Anthochaera lunulata*	CS3
New Holland Honeyeater	*Phylidonyris novaehollandiae*	CS3
White-cheeked Honeyeater	*Phylidonyris nigra*	CS3
Tawny-crowned Honeyeater	*Phylidonyris melanops*	CS3
Petroicidae (Australian robins)		
Scarlet Robin	*Petroica multicolor*	CS3
Western Yellow Robin	*Eopsaltria griseogularis*	CS3
Neosittidae (sittellas)		
Varied Sittella	*Daphoenositta chrysoptera*	CS3
Pachycephalidae (whistlers)		
Golden Whistler	*Pachycephala pectoralis*	CS3
Grey Shrike-thrush	*Colluricincla harmonica*	CS3
Corvidae (ravens and crows)		
Grey Currawong	*Strepera versicolor*	CS3
Dasyuridae (dasyurids)		
Chuditch	*Dasyurus geoffroii*	CS1
Peramelidae (bandicoots)		
Quenda, Southern Brown Bandicoot	*Isoodon obesulus*	CS2
Macropodidae (kangaroos and wallabies)		
Brush or Black-gloved Wallaby	*Macropus irma*	CS2
Mollosidae (mastiff bats)		
Western Freetail-bat	*Mormopterus* sp. (*M. planiceps*: long penis form, part). Regarded as 'Species 4, population O' by Adams *et al*. (1988).	CS3
Vespertilionidae (vesper bats)		
Western False Pipistrelle	*Falsistrellus mackenziei*	CS2
Muridae (rats and mice)		
Rakali or water rat	*Hydromys chrysogaster*	CS2

APPENDICES

Appendix 1. Categories used in the assessment of conservation status.

IUCN categories (based on review by Mace and Stuart 1994) as used for the Environmental Protection and Biodiversity Conservation (EPBC) Act and the WA Wildlife Conservation Act.

Extinct. Taxa not definitely located in the wild during the past 50 years.

Extinct in the Wild. Taxa known to survive only in captivity.

Critically Endangered. Taxa facing an extremely high risk of extinction in the wild in the immediate future.

Endangered. Taxa facing a very high risk of extinction in the wild in the near future.

Vulnerable. Taxa facing a high risk of extinction in the wild in the medium-term future.

Near Threatened. Taxa that risk becoming Vulnerable in the wild.

Conservation Dependent. Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.

Data Deficient (Insufficiently Known). Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

Least Concern. Taxa that are not Threatened.

Schedules used in the WA Wildlife Conservation Act.

Schedule 1. Rare and Likely to become Extinct.

Schedule 2. Extinct.

Schedule 3. Migratory species listed under international treaties.

Schedule 4. Other Specially Protected Fauna.

WA Department of Conservation and Land Management Priority species
(species not listed under the Conservation Act, but for which there is some concern).

Priority 1. Taxa with few, poorly known populations on threatened lands.

Priority 2. Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.

Priority 3. Taxa with several, poorly known populations, some on conservation lands.

Priority 4. Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.

Priority 5. Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix 2. Categories used by Hill *et al*. (1996) in their assessment of wetlands on the Swan Coastal Plain (as summarised in DEP 2000).

Conservation Category Wetlands. Wetlands recognised at the international, national or regional level; "high conservation" and "conservation" wetlands identified using EPA assessment (EPA 1990, 1993); wetlands that are 95 -100% vegetated and sections of extensive wetlands. These wetlands are those for which the appropriate management regime aims to preserve their natural attributes and functions.

Resource Enhancement Wetlands. Wetlands that are 10 - 94% vegetated; wetlands identified as "resource enhancement" and "open space" using EPA assessment (EPA 1990, 1993). These wetlands are those for which the appropriate management regime aims to restore, through maintenance of their natural attributes and functions.

Multiple Use Wetlands. Wetlands that are 0 - 9% vegetated; wetlands identified as "multiple use" using EPA assessment (EPA 1990, 1993). These wetlands are those for which the appropriate management regime considers their use and development in the context of water, town and environmental planning.

Appendix 3. Species of conservation significance.

The following accounts provide basic information on the species of conservation significance that includes their conservation status, the reason for their significance, aspects of their ecology, potential threatening processes and the inferred status of the species at the study site. Information presented has been collated from a number of references: Storr *et al*. (1983; 1990; 1999; 2002), Marchant and Higgins (1990; 1993), Cogger *et al*. (1993), Lee (1995), Strahan (1995), Higgins and Davies (1996), Maxwell *et al*. (1996), Churchill (1998), Debus (1998), Johnstone and Storr (1998; 2005), Morgan *et al*. (1998), Duncan *et al*. (1999), Higgins (1999), Cogger (2000), DEP (2000), Garnett and Crowley (2000), Allen *et al*. (2003), Burbidge (2004), Menkhorst and Knight (2004) and DEH (2006). Tony Kirby (Western Australian Museum) kindly provided bird records from the Baldivis and Stakehill Road area noted as "T. Kirby, unpubl. data, *in litt*.".

REPTILES

Species :	*Ctenotus australis*	Conservation status:	**CS3**
Common name:	Western Limestone Ctenotus		
Habitat:	Coastal dunes, sand-plains and limestones with heath (and often with eucalypt or banksia woodlands).		
Notes:	Although not listed as a threatened or priority species *C. australis* occurs in near-coastal areas between approximately Mandurah and Shark Bay. This species would be at the south of its known range if present.		
Status on site:	Possibly present in areas of remnant banksia woodland (bridal trail).		
Species :	*Ctenotus gemmula* (Swan Coastal Plain)	Conservation status:	**CS2**
Common name:	Jewelled Ctenotus (Swan Coastal Plain)		
Habitat:	Pale sands with heath and *Banksia* spp. or mallee woodlands.		
Notes:	Listed as Priority 3 by DEC. This species has two disjunct populations: on the Swan Coastal Plain, where it is scarce and of concern; and on the Lower-west Coastal Plain (Albany to Esperance), where it is not currently listed as a threatened or priority species.		
Status on site:	Possibly present in areas of remnant banksia woodland (bridal trail).		
Species :	*Ctenotus labillardieri*	Conservation status:	**CS3**
Common name:	Red-legged Ctenotus		
Habitat:	Heath, forests and rock outcrops, including wet sclerophyll forest.		
Notes:	Although not listed as a threatened or priority species and common in the Darling Range, *C. labillardieri* is uncommon on the coastal plain. This species is endemic to south-western Western Australia, between Perth (Swan River) and Ravensthorpe.		
Status on site:	Unlikely to be present due to lack of suitable habitat.		
Species :	*Egernia luctuosa*	Conservation status:	**CS3**
Common name:	Mourning Skink		
Habitat:	Dense vegetation surrounding swamps, lakes, creeks and rivers.		
Notes:	Although not listed as a threatened or priority species and common in suitable habitat to the south, *E. luctuosa* is uncommon on the Swan Coastal Plain. This species is endemic to south-western Western Australia, between Perth (Swan River) and Cheyne Beach (east of Albany), and inland to Dwellingup and Pemberton.		

Status on site:	Possibly present, although the small size of the wetlands greatly reduces this probability.		
Species :	*Lerista lineata*	Conservation status:	**CS2**
Common name:	None.		
Habitat:	Coastal heath on sand, shrubland.		
Notes:	Listed as Priority 3 by DEC, and is of concern because this species has three, small, disjunct populations: near Busselton; between Perth and Mandurah (including Garden Island); and at Woodleigh Station near Shark Bay.		
Status on site:	Unlikely to be present due to lack of suitable habitat.		
Species :	*Morelia spilota imbricata*	Conservation status:	**CS1**
Common name:	Carpet Python (south-western population)		
Habitat:	Undisturbed bushland and rocky outcrops.		
Notes:	Listed as Specially Protected under the WA Wildlife Conservation Act and also as Priority 4 by DEC and is of concern because this subspecies has declined dramatically in the face of urban development and land clearing. *M. spilota imbricata* occurs in the south-western of WA, south of a line that runs from approximately Geraldton in the north-west to Eyre in the south-east. It is often arboreal and preys on birds, other reptiles and small to medium size mammals. At least six other subspecies of *M. spilota* are recognised around Australia.		
Status on site:	Possibly present in the region, but unlikely to be present on the site due to lack of connecting habitat.		
Species :	*Neelaps calonotos*	Conservation status:	**CS2**
Common name:	Black-striped Snake		
Habitat:	Dunes and sand plains with heath or eucalypt or banksia woodlands.		
Notes:	Listed as Priority 3 by DEC, and is of concern because this species is restricted to an area between Lancelin and Mandurah (east to Gingin and Riverton). *N. calonotos* was previously listed under the WA Wildlife Conservation Act but is now thought to be abundant on *Banksia* sandplain. It is, however, still threatened by encroaching land development.		
Status on site:	Possibly present, although the small size of the bushland remnants greatly reduce this probability.		

BIRDS

Species :	*Dromaius novaehollandiae novaehollandiae*	Conservation status:	**CS3**
Common name:	Emu (mainland population)		
Habitat:	Plains, scrublands, open woodlands, heaths, semi-arid regions and agricultural areas.		
Notes:	Assessed as 'Lower Risk (Least Concern)' by Garnett and Crowley (2000) because, although widespread in semi-arid Australia, *D. n. novaehollandiae* has disappeared from settled areas and many sub-populations have been isolated. *D. n. novaehollandiae* is threatened by habitat destruction or hunting associated with dense settlement and intensive agriculture.		
Status on site:	Unlikely to be present due to surrounding settlement.		
Species :	*Oxyura australis*	Conservation status:	**CS3**
Common name:	Blue-billed Duck		

Habitat:	Deep and well vegetated freshwater lakes, dams and swamps		
Notes:	Assessed as 'Lower Risk (Least Concern)' by Garnett and Crowley (2000) because this species is sparse throughout much of its range, but high numbers recorded from artificial wetlands in Victoria took this species out of threatened categories. Drainage and salinisation of wetlands have reduced the habitat available to *O. australis*. *O. australis* occurs in two distinct subpopulations: one in southern and western Western Australia, and the other south-eastern Australia.		
Status on site:	Unlikely to be present due to lack of suitable deep water habitat.		
Species :	*Biziura lobata*	Conservation status:	**CS3**
Common name:	Musk Duck		
Habitat:	Deep and well vegetated freshwater lakes, dams and swamps.		
Notes:	Although not listed as a threatened or priority species, *B. lobata* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Unlikely to be present due to lack of suitable deep water habitat.		
Species :	*Stictonetta naevosa*	Conservation status:	**CS3**
Common name:	Freckled Duck		
Habitat:	Large, well vegetated swamps.		
Notes:	Assessed as 'Lower Risk (Least Concern)' by Garnett and Crowley (2000) because this species is scarce throughout much of its range, but population numbers fluctuate in response to seasonal conditions (and therefore a consistent decline in the population level has not been satisfactorily detected). Clearing and diversion of wetland drainage may threaten this species. *S. naevosa* occur in south-western and south-eastern Australia. In times of drought *S. naevosa* move towards the coast (and may use open lakes).		
Status on site:	Unlikely to be present due to lack of large wetlands.		
Species :	*Anas rhynchotis*	Conservation status:	**CS3**
Common name:	Australasian Shoveler		
Habitat:	Large freshwater and saline lakes and swamps.		
Notes:	Although not listed as a threatened or priority species, *A. rhynchotis* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Unlikely to be present due to lack of large wetlands.		
Species :	*Malacorhynchus membranaceus*	Conservation status:	**CS3**
Common name:	Pink-eared Duck		
Habitat:	Freshwater and saline lakes and swamps, saline coastal wetlands, lignum swamps, shallow, temporary waters.		
Notes:	Although not a threatened or priority species, *M. membranaceus* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Unlikely to be present due to lack of suitable wetlands.		
Species :	*Aythya australis*	Conservation status:	**CS3**
Common name:	Hardhead		
Habitat:	Deep, permanent wetlands, brackish coastal swamps, dams, sewage ponds.		
Notes:	Although not listed as a threatened or priority species, *A. australis* is listed as a habitat specialist with a reduced population (at least in the vicinity of		

	the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Unlikely to be present due to lack of deep wetlands.		
Species :	*Ardea alba*	Conservation status:	**CS1**
Common name:	Great Egret		
Habitat:	Estuaries, tidal flats, rivers, freshwater lakes, sewage ponds and dams.		
Notes:	Listed as Migratory under the EPBC Act. Common and widespread throughout Australia (except deserts). *A. alba* forages in aquatic habitats for fish, amphibians, and invertebrates.		
Status on site:	Possibly present as a vagrant in wetland areas, but unlikely to be resident or permanently reliant on site (due to the small size and poor quality of the wetlands).		
Species :	*Ardea ibis*	Conservation status:	**CS1**
Common name:	Cattle Egret.		
Habitat:	Paddocks, pastures, wetlands, and tidal mudflats.		
Notes:	Listed as Migratory under the EPBC Act. Colonised Australia (from Indonesia) in the 1940s and is now widespread throughout tropical and temperate Australia. *A. ibis* is a vagrant in the south-west region.		
Status on site:	Unlikely to be present.		
Species :	*Ixobrychus minutus*	Conservation status:	**CS2**
Common name:	Little Bittern		
Habitat:	Dense vegetation (reeds, rushes, sedges) in or adjacent to freshwater wetlands.		
Notes:	Listed as Priority 4 by to DEC and of concern because of habitat loss due to salinisation, clearing, grazing, wetland drainage and altered fire regimes. *I. minutus* occurs in south-western Western Australia (south-west of a line between Perth and Albany), in the Kimberley, and along the eastern coast of Australia.		
Status on site:	Unlikely to be present due to lack of suitable habitat.		
Species :	*Ixobrychus flavicollis*	Conservation status:	**CS3**
Common name:	Black Bittern		
Habitat:	Well sheltered waterside vegetation adjacent to rivers and wetlands.		
Notes:	Assessed as 'Lower Risk (Least Concern)' by Garnett and Crowley (2000) because the population in south-western Australia is in decline because of wetland drainage and salinisation.		
Status on site:	Unlikely to be present due to lack of suitable habitat.		
Species :	*Botaurus poiciloptilus*	Conservation status:	**CS1**
Common name:	Australasian Bittern		
Habitat:	Dense vegetation (reeds, rushes, sedges) in or adjacent to freshwater wetlands, drains and, occasionally, salt marshes.		
Notes:	Listed as Vulnerable under the WA Wildlife Conservation Act and is of concern because of habitat loss due to salinisation, clearing, grazing, wetland drainage and altered fire regimes. In Western Australia this species is now largely confined to near-coastal areas, approximately south-west of a line between Moora and Cape Arid (near Esperance). It was formerly known throughout the wheatbelt. *B. poiciloptilus* has reasonably specific habitat requirements and is therefore sensitive to habitat alteration.		
Status on site:	Unlikely to be present due to lack of suitable habitat.		
Species :	*Lophoictinia isura*	Conservation status:	**CS3**
Common name:	Square-tailed Kite		

Habitat:	Heathlands, woodlands, forests, rainforests, timbered watercourses, hills and gorges.	
Notes:	Although not listed as a threatened or priority species, *L. isura* is listed as a wide ranging species that is locally extinct (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000). This species occurs in most habitats around Australia, with the exception of the most arid, treeless regions. Southern breeding birds migrate north during the southern winter, returning again to breed the following spring.	
Status on site:	Unlikely to be present due to lack of suitable habitat.	
Species :	*Accipiter fasciatus*	Conservation status: **CS3**
Common name:	Brown Goshawk	
Habitat:	Open forests and woodlands, farmlands, parks and gardens.	
Notes:	Although not listed as a threatened or priority species, *A. fasciatus* is listed as a wide ranging species with reduced populations (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).	
Status on site:	Unlikely to be resident on the site but may be resident in nearby areas, and may forage over the site.	
Species :	*Accipiter cirrhocephalus*	Conservation status: **CS3**
Common name:	Collared Sparrowhawk	
Habitat:	Forests, woodlands, inland scrubs, river margins, farmlands and gardens.	
Notes:	Although not listed as a threatened or priority species, *A. cirrhocephalus* is listed as a wide ranging species with reduced populations (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).	
Status on site:	Unlikely to be resident on the site but may be resident in nearby areas, and may forage over the site.	
Species :	*Aquila audax*	Conservation status: **CS3**
Common name:	Wedge-tailed Eagle	
Habitat:	Most habitats within Australia.	
Notes:	Although not listed as a threatened or priority species, *A. audax* is listed as a wide ranging species with reduced populations (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).	
Status on site:	Unlikely to be resident on the site but may be resident in nearby areas, and may forage over the site.	
Species :	*Hieraaetus morphnoides*	Conservation status: **CS3**
Common name:	Little Eagle	
Habitat:	Open forests woodlands, scrublands, plains, watercourses and lakes.	
Notes:	Although not listed as a threatened or priority species, *H. morphnoides* is listed as a wide ranging species with reduced populations (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).	
Status on site:	Known from the area (T. Kirby, unpubl. data, *in litt*.), unlikely to be resident on the site but may be resident in nearby areas, and may forage over the site.	
Species :	*Falco peregrinus*	Conservation status: **CS1**
Common name:	Peregrine Falcon	
Habitat:	Cliffs, gorges, timbered watercourses, and tall man-made infrastructure.	
Notes:	Listed as Specially Protected under the WA Wildlife Conservation Act. *F. peregrinus* is cosmopolitan but uncommon throughout Australia and	

	prefers sites with tall perches (such as gorges, trees or power poles).		
Status on site:	Known from the area (T. Kirby, unpubl. data, *in litt*.) but likely to only be a vagrant over the site.		
Species :	*Gallinula tenebrosa*	Conservation status:	**CS3**
Common name:	Dusky Moorhen		
Habitat:	Well vegetated wetlands, drains, rivers, parks, and dams.		
Notes:	Although not listed as a threatened or priority species, *G. tenebrosa* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Unlikely to be present due to lack of suitable wetlands.		
Species :	*Tringa nebularia*	Conservation status:	**CS1**
Common name:	Common Greenshank		
Habitat:	Estuaries, tidal flats, mangroves, rivers, wetlands, sewage ponds and saltfields.		
Notes:	Listed as Migratory under the EPBC Act. *T. nebularia* breeds from Scotland to Siberia and migrates to arrive in Australia from August to October, returning to the breeding grounds by May or June. *T. nebularia* occurs in association with wetland or aquatic habitats throughout Australia (except in the central deserts) where it feeds predominantly on aquatic insects.		
Status on site:	Unlikely to be present due to lack of suitable wetlands.		
Species :	*Actitis hypoleucos*	Conservation status:	**CS1**
Common name:	Common Sandpiper		
Habitat:	Estuaries, tidal flats, mangroves, rivers, wetlands, sewage ponds and saltflats.		
Notes:	Listed as Migratory under the EPBC Act. *A. hypoleucos* breeds from British Isles to Siberia and migrates to arrive in Australia from July, returning to the breeding grounds by April. *A. hypoleucos* prefers stony or pebbly substrates associated with water bodies and is uncommon, though widespread, throughout Australia (except in the central deserts). *A. hypoleucos* may congregate in groups but is most commonly observed singly.		
Status on site:	Unlikely to be present due to lack of suitable wetlands.		
Species :	*Phaps chalcoptera*	Conservation status:	**CS3**
Common name:	Common Bronzewing		
Habitat:	Forests, woodlands, thickets and heaths.		
Notes:	Although not listed as a threatened or priority species, *P. chalcoptera* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Present.		
Species :	*Calyptorhynchus banksii naso*	Conservation status:	**CS1**
Common name:	Forest Red-tailed Black-Cockatoo		
Habitat:	Open forests and woodlands, suburban gardens.		
Notes:	Listed as Vulnerable under the WA Wildlife Conservation Act and is of concern because clearing has greatly reduced the available breeding and feeding habitat. Feral bees and galahs also compete with *C. b. naso* for nesting hollows. Climatic change may explain the westward contraction of this subspecies into areas with higher rainfall. *C. b. naso* occurs in the		

	south-west of Western Australia, approximately south-west of a line between Gingin and the Green Range (near Wellstead, east of Albany). This range of this subspecies is closely tied to the distribution of Marri (*Corymbia callophylla*); the favoured nesting and food tree of *C. b. naso*. At least four other subspecies of *C. banksii* have been recognised (*C. b. banksii*, *C. b. graptogyne*, *C. b. samueli* and *C. b. macrorhynchus*), the latter two being present elsewhere in Western Australia.
Status on site:	Likley to be present. Known to breed in the Baldivis area (T. Kirby, unpubl. data, *in litt*.).
Species :	*Calyptorhynchus latirostris* Conservation status: **CS1**
Common name:	Carnaby`s Cockatoo
Habitat:	Open forests and woodlands, Kwongan heath, sand plains, suburban vegetation and pine plantations.
Notes:	Listed as Endangered under the EPBC and WA Wildlife Conservation Acts. *C. latirostris* occurs in the south-west of Western Australia, approximately south-west of a line between the Murchison River (near Kalbarri) and Cape Arid National Park (east of Esperance). This species generally breeds in inland areas, moving to cooler, coastal areas for the non-breeding period (late spring to mid-winter). Land clearing and degradation has reduced available breeding sites (tree hollows) and fragmented breeding and feeding sites. Feral bees, galahs and corellas out-compete *C. latirostris* for nesting hollows. Illegal trapping and smuggling also threaten this species.
Status on site:	Present. Known to breed in the Baldivis area (T. Kirby, unpubl. data, *in litt*.).
Species :	*Calyptorhynchus baudinii* Conservation status: **CS1**
Common name:	Baudin`s Cockatoo
Habitat:	Jarrah, Marri and Karri forests, woodlands, coastal scrub.
Notes:	Listed as Vulnerable under the EPBC Act and as Endangered under the WA Wildlife Conservation Act. *C. baudinii* occurs in the deep south-west of Western Australia, approximately south-west of a line between Morangup (near Bullsbrook, north of Perth) and Waychinicup National Park (east of Albany). Birds generally breed in the Karri, Marri and Wandoo forests in the southern parts of the species' range and move north to the Darling Range and Swan Coastal Plain during autumn and winter (non-breeding period). Clearing for agriculture and logging has removed nesting and feeding trees for this species.
Status on site:	Unlikely to be present, although may forage in general area the non-breeding season.
Species :	*Polytelis anthopeplus anthopeplus* Conservation status: **CS3**
Common name:	Regent Parrot (western population)
Habitat:	Farmlands, timbered watercourses, woodland clearings, forests and mallee.
Notes:	Assessed as 'Lower Risk (Least Concern)' by Garnett and Crowley (2000) because a decline in population density has been observed in at least half the range of this subspecies, but density has also increased in other parts of the range. Clearing for agriculture and the death of suitable nest trees (particularly *Eucalyptus salmonophloia*) due to salinity may be responsible for the decline in the WA wheatbelt. *P. a. anthopeplus* occurs in the south-west of Western Australia. An eastern states' subspecies, *P.*

	a. monarchoides, is also recognised.		
Status on site:	Unlikely to be present, although may pass through the general area as a vagrant.		
Species :	*Platycercus icterotis icterotis*	Conservation status:	**CS3**
Common name:	Western Rosella (south-western population)		
Habitat:	Open forest, woodland clearings, farmlands, timbered watercourses, crops, orchards and gardens.		
Notes:	Although not listed as a threatened or priority species and common in the broader region (particularly in the Darling Range), *P. i. icterotis* is locally uncommon on the Swan Coastal Plain (DEP 2000).		
Status on site:	Unlikely to be present due to lack of suitable woodlands.		
Species :	*Ninox connivens connivens*	Conservation status:	**CS2**
Common name:	Barking Owl (south-western population)		
Habitat:	Open forests, woodlands, dense scrub and timbered watercourses.		
Notes:	Listed as Priority 2 by DEC and is of concern because the population of this subspecies has declined dramatically as a result of habitat clearing and logging. *N. c. connivens* occurs in the south-west of Western Australia, approximately south-west of a line between the Greenough River (south of Geraldton) and Esperance. The northern subspecies, *N. c. peninsularis*, occurs in the Pilbara and Northern Territory and is not currently listed as a threatened or priority species.		
Status on site:	Unlikely to be present.		
Species :	*Merops ornatus*	Conservation status:	**CS1**
Common name:	Rainbow Bee-eater		
Habitat:	Open woodlands, sand ridges, sand pits, riverbanks, beaches, dunes, cliffs, mangroves and man-made grassed fields.		
Notes:	Listed as Migratory under the EPBC Act. *M. ornatus* occurs year-around in the tropics, with a southward migration, to both south-eastern and south-western Australia, in early spring. Southern birds return north in autumn. When present, *M. ornatus* is common and prominent in natural and altered environments.		
Status on site:	Highly likely to be present (known to be present in the area, T. Kirby, unpubl. data, *in litt*.).		
Species :	*Malurus splendens*	Conservation status:	**CS3**
Common name:	Splendid Fairy-wren		
Habitat:	Forest clearings, woodlands, margins of watercourses and wetlands, parklands and golf-courses with sufficient understorey.		
Notes:	Although not listed as a threatened or priority species, *M. splendens* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Possibly present.		
Species :	*Sericornis frontalis*	Conservation status:	**CS3**
Common name:	White-browed Scrubwren		
Habitat:	Forest and woodland undergrowth, heaths, mallee, mulga, parks and gardens.		
Notes:	Although not listed as a threatened or priority species, *S. frontalis* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Present.		

Species :	*Smicrornis brevirostris*	Conservation status:	**CS3**
Common name:	Weebill		
Habitat:	Eucalypt and acacia woodlands.		
Notes:	Although not listed as a threatened or priority species, *S. brevirostris* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Present.		
Species :	*Acanthiza apicalis*	Conservation status:	**CS3**
Common name:	Inland Thornbill		
Habitat:	Woodland, wet, coastal and dry scrub, heaths and mangroves.		
Notes:	Although not listed as a threatened or priority species, *A. apicalis* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Present.		
Species :	*Acanthiza inornata*	Conservation status:	**CS3**
Common name:	Western Thornbill		
Habitat:	Tall forests to open woodlands, coastal scrubs.		
Notes:	Although not listed as a threatened or priority species, *A. inornata* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Unlikely to be present.		
Species :	*Acanthiza chrysorrhoa*	Conservation status:	**CS3**
Common name:	Yellow-rumped Thornbill		
Habitat:	Woodland with grasses, paddocks, plantations, orchards, farms, parks and lawns.		
Notes:	Although not listed as a threatened or priority species, *A. chrysorrhoa* is listed as a habitat specialist with a reduced population (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Likely to be present (known to be present in the area, T. Kirby, unpubl. data, *in litt*.).		
Species :	*Anthochaera lunulata*	Conservation status:	**CS3**
Common name:	Western Wattlebird		
Habitat:	Banksia and eucalypt woodlands, heaths, parks and gardens.		
Notes:	Although not listed as a threatened or priority species, *A. lunulata* is listed as a wide ranging species with reduced populations (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Possibly present, limited suitable habitat available (known to be present in the area, T. Kirby, unpubl. data, *in litt*.).		
Species :	*Phylidonyris novaehollandiae*	Conservation status:	**CS3**
Common name:	New Holland Honeyeater		
Habitat:	Eucalypt forests and woodlands, watercourse vegetation, heaths, orchards, parks and gardens.		
Notes:	Although not listed as a threatened or priority species, *P. novaehollandiae* is listed as a wide ranging species with reduced populations (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Likely to be present (known to be present in the area, T. Kirby, unpubl. data, *in litt*.).		

Species :	*Phylidonyris nigra*	Conservation status:	**CS3**
Common name:	White-cheeked Honeyeater		
Habitat:	Eucalypt forests and woodlands, watercourse vegetation, heaths, orchards, parks and gardens.		
Notes:	Although not listed as a threatened or priority species, *P. nigra* is listed as a wide ranging species with reduced populations (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Likely to be present.		
Species :	*Phylidonyris melanops*	Conservation status:	**CS3**
Common name:	Tawny-crowned Honeyeater		
Habitat:	Heath, banksia woodland, mallee, eucalypt woodlands.		
Notes:	Although not listed as a threatened or priority species, *P. melanops* is listed as a wide ranging species with reduced populations (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000).		
Status on site:	Possibly a seasonal migrant through the site.		
Species :	*Petroica multicolor campbelli*	Conservation status:	**CS3**
Common name:	Scarlet Robin (south-western population)		
Habitat:	Forests, woodlands, watercourses, parks, orchards and urban gardens.		
Notes:	Assessed as 'Lower Risk (Least Concern)' by Garnett and Crowley (2000) because habitat clearance and fragmentation has reduced the range of this species. Three other subspecies of *P. multicolor* occur in Australia, but none in Western Australia.		
Status on site:	Present.		
Species :	*Eopsaltria griseogularis*	Conservation status:	**CS3**
Common name:	Western Yellow Robin		
Habitat:	Open forests, woodlands, coastal scrubs and dense mallee.		
Notes:	Although not listed as a threatened or priority species, *E. griseogularis* is listed as a habitat specialist with a reduced range on the Swan Coastal Plain by DEP (2000).		
Status on site:	Unlikely to be present on site due to lack of large remnants but known to be present in the area (T. Kirby, unpubl. data, *in litt*.).		
Species :	*Daphoenositta chrysoptera*	Conservation status:	**CS3**
Common name:	Varied Sittella		
Habitat:	Open eucalypt woodlands and forests, mallee, inland acacia, parks and gardens.		
Notes:	Although not listed as a threatened or priority species, *D. chrysoptera* is listed as a habitat specialist with a reduced range on the Swan Coastal Plain by DEP (2000).		
Status on site:	May visit the site to forage in Tuarts.		
Species :	*Pachycephala pectoralis*	Conservation status:	**CS3**
Common name:	Golden Whistler		
Habitat:	Eucalypt forests and woodlands, rainforests, scrubs, mallee, orchards, parks, gardens.		
Notes:	Although not listed as a threatened or priority species, *P. pectoralis* is listed as a habitat specialist with a reduced range on the Swan Coastal Plain by DEP (2000).		
Status on site:	Present.		
Species :	*Colluricincla harmonica*	Conservation status:	**CS3**

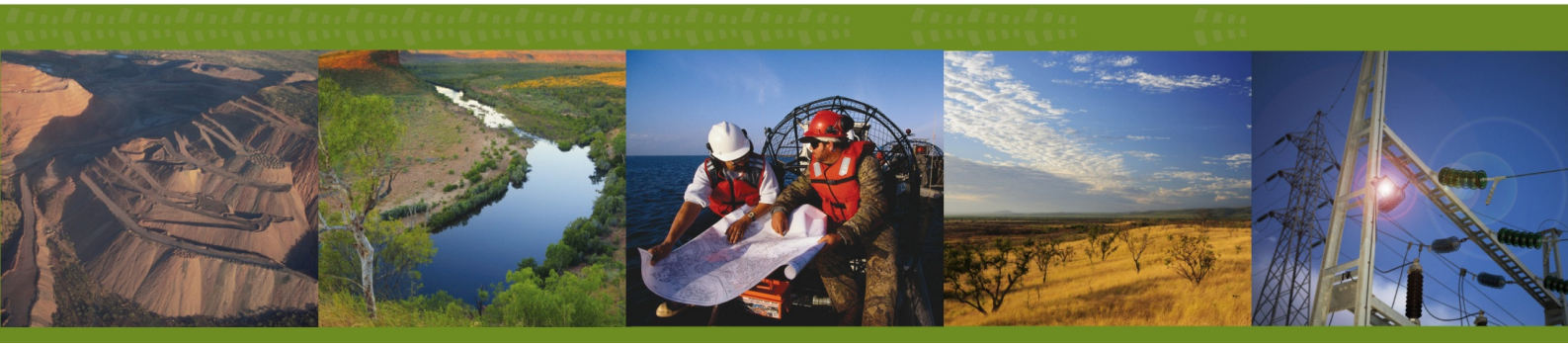
Common name:	Grey Shrike-thrush
Habitat:	Eucalypt forests and woodlands, coastal scrubs, mallee, mulga, watercourse vegetation, golf courses, parks and gardens.
Notes:	Although not listed as a threatened or priority species, *C. harmonica* is listed as a habitat specialist with a reduced range on the Swan Coastal Plain by DEP (2000).
Status on site:	Possibly present.

Species :	*Strepera versicolor*	Conservation status:	**CS3**
Common name:	Grey Currawong		
Habitat:	Forests and woodlands, heaths, orchards.		
Notes:	Although not listed as a threatened or priority species, *S. versicolor* is listed as a wide ranging species that is locally extinct (at least in the vicinity of the metropolitan area) on the Swan Coastal Plain by DEP (2000). This species occurs throughout southern Australia.		
Status on site:	Unlikely to be present.		

MAMMALS

Species :	*Dasyurus geoffroii*	Conservation status:	**CS1**
Common name:	Chuditch		
Habitat:	Wet and dry sclerophyll forest, mallee.		
Notes:	Listed as Vulnerable under the EPBC and WA Wildlife Conservation Acts. A ten year recovery plan was published in 1991 and has since been successfully implemented. Habitat alteration through clearing, grazing and changed fire regimes, competition with foxes and cats for food, predation by foxes, hunting, and poisoning all threaten *D. geoffroii*. This species occupies large home ranges, is highly mobile and appears able to utilise bush remnants and corridors.		
Status on site:	Unlikely to be present due to lack of large remnants.		
Species :	*Isoodon obesulus fusciventer*	Conservation status:	**CS2**
Common name:	Southern Brown Bandicoot, Quenda		
Habitat:	Sandy soils with low ground cover. Prefers areas that are regularly burnt. Highest densities occur in association with wetlands and damplands.		
Notes:	Listed as Priority 5 by DEC and is of concern because habitat clearing and fragmentation, fire, and predation by foxes, cats and domestic dogs threaten this species. *I. o. fusciventer* occurs in the south-west of Western Australia. Two other subspecies are recognised, neither of which occurs in Western Australia.		
Status on site:	Possibly present.		
Species :	*Macropus irma*	Conservation status:	**CS2**
Common name:	Brush Wallaby, Kwoora		
Habitat:	Open dry sclerophyll forests with open, seasonal wet flats with low grasses and open scrub.		
Notes:	Listed as Priority 5 by DEC and is of concern because it is threatened by habitat clearing and fragmentation, predation by foxes and illegal hunting. *M. irma* occurs in the south-west of Western Australia, from approximately Geraldton to Esperance.		
Status on site:	Unlikely to be present due to lack of large remnants.		
Species :	*Falsistrellus mackenziei*	Conservation status:	**CS2**
Common name:	Western False Pipistrelle		
Habitat:	Karri, Jarrah and Tuart forests and *Banksia* woodlands.		
Notes:	Listed as Priority 4 by DEC. *F. mackenziei* occurs in the wet sclerophyll and higher rainfall areas of dry sclerophyll forest in the south-west of Western Australia.		
Status on site:	Unlikely to be present due to lack of large remnants.		

Species :	*Mormopterus* sp. (*M. planiceps*: long penis form, part). Regarded as 'Species 4, population O' by Adams *et al*. (1988).	Conservation status:	**CS3**
Common name:	Western Freetail-bat		
Habitat:	Tall forests, open woodland, mallee and coastal heath.		
Notes:	Although not listed as a threatened or priority species, there is currently a major revision of many *Mormopterus* species and subspecies throughout Australia. This species, the 'Western Freetail-bat', occurs in south western Western Australia, from approximately Lancelin to Kalgoorlie to Eyre (including the wheatbelt), and represents the south-western population of the species formerly recognised as *M. planiceps*. Two other populations of *M. planiceps* are informally recognised as individual taxa: the 'Southern Freetail-bat' (*M. planiceps*: long penis form, part) of south-eastern Australia, and the 'Inland Freetail-bat' (*M. planiceps*: short penis form) of arid and semi-arid southern Australia (including Western Australia).		
Status on site:	Unlikely to be present due to lack of large remnants.		
Species :	*Hydromys chrysogaster*	Conservation status:	**CS2**
Common name:	Water Rat, Rakali		
Habitat:	Permanent bodies of fresh or brackish water.		
Notes:	Listed as Priority 4 by DEC and is of concern because the species' population is in decline, particularly along rivers affected by salting or degradation. In Western Australia *H. chrysogaster* occurs in the south-west, along parts of the Pilbara coast (including some islands) and in the Kimberley. It also occurs throughout northern and eastern Australia. The distribution of this species is very patchy within this range.		
Status on site:	Unlikely to be present due to lack of permanent water bodies.		



Karnup Sand Mining Project

Environmental Investigations

Prepared for
Urban Resources
by Strategen

June 2015

STRATEGEN
environmental consultants

Karnup Sand Mining Project

Environmental Investigations

Strategen is a trading name of
Strategen Environmental Consultants Pty Ltd
Level 2, 322 Hay Street Subiaco WA
ACN: 056 190 419

June 2015

Limitations

Scope of services

This report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen Environmental Consulting Pty Ltd (Strategen). In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services.

Purpose and use of the report

The purpose of the report is to provide details of an on-site environmental investigation for Alcoa of Australia Limited for a site at the Kwinana Residue Disposal Facility. The report may not be reproduced or disclosed to any person other than the Client for any other purpose without the express written authority of Strategen.

Reliance on data

In preparing the report, Strategen has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, Strategen has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen.

The report is based on conditions encountered and information reviewed at the time of preparation. Strategen disclaims responsibility for any changes that may have occurred after this time.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted consulting practices. No other warranty, expressed or implied, is made.

Report for benefit of client

The report has been prepared solely for the benefit of the Client and no other party. Strategen assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of Strategen or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Ownership of report

Readers are advised that this report has been produced under contractual arrangements such that the Consultant grants to the Client a permanent, irrevocable, royalty free, non-exclusive licence (including the right to grant a sub-licence) to use, reproduce, adapt and exploit the intellectual property rights in the Report anywhere in the world. Copyright arising from the report and the provision of the services in accordance with the contract or agreement with the Client belongs exclusively to Strategen unless otherwise agreed.

Client: Urban Resources

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Preliminary draft Report	Rev A	For review by client	D Panickar, E Congear / D Newsome	Electronic	5 June 2015
Draft Report	Rev B	For review by client	D Newsome	Electronic	22 June 2015
Final Draft Report	Rev C	For review by client	D Newsome	Electronic	23 June 2015
Final Report	Rev 0	For review by client	D Newsome	Electronic	30 June 2015

Filename: URE15096_01 R004 Rev 0 - 30 June 2015

Table of contents

List of tables

List of figures

List of appendices

1. Introduction

1.1 Background

Urban Resources Pty Ltd proposes to operate the Karnup Sand Mining Project located between Stakehill Road and the Kwinana Freeway in Karnup, approximately 48 km south of Perth, Western Australia (the Project; Figure 1). The Project involves the mining of 1 553 800 m^3 of sand from the Project area. The Project area is defined as the portion of M70/1262 that is west of the Kwinana Freeway boundary, as outlined by Figure 1. Urban Resources will rehabilitate the landscape post mining to a form suitable for the future land parks and recreation use as proposed by LandCorp.

The proposed mining area occurs within Mining Tenement M70/1262 comprising remnant native woodland vegetation, historical pine plantations and natural regeneration in areas which were previously cleared. Wetland areas which occur within M70/1262 do not fall into the proposed mining area and therefore will not be impacted by the Project.

The proposed mining will require clearing of native vegetation which could contain species of, or habitat for conservation significant flora as well as Threatened species of black cockatoos. A flora, vegetation and black cockatoo habitat assessment was deemed necessary to determine the environmental values of the potential clearing area.

1.2 Scope

Strategen was commissioned to undertake a flora and vegetation assessment and black cockatoo habitat assessment by Urban Resources within the western portion of M70/1262 in May 2015 (the Survey area; Figure 4).

Wetland areas were not included within the area surveyed as they will not be impacted by the proposed mining.

1.3 Legislative context

This assessment has been conducted with reference to the following Australian and Western Australian legislation:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) – Australian Government
- *Wildlife Conservation Act 1950* (WC Act) – State
- *Environmental Protection Act 1986* (EP Act) – State
- *Biosecurity and Agriculture Management Act 2007* (BAM Act) – State.

1.3.1 Conservation significant flora and ecological communities

Threatened species are listed under the EPBC Act at the Australian Government level and under the WC Act at the State level (Appendix 4). Priority species are listed by the Department of Parks and Wildlife (Parks and Wildlife) and include species of 'significant conservation value' (Appendix 4).

Threatened Ecological Communities (TECs) are listed under both the EPBC Act and EP Act (Appendix 4). Priority Ecological Communities (PECs) are listed by Parks and Wildlife and include species of significant conservation value (Appendix 4).

1.3.2 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are protected under the EP Act, and include the following:

- World Heritage areas
- areas included on the National Estate Register
- defined wetlands and associated buffers
- vegetation within 50 m of a listed threatened species
- TECs.

1.3.3 Protection of native vegetation

Native vegetation is defined under the EP Act as "indigenous aquatic or terrestrial vegetation, and includes dead vegetation unless that dead vegetation is of a class declared by regulation to be excluded from this definition but does not include vegetation in a plantation".

This definition of native vegetation does not include vegetation that was intentionally sown, planted or propagated unless wither of the following apply:

(a) the vegetation was sown, planted or propagated as required under the EP Act or another written law

(b) the vegetation is of a class declared by regulation to be included in this definition.

Native vegetation can only be cleared with a clearing permit, unless for some circumstances where exemptions apply pursuant to the EP Act and the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (the Regulations). Clearing permits issued pursuant to the Regulations may be issued as area permits or purpose permits. Exemptions for clearing under Regulation 5 of the Regulations do not apply within ESAs.

1.3.4 Introduced species

The BAM Act provides for management and control of listed organisms, including introduced flora species (weeds). Species listed as declared pests under the BAM Act are classified under three categories:

1. C1 Exclusion: Pests assigned under this category are not established in Western Australia, and control measures are to be taken to prevent them entering and establishing in the State.
2. C2 Eradication: Pests assigned under this category are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
3. C3 Management: Pests assigned under this category are established in Western Australia, but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area that is currently free of that pest.

Under the BAM Act, land managers are required to manage populations of declared pests as outlined under the relevant category.

1.3.5 Regulatory guidance

The flora and vegetation survey component of this investigation has been designed to address the recommendations of the EPA as described in the following guidance:

- EPA Position Statement No. 2 *Environmental Protection of Native Vegetation in Western Australia* (EPA 2000)
- EPA Position Statement No. 3 *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002)
- EPA Position Statement No. 10 *Level of Assessment for Proposals Affecting Natural Areas Within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region* (EPA 2006)
- EPA Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004).

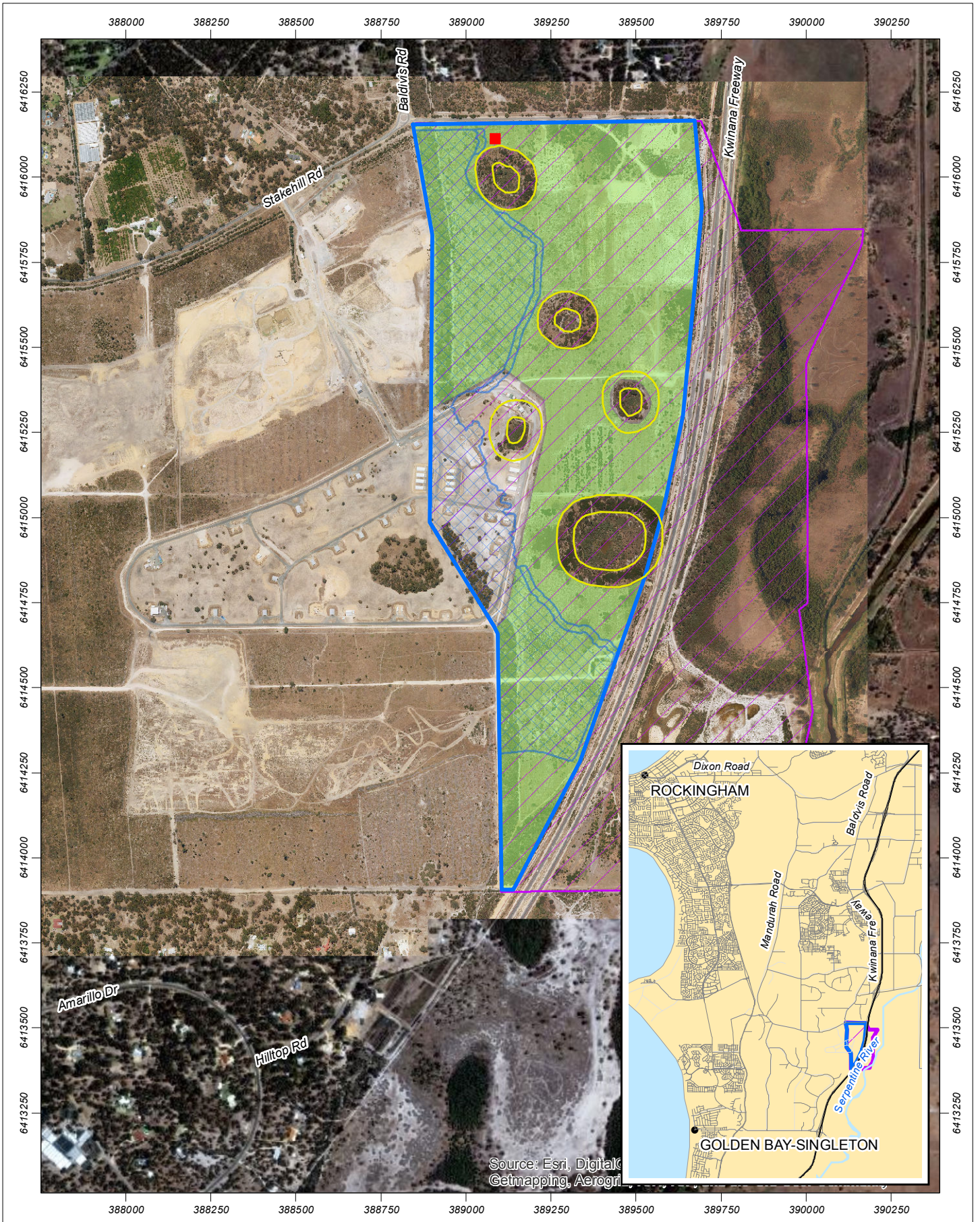


Figure 1: Regional location of the Project

Scale 1:15,000 at A4

0 100 200 300 400 500 m

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 23/06/2015
Author: JCrute
Source: Aerial image: Landgate, flown 11/2014. Aerial image background: ESRI approx. 2010.

Legend

- Site compound boundary
- 50m wetland buffer
- Project area
- Mining area
- Tenement M70/1262
- Survey area

STRATEGEN
info@strategen.com.au
www.strategen.com.au

Path: Q:\Consult\2015\URE\URE15096.01\ArcMap_documents\R004\RevC\URE15096_01_R004_RevC_F001.mxd

1.4 Environmental setting

1.4.1 Soils and topography

The Survey area is located within the Swan Coastal Plain 2 (SWA2 – Swan Coastal Plain subregion) of Western Australia (Mitchell et al. 2002). The Swan Coastal Plain comprises five major geomorphological systems that lie parallel to the coast, namely (from west to east) the Quindalup Dunes, Spearwood Dunes, Bassendean Dunes, Pinjarra Plain and Ridge Hill Shelf (Churchward & McArthur 1980; Gibson et al. 1994). Each major system is composed of further subdivisions in the form of detailed geomorphological units (Churchward & McArthur 1980; Semeniuk 1990; Gibson et al.1994). Beard (1990) describes the Swan Coastal Plain as a low-lying coastal plain, often swampy, with sandhills also containing dissected country rising to the duricrusted Dandaragan plateau on Mesozoic, mainly sandy, yellow soils. The Survey area itself is situated predominately on Bassendean sand.

1.4.2 Climate

The Karnup locality experiences a Mediterranean climate characterised by mild, wet winters and warm to hot, dry summers. The nearest Bureau of Meteorology (BoM) weather station at Medina Research Station (Station No. 9194) provides average monthly climate statistics for the Karnup locality (Figure 2). Average annual rainfall recorded at Medina since 1983 is 752.5 mm (BoM 2015). Rainfall may occur at any time of year; however, most occurs in winter in association with cold fronts from the southwest. Highest temperatures occur between December and March, with average monthly maximums ranging from 28.2℃ in December to 31.5℃ in February (BoM 2015). Lowest temperatures occur between June and September, with average monthly minimums ranging from 8.2℃ in July and August to 9.2℃ in September (BoM 2015).

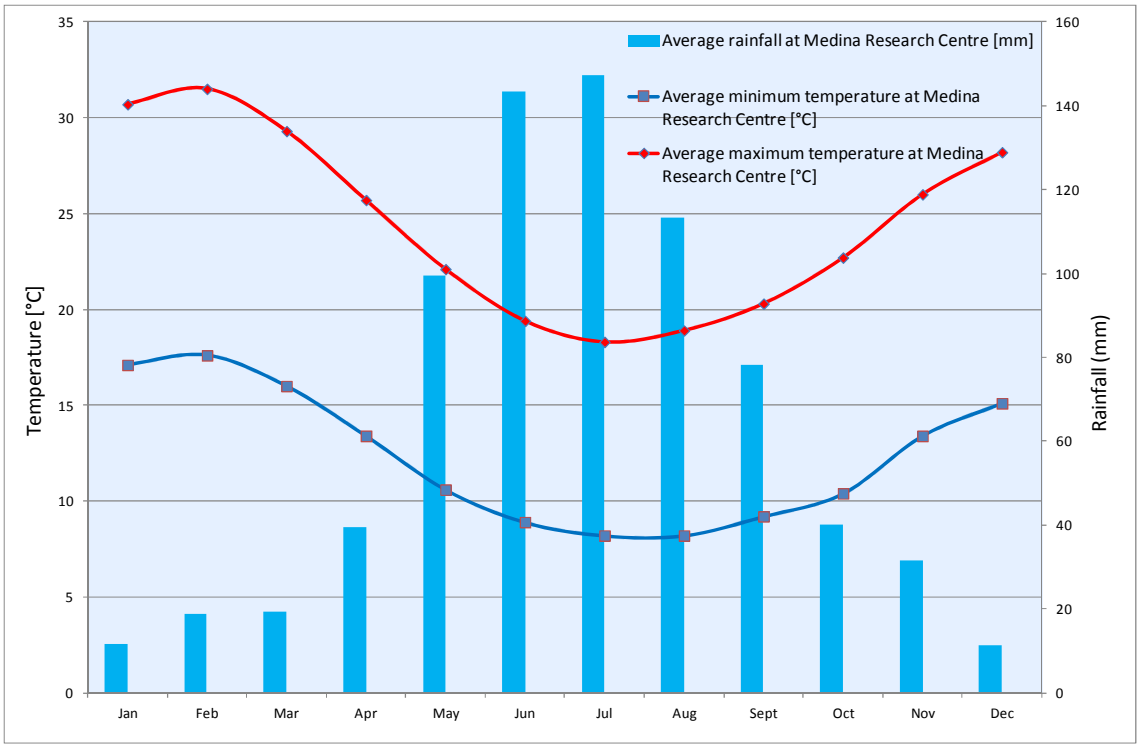


Figure 2: Mean monthly climatic data (temperature and rainfall) for Medina Research Centre

1.4.3 Regional vegetation

Vegetation occurring within the region was initially mapped at a broad scale (1:1 000 000) by Beard during the 1970s. This dataset has formed the basis of several regional mapping systems, including physiographic regions defined by Beard (1981); System 6 Vegetation Complex mapping undertaken by Heddle et al. (1980); the biogeographical region dataset (Interim Biogeographic Regionalisation for Australia, IBRA) for Western Australia (DotE 2015a).

IBRA subregion

The Survey area occurs within the Swan Coastal Plain 2 IBRA subregion which is dominated by *Banksia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains and paperbark (*Melaleuca*) in swampy areas (Mitchell et al. 2002).

Beard (1990) Botanical Subdistrict

The Survey area occurs within the Drummond Botanical Subdistrict which is characterised by low *Banksia* woodlands on leached sands; *Melaleuca* swamps on poorly-drained depressions; and *Eucalyptus gomphocephala* (Tuart), *Eucalyptus marginata* (Jarrah) and *Corymbia calophylla* (Marri) woodlands on less leached soils (Beard 1990).

System 6 mapping

System 6 mapping refers to vegetation mapping undertaken at a Vegetation Complex scale by Heddle *et al.* (1980). This is the primary source of information used to calculate potential impacts of proposals to clear native vegetation on the Swan Coastal Plain. The Survey area occurs at the interface between the Serpentine River and Karrakatta vegetation complexes. These complexes can be described as:

- Serpentine River – closed scrub of *Melaleuca* spp. and fringing woodland of *Eucalyptus rudis* and *M. rhaphiophylla* along streams
- Karrakatta – predominantly open forest of *Eucalyptus gomphocephala – E. marginata – C. calophylla* and woodland of *E. marginata – Banksia* spp.

2. Objectives

The general aim of this survey was to undertake an environmental investigation of the Survey area. The objectives were to:

- conduct a desktop survey for Threatened and Priority flora which have been identified as being present in or around the Survey area
- collect and identify the vascular plant species present within the Survey area
- search areas of suitable habitat for Threatened and/or Priority flora
- define and map the native vegetation communities present within the Survey area
- provide recommendations on the local and regional significance of the vegetation communities
- identify habitat for Threatened species of black cockatoos within the Survey area
- prepare a report summarising the findings.

3. Methods

3.1 Desktop Assessment

A desktop assessment was conducted using Florabase, Parks and Wildlife, and Department of the Environment (DotE) databases to identify the possible occurrence of TECs, PECs, Threatened and Priority flora, and conservation significant fauna species potentially occurring within the Survey area. Reports that document regional flora, vegetation and fauna within the surrounds of the Survey area were also reviewed prior to the field assessment.

A database search request was also submitted to the Threatened Communities Branch of Parks and Wildlife to identify any potential TECs or PECs within 5 km of the Survey area.

3.2 Field assessment

3.2.1 Flora and vegetation

Assessment of flora and vegetation within the Survey area was undertaken by an experienced ecologist from Strategen and senior ecologist from Mattiske Consulting on 1 May 2015 (Table 1). Five vegetation mapping sites were surveyed and the entire site was traversed on foot to record changes in vegetation structure and type (Appendix 1; Appendix 2). The field survey was conducted according to standards set out in Guidance Statement 51 (EPA 2004).

Table 1: Personnel

Name	Project involvement	Flora collection permit
Mr. D. Panickar Strategen (Experienced Ecologist)	Planning, fieldwork, data interpretation and report preparation	SL010993
Mr. J. Cargill Mattiske Consulting (Senior Ecologist)	Fieldwork and plant identification	SL011297

Site selection for vegetation mapping was based on differences in structure and species composition of the communities present within the Survey area. Vegetation mapping sites were determined from aerial photographs and opportunistic sites were selected in the field where a change in vegetation structure or composition was observed.

Flora and vegetation was described and sampled systematically at each survey site and additional opportunistic collecting was undertaken wherever previously unrecorded plants were observed. At each site the following floristic and environmental parameters were noted:

- GPS location
- topography
- soil type and colour
- outcropping rocks and their type
- percentage cover and average height of each vegetation stratum
- presence of significant trees.

For each vascular plant species, the average height and percent cover (both live and dead material) were recorded.

All plant specimens collected during the field surveys were dried and fumigated in accordance with the requirements of the Western Australian Herbarium. The plant species were identified through comparisons with pressed specimens housed at the Western Australian Herbarium where necessary. Nomenclature of the species recorded is in accordance with Western Australian Herbarium (1998-).

3.2.2 Black cockatoo habitat assessment

Desktop assessments identified the potential presence of all three species of Threatened species of black cockatoos (Forest Red-tailed Black-Cockatoos [FRTBC], Baudin's Black-Cockatoos [BBC] and Carnaby's Black-Cockatoos [CBC]) within the Survey area. A foraging and significant tree assessment was undertaken simultaneously with the flora and vegetation assessment to quantify the value of the Survey area as potential habitat for black cockatoos.

Foraging assessment

The Survey area was traversed on foot to record any flora species with the potential to provide a food source for black cockatoos. Data from this assessment were combined with vegetation mapping units defined during the flora and vegetation assessment. Vegetation units were then assigned a foraging value based on the presence and quantity of potential food species and any evidence of foraging by black cockatoos.

Significant tree assessment

Significant trees are defined as trees of suitable species with a diameter at breast height (DBH) greater than 500 mm (> 300 mm for salmon gum and wandoo) (DSEWPaC [now DotE] 2012). Tree species which are considered to be potential breeding or roosting trees are outlined in Table 2. Trees with a DBH greater than 500 mm (or >300 mm for salmon gum and wandoo) are large enough to potentially contain hollows suitable for nesting black cockatoos, or have the potential to develop suitable hollows over the next 50 years. Trees of this size may also be large enough to provide roosting habitat (i.e. trees which provide a roost or rest area for the birds). The locations of such trees within the Survey area were recorded using a Global Positioning System (GPS) device. In addition to the location and DBH, the species of each tree was also recorded.

Table 2: Black cockatoo potential breeding tree species (Groom 2011, DSEWPaC 2012)

Scientific name	Common name	Breeding	Roosting
Corymbia calophylla	Marri	Yes	Yes
Corymbia maculata	Spotted Gum		Yes
Eucalyptus accedens	Powderbark	Yes	
Eucalyptus camaldulensis	River Red Gum		Yes
Eucalyptus citriodora	Lemon Scented Gum		Yes
Eucalyptus diversicolor	Karri	Yes	
Eucalyptus globulus	Tasmania Blue Gum		Yes
Eucalyptus gomphocephala	Tuart	Yes	Yes
Eucalyptus grandis	Flooded Gum, Rose Gum		Yes
Eucalyptus longicornis	Red Morrell	Yes	
Eucalyptus loxophleba	York Gum	Yes	
Eucalyptus marginata	Jarrah	Yes	Yes
Eucalyptus megacarpa	Bullich	Yes	Yes
Eucalyptus occidentalis	Swamp Yate	Yes	
Eucalyptus patens	Blackbutt	Yes	Yes
Eucalyptus robusta	Swamp Mahogany		Yes
Eucalyptus rudis	Flooded Gum	Yes	Yes
Eucalyptus salmonophloia	Salmon Gum	Yes	
Eucalyptus salubris	Gimlet	Yes	
Eucalyptus wandoo	Wandoo	Yes	Yes
Pinus pinaster	Pinaster, Maritime Pine		Yes
Pinus radiata	Monterey, Radiata Pine		Yes

3.3 Data analysis and vegetation mapping

Due to the degraded nature and uniform distribution of vegetation within the Survey area, quadrat data were grouped into a species by site matrix to delineate individual vegetation types (VTs) present within the Survey area. Aerial photography interpretation and field notes taken during the survey were then used to develop VT mapping polygon boundaries over the Survey area. These polygon boundaries were then digitised using Geographic Information System (GIS) software.

VT descriptions (though floristic in origin) have been adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 6.0 (ESCAVI 2003), a system of describing structural vegetation units (based on dominant taxa). This model follows nationally-agreed guidelines to describe and represent vegetation types, so that comparable and consistent data is produced nation-wide. For the purposes of this report, a VT is considered equivalent to a NVIS sub-association as described in ESCAVI (2003).

Vegetation condition was recorded at all quadrats, and also opportunistically within the Survey area during the field assessment where required. Vegetation condition was described using the vegetation condition scale for the South West Botanical Province (Keighery 1994). Vegetation condition polygon boundaries were developed using this information in conjunction with aerial photography interpretation, and were digitised as for vegetation type mapping polygon boundaries.

3.4 Flora and vegetation assessment limitations and constraints

Table 3 displays the evaluation of the flora and vegetation assessment against a range of potential limitations that may have an effect on that assessment. Based on this evaluation, the assessment has not been subject to constraints that would affect the thoroughness of the assessment and the conclusions reached.

Table 3: Flora and vegetation assessment potential limitations and constraints

Potential limitation	Impact on assessment	Comment
Sources of information and availability of contextual information (i.e. pre-existing background versus new material).	**Not a constraint.**	The study has been undertaken in the Drummond Botanical Subdistrict on the Swan Coastal Plain which has been well studied and documented with ample literature available (Beard 1990).
Scope (i.e. what life forms, etc., were sampled).	**Not a constraint.**	Due to the degraded nature and uniform distribution of vegetation within the Survey area, most life forms are likely to have been sampled adequately during the time of the survey.
Proportion of flora collected and identified (based on sampling, timing and intensity).	**Not a constraint.**	The proportion of flora surveyed was adequate. The entire site was traversed and all species observed were recorded in accordance with a Level 1 survey.
Completeness and further work which might be needed (i.e. was the relevant survey area fully surveyed).	**Not a constraint**	The information collected during the survey was sufficient to assess the vegetation that was present during the time of the survey.
Mapping reliability.	**Not a constraint.**	Aerial photography of a suitable scale was used to map the Survey area. Sites were chosen from these aerials to reflect changes in community structure. Opportunistic sites were also used if differences were observed during on ground reconnaissance. Vegetation types were assigned to each site based on topography, soil type, presence/absence and percent foliage cover of vegetation.
Timing, weather, season, cycle.	**May be a constraint.**	Flora and vegetation surveys are normally conducted following winter rainfall in the South-West Province, ideally during spring (EPA 2004). The field assessment was conducted in May and as such, some annual herb and forb species may not have been recorded during the assessment.
Disturbances (fire flood, accidental human intervention, etc.).	**Not a constraint.**	The Survey area and regional surrounds have been subject to disturbance over a significant period of time. Given the wide range of this disturbance, this is not considered to be a limitation within the Survey area.
Intensity (in retrospect, was the intensity adequate).	**Not a constraint.**	The entire site was traversed on foot and differences in vegetation structure were recorded appropriately.
Resources (i.e. were there adequate resources to complete the survey to the required standard).	**Not a constraint.**	The available resources were adequate to complete the survey.
Access problems (i.e. ability to access survey area).	**Not a constraint.**	Existing tracks enabled adequate access to survey the vegetation within the Survey area. Where access was not available by car, the area was easily traversed by foot.
Experience levels (e.g. degree of expertise in plant identification to taxon level).	**Not a constraint.**	All survey personnel have the appropriate training in sampling and identifying the flora of the region.

4. Results

4.1 Desktop assessment results

4.1.1 Flora and vegetation

A total of 108 native vascular plant taxa from 40 plant families have the potential to occur within the vicinity of the Survey area (Parks and Wildlife 2007-). The majority of taxa were from within the *Cyperaceae* (15 taxa), *Myrtaceae* (9 taxa) and *Fabaceae* (8 taxa) families (Appendix 3).

Threatened and Priority Ecological Communities

A TEC is defined under the EP Act as an ecological community listed, designated or declared under a written law or a law of the Australian Government as Threatened, Endangered or Vulnerable. There are four State categories of TECs (DEC 2010)[1]:

- presumed totally destroyed (PD)
- critically endangered (CR)
- endangered (EN)
- vulnerable (VU).

A description of each of these TEC categories is presented in Appendix 4. TECs are gazetted as such (Parks and Wildlife 2014a) and some Western Australian TECs are listed as Threatened under the EPBC Act.

Under the EPBC Act, a person must not undertake an action that has or will have a significant impact on a listed TEC without approval from the Australian Government Minister for the Environment, unless those actions are not prohibited under the EPBC Act. A description of each of these categories of TECs is presented in Appendix 4. The current EPBC Act list of TECs can be located on the DotE (2015b) website.

Ecological communities identified as threatened, but not listed as TECs, are classified as Priority Ecological Communities (PECs). These communities are under threat, but there is insufficient information available concerning their distribution to make a proper evaluation of their conservation status. Parks and Wildlife categorises PECs according to their conservation priority, using five categories, P1 (highest conservation significance) to P5 (lowest conservation significance), to denote the conservation priority status of such ecological communities. Appendix 4 defines PECs (DEC 2010). A list of current PECs can be viewed at the Parks and Wildlife (2014b) website.

No TECs or PECs were identified as having the potential to occur within the Survey area (Figure 3). The closest PEC identified in proximity to the Survey area was SCP 25 (Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands) which had a buffer of approximately 1.3 km from the Survey area.

[1] The Department of Environment and Conservation is still listed as the author of all TEC and PEC databases and have been referred to as such in this document instead of the Department of Parks and Wildlife (Parks and Wildlife).

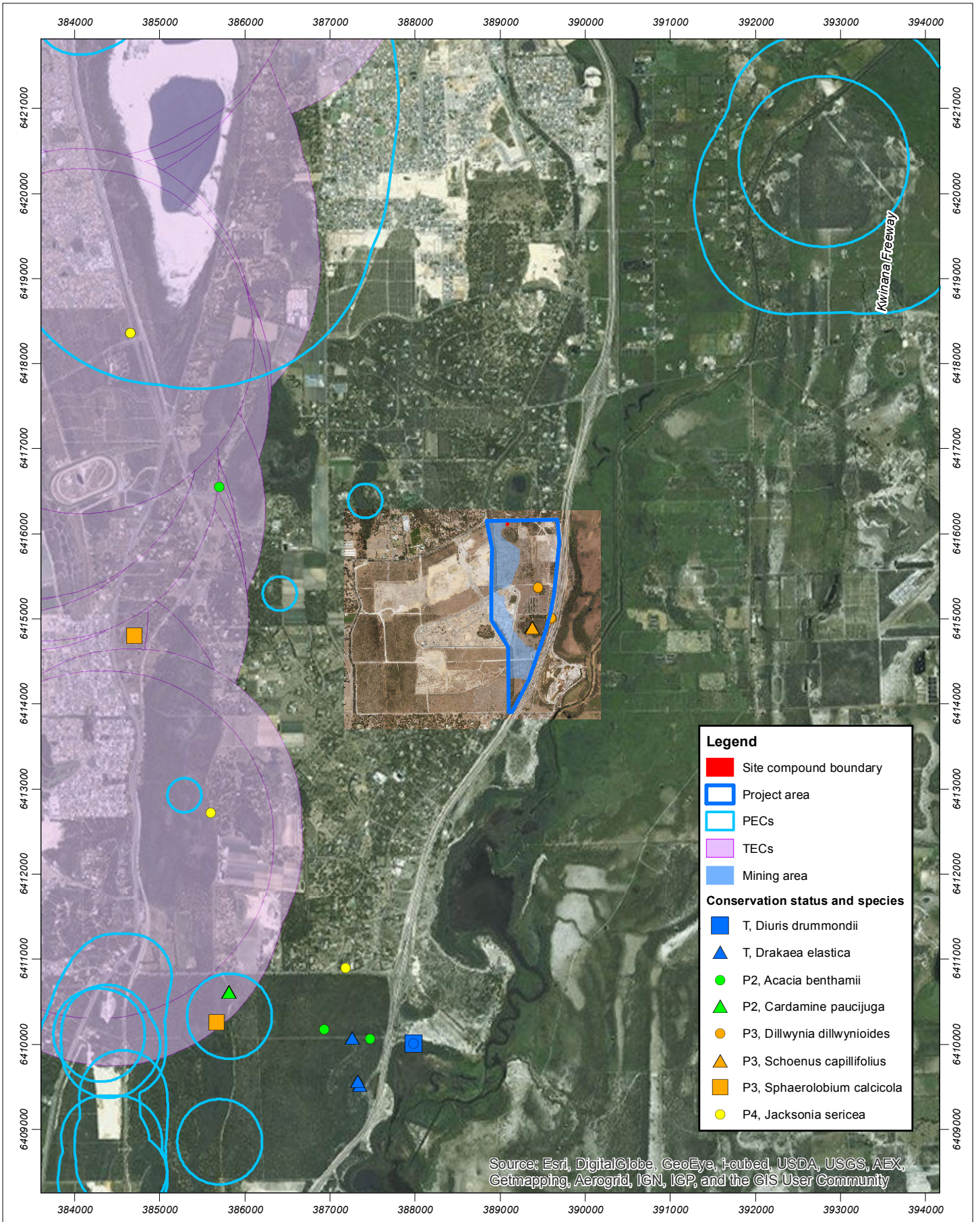


Figure 3: Location of Threatened and Priority Flora, TECs and PECs

Scale 1:60,000 at A4

0 0.5 1 1.5 2 km

N

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 23/06/2015
Author: JCrute
Source: Aerial image: Landgate, flown 11/2014. Background aerial image: : ESRI online, approx. 2010. TEC/PEC & Flora: DPAW 2015.

Path: Q:\Consult\2015\URE\URE15096.01\ArcMap_documents\R004\RevC\URE15096_01_R004_RevC_F002.mxd

STRATEGEN
info@strategen.com.au
www.strategen.com.au

Threatened and Priority flora

A desktop survey for Threatened and Priority flora that may potentially occur within the Survey area was undertaken using NatureMap (Parks and Wildlife 2007-), the Western Australian Herbarium (Western Australian Herbarium 1998-), and the DotE Protected Matters Search Tool (DotE 2015c).

Flora within Western Australia that is considered to be under threat may be classed as either Threatened flora or Priority flora. Where flora has been gazetted as Threatened flora under the WC Act, the taking of such flora without the written consent of the Minister is an offence. The WC Act defines "to take" flora as to gather, pluck, 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 considered to be species which are potentially under threat, but for which there is insufficient information available concerning their distribution and/or populations to make a proper evaluation of their conservation status. Parks and Wildlife categorises Priority flora according to their conservation priority using five categories, P1 (highest conservation significance) to P5 (lowest conservation significance), to denote the conservation priority status of such species. Priority flora species are regularly reviewed and may have their priority status changed when more information on the species becomes available. Appendix 4 defines levels of Threatened and Priority flora (Western Australian Herbarium 1998-).

At the national level, the EPBC Act lists Threatened species as extinct, extinct in the wild, critically endangered, endangered, vulnerable, or conservation dependent. Appendix 4 defines each of these categories of Threatened species. The EPBC Act prohibits an action that has or will have a significant impact on a listed Threatened species without approval from the Australian Government Minister for the Environment. The current EPBC Act list of Threatened flora may be found on the DotE (2015d) website.

Table 4 shows the Threatened and Priority flora potentially occurring within the Survey area. The desktop assessment identified ten Threatened flora and three Priority flora species that have the potential to occur within the area. Of these, based on specific habitat requirements, three Threatened flora species (*Caladenia huegelii, Drakaea elastica* and *Drakaea micrantha*) and four Priority flora species (*Cardamine paucijuga, Sphaerolobium calcicola, Dillwynia dillwynioides* and *Jacksonia sericea*) were considered to have the potential to occur. Figure 3 shows occurrences of *Dillwynia dillwynioides* and *Schoenus capillifolius* within wetlands in proximity to the Survey area (Bennett 2006). As the proposed mining will not occur within wetland areas, these occurrences will not be impacted by the Proposal.

Table 4: Threatened and Priority flora potentially occurring within the Survey area

Species	Conservation status		Description	Potential to occur
	EPBC Act	WC Act		
Andersonia gracilis	**Threatened** - Endangered	Threatened	A slender shrub to 50 cm tall with few, spreading branches. Flowers are pink to pale mauve. Habitat for this species occurs within seasonally damp, black sandy clay flats near swamps (Western Australian Herbarium 1998-, DotE 2015e).	**Unlikely –** Preferred soil type/habitat does not occur within the Survey area– wetland areas will not be impacted by the proposed mining.
Caladenia huegelii	**Threatened** – Endangered	Threatened	A slender orchid from 30 to 50 cm tall. One or two striking flowers characterised by a greenish-cream lower petal with a maroon tip. Other petals are cream with red or pink suffusions. Habitat for this species occurs within well-drained, deep sandy soils in low mixed Banksia, Allocasuarina and Jarrah woodlands (Western Australian Herbarium 1998-, DotE 2015e).	**Possible –** Preferred soil type/habitat occurs within the Survey area.
Centrolepis caespitosa	**Threatened** – Endangered	Priority 4	A diminutive, densely tufted, glabrous annual herb. Flowers are red/brown and are singular. Habitat for this species is relatively unknown. Brown et al. (1998) identified that this species occurs within winter-wet claypans dominated by low shrubs and sedges.	**Unlikely –** Preferred soil type/habitat does not occur within the Survey area– wetland areas will not be impacted by the proposed mining. It is worth noting that Parks and Wildlife have removed this species from its Threatened flora listing and is now classed as Priority 4.
Darwinia foetida	**Threatened** – Critically Endangered	Threatened	An erect, spreading shrub to 70 cm tall. Green flowers, visible from October to November. Habitat for this species occurs within wet/winter-damp clay under Myrtaceous shrubland (DotE 2015e).	**Highly unlikely –** Preferred habitat does not occur within the Survey area as wetland areas will not be impacted by the proposed mining. Additionally, both Western Australian Herbarium (1998-) and DotE (2015e) list this species' distribution to be highly restricted within the Muchea area (approximately 70 km north of Perth).
Diuris drummondii	**Threatened** – Vulnerable	Threatened	A perennial orchid to 105 cm tall. Often forms dense colonies with individuals displaying between three and eight widely spaced yellow flowers. Habitat for this species occurs in low-lying depressions in peaty and sandy clay swamps (DotE 2015e).	**Unlikely –** Preferred soil type/habitat does not occur within the Survey area– wetland areas will not be impacted by the proposed mining.
Diuris micrantha	**Threatened** – Vulnerable	Threatened	A slender orchid to 60 cm tall. Yellow flowers with reddish-brown markings measuring 1.3 cm across. Habitat for this species occurs within clay-loam substrates in winter-wet depressions or swamps (DotE 2015e).	**Unlikely –** Preferred soil type/habitat does not occur within the Survey area– wetland areas will not be impacted by the proposed mining.
Diuris purdiei	**Threatened** – Endangered	Threatened	A slender orchid to 45 cm tall. Unusually flattened flowers, marked with brown blotches on their under surface. Habitat for this species occurs in areas subject to winter inundation within dense heath with scattered Myrtaceous trees (DotE 2015e).	**Unlikely –** Preferred soil type/habitat does not occur within the Survey area – wetland areas will not be impacted by the proposed mining.
Drakaea elastica	**Threatened** – Endangered	Threatened	A slender orchid to 30 cm tall with a prostrate, round to heart shaped leaf. Singular, bright green, glossy flower. Habitat for this species is within bare patches of white sand over dark sandy loams on damp areas (DotE 2015e).	**Possible –** Preferred soil type/habitat occurs within the Survey area.

Species	Conservation status		Description	Potential to occur
	EPBC Act	WC Act		
Drakaea micrantha	**Threatened** – Vulnerable	Threatened	A tuberous, terrestrial orchid to 30 cm tall. Silvery-grey heart shaped leaf with prominent green veins. Red and yellow singular flower. Habitat for this species occurs within cleared, open sandy patches (Brown et al. 1998).	**Possible –** Preferred soil type/habitat occurs within the Survey area.
Lepidosperma rostratum	**Threatened** – Endangered	Threatened	A rhizomatous sedge to 30 cm in diameter. Stems are circular in cross section and flowers are spike-like and up to 4 cm long. Habitat for this species occurs in sandy soils among low heath comprised of *Banksia telmatiaea* and *Calothamnus hirsutus* in winter-wet swamps.	**Unlikely –** Preferred soil type/habitat does not occur within the Survey area – wetland areas will not be impacted by the proposed mining.
Synaphea stenoloba	**Threatened** – Endangered	Threatened	A caespitose shrub to 45 cm tall. Yellow flowers visible from August to October. Habitat for this species occurs within loamy soils in low lying areas that are seasonally inundated (DotE 2015e).	**Unlikely –** Preferred soil type/habitat does not occur within the Survey area – wetland areas will not be impacted by the proposed mining.
Acacia benthamii	Not listed	Priority 2	A shrub to 1 m tall. Flowers are yellow and visible from August to September (Western Australian Herbarium 1998-). Habitat for this species is typically on limestone breakaways.	**Unlikely –** Preferred soil type/habitat does not occur within the Survey area.
Cardamine paucijuga	Not listed	Priority 2	A slender, erect annual herb to 0.4 m tall. Flowers are white and visible from September to October (Western Australian Herbarium 1998-). Habitat for this species occurs in a broad range of settings.	**Possible –** Preferred soil type/habitat could occur within the Survey area.
Sphaerolobium calcicola	Not listed	Priority 3	A slender, multi-stemmed, scandent or erect shrub to 1.5 m tall. Flowers are orange-red and visible in June or from September to November (Western Australian Herbarium 1998-). Habitat for this species occurs in a broad range of settings.	**Possible –** Preferred soil type/habitat could occur within the Survey area.
Dillwynia dillwynioides	Not listed	Priority 3	A decumbent or erect, slender shrub to 1.2 m tall. Flowers are red and yellow/orange and visible in August to December (Western Australian Herbarium 1998-). Habitat for this species is in winter-wet depressions and sandy soils.	**Possible –** Preferred soil type/habitat occurs within the Survey area.
Schoenus capillifolius	Not listed	Priority 3	A semi-aquatic, tufted, annual grass-like herb to 5 cm tall. Flowers are green and visible from October to November (Western Australian Herbarium 1998-). Habitat for this species is in brown mud in claypans.	**Unlikely –** Preferred soil type/habitat does not occur within the Survey area – wetland areas will not be impacted by the proposed mining.
Stylidium longitubum	Not listed	Priority 3	An erect annual herb to 12 cm tall. Flowers are pink and visible from October to December (Western Australian Herbarium 1998-). Habitat for this species occurs in sandy clay in seasonal wetlands.	**Unlikely –** Preferred soil type/habitat does not occur within the Survey area – wetland areas will not be impacted by the proposed mining.
Jacksonia sericea	Not listed	Priority 4	A Low spreading shrub to 0.6 m tall. Flowers are orange and visible from December to February (Western Australian Herbarium 1998-). Habitat for this species occurs in calcareous and sandy soils.	**Possible –** Preferred soil type/habitat occurs within the Survey area.

4.1.2 Black cockatoo habitat

All three species of Threatened black cockatoos occurring in Western Australia were identified as having the potential to occur within the Survey area based on a desktop survey for Threatened fauna (DotE 2015c; Appendix 3). Table 5 displays the current conservation status for the three identified species within the Survey area. Desktop surveys also identified the presence of Jarrah-*Banksia* woodland within the Survey area which may provide both foraging and breeding habitat for black cockatoos.

Table 5: Threatened species of black cockatoos potentially occurring within the Survey area

Species		Conservation status	
Common name	Scientific name	EPBC Act	WC Act
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	Endangered	Threatened
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	Vulnerable	Threatened
Forest Red-tailed Black Cockatoo	*Calyptorhynchus banksii* naso	Vulnerable	Threatened

Foraging and breeding habits of black cockatoos

Carnaby's Black-Cockatoos feed on the seeds, nuts and flowers, of a variety of native and introduced plant species and insect larvae (DotE 2015e). Food plants generally occur within proteaceous genera such as *Banksia, Dryandra, Hakea* and *Grevillea*, though are known to forage on eucalypt species in woodland areas. Carnaby's black cockatoos have also adapted to feeding on exotic species such as pines and cape lilac and weeds such as wild radish and wild geranium (DotE 2015e). Carnaby's black cockatoos usually breed between July and December in the hollows of live or dead eucalypts; primarily in Salmon Gum and Wandoo, but also within Jarrah, Marri and other eucalypt species (Johnstone 2010a). Hollows are usually at least 2 m above ground, sometimes over 10 m and the depth of the hollow vary from 0.25 m to 6 m (DotE 2015e). The Western Australian Department of Parks and Wildlife (Parks and Wildlife), renewed the Carnaby's Cockatoo Recovery Plan in 2013, clearly mapping the distribution of likely breeding and non-breeding areas in south-west WA for CBC (Parks and Wildlife 2013). Based on this map, the Survey area is situated within the CBC breeding range.

Baudin's Black-Cockatoos primarily occur in eucalypt forests and forage at all strata levels within the forests with a tendency to favour areas containing Marri (Johnstone and Kirkby 2008, DotE 2015e). Breeding generally occurs in the Jarrah, Marri and Karri forests of the southwest of Western Australia in areas averaging more than 750 mm of rainfall annually (DotE 2015e). As with the other two species of Threatened black cockatoos in Western Australia, breeding habitat also occurs in former woodland or forest that has been reduced to isolated trees (DotE 2015e).

Forest Red-tailed Black-Cockatoos depend primarily on Marri and Jarrah trees for both foraging and nesting. The seeds of both eucalypts are the favoured food source of the birds and hollows within live or dead individual trees are utilised for nesting purposes (Johnstone and Kirkby 1999). Breeding varies between years and occurs at times of Jarrah and Marri fruiting. These black cockatoos breed in woodland or forest, but may also breed in former woodland or forest that has been reduced to isolated trees (DotE 2015e).

4.2 Field survey results

4.2.1 Native flora

A total of 41 native vascular plant taxa from 34 plant genera and 18 plant families were recorded within the Survey area. The majority of taxa were recorded within the Fabaceae (8 taxa), Myrtaceae (6 taxa) and Proteaceae (5 taxa) families (Appendix 5). The relatively low number of plant genera recorded reflects the disturbed nature of the site.

4.2.2 Threatened and Priority flora

No Threatened flora species pursuant to Schedule 1 of the WC Act and as listed by Parks and Wildlife (2014c) or Priority flora species as listed by Western Australian Herbarium (1998-) were recorded within the Survey area (Appendix 5).

4.2.3 Threatened and Priority Ecological Communities

No TECs as listed by Parks and Wildlife (2014a) or PECs as listed by Parks and Wildlife (2014b) were identified within the Survey area. The closest PEC identified in proximity to the Survey area was SCP 25 (Southern *Eucalyptus gomphocephala – Agonis flexuosa* woodlands) which had a buffer of approximately 1.3 km from the Survey area (refer to section 4.1.1), but was not inferred to occur within the Survey area based on floristic composition.

4.2.4 Introduced (exotic) flora

A total of six introduced (exotic) taxa were recorded within the Survey area (Appendix 5):

- **Briza maxima*
- **Carpobrotus edulis*
- **Conyza sumatrensis*
- **Eragrostis curvula*
- **Hypochaeris glabra*
- **Lagurus ovatus.*

None of these species is a Declared Plant species in Western Australia pursuant to Section 22 of the *Biosecurity and Agriculture Management Act 2007* (BAM Act) according to the Western Australian Department of Agriculture and Food (DAFWA 2014).

4.3 Vegetation Types

Five native vegetation types (VTs) were defined and mapped within the Survey area (Appendix 1; Figure 4) and are summarised in Table 6. Areas containing pine plantations or cleared vegetation have not been counted as unique VTs. The flora and vegetation assessment and black cockatoo habitat assessment surveyed the majority of the Project area however did not include the Explosives Reserve Facility due to restricted access. The vegetation associated with this area has been inferred and a high level of confidence on this inference exists.

Total areas occupied within the Survey area by each of the identified VTs are set out in Table 7.

Table 6: Vegetation Types

Vegetation Type	Description
1	*Macrozamia fraseri, Daviesia triflora* and *Acacia stenoptera* mid open shrubland over *Lyginia barbata, Conostylis aculeata* and *Phlebocarya ciliata* low open sedgeland with *Xylomelum occidentale* and *Eucalyptus rudis* occurring as isolated trees.
2	*Banksia menziesii, B. attenuata, Allocasuarina fraseriana* and *Eucalyptus marginata* open woodland over *Kunzea glabrescens, Acacia pulchella* and *Macrozamia fraseri* mid sparse shrubland over *Hibbertia hypericoides, Conostephium pendulum* and *Gompholobium tomentosum* low sparse shrubland. Including 1.02 ha inferred VT2 within Explosives Reserve.
3	*Jacksonia sternbergiana* and *Adenanthos cygnorum* subsp. *cygnorum* mid shrubland over *Conostylis aculeata* and *Lyginia barbata* low sparse sedgeland.
4[1]	*Banksia menziesii, B. attenuata, Eucalyptus marginata* and *Allocasuarina fraseriana* low open woodland over *Jacksonia furcellata, Regelia ciliata* and *B. sessilis* mid sparse shrubland over *Tetraria octandra* and *Ficinia nodosa* low sparse sedgeland.
5	*Eucalyptus* sp. (planted) open woodland over *Acacia saligna, Jacksonia furcellata* and *Kunzea glabrescens* tall sparse shrubland over **Eragrostis curvula* low sparse tussock grassland.
P[2]	Pine plantation (*Pinus pinaster*).
C[2]	Cleared areas.

1 This vegetation type appears to be the result of rehabilitation activities.

2 Cleared areas and pine plantations have been mapped but are not counted as a unique VT.

4.3.1 Vegetation Type coverage

The total area mapped within the Survey area was 94.94 ha which includes cleared areas and pine plantations (Table 7). The dominant VT within the Survey area was VT 1 which can be broadly described as an open shrubland of *Macrozamia fraseri, Daviesia triflora* and *Acacia stenoptera* with isolated *Xylomelum occidentale* and *Eucalyptus rudis* trees.

Table 7: Area (ha) covered by each VT within the Survey area

VT	Area (ha)	Percentage of the Survey area
1	59.37	62.53
2	7.91	8.33
3	2.02	2.12
4	9.36	9.85
5	7.11	7.50
Pine plantation	3.29	3.47
Cleared areas	5.88	6.20
TOTAL	**94.94**	**100.00**

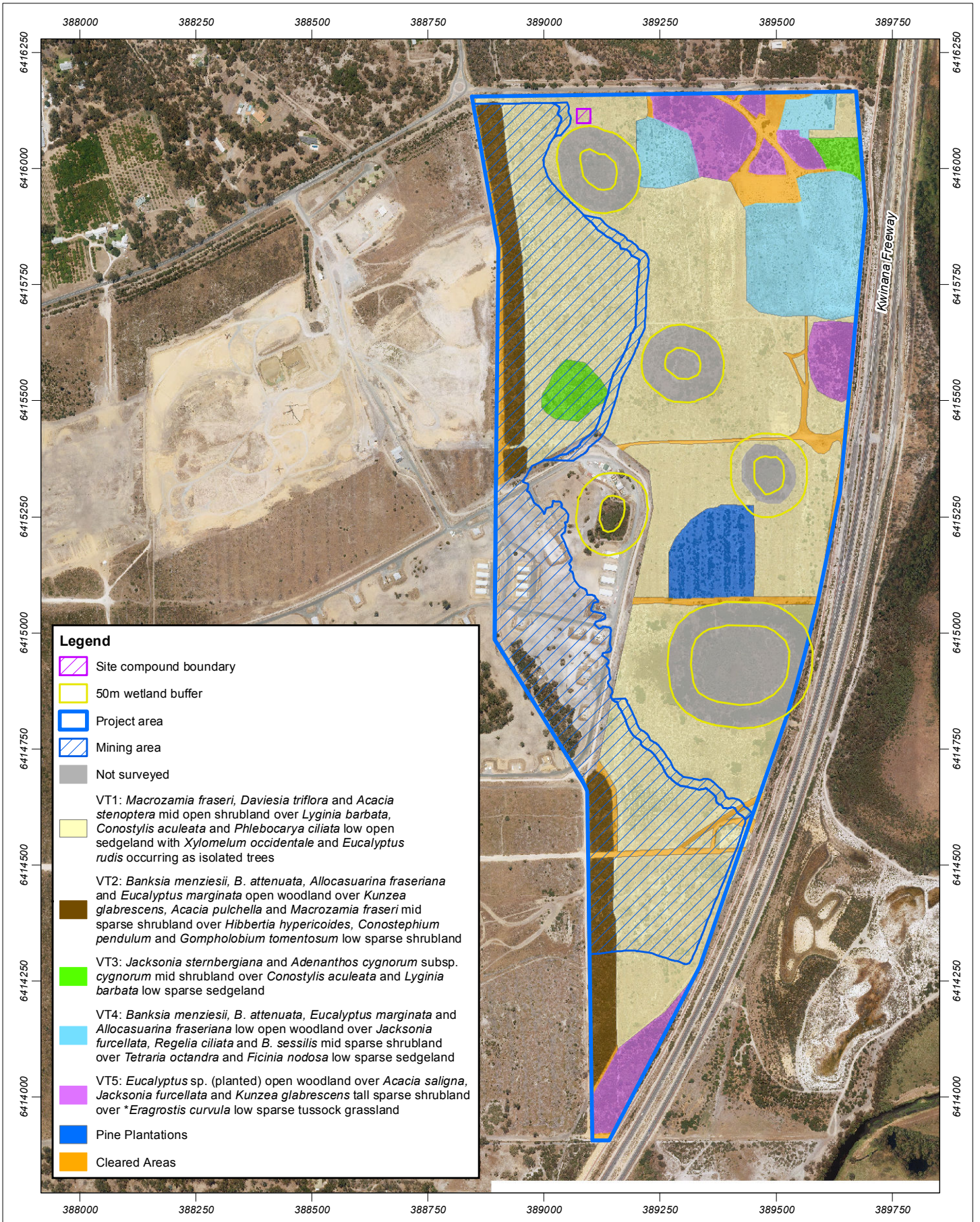


Figure 4: Vegetation types mapped within the Project area

Scale 1:10,997 at A4

0 50 100 150 200 250 Meters

N

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 23/06/2015
Author: JCrute
Source: Aerial image: Landgate, flown 11/2014.

Path: Q:\Consult\2015\URE\URE15096.01\ArcMap_documents\R004\RevC\URE15096_01_R004_RevC_F004.mxd

STRATEGEN
info@strategen.com.au
www.strategen.com.au

4.4 Vegetation condition

The majority of the Survey area is in various stages of natural regeneration following the clearing of existing pine plantations from 2004 (approx.). Natural regeneration has been largely successful throughout majority of the Survey area and as such, vegetation condition within these areas was mapped as Good (Keighery 1994; Table 8). Vegetation condition throughout the remainder of the Survey area was mapped as follows:

- Very good: retained *Banksia* woodland in the vegetated strip on the western boundary of the Survey area
- Good: retained *Eucalyptus*/*Acacia* woodland along the southern boundary of the Survey area
- Completely Degraded: Cleared areas and pine plantations.

A summary of vegetation condition within the Survey area is displayed in Figure 5. Table 9 gives a numerical breakdown of the area occupied by each vegetation condition rating within the Survey area.

Table 8: Vegetation condition scale (Keighery 1994)

Condition rating	Description
Pristine (1)	Pristine or nearly so, no obvious sign of disturbance.
Excellent (2)	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good (3)	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good (4)	Vegetation structure significantly altered by obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback, grazing.
Degraded (5)	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded (6)	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.

Table 9: Area (ha) covered by each vegetation condition rating category within the Survey area

Vegetation Condition	Area (ha)	Percentage of the Survey area
Excellent	-	-
Very Good	7.91	8.33
Good	77.86	82.01
Completely Degraded	9.17	9.66
Total	**94.94**	**100.00**

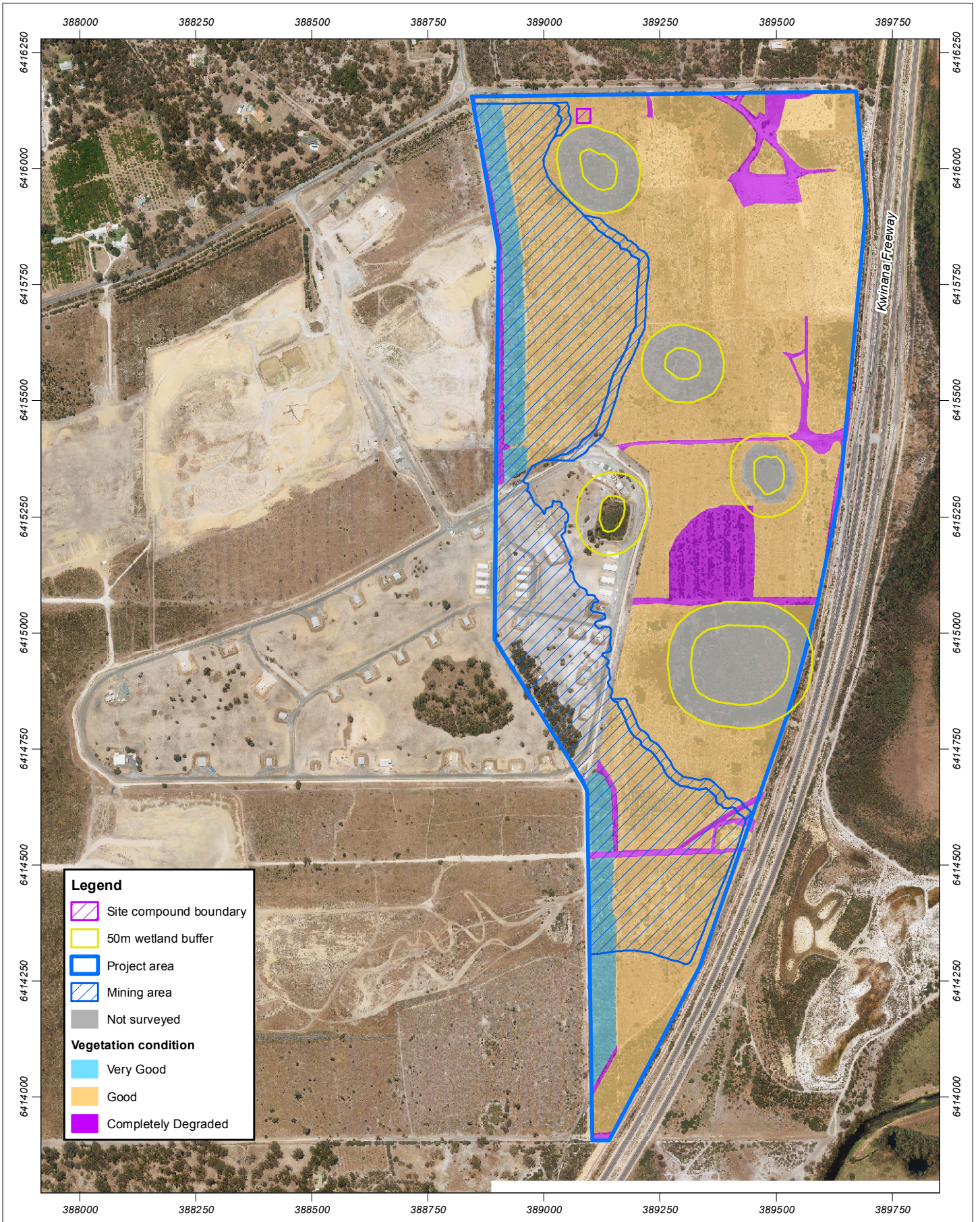


Figure 5: Vegetation condition mapped within the Project area

Scale 1:10,997 at A4

0 50 100 150 200 250 Meters

N

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 23/06/2015
Author: JCrute
Source: Aerial image: Landgate, flown 11/2014.

Path: Q:\Consult\2015\URE\URE15096.01\ArcMap_documents\R004\RevC\URE15096_01_R004_RevC_F005.mxd

STRATEGEN
info@strategen.com.au
www.strategen.com.au

4.5 Black cockatoo habitat

4.5.1 Foraging assessment

The Survey area was divided into six different vegetation types (VTs) (including pine plantations) and cleared areas, as informed outlined in section 4.3. A summary of the value of each vegetation type as foraging habitat for black cockatoo species is presented in Table 10 (Groom 2011, Johnstone 2010b, Johnstone 2010c, Johnstone *et al.* 2011).

Foraging habitat for black cockatoos is generally defined as the availability of plant food sources within an area (Finn 2012). Food availability for black-cockatoos is a function of the diversity, abundance, distribution, energetic and nutritional qualities, and seasonality (phenology) of the food sources within a particular area. Table 11 summarises the value of each vegetation type in terms of the quality of foraging habitat provided for black cockatoos.

The highest quality foraging habitat for black cockatoos was noted within VT 2 which contained high densities of black cockatoo food species including eucalypts and *Banksia* spp. at canopy and midstorey levels. The lowest quality foraging habitat for black cockatoos (not including cleared areas) was noted within VT 5 which contained limited potential food resources for all three species of black cockatoos (refer to footnote following Table 10) and in the pine plantation which provides limited food resources for CBC only.

Based on the results of the foraging assessment, the Survey area is considered to contain 7.91 ha of very good quality foraging habitat, 9.36 ha of good quality foraging habitat and 66.48 ha of low quality foraging habitat for CBC, BBC and FRTBC. The Survey area also contains an additional 3.29 ha of low quality foraging habitat for CBC only (within the pine plantation).

Signs of CBC foraging were observed in scattered occurrences within VT 2.

Table 10: Vegetation types and black cockatoo foraging species within the Survey area

Vegetation type	Description	Black cockatoo foraging species	Area (ha)
1	*Macrozamia fraseri, Daviesia triflora* and *Acacia stenoptera* mid open shrubland over *Lyginia barbata, Conostylis aculeata* and *Phlebocarya ciliata* low open sedgeland with *Xylomelum occidentale* and *Eucalyptus rudis* occurring as isolated trees.	CBC – *E. rudis* BBC – Nil FRTBC – Nil.	59.37
2	*Banksia menziesii, B. attenuata, Allocasuarina fraseriana* and *Eucalyptus marginata* open woodland over *Kunzea glabrescens, Acacia pulchella* and *Macrozamia fraseri* mid sparse shrubland over *Hibbertia hypericoides, Conostephium pendulum* and *Gompholobium tomentosum* low sparse shrubland. Including 1.02 ha inferred VT2 within Explosives Reserve.	CBC – *B. menziesii, B. attenuata, A. fraseriana, E. marginata* BBC – *A. fraseriana, E. marginata* FRTBC – *A. fraseriana, E. marginata.*	7.91
3	*Jacksonia sternbergiana* and *Adenanthos cygnorum* subsp. *cygnorum* mid shrubland over *Conostylis aculeata* and *Lyginia barbata* low sparse sedgeland.	CBC – Nil BBC – Nil FRTBC – Nil.	2.02
4	*Banksia menziesii, B. attenuata, Eucalyptus marginata* and *Allocasuarina fraseriana* low open woodland over *Jacksonia furcellata, Regelia ciliata* and *B. sessilis* mid sparse shrubland over *Tetraria octandra* and *Ficinia nodosa* low sparse sedgeland.	CBC – *B. menziesii, B. attenuata, B. sessilis, A. fraseriana, E. marginata, J. furcellata* BBC – *B. sessilis, A. fraseriana, E. marginata* FRTBC – *A. fraseriana, E. marginata.*	9.36

Vegetation type	Description	Black cockatoo foraging species	Area (ha)
5	*Eucalyptus* sp. (planted) open woodland over *Acacia saligna, Jacksonia furcellata* and *Kunzea glabrescens* tall sparse shrubland over **Eragrostis curvula* low sparse tussock grassland.	CBC – *A. saligna, J. furcellata, E.* sp. (planted)* BBC – *E.* sp. (planted)* FRTBC – *E.* sp. (planted)*.	7.11
P	Pine plantation (*Pinus pinaster*).	CBC – *P. pinaster* BBC – Nil FRTBC – Nil.	3.29
C	Cleared areas.	CBC – Nil BBC – Nil FRTBC – Nil.	5.88

*The *Eucalyptus* species present in this vegetation type was unable to be identified at the time of assessment. The species did not appear to be native to Western Australia and was likely planted in the Survey area. All three species of black cockatoos may forage on this species; however this is not likely to constitute significant foraging species for black cockatoos.

Table 11: Quality of black cockatoo foraging habitat within the Survey area

Vegetation type	Foraging quality	Justification
1	Low	Low density of species suitable for foraging by black cockatoos (i.e. foliage cover of suitable species 10-20%) and presence of food sources at only one stratum (i.e. canopy).
2	Very good	High density of species suitable for foraging by black cockatoos (i.e. foliage cover of suitable species >60%) and presence of food sources at several strata (i.e. canopy, midstorey and understorey).
3	Nil	No suitable foraging species for black cockatoos present.
4	Good	High density of species suitable for foraging by black cockatoos (i.e. foliage cover of suitable species >60%) but food sources only present at one or two strata (i.e. canopy and midstorey).
5	Low	Low density of species suitable for foraging by black cockatoos (i.e. foliage cover of suitable species 10-20%) and presence of food sources at only one stratum (i.e. canopy).
Pine plantation	Low (CBC only)	Low density of species suitable for foraging by black cockatoos (i.e. foliage cover of suitable species 10-20%) and presence of food sources at only one stratum (i.e. canopy).
Cleared areas	Nil	Cleared areas - no vegetation present.

5. Discussion

Vegetation within the Survey area comprises five native VTs and a remnant pine plantation. Transitions between VTs were generally discontinuous, though occasionally abrupt with margins representing admixtures of more than one VT. This discontinuity is primarily due to changes in soil profile and topography, and presence of cleared areas. At a broad scale, the majority of the Survey area was observed to be in various states of natural regeneration following clearing of historical pine plantations with vegetation comprised of *Macrozamia fraseri, Daviesia triflora* and *Acacia stenoptera* open shrubland with emergent *Xylomelum occidentale* and *Eucalyptus rudis* trees. The linear strip of vegetation which runs along the western and southern boundaries of the Survey area represented a different vegetation structure which was primarily a Jarrah-*Banksia* woodland which was relatively undisturbed by the historical pine plantation.

The flora and vegetation assessment conducted within the Survey area was undertaken during autumn, outside the prime flowering time for majority of species within the area. Field reconnaissance involved traversing the majority of the Survey area, which ensures that an accurate representation of all VTs and potential conservation significant flora were obtained.

The number of native and exotic species recorded on the Survey area totalled 47 vascular plant taxa from 40 genera and 20 families. The relatively low number of plant genera recorded reflects the disturbed nature of the site. Six of these taxa were introduced (exotic species) which were present in moderate to high densities throughout the Survey area. No Declared Plant species pursuant to Section 22 of the BAM Act were recorded within the Survey area (DAFWA 2014).

No conservation significant species or ecological communities were recorded within the Survey area. Effort was made during the field assessment to look for areas of suitable habitat for conservation significant species but none were found, which is likely related to both the disturbed and regenerative nature of the Survey area and the time of year at which the survey was conducted. Given that the survey was conducted outside the prime flowering time for majority of the conservation significant species, there is a possibility that some of these species may occur on the Survey area – however majority of these are likely to be restricted to wetland areas which will not be impacted by the proposed mining.

Conservation significant flora species potentially occurring on the Survey area that may have been missed due to the survey timing are likely to be the three Threatened orchids; *Caladenia huegelii, Drakaea elastica* and *Drakaea micrantha* which are all diminutive in stature and are at their most visible when in flower. Both *Drakaea* species are likely to be restricted to wetland/damp areas and thus are highly unlikely to be impacted by the proposed mining. *C. huegelii* has the potential to occur outside of these wetland areas. Given the disturbed nature of the site and the relatively low number of plant genera recorded on the site it is considered unlikely that the species would be located.

All five native VTs appear to be well represented within the local area based on surrounding vegetation and are consistent with the vegetation expected to be found within the region. Levels of species diversity within each VT is likely to be a reflection of the regenerative nature of majority of the Survey area and impacts from historical pine plantations.

Vegetation condition within the Survey area ranged from Very Good to Completely Degraded (Keighery 1994), with majority of the Survey area (approximately 62%) mapped to be in “Good” condition.

Approximately 7.91 ha of very good quality foraging habitat, 9.36 ha of good quality foraging habitat and 66.48 ha of low quality foraging habitat for CBC, BBC and FRTBC was recorded within the Survey area. The Survey area also contains an additional 3.29 ha of low quality foraging habitat for CBC only (within the pine plantation). No potentially significant trees which could potentially be used by black cockatoos for roosting or breeding purposes in the future were recorded within the Survey area.

6. Recommendations

6.1 Black cockatoos

All three black cockatoo species with the potential to occur within the Survey area are classed as Threatened under the EPBC Act and impact to the breeding or foraging habitats of these species can require referral to, and possible assessment by, DotE.

The *Referral Guidelines for Three Threatened Black Cockatoo Species* (DSEWPaC 2012) assists in determining whether an action needs to be referred under the EPBC Act and has been used to identify whether an EPBC Act referral is recommended for the proposal.

Table 12 outlines the whether the proposal meets any of the trigger levels for referral. From the guidelines, a criterion that could be triggered is the clearing of more than 1 ha of good quality habitat; however, it is considered that no other criteria would be triggered. This indicates that the clearing of vegetation associated with the proposal may require referral under the EPBC Act.

Table 12: Assessment of the proposal against the black cockatoo Referral Guidelines

Referral trigger	Assessment of proposal against referral trigger	Significant impact triggered
High risk of significant impacts: referral recommended		
Clearing of any known nesting tree	No known nesting trees to be cleared.	No
Clearing or degradation of any part of a vegetation community known to contain breeding habitat	The Survey area does not contain breeding habitat or potentially significant trees which could potentially be used by black cockatoos for roosting or breeding purposes in the future.	No
Clearing or degradation of more than 1 ha of quality foraging habitat	Up to 6.54 ha of very good quality foraging habitat and 24.29 ha of low quality foraging habitat for all three species of black cockatoos may be cleared as a result of the proposal.	**Yes**
Clearing or degradation of a known night roosting tree	No known night roosting trees have been recorded within the Proposal Area.	No
Creating a gap of more than 4 km between patches of Black Cockatoo habitat	The Survey area is located in close proximity to a number of existing reserves within Rockingham Lakes Regional Park containing potential black cockatoo habitat including: • Anstey Swamp (4 km) • Paganoni Swamp (3.8 km). As such, the proposal will not create a gap of more than 4 km between patches of habitat.	No

6.2 Conservation significant flora

One conservation significant flora species, *Caladenia huegelii*, whilst unlikely due to disturbance, could potentially occur within the Survey area and may not have been recorded during the flora and vegetation survey due to timing constraints.

The abovementioned species is diminutive in stature and is most visible when in flower. A targeted spring survey in accordance with methodology outlined in DotE (2013) would determine if these species is present within the Survey area.

All other conservation significant flora species (listed in the survey report) are unlikely to occur within the Survey area. Most of these species should either have been visible during time of survey or have habitat requirements which do not occur within the Survey area (i.e. wetland areas).

7. References

Beard JS 1981, *Swan, 1:1000000 vegetation series: explanatory notes to sheet 7: the vegetation of the Swan area,* University of Western Australia Press, Nedlands, Western Australia.

Beard JS 1990, *Plant Life of Western Australia.* Kangaroo Press, Kenthurst, New South Wales.

Bennett Environmental Consulting (Bennett) 2006, *Flora and vegetation of Baldivis Explosives Reserve*, report prepared for Strategen, Perth, 2006.

Brown A, Thomson-Dans C & Marchant N 1998, *Western Australia's Threatened Flora*, Department of Conservation and Land Management, Perth.

Bureau of Meteorology (BOM) 2015, *Climatic Statistics for Australian Locations*: *Monthly climate statistics for Medina Research Centre,* [Online], Australian Government, Available from: *http://www.bom.gov.au/climate/averages/tables/cw_009194.shtml* [15 May 2015].

Churchward HM & McArthur WM 1980, 'Landforms and Soils of the Darling System', in *Atlas of Natural Resources, Darling System, Western Australia,* eds Department of Conservation and Environment, Perth, pp. 25-33.

Department of Agriculture and Food (DAFWA) 2014, *Declared Pests (s22) list,* [Online], Government of Western Australia, Available from: *http://www.biosecurity.wa.gov.au/organisms/export/PER-DP* [15 May 2015].

Department of the Environment (DotE) 2013, *Draft Survey Guidelines for Australia's Threatened Orchids*, [Online], Australian Government. Available from: *http://www.environment.gov.au/system/files/resources/e160f3e7-7142-4485-9211-2d1eb5e1cf31/files/draft-guidelines-threatened-orchids.pdf* [5 May 2015].

Department of the Environment (DotE) 2015a, *Interim Biogeographic Regionalisation for Australia, Version 7,* [Online], Australian Government, Available from: *http://www.environment.gov.au/topics/land/national-reserve-system/science-maps-and-data/australias-bioregions-ibra* [15 May 2015].

Department of the Environment (DotE) 2015b, *EPBC Act List of Threatened Ecological Communities,* [Online], Australian Government, Available from: *http://www.environment.gov.au/cgi-bin/sprat/public/publiclookupcommunities.pl* [5 May 2015].

Department of the Environment (DotE) 2015c, *EPBC Act Protected Matters Search Tool*, [Online], Australian Government. Available from: *http://www.environment.gov.au/epbc/pmst/index.html* [5 May 2015].

Department of the Environment (DotE) 2015d, *EPBC Act List of Threatened Flora,* [Online], Australian Government, Available from: *http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl?wanted=flora* [5 May 2015].

Department of the Environment (DotE) 2015e, *Species Profiles and Threats Database*, [Online], Australian Government. Available from: *http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl* [5 May 2015].

Department of Environment and Conservation (DEC) 2010, *Definitions, Categories and Criteria for Threatened and Priority Ecological Communities*, [Online], Government of Western Australia, Available from: *http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/tecs/tec-definitions-dec2010.pdf* [5 May 2015].

Department of Parks and Wildlife (Parks and Wildlife) 2007-, *Naturemap, Mapping Western Australia's Biodiversity,* [Online], Government of Western Australia, Available from: *http://naturemap.dec.wa.gov.au/default.aspx* [5 May 2015].

Department of Parks and Wildlife (Parks and Wildlife) 2013, *Carnaby's Cockatoo (Calyptorhynchus Latirostris) Recovery Plan: WA Wildlife Management Program No.52,* Government of Western Australia, Perth.

Department of Parks and Wildlife (Parks and Wildlife) 2014a, *List of Threatened Ecological Communities on the Department of Environment and Conservation's Threatened Ecological Community (TEC) Database endorsed by the Minister for the Environment, May 2014,* [Online], Government of Western Australia, Available from: *http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/tecs/Threatened_ecological_communities_endorsed_by_the_Minister_for_Environment_May 2014.pdf* [5 May 2015].

Department of Parks and Wildlife (Parks and Wildlife) 2014b, *Priority Ecological Communities for Western Australia Version 21,* [Online], Government of Western Australia, Available from: *http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Priority_ecological_communities_list.pdf* [5 May 2015].

Department of Parks and Wildlife (Parks and Wildlife) 2014c, *Wildlife Conservation (Threatened Flora) Notice 2014,* [Online], Government of Western Australia, Available from: *http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Threatened_Flora_Rare_Flora_Notice.pdf* [15 May 2015].

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2012, *EPBC Act referral guidelines for three threatened black cockatoo species*, [Online], Australian Government, Available from: *http://www.environment.gov.au/system/files/resources/895d4094-af63-4dd3-8dff-ad2b9b943312/files/referral-guidelines-wa-black-cockatoo.pdf* [15 May 2015].

Environmental Protection Authority (EPA) 2000 *Position statement 2: Environmental protection of vegetation in Western Australia – Clearing of native vegetation, with particular reference to the agricultural area*, Government of Western Australia, Perth.

Environmental Protection Authority (EPA) 2002 *Position statement 3: Terrestrial biological surveys as an element of biodiversity protection,* Government of Western Australia, Perth.

Environmental Protection Authority (EPA) 2004, *Guidance for the assessment of environmental factors (in accordance with the Environmental Protection Act 1986) No. 51 – Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia.* Government of Western Australia, Perth.

Environmental Protection Authority (EPA) 2006, *Level of Assessment for Proposals Affecting Natural Areas Within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region,* Government of Western Australia, Perth.

Executive Steering Committee for Australian Vegetation Information (ESCAVI) 2003, *Australian Vegetation Attribute Manual: National Vegetation Information System, Version 6.0,* Department of the Environment and Heritage, Australian Capital Territory.

Finn H 2012, *Assessment of habitat values for black-cockatoos within selected sites at Newmont Boddington Gold Mine,* report prepared for Newmont Boddington Gold Pty Ltd.

Gibson N, Keighery B, Keighery G, Burbidge A & Lyons M 1994, *A Floristic survey of the southern Swan Coastal Plain*, report prepared for the Australian Heritage Commission, 1994.

Groom C. 2011, *Plants Used by Carnaby's Black Cockatoo,* Department of Environment and Conservation, Perth.

Heddle EM, Loneragan OW & Havel JJ 1980, *Darling System, Vegetation Complexes*, Forest Department, Perth.

Johnstone R 2010a, *Information sheet: Carnaby's Cockatoo (Calyptorhynchus latirostris)*, Western Australian Museum, Perth.

Johnstone R 2010b, *Information sheet: Forest Red-tailed Black Cockatoo (Calyptorhynchus banksii naso)*, Western Australian Museum, Perth.

Johnstone R 2010c, *Information sheet: Baudin's Cockatoo (Calyptorhynchus baudinii)*, Western Australian Museum, Perth.

Johnstone R & Kirkby T. 1999, 'Food of the Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso in south-west Western Australia', *The Western Australian Naturalist,* vol. 22, pp. 167-177.

Johnstone R & Kirkby T 2008, 'Distribution, status, social organisation, movements and conservation of Baudin's Cockatoo *(Calyptorhynchus baudinii)* in South-west Western Australia', *Records of the Western Australian Museum,* vol. 25, pp. 107 – 118.

Johnstone, R. E., Johnstone, C. and Kirkby, T. 2011, *Black-cockatoos on the Swan Coastal Plain*, report prepared for the Department of Planning, Perth, 2011.

Keighery B 1994, *Bushland Plant Survey: A Guide to Plant Community Survey for the Community*, Wildflower Society, Floreat.

Mitchell D, Williams K & Desmond A 2002, 'Swan Coastal Plain 2 (SWA2 – Swan Coastal Plain subregion)', in *A biodiversity audit of Western Australia's 53 Biogeographical Subregions in 2002,* eds Department of Conservation and Land Management, Perth, pp. 606-623.

Semeniuk V 1990, 'The geomorphology and soils of Yoongarillup Plain, in the Mandurah-Bunbury coastal zone, southwestern Australia: a critical appraisal', *Journal of the Royal Society of Western Australia*, vol. 73, pp. 1-7.

Western Australian Herbarium 1998-, *FloraBase – the Western Australian Flora*, [Online], Government of Western Australia, Available from: *http://florabase.dpaw.wa.gov.au/* [15 May 2015].

Appendix 1
Vascular plant taxa recorded by site and vegetation type

Species	Site					Legend
	1	2	3	4	5	VT1
Acacia pulchella var. *glaberrima*		x	x			VT2
Acacia saligna					x	VT3
Acacia stenoptera	x					VT4
Adenanthos cygnorum subsp. *cygnorum*			x	x		VT5
Allocasuarina fraseriana		x		x		
Banksia attenuata		x		x		
Banksia menziesii		x		x		
Banksia sessilis				x		
Brachyloma preissii		x				
**Briza maxima*	x	x	x			
Burchardia congesta		x				
**Carpobrotus edulis*	x	x	x	x	x	
Conostephium pendulum		x				
Conostylis aculeata subsp. *aculeata*	x	x	x			
**Conyza sumatrensis*				x		
Corymbia calophylla					x	
Dampiera linearis		x				
Dasypogon bromeliifolius	x	x				
Daviesia triflora	x	x				
Desmocladus flexuosus	x	x	x			
**Eragrostis curvula*		x		x	x	
Eucalyptus marginata		x		x		
Eucalyptus rudis	x					
Eucalyptus sp. (planted)				x	x	
Ficinia nodosa				x		
Gompholobium tomentosum	x	x	x			
Hemiandra pungens			x			
Hibbertia hypericoides		x				
**Hypochaeris glabra*	x			x		
Jacksonia furcellata				x	x	
Jacksonia sternbergiana			x	x		
Kennedia prostrata	x	x				
Kunzea glabrescens	x	x			x	
Lagenophora huegelii		x				
**Lagurus ovatus*					x	
Lechenaultia biloba	x					
Lepidosperma pubisquameum		x				
Lyginia barbata	x	x	x			
Macrozamia fraseri	x	x	x			
Olearia axillaris	x					
Patersonia occidentalis	x	x				
Phlebocarya ciliata	x					
Poaceae sp.	x		x			
Regelia ciliata				x		
Stylidium sp.	x					
Tetraria octandra		x		x		
Xylomelum occidentale	x					

* denotes introduced (exotic) species (Western Australian Herbarium 1998-)

Appendix 2
Photographic record of site and vegetation types

Plate 1: Site 01 (VT 1)

Plate 2: Site 02 (VT 2)

Plate 3: Site 03 (VT 3)

Plate 4: Site 04 (VT 4)

Plate 5: Site 05 (VT 5)

Plate 6: Pine plantation

Plate 7: Cleared areas