Iluka Resources Ltd

Environmental Assessment

Flora and Fauna Survey

December 2004

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1. Introduction

Iluka Resources Ltd holds a number of tenements in the vicinity of Waroona, 110 km south of Perth, Western Australia. These tenements lie on the eastern margin of the Swan Coastal Plain, through foothills at the base of the Darling Scarp. The foothills and associated plain are known to contain economically viable heavy mineral deposits.

1.1 Scope of Work

GHD was commissioned by Iluka Resources Ltd to carry out a flora and fauna assessment of the potential mineral sand mining area immediately north of Waroona and on the eastern side of the South Western Highway.

The project area is approximately 600 ha and encompasses primarily rural land, with the southern section, close to the outskirts of Waroona, including a disused motor racing track.

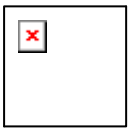
The scope of each of the assessments included the following tasks and elements:

Flora

- Background research into vegetation types previously existing in the general area;
- Field survey of all large remnants and any areas which have remnant understorey or shrub layers including an assessment of vegetation type and structure, and search for flora of significance;
- Allocation of a condition rating (based on Keighery, 1994 scale) for all major remnants;
- Mapping of the vegetation of the whole site based on remaining vegetation and records of pre-existing vegetation;
- Discussion of the presence or likelihood of occurrence of all listed Declared Rare and Priority Flora as shown in the DCLM information obtained by Iluka;
- A full flora list with discussion of any plants which are out of their normal range or significance;
- Discussion of any management risks such as the spread of dieback or Declared Weed species;
- A regional comparison of the vegetation type with regard to its existence elsewhere and the amount which is protected in reserves (Shepherd, *et al*., 2002).

Fauna

- An opportunistic field survey listing all vertebrate fauna observed or believed to occur;



- A discussion of the presence or likelihood of occurrence of all listed threatened fauna as shown in the DCLM information obtained by Iluka Resources Ltd and the potential risks to such species from the development of the site;
- An assessment of the habitat value of the remaining vegetation, especially nest trees and creekline vegetation; and
- An assessment of the value of vegetation linkages which occur across the site.

2. Physical Conditions of the Site

2.1 Location

The area surveyed is indicated in Figure 1. It is located approximately 110 km south of Perth along the South Western Highway and 1 km north of the town of Waroona. The land has mostly been developed for cattle farming for a long period and encompasses winter-wet flats in the western sector, some low sand dunes in the central area and moderate to steep granitic foothills along the eastern boundary.

2.2 Climate

The area has a Mediterranean-type climate, characterised by warm and dry summers, with cool, wet winters. The long-term average rainfall for the adjacent Samson Brook catchment (WRC, 2002) is approximately 1200 mm and most of this falls between May and September. Rainfall is seasonal and highly predictable. The annual average pan evaporation is between 1200 and 1600 mm, and monthly evaporation ranges from 50 mm in June to 230 mm in January.

Temperatures are warm to hot in summer and cool in winter. Summer daily temperatures generally range from 15-30°C, whilst in winter the daily range is 5-15°C.

During summer, winds usually blow from the east in the morning and the south-west and south-east in the afternoon. In winter, winds come from the western sector with highest occurrences from the north-west. The strongest winds occur mostly from the western sector.

2.3 Geology

The main geological element in the area is the presence of the western edge of the Darling Plateau of which, the dominant rock type is a coarse-grained porphyritic granite. Dolerite dykes occur within areas of both granite and gneissic rocks. Laterite occupies some of the land surface, with another common surficial deposit pisolitic sandy gravel. This gravel is ferruginous and may be locally re-cemented to form an erosion resistant 'pseudo-caprock'. Gravelly, silty sand is characteristic of the drainage lines. The Darling Fault line runs north-south through the study area.

- Quaternary: Guildford formation
    - The Guildford formation consists of mixes of sand, clay and conglomerate, which may be locally calcareous. Most of the unit is of fluvial origin, but also includes estuarine and shallow-marine intercalations (Biggs and Wilde, 1980).
- Quaternary: Yoganup formation

- Fossil shoreline sands at the foot of the present Darling Scarp, some contain heavy minerals. The yellow sand probably accumulated as a fore-dune or beach ridge under active surf conditions (Biggs and Wilde, 1980).

- Archaean: Gneisses
  - The gneisses are derived from sediments (paragneiss), as well as deformed granite (orthogneiss) near the Darling Fault. The gneiss may include metasediments mainly of quartzite and banded iron formation (Biggs and Wilde, 1980).

2.4 Landscape and Soils

The study area lies on the western edge of the broad physiographic unit known as the Darling Plateau, with rocky slopes which characterise the plateau's edge, abutting the eastern edge of the Swan Coastal Plain.

- Swan Coastal Plain: Fluviatile deposits
  - Guildford Soils: Flat plain with medium textured deposits; yellow duplex soils
- Swan Coastal Plain: Ridge Hill Shelf
  - Forrestfield Soils: Lateritised foothills of the Darling Scarp dominated by gravelly and sandy soils.
- Darling Plateau: Major Valley Slopes and Scarps
  - Darling Scarp: Very steep slopes with shallow red and yellow earths and much rock outcrop

2.5 Hydrology

The hydrology of the study area is extremely varied. Granite and lateritic outcrops mark the tops of slopes at the western edge of the Darling Plateau, and provide excellent surfaces for runoff of incident rainfall. Winter-wet creeklines incise the slopes, ranging in size from the Nanga Brook (just south of the study area) to small intermittent creek systems. Toward the western side of the study area, on the eastern Swan Coastal Plain, open pastures can become waterlogged during the winter months.

In addition, a number of farm dams on the seasonal creeklines provide relatively permanent water sources for livestock, as well as native and feral animals.

3. Flora

3.1 Historical vegetation complexes

Vegetation complexes are predominantly reflective of the soil and moisture condition of a landscape. The historical vegetation types in the study area would have reflected the topography and soils, with vegetation present on the Swan Coastal Plain being distinct from that found on the slopes of the Darling Scarp.

Beard (1979) mapped Swan Coastal Plain vegetation in this area as being a woodland of *Corymbia calophylla* (Marri), while Heddle, *et al*. (1980) described this vegetation as part of the Guildford Complex, with other dominant tree species being *Eucalyptus marginata* (Jarrah) and *E*. *wandoo* (Wandoo). Minor components include *E. rudis* and *M. rhaphiophylla*. Associated species are *Kingia australis, Xanthorrhoea preissii, Hardenbergia comptoniana* and species of *Hibbertia*.

As the Darling Scarp is an erosional landscape comprising river valleys, rocky outcrops and lateritic soils, the vegetation is a mosaic of types. Heddle, *et al.* (1980) describe two vegetation complexes on the foothills of the Darling Scarp and the Darling Scarp itself.

- Vegetation of the Forrestfield Complex, on the Ridge Hill Shelf, ranges from open forest of Marri, Wandoo and Jarrah to open forest of Jarrah, Marri, *Allocasuarina fraseriana* and *Banksia* species. There is a fringing woodland of *E. rudis* in the gullies that dissect this landform. Associated species on the gravelly soils include *Banksia grandis, Xylomelum occidentale, Dryandra sessilis, Macrozamia reidlei, Xanthorrhoea preissii*, and species of *Hibbertia*. On sandy soils common associated species are *Banksia attenuata, Banksia grandis, Stirlingia latifolia, Melomelaena tetragona* and *Nuytsia floribunda*.
- Vegetation of the Darling Scarp Complex ranges from low open woodland to lichens according to depth of soils. Woodland components are chiefly Wandoo, with *E. laeliae* in the north, *C. haematoxylon* in the south, and Marri throughout the region.

Mattiske and Havel (1998) provide an updated study of the vegetation complexes on the Darling Plateau. The complex is described as follows:

- Darling Scarp Complex: Mosaic of open forest of *E. marginata* ssp. *marginata – C. calophylla*, with some admixtures of *E. laeliae* in the north (subhumid zone) with occasional *E. marginata* ssp. *elegantella* (mainly in the subhumid zone) and *C. haematoxylon* in the south (humid zone) on deeper soils adjacent to outcrops, woodland of *E. wandoo* (subhumid and semiarid zones), low woodland of *A. huegeliana* on shallow soils over granite outcrops, closed heath of Myrtaceae-Proteaceae species and lithic complexes on or near granite outcrops in all climate zones. Component understorey species can include *Thomasia glutinosa, Veritcordia acerosa, Hakea incrassata, H.stenocarpa, Grevillea bipannatifida,*

Hovea pungens, Goodenia fasciculata, Conospermum huegelii and *Gevillea endlicherana.*

The pre-existing vegetation complexes mapped by Beard are shown in Figure 2.

3.2 Flora survey

A qualified botanist conducted a flora survey of the site over two days during spring, on the 2nd and 3rd of October 2003. A full list of the species identified within the survey area is included in Appendix A. A total of 155 species was recorded, but this did not include a comprehensive survey of introduced pasture species. Of the species recorded, 33 were introduced.

3.2.1 Vegetation type and structure

The vegetation present on the site reflects, to varying extents, the three historical vegetation complexes. Vegetation along the Eastern boundary represents the mosaic that comprises the Darling Scarp Complex (Figure 2). Vegetation of the Guildford Complex is found on the flatter land of the Swan Coastal Plain, and sandwiched between these two on the Ridge Hill Shelf, is the Forrestfield Complex.

Swan Coastal Plain

Creeks, fencelines and gentle slopes (Guildford Complex)

Most of the flat land on the site has been grazed by beef and dairy herds, and as such, species diversity of the remnant vegetation has been reduced and is limited to large trees and unpalatable shrubs. This vegetation broadly matches the Guildford Vegetation Complex described by Heddle *et al.* (1980):

- *Eucalyptus marginata*, *Corymbia calophylla*, *Xanthorrhoea preissii* and *Xylomelum occidentale* were scattered upslope within the paddocks and along fencelines.
- *Melaleuca rhaphiophylla*, *M. preissii*, *E. rudis*, *C. calophylla*, *Taxandria linearifolia* and *Kingia australis* were dominant species along creeklines (Sites 5,
- 11 and 15, Figure 2).
- While some reeds (*Juncus pallidus*) and rushes (*Isolepis* sp) were found along Nanga Brook and in the wetland on Location 265 (Sites 11 and 15), the understorey of most creek and fenceline vegetation has been replaced by weeds and pasture species.

This vegetation has been assigned a condition of 5 or 6 on the Keighery scale of vegetation condition (Keighery, 1994). Appendix B provides an interpretation of the Keighery condition scale.

Sandhill on Location 283 (Forrestfield Complex)

The condition of the vegetation remnant in the south eastern corner of Location 283 is good, and has a rating of 3 (Keighery, 1994). *Eucalyptus marginata* is dominant on the sandy slope, with the occasional *Xylomelum occidentale* (Sites 8 and 9). Grazing is evidenced by the absence of a shrub layer, but the understorey is composed of a diverse mix of herbaceous species and monocotyledons. Common among these were *Xanthorrhoea gracilis*, *Desmocladus flexuosus*, *Sowerbaea laxiflora* , *Haemodorum* sp. and the orchid, *Caladenia flava*. Scattered *Banksia grandis* and *B. attenuata* were also present.

Speedway (Forrestfield Complex)

The vegetation of the speedway area is woodland of *Eucalyptus marginata* and *Corymbia calophylla*, with scattered *Banksia grandis*, *B. attenuata* and *Xylomelum occidentale* with varying condition. That on the western and northern sides of the speedway is in moderate to very good with small areas in excellent condition (Site 16), with ratings between 1 and 2 on Keighery's scale of vegetation condition (Keighery, 1994). That in the south and centre is in moderate condition (rating of 3 to 4), while that on the eastern side is in poor condition (rating of 5). The composition of trees, herbaceous species and monocotyledons is similar to the sandhill on Location 283 (Appendix A). A dense shrub layer is also present, with common species including *Hibbertia hypericoides*, *Bossiaea eriocarpa*, *Adenanthos meisneri, Dampiera linearis, Agrosticrinum scabrum* and *Pimelea imbricata*.

Ridge Hill Shelf

Vegetation of the Forrestfield Complex was represented on the Ridge Hill Shelf on Locations no's 513, 478, 265, 652, 289 and 255 (Figure 1). Vegetation of this type was found at Sites 1, 2, 7, 10, 12 and 13. It is dominated by *Eucalyptus marginata/Corymbia calophylla* woodland with a range of shrub and groundcover species. In most parts of the survey area the understorey has been significantly grazed but there are some groundcover (often tuberous) species remaining at most sites.

The three vegetated creeks or gullies on the Ridge Hill Shelf (one on each property) were fringed in places with *Melaleuca rhaphiophylla*, and sometimes, *Eucalyptus rudis*. *E. marginata* and *C. calophylla* were common upslope.

- Pasture grasses have replaced the understorey in the gully on Location 265, and its condition is rated as very poor, being 5 on the Keighery scale.
- The creek and waterfall on Loc. 255 was also assigned this rating, as between 95 and 98 % of the vegetation was composed of pasture species (Site 4). However, a number of shrubs and herbaceous species were also present.
- The section of Wealand Brook on Lot 3 was in slightly better condition, with 40 % native vegetation cover (Site 6). It was assigned a condition of 4 on Keighery's scale. There were a greater number of herbs and shrubs along the creekline and adjacent slopes.

- Both the creekline on Lot 3, and that on Location 255 were infested with the Declared cottonbush weed. The management requirements for this weed are detailed in the Department of Agriculture's *Declared Plant Control Handbook* (2002).

The steep granitic gully in the eastern portion of Location 255 is vegetated with an open forest of *Eucalyptus marginata*, *Corymbia calophylla* and scattered *E. wandoo*. This is typical of the drier vegetation of the Forrestfield Complex. Many plants of the pink and white *Hypocalymma angustifolium* were flowering in the gully. Other shrubs included *Hibbertia hypericoides*, *Hypocalymma robustum*, *Hakea lissocarpha* and *Baeckea camphorosmae*. This vegetation has been assigned a condition ration of 3 on the Keighery scale.

Darling Scarp

Vegetation remnants of the Darling Scarp Complex were represented along the eastern boundary of the site (Sites 3, 6 and 14). These remnants were mainly comprised of open forest of *Eucalyptus marginata* and *Corymbia calophylla*, with woodland of *E. wandoo*. Lateritic hilltops and hillsides, and granitic slopes exhibited vegetation in a poor condition (between 4 and 5 on the Keighery scale). While some shrubs and herbaceous species were present, grazing, pasture species and weeds have reduced the species diversity.

One exception to the generally poor condition of the Darling Scarp Complex on the site was upstream on Wealand Brook (Site 6). This bush is in moderately good condition (rating of 3 on the Keighery scale), and includes a variety of herbs, small and large shrub species. A second, small, area of bushland in moderately good condition exists at the south-eastern corner of the study area on a granitic slope. This area has retained the tree layer and some of the shrub and herbaceous layer but, like all other areas across the site, has some weed infestation.

3.3 Flora species of conservation significance

Declared rare flora are published in the State government gazette as being rare, threatened or otherwise in need of special protection. Priority flora are either poorly known, or are rare but not currently threatened, and are being monitored. These lists are maintained by the Department of Conservation and Land Management (DCLM).

The DCLM databases were searched for Declared Rare and Priority Flora species in the general vicinity of the study area. The information from the DCLM databases for the Swan Coastal Plain area and the Darling Scarp/Darling Plateau area is summarised in Table 1.

The codes assigned to flora species of conservation significance by DCLM are described in Table 2.

Results of Field Investigations

One Priority 3 species was recorded during the survey. *Acacia oncinophylla* ssp. *oncinophylla* was observed in very small numbers in two locations, in both cases on the Darling Scarp slopes near to the eastern edges of the survey area. The plant grows to 2m tall and is present in granitic, rocky soil. Only approximately 4 plants were observed in total. This species has not previously been recorded for the general area but has been found at Dwellingup, Serpentine, Mogumber, Mundaring, John Forrest National Park and Mt Lennard. It flowers between August and October and is distinctive in that is has 'minnie ritchie' bark, a fine, reddish bark which is separated into many small curls. As these plants on the scarp, and within granite outcrops, they will not be disturbed for any mining operations.

The majority of other potential Priority or Declared Rare plant species for the general area have been previously recorded in winter-wet flats and swamps at the base of the Scarp. All of these habitat sites have been cleared for grazing within the study area and there are no swamps or wet flats which retain anything but scattered tree species. It is therefore unlikely that theses species of conservation significance have been overlooked during the current survey. *Calothamnus graniticus* ssp. *leptophyllus* and *Eucalyptus graniticola* are two species which grow on granitic slopes but both are large, distinctive species which were unlikely to be missed.

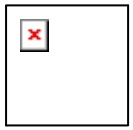
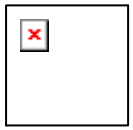


Table 1 Flora of Conservation Significance recorded in the DCLM database as being present in the vicinity of the proposed Iluka minesite near Waroona.

Taxon (species or subspecies)	Conservation Code (CALM)	Description	Preferred Habitat	Known Localities
Anthotium junciforme	Priority 4	Open, erect to prostrate perennial herb. 0.05-0.4 m high. Leaves 0.5-1mm wide, flowering stems 12-40cm long. fl blue, violet, purple, Nov-Mar	Sandy clay, clay, winter-wet depressions, drainage lines	Wattle Grove, Midland, Bayswater, Serpentine, Upper Swan, Kenwick, Busselton, Scott River Plain, Albany
Aponogeton hexatepalus	Priority 4	Rhizomatous or cormous, aquatic perennial herb. Leaves floating. fl green white, Jul-Oct	Mud, freshwater: ponds, rivers, claypans	Perth, Pinjarra, Capel, Bunbury, Boyanup, Nannup
Caladenia longicauda subsp clivicola	Priority 4	Tuberous, perennial herb; 0.3-0.5m high; fl white, green, yellow, Sep-Oct.	Clayey loam, gravel, sand, granite outcrops	Harvey, Dardanup, Dunsborough, Pinjarra, Lesmurdie, Cape Naturaliste
Caladenia speciosa	Priority 4	Tuberous, perennial herb; 0.35-0.6m high; fl white, pink, Sep-Oct	White, grey or black sand	Myalup, Eaton, Yarloop, Ludlow, Gingin
Calothamnus graniticus subsp leptophyllus	Priority 4	Erect, multi-stemmed shrub 1-2m high. Fl red.	Clay over granite, lateritic soils, hillsides.	Oakley Dam, North Dandalup, Sth Dandalup
Chamaescilla gibsonii	Priority 3	Clumped tuberous, herb; fl. blue, Sep	Clay to sandy clay. Winter-wet flats, shallow water-filled claypans	Ellen Brook, Yule Brook, Mogumber, Muchea, Drakesbrook, Capel, Brunswick Jun

Taxon (species or subspecies)	Conservation Code (CALM)	Description	Preferred Habitat	Known Localities
Drosera marchantii subsp marchantii	Priority 4	Erect, tuberous perennial herb; 0.1-0.4m high; fl pink, Aug-Oct	Lateritic soils, damp swampy areas	Waterloo, Collie, Stratham, Donnybrook, Argyle
Eleocharis keigheryi	Declared Rare Flora	Erect, grass-like sedge to 0.4m high. Fl green.	Sandy, clay loam. Emergent in freshwater creeks and claypans.	Kenwick, Lesueur, Ellen Brook, Boyanup, Waroona
Eryngium ferox	Priority 3	Tuberous herb	Grey to brown loamy to sandy clay, brown cracking clay. Winter wet flats, swamps, dried claypans, ridges	Collie, Pinjarra, Capel
Eucalyptus graniticola	Declared Rare Flora	Mallee	Exposed granite slopes	Darling Scarp
Grevillea bipinnatifida subsp pagna	Priority 1	Prostrate, lignotuberous shrub; 0.2-0.7 m high; fl. red, orange, yellow, Aug-Nov	Grey sandy clay and loam, ironstone. Seasonal wetlands, swamps, roadsides	Waroona
Isopogon drummondii	Priority 3	Erect shrub 0.4-1m high. Flowers yellow, Feb to June.	White, grey or yellow sand, often over laterite	Cockleshell Gully, Mt Lesueur, Mogumber, Moora, Forrestfield, 2-3 km W of Waroona
Millotia tenuifolia var laevis	Priority 2	0.02 to 0.1m high. Fl yellow.	Granite or laterite soils	Dunsborough, Red Hill, Cape Naturaliste, Collie
Phyllangium palustre	Priority 2	Erect succulent annual herb	Clay, winter-wet claypans, low-lying seasonal wetlands	Beaufort River, Kojonup, Lake Muir, 3km N of Waroona, S of Pinjarra.
Rhodanthe pyrethrum	Priority 3	Erect, slender annual herb; 0.05-0.2m high; fl white, yellow, Oct- Dec	Clay, sandy clay, winter-wet depressions, clay pans, swamps	Bullsbrook, Boyanup, Kenwick, Waterloo, Harvey, Eaton



Taxon (species or subspecies)	Conservation Code (CALM)	Description	Preferred Habitat	Known Localities
Schoenus capillifolius	Priority 2	Semi-aquatic annual tufted sedge; 0.05m high; fl green Oct-Nov	Brown mud, claypans	Upper Swan, Kenwick, Waterloo, Beaufort River
Schoenus natans	Priority 4	Aquatic annual sedge	Winter-wet depressions	Pinjarra, Busselton, Gingin, Beaufort River, West Dale, Lake Muir
Schoenus sp Waroona	Priority 3	Tufted annual sedge; 0.02-0.06m high; fl brown, red, green, Oct-Nov	Clay or sandy clay, winter-wet flats	Kenwick, Harvey, Waroona, Austin Bay
Stylidium ireneae	Priority 4	Small herb to 0.3m. Fl pink.	Sandy loam, watershed of creekline	Waroona, Lane Poole, Serpentine Dam, North Dandalup, Augusta
Synaphea stenoloba	Declared Rare Flora	Caespitose shrub; 0.3-0.45m high; fl yellow, Aug-Oct	Sandy or sandy clay soils, winter-wet flats, granite	Pinjarra
Tetraria australiensis	Declared Rare Flora	Rhizomatous herb to 0.5m.	Grey sand over clay, in winter-wet slopes and flats edging temporary swamps	Mundijong, Busselton, (Cannington, Serptentine River)
Trichocline sp. Treeton	Priority 2	Tuberous, perennial, herb, to 1.6 m high.	Sand over limestone, sandy clay over ironstone. Seasonally wet flats.	Treeton, Meelon
Villarsia submersa	Priority 4	Aquatic, extremely slender perennial, herb. Fl. white, Aug-Nov. In freshwater 0.05-0.6 m deep..	Pools, lakes, swamps, winter-wet depressions, claypans	Gunapin, Boyanup, Lake Muir, Denmark, Forrestdale, Kenwick, Frankland River, Lane Poole

Table 2 Conservation Codes and Descriptions for CALM Declared Rare and Priority Flora Species

Conservation Code	Description
R: Declared Rare Flora – Extant Taxa	Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
X: Declared Rare Flora – Presumed Extinct Taxa	Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
1: Priority One – Poorly Known Taxa	Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
2: Priority Two – Poorly Known Taxa	Taxa which are known from one or a few (generally<5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
3: Priority Three – Poorly Known Taxa	Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.
4: Priority Four – Rare Taxa	Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 – 10 years. (Department of Conservation and Land Management, 2001).

Of the above twenty three species listed in Table 2, eleven were considered to be potentially present in the proposed area of impact based on a similarity of habitat types and/or on known previous collections and localities. These are the species *Caladenia longicauda* subsp *clivicola*, *Caladenia speciosa*, *Calothamnus graniticus* subsp *leptophyllus*, *Drosera marchantii* subsp *marchantii*, *Eleocharis keigheryi*, *Eucalyptus graniticola*, *Grevillea bipinnatifida* subsp *pagna*, *Isopogon drummondii*, *Millotia tenuifolia* var *laevis*, *Stylidium ireneae* and *Synaphea stenoloba*.

3.4 Weed Species

A large number of weed species were recorded in the survey area. Species which had been planted in gardens or paddocks or around other developed areas were generally not recorded as they are generally unlikely to become a threat to the remnant native vegetation. The majority of weed species are those which have been deliberately or inadvertently introduced as pasture or in fodder. These species have completely replaced the native understorey over the majority of the survey area and are common and widespread across the Swan Coastal Plain and other areas.

3.4.1 Declared Weeds

Declared weeds are those which have been listed by the Department of Agriculture under the *Agriculture and Related Resources Protection Act (1972*) as being of particular significance, usually because of their risk to agriculture. If these species are present, the landowner or manager is required to carry out weed control to a specified extent and to prevent the further spread or movement of them. The following Declared species were present in the study area and their locations are shown on Figure 2:

- Arum lily (*Zantedeschia aethiopica*). This species is present along Nanga Creek, Ferraro Brook, the unnamed creekline on Location 255 and in woodland on the foothills of Location 478. It is not present in large numbers in most places and could be relatively easily controlled at this time.
- Cotton bush (*Gomphocarpos fruiticosus*). This plant is mostly found in damp areas close to streamlines or where moisture runs off rocks. It is present within the survey site up on the scarp close to granites on Location 255 and Lot 3 and downstream on Location 255.
- Blackberry (*Rubrus ulmifolius*). Occurs on Location 255 in small numbers along the creek.
- Apple of Sodom (*Solanum linnaeanum*). Observed on a sloping paddock in the foothills on Location 478.

3.4.2 Other Weeds of Significance

The Commonwealth Government has produced a list of the top 20 Weeds of National Significance as part of the National Weed Strategy. These weeds are listed primarily due to risk they pose to native ecosystems and their ability to spread rapidly. Two are present in the study area:

- Bridal creeper (*Asparagus asparagoides*). Found over shrubs on high ground at the eastern end of Location 255 and on Lot 3.
- Blackberry.

A range of other weeds within the study area are listed pest plants which have the potential to spread and invade native ecosystems. These are primarily bulbous plants and include *Watsonia sp., Freesia* and *Sparaxis bulbifera*.

4. Fauna

4.1 Field Survey

A field survey was carried out by qualified zoologist over two days to examine the habitats present and their condition, and to carry out an opportunistic survey of the fauna.

The visit was made in October 2003 – mid spring – following a winter of average rains. Weather conditions during the survey – overcast and windy – meant that number of reptiles sighted was lower than expected. Ground conditions, still moist under logs, rocks and debris, also indicated that reptile emergence from winter torpor was likely to be reduced.

Windy conditions may have also impacted on numbers of bird species sighted, but the lack of significant stands of understorey for cover across much of the study area is more likely to reduce bird sightings.

A full list of fauna observed can be found in Appendix C. In all, 43 bird species, 7 mammal species, 2 frog species and 8 reptile species were observed. No fish species were observed, despite the presence of numerous farm dams and flowing winter-wet creeks.

Of the fauna observed, five species are listed as introduced/naturalised: two bird species (Kookaburra, Laughing Turtle-dove) and three mammals (Red Fox, cat, rabbit). Two species observed are listed as significant fauna (Baudin's Black Cockatoo, Quenda), and are discussed below.

4.2 Expected Fauna

Western Australian Museum records indicate that 53 bird species, 16 mammal species, 5 frog species, 6 fish species and 35 reptile species have been observed in the Waroona area (Appendix D). This is by no means a complete list, as many larger mammals and birds are highly mobile and are capable of moving over great distances. For example, WA Museum records do not indicate that the Western Grey Kangaroo has been observed in the area. As the study area is relatively small (600 ha) it is unlikely that any official WA Museum fauna surveys have been specifically conducted for the area.

Nomenclature

Field observations were undertaken using a range of references, and the nomenclature for taxonomic orders and animal names was sourced on information provided by the Western Australian Museum's online FaunaBase program.

4.3 Significant Fauna

4.3.1 Conservation Significance

Rare species of fauna have been gazetted in the *Wildlife Conservation Act 1950*; *Wildlife Conservation (Specially Protected Fauna) Notice 2003*, are described by the following conservation codes (Table 3). These may be trigger species in the Federal *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999*.

Table 3 Conservation Codes for Gazetted Fauna

Conservation Code	Description
Schedule 1	"…fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection."
Schedule 2	"…fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection."
Schedule 3	"…birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of special protection."
Schedule 4	"…fauna that is in need of special protection, otherwise than for the reasons mentioned [in Schedule 1 – 3]"

In addition to these species with a formal gazetted conservation status, the DCLM also maintains a Priority list of species that are restricted, vulnerable or too poorly known to be considered for gazetting (Table 4). These species have no special protection, but their presence would normally be considered. The taxon needs further survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Table 4 Conservation Codes for Priority Fauna

Conservation Code	Description
Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown Land, water reserves, etc.
Priority 3	Taxa which are known from few specimens or sight records, some of which are on lands not under immediate threat of

Conservation Code	Description
	habitat destruction or degradation.
Priority 4	Rare taxa. Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 – 10 years.

A listing of Rare and Priority species in the Department of Conservation and Land Management (DCLM) rare fauna database for the general Waroona area was obtained (Table 5).

Table 5 Listing of Rare and Priority Fauna Species from the DCLM Rare Fauna Database for the Waroona area.

Degree of Threat	Family	Genus	Species	Common Name	Number of DCLM Records
Schedule 1	Dasyuridae (carnivorous marsupials)	*Dasyurus*	*geoffroii*	Chuditch, Western Quoll	none
Schedule 1	Psittacidae (lorikeets and parrots)	*Calyptorhyrnchus*	*latirostris*	Carnaby's Black Cockatoo	none
Schedule 4	Falconidae (falcons)	*Falco*	*peregrinus*	Peregrine Falcon	none
Priority 4	Peramelidae (bandicoots)	*Isoodon*	*obesulus fusciventor*	Quenda, Southern Brown Bandicoot	none

4.3.2 Significant Fauna Risks

Only two rare or priority species were recorded during the field survey. These were the Quenda and Baudin's Black Cockatoo. No actual sightings of the Quenda were made, but in dense bush immediately to the south-west of the old Waroona speedway, footprints, signs of feeding and shelters were visible.

The **Quenda** occurs widely in the south-west of Western Australia, and despite declining greatly due to land clearing and fox predation, remains common. It remains regarded as vulnerable because of the loss of many other mammal species of comparable size, but it has survived over a large part of its range and is not endangered. It is largely restricted to denser vegetation where it can survive fox predation, but also occurs widely in more open vegetation.

The **Chuditch** was formerly very widespread in a range of habitats, but is now virtually restricted to forest areas where it occurs widely but at low densities due to the large home range of individuals. The Chuditch has responded well to fox control. DCLM records do not note this species in the study area, and no sightings were made, even during the nocturnal survey when it was expected more mammals to be active.

The **Peregrine Falcon** is a widespread, although uncommon species. It is seen occasionally anywhere in the south-west of Western Australia as well as other areas in the state. This species was previously regarded as threatened by eggshell thinning due to past practices of pesticide use, as well as being hunted as a pest, and capture for falconry and the cage trade. In Western Australia this species is regarded as uncommon but secure, and it is mainly gazetted to protect it from illegal capture. It could breed in the larger trees, but is mainly known to utilise cliff sites for such purposes.

Carnaby's Black Cockatoo breeds primarily in the northern and eastern parts of its range in the Wheatbelt and tends to move to the coastal belt when not breeding. It is widespread in the forest areas of the Darling Plateau, but is less common in the south. This species is primarily impacted by loss of tree hollows for breeding, particularly in the Wheatbelt. This species was not recorded in the study area, but is considered a possible visitor as this species moves around seasonally in flocks to feeding areas in proteaceous scrubs and heaths and eucalypt woodlands.

Baudin's Black Cockatoo is of a similar size to Carnaby's Black Cockatoo, but is a forest dwelling species, primarily feeding on the seeds of Marri and other eucalypts. This species is more common in the south. This species was recorded extensively across the study area with flocks in excess of twenty pairs commonly sighted flying over as well as feeding on Marri nuts and Guildford Grass (*Romulea rosea*) bulbs. This species is listed as Schedule 1 taxa – fauna that is rare or is likely to become extinct, and represents an addition to the fauna species described in Table 5. Like Carnaby's Black Cockatoo, this species is impacted by loss of tree hollows for breeding.

Clearing of native vegetation represents the major risk of further impacts on fauna in the study area, whether they are rare or common. The clearing of many large mature trees in the area for use as nesting hollows (particularly by bird species) will restrict potential reproduction to areas further up the Darling Scarp.

4.4 Habitat Value

Although a relatively rich fauna is predicted for the project area, many species, such as mammals and birds, may only be present as vagrants. This is due to the fact that much of the site has been previously cleared for agricultural practices, and the fauna habitats remaining are therefore severely degraded. Larger areas of native vegetation adjacent to the site on the Darling Plateau are likely to provide more significant fauna habitats than the remnants of the project area. Any remnant vegetation is important, however, in providing habitat in a fragmented landscape.

4.4.1 Trees

The large mature and hollow trees provide good habitat for bird species that utilise these resources, such as Baudin's Black Cockatoo. Likewise, possums, and other arboreal mammals also utilise such hollows, and evidence was seen suggesting that a healthy population of possums occur in the study area.

Many of the trees seen in the area were in a large and mature state, with little recruitment seen. The livestock in the area consists mainly of cattle, and they represent the major factor in preventing regrowth of the larger eucalypt and tree species. There is also substantial evidence of bark stripping by the cattle across much of the study area. This may have been due to the recent and prolonged drought causing the livestock to seek alternate food sources when pasture grass cover was minimal. Such impact by chewing of and rubbing against the trunks of the trees will reduce the overall health of the remaining vegetation, and may cause an increase in tree deaths through stress and ringbarking. While dead and hollow trees do provide habitat for fauna, a general decline in vegetation health will have a corresponding decline in the richness and biodiversity of resident fauna.

4.4.2 Shrub Layer

Despite the apparent healthy and mature crown cover of much of the remnant stands of vegetation, the lack of understorey shrubs and groundcover species across most of the study area under the large trees reduces the habitat value. Few stands of healthy understorey vegetation remain in the study area. Most of the remaining shrub vegetation clings to areas of granite and laterite outcrops, and it is this area that was the most prolific in observing bird species (Splendid Wren, Scarlet Robin, Scrubwren, Brown Honeyeater) to take advantage of the flowering Myrtaceous and Proteaceous shrubs that dominate the area.

As well as bird species, rocky outcrops provide good habitat for small mammals and reptiles that take advantage of the abundant shelter from crevices, and food sources such as scorpions, centipedes and other invertebrates.

4.4.3 Creeklines

None of the creeklines in the study area remain unaffected by land clearing and agricultural practices. Many have become impacted by increasing weed species, such as bridal creeper and the arum lily. Creeklines in the study area have also been dammed to provide a permanent water source for stock, as flow of creeks is generally restricted to the winter wet period. The creation of permanent water sources and artificial wetlands can be a boon to both native and feral animals in times of rainfall deficiency. It is highly likely that some of the larger mammals utilise these dams as water sources. Amphibian and water birds have also taken advantage of the increased permanency of water in farm dams and regularly use them as feeding and breeding habitats.

Creeklines also have value providing linkage between habitats, and this will be discussed below.

4.4.4 Speedway Vegetation

Of all the areas examined in the study area, the south-west corner on the outside of the old Waroona speedway showed the healthiest vegetative cover. As well as a healthy and mature tree cover, this site had healthy shrub and ground cover layers. The site had not been burnt for a substantial period of time, with litter layer up to 15 cm thick in places. The site is dominated by Marri and *Banksia grandis*, with a rich Myrtaceous and Proteaceous shrub layer, and thick sedge dominated ground cover, over relatively deep yellow sands.

This thick and healthy vegetation has provided excellent cover for a suite of animal species. In the vicinity of this site, tracks of the Quenda, *Isoodon obeselus fusciventer*, were numerous, and diggings and shelter evident across the site. This is a DCLM Priority 4 species; while not endangered, it remains threatened from predation by the Red Fox, and feral cats. Cat tracks of a similar age were seen in between those of the Quenda.

As well as the thick vegetation, semi-permanent water can be found on the north-west corner, where two frog species were heard to be calling. The speedway site abuts a cleared paddock to the west, a homestead to the south, a degraded gravel pit-cum-road fill site to the east, and a tree dominated road verge to the north. In terms of overall site characteristics, the speedway is rich in flora and fauna biodiversity. Although this site is on Forrestfield soils, and slightly elevated above the remainder of the Swan Coastal Plain, it provides an important refuge for fauna, as few remaining healthy stands of remnant vegetation and habitat can be found in the eastern Swan Coastal Plain.

4.5 Vegetation Linkages

The intermittent nature of remnant vegetation patches in the study area indicates poor vegetation linkage between habitats. Few of the remaining vegetation sites examined in this study retain significant shrub and groundcovers, minimising the likelihood of providing linkage between sites. Much of the eastern Swan Coastal Plain has been cleared of vegetation over the last century for agricultural purposes, and few stands of remnant vegetation remain. In the study site, no linkages exist between the well forested western edge of the Darling Plateau, and the flats of the Swan Coastal Plain. It is therefore not likely to expect much faunal movement, apart from bird species and the occasional large mammal, through the study area.

Generally, creeklines provide important linkages between upland and lowland habitats, but these too, have been impacted by land clearing practices, reducing the importance of these as providing corridors for faunal movement. Most of the ephemeral creeklines in the study site have been completely cleared in their lower reaches, and their

usefulness as vegetation linkages is minimal. Wealand Brook retains the most vegetative cover, but its minimal linkage to other habitats both up and downstream reduces its viability as a corridor for faunal movement, particularly ground dwelling fauna.

The important habitat of the speedway is poorly linked with other remnant vegetation in the study area, and has become an important refuge for ground dwelling fauna. The lack of continuous linkage, particularly with the healthier forested areas of the Darling Plateau indicates that the relative isolation means the speedway site is more vulnerable to impact.

4.6 Conservation Values, Impacts and Management

In total, the study site considered here has a low specific value associated with fauna because it is typical of habitat that has been severely disjointed by previous land clearing practices. However, any remaining habitat is considered important due to the restricted nature of remnants, particularly in the eastern Swan Coastal Plain. The vegetation of Speedway site is a very small, but important, remnant in a highly fragmented and reduced landscape.

The value of remnant vegetation and associated fauna habitats can be maximised by leaving a proportion of larger trees with hollows, where possible; and avoiding clearing in the breeding season of the Baudin's Black Cockatoo.

Baudin's Black Cockatoo is known to breed in October to November, with the female laying one to two eggs. Nesting sites typically consist of hollow mature trees in excess of 80-90 cm diameter. No preference for particular tree species is shown, but birds are known to prefer a top opening entrance, with a hollow 0.4-2m in depth. Such size trees may be 200 years old. Only the female of the species stays on the nest to incubate the eggs and brood the chicks. Incubation takes one month, and fledging of juveniles after a further 2 months.

The Quenda is relatively common throughout the south-west and the potential loss of the population or individual at the speedway will not endanger the species generally. Because of the isolation of the speedway vegetation, there will be no opportunity for animals to move to other areas of shelter once clearing begins. It is therefore recommended that attempts are made to capture the animals and relocated them prior to clearing commencing. Consultation with DCLM will provide advice on this action.

5. References

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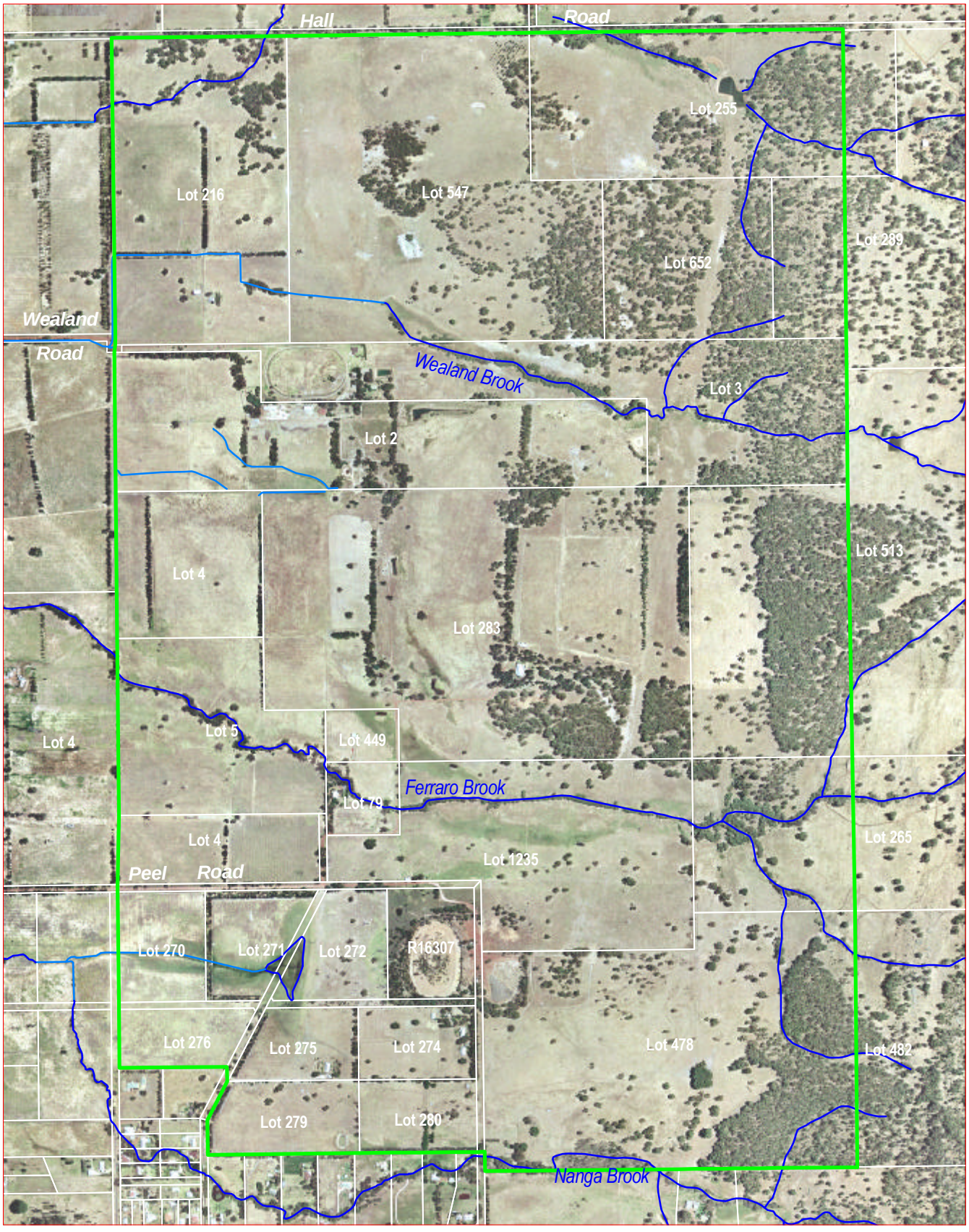


Legend:

Survey Area

Cadastre

N

0 300 600 900 Meters

Date of photography: 2002

ILUKA

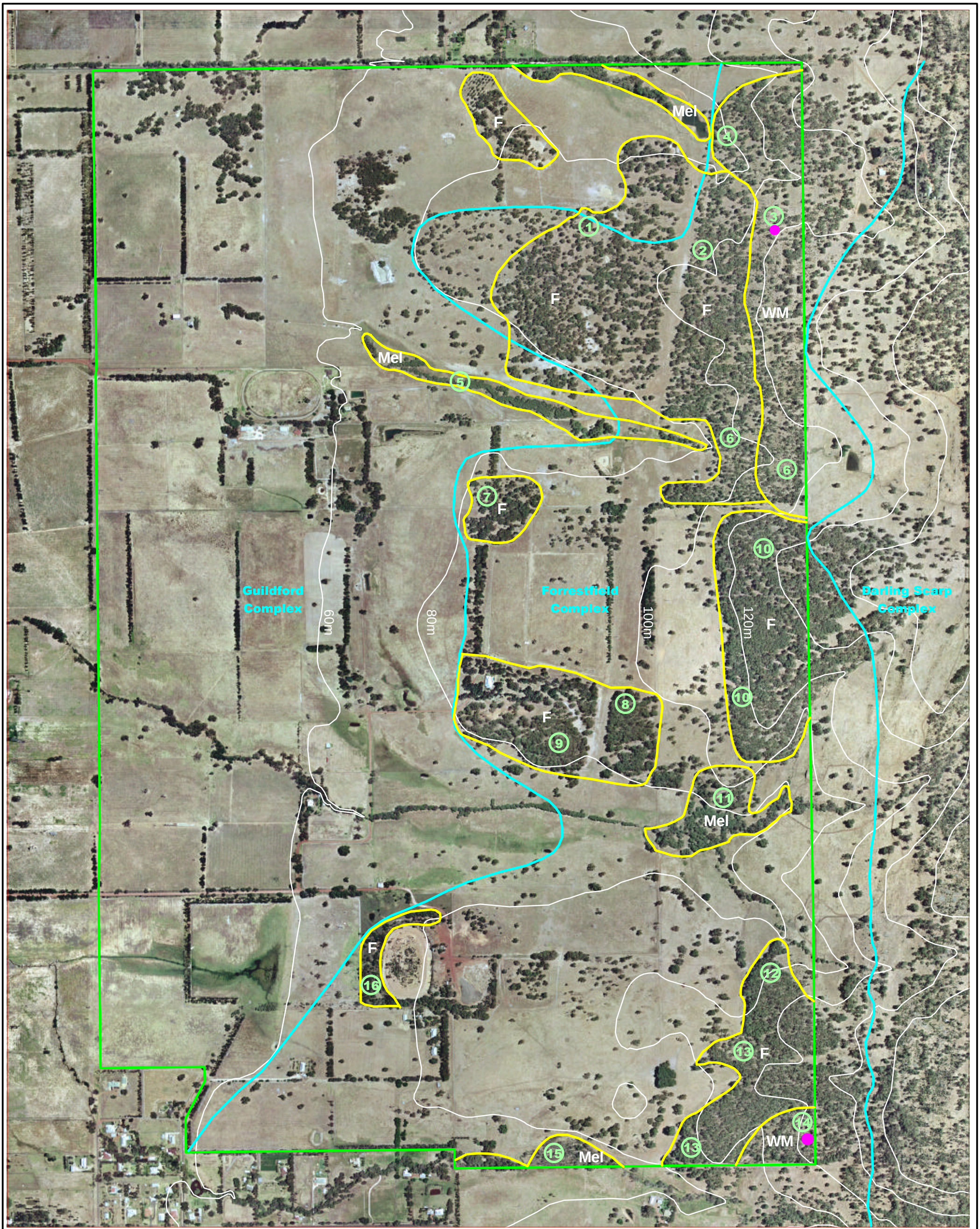
ORIG :	S.JONES
DRAWN :	S.P.
SCALE :	1:15 000
DATE :	9 DEC 2003

WAROONA

SURVEY AREA

DWG No : 125182 ver.00

FIGURE : 1



Legend

- Site Locations
- Assessed Remnants
- Vegetation Complex Boundaries Beard/Heddle et al.
- Survey Area
- Acacia oncinophylla ssp.oncinophylla

Vegetation Complex

F	Jarrah/Marri (Forrestfield)
WM	Wandoo/Marri (Darling Scarp)
MEL	Melaleuca, Eucalyptus rudis

N

0 200 400 600 Meters

Ver.	ORIG:	DESIGN	DATE	COMMENTS
01	S.J.	S.P.	9.12.03	GENERAL REVISION

REVISIONS

ILUKA

ORIG :	S.JONES
DRAWN :	S.P.
SCALE :	1:10,000
DATE :	13 NOV 2003

WAROONA

VEGETATION COMPLEXES & REMNANT VEGETATION

DWG No : 124595 ver.01

FIGURE : 2

Appendix A

Flora list and locations

Family	Genus	Species	Common Name	Status	Swan Coastal Plain (Guildford/Forrestfield Complex)			Ridge Hill Shelf (Forrestfield Complex)		Darling Scarp (Darling Scarp Complex)	
					Creeks, and gentle slopes	Sandhill/ slopes	Speedway	Gullies	Steep granitic gully	Hilltops, slopes	Gullies
					Locs. 255, 547, Lot 3, Lot 2, Locs 283, 1235, 49, 478, 272.	Locations 513, 283, 652	R16307	Locs. 255, Lot 3	Loc. 255	Locs. 255, 289, 478 and Lot 3.	Loc. 478
Mimosaceae	Acacia	oncinophylla ssp. oncinophylla		Priority 3						X	X
Mimosaceae	Acacia	longifolia ssp longifolia		*				X			
Mimosaceae	Acacia	podalyriifolia		*			X				
Mimosaceae	Acacia	pulchella	Prickly Moses				X	X			
Proteaceae	Adenanthos	meisneri					X				
Anthericaceae	Agrostocrinum	scabrum	False blind grass				X				
Primulaceae	Anagallis	arvensis		*						X	
Haemodoraceae	Anigozanthos	manglesii					X				
Asteraceae	Arctotheca	calendula	Capeweed	*	X						
Asparagaceae	Asparagus	asparagoides	Bridal Creeper	PP	X			X		X	
Poaceae	Avena	fatua	Oats	*	X					X	
Myrtaceae	Baeckea	camphorosmae					X	X	X		
Proteaceae	Banksia	grandis				X	X			X	
Proteaceae	Banksia	attenuata				X	X				
Pittosporaceae	Billardiera	sp.					X				
Boryaceae	Borya	sphaerocephala	Pincushions				X	X			X
Papilionaceae	Bossiaea	eriocarpa					X				
Papilionaceae	Bossiaea	obovata					X				
Papilionaceae	Brachysema	sp.					X				
Poaceae	Briza	maxima		*		X				X	X
Poaceae	Briza	minor		*		X					X
Poaceae	Bromus	catharticus	Brome Grass	*	X						
Colchicaceae	Burchardia	umbellata	Milkmaids			X	X	X			
Asteraceae	Carduus	sp.	Thistle	*	X						
Anthericaceae	Caesia	micrantha				X	X				
Orchidaceae	Caladenia	flava	Cowslip		X	X		X		X	
Anthericaceae	Chamaescilla	corymbosa				X		X			
Adiantaceae	Cheilanthes	austrotenuifolia	Rock fern					X			X
Ranunculaceae	Clematis	pubescens						X			
Epacridaceae	Conostephium	pendulum						X			
Haemodoraceae	Conostylis	aculeata				X	X				
Haemodoraceae	Conostylis	setigera				X	X				
Myrtaceae	Corymbia	calophylla	Marri		X	X	X	X	X	X	X
Asteraceae	Craspedia	glauca	Billy buttons			X					
Cuscutaceae	Cuscuta	sp.					X				
Cyperaceae	Cyathochaeta	sp.			X	X					
Goodeniaceae	Dampiera	linearis					X				
Dasypogonaceae	Dasypogon	bromeliifolius	Drumsticks				X				
Papilionaceae	Daviesia	horrida	Prickly Pea							X	X
Papilionaceae	Daviesia	physodes					X				

Family	Genus	Species	Common Name	Status	Swan Coastal Plain (Guildford/Forrestfield Complex)			Ridge Hill Shelf (Forrestfield Complex)		Darling Scarp (Darling Scarp Complex)	
					Creeks, and gentle slopes	Sandhill/ slopes	Speedway	Gullies	Steep granitic gully	Hilltops, slopes	Gullies
					Locs. 255, 547, Lot 3, Lot 2, Locs 283, 1235, 49, 478, 272.	Locations 513, 283, 652	R16307	Locs. 255, Lot 3	Loc. 255	Locs. 255, 289, 478 and Lot 3.	Loc. 478
Papilionaceae	Daviesia	preissii					X				
Restionaceae	Desmocladus	fasciculatus				X				X	
Restionaceae	Desmocladus	flexuosus				X					
Orchidaceae	Diuris	?longifolia								X	
Droseraceae	Drosera	macrantha ssp.macrantha				X	X	X			
Droseraceae	Drosera	erythrorhiza						X			
Droseraceae	Drosera	glandiduligera									
Droseraceae	Drosera	pallida					X			X	
Proteaceae	Dryandra	armata						X	X		X
Poaceae	Erharta	calycina	African lovegrass	*			X	X			
Apiaceae	Erodium	sp.	Cranes bill	*							X
Myrtaceae	Eucalyptus	marginata	Jarrah		X	X	X	X	X	X	X
Myrtaceae	Eucalyptus	wandoo	Wandoo					X	X	X	
Myrtaceae	Eucalyptus	camaldulensis	River gum	*			X				
Myrtaceae	Eucalyptus	caesia	Silver princess	*			X				
Myrtaceae	Eucalyptus	rudis	Flooded gum		X			X			
Moraceae	Ficus	carica	Fig (edible)	*				X			
Iridaceae	Freesia	sp.	Freesia	*				X			
Asclepiadaceae	Gomphocarpus	fruticosus	Cotton bush	DP	X			X			
Papilionaceae	Gompholobium	scabrum				X					
Papilionaceae	Gompholobium	knightianum					X				
Papilionaceae	Gompholobium	tomentosum					X				
Proteaceae	Grevillea	bipinnatifida	Fuschia Grevillea					X		X	
Proteaceae	Grevillea	wilsonii	Native Fuschia				X			X	
Proteaceae	Grevillea	quercifolia					X				
Haemodoraceae	Haemodorum	?discolor				X	X	X		X	X
Haemodoraceae	Haemodorum	?laxum					X				
Proteaceae	Hakea	lissocarpha	Honey Pot				X	X	X	X	
Proteaceae	Hakea	amplexicaulis				X	X	X			
Proteaceae	Hakea	ruscifolia					X				
Lamiaceae	Hemigenia	incana						X			X
Dilleniaceae	Hibbertia	hypericoides	buttercups			X	X	X	X		
Dilleniaceae	Hibbertia	perfoliata								X	
Dilleniaceae	Hibbertia	sp.								X	
Papilionaceae	Hovea	elliptica						X			
Violaceae	Hybanthus	floribundus	Shrub violet				X				
Myrtaceae	Hypocalymma	angustifolium	White Myrtle					X	X	X	X
Myrtaceae	Hypocalymma	robustum	Swan River Myrtle				X	X	X		X
Asteraceae	Hypochaeris	radicata	Flatweed	*						X	

Family	Genus	Species	Common Name	Status	Swan Coastal Plain (Guildford/Forrestfield Complex)			Ridge Hill Shelf (Forrestfield Complex)		Darling Scarp (Darling Scarp Complex)	
					Creeks, and gentle slopes	Sandhill/ slopes	Speedway	Gullies	Steep granitic gully	Hilltops, slopes	Gullies
					Locs. 255, 547, Lot 3, Lot 2, Locs 283, 1235, 49, 478, 272.	Locations 513, 283, 652	R16307	Locs. 255, Lot 3	Loc. 255	Locs. 255, 289, 478 and Lot 3.	Loc. 478
Cyperaceae	Hypolaena	exsulca									
Cyperaceae	Isolepis	sp.			X						
Papilionaceae	Jacksonia	spinosa					X				
Papilionaceae	Jacksonia	furcellata					X				
Papilionaceae	Jacksonia	sternbergiana				X	X				
Juncaceae	Juncus	?pallidus			X						
Papilionaceae	Kennedia	prostrata	Running postman			X	X	X			
Xanthorrhoeaceae	Kingia	australis			X		X	X			
Myrtaceae	Kunzea	pulchella					X				
Caesalpiniaceae	Labichea	punctata					X				
Asteraceae	Lagenophora	huegelii				X		X		X	
Cyperaceae	Lepidosperma	squamatum				X	X				
Cyperaceae	Lepidosperma	longitudinale					X				
Cyperaceae	Lepidosperma	gracile					X			X	
Cyperaceae	Lepidosperma	squamatum					X				
Cyperaceae	Lepidosperma	effusum									X
Goodeniaceae	Leschenaultia	biloba				X					X
Dasypogonaceae	Lomandra	pupurea				X					
Orchidae	Lyperanthus	sp.									
Zamiaceae	Macrozamia	reidlei	Zamia							X	X
Myrtaceae	Melaleuca	preisii			X						
Myrtaceae	Melaleuca	thymoides					X				
Myrtaceae	Melaleuca	rhaphiophylla			X			X			
Myrtaceae	Melaleuca	scabra					X				X
Cyperaceae	Mesomelaena	tetragona					X			X	
Orchidaceae	Microtis	sp.	Mignonette orchid				X				
Papilionaceae	Nemcia	capitata						X			
Poaceae	Neurachne	alopecuroidea						X		X	X
Lauraceae	Nuytsia	floribunda	Christmas Tree		X		X	X	X	X	
Rubiaceae	Opercularia	vaginata				X				X	
Oxalidaceae	Oxalis	pres-capre		*						X	
Oxalidaceae	Oxalis	purpurea		*	X						X
Oxalidaceae	Oxalis	glabra		*	X`						
Iridaceae	Patersonia	occidentalis				X				X	X
Poaceae	Pennisetum	clandestinum	Kikuyu	*				X			
Apiaceae	Pentapeltis	peltigera				X	X				
Rutaceae	Phyllanthus	calycinus				X	X	X		X	
Thymelaeaceae	Pimelea	suaveolens						X			
Thymelaeaceae	Pimelea	rosea						X			
Thymeleaceae	Pimelea	imbricata					X				
Orchidaceae	Pterostylis	sp.	Slender snail		X						

Family	Genus	Species	Common Name	Status	Swan Coastal Plain (Guildford/Forrestfield Complex)			Ridge Hill Shelf (Forrestfield Complex)		Darling Scarp (Darling Scarp Complex)	
					Creeks, and gentle slopes	Sandhill/ slopes	Speedway	Gullies	Steep granitic gully	Hilltops, slopes	Gullies
					Locs. 255, 547, Lot 3, Lot 2, Locs 283, 1235, 49, 478, 272.	Locations 513, 283, 652	R16307	Locs. 255, Lot 3	Loc. 255	Locs. 255, 289, 478 and Lot 3.	Loc. 478
			orchid								
Amaranthaceae	Ptilotus	manglesii				X					
Iridaceae	Romulea	rosea	Guildford grass	*	X					X	X
Rosaceae	Rubus	fruticosus	Blackberry	DP, PP				X			
Polygonaceae	Rumex	sp.	Dock	*	X			X			
Goodeniaceae	Scaevola	paludosa					X				
Goodeniaceae	Scaevola	calliptera	Royal robe			X	X	X			
Solanaceae	Solanum	linnaeanum	Apple of Sodom	DP						X	
Solanaceae	Solanum	nigrum	Black berry nightshade	*	X			X			
Anthericaceae	Sowerbaea	laxiflora				X		X		X	
Iridaceae	Sparaxis	bulbifera		*	X						X
Papilionaceae	Sphaerolobium	medium				X	X				
Stackhousiaceae	Stackhousia	monogyna								X	
Stylidiaceae	Stylidium	brunonianum								X	X
Stylidiaceae	Stylidium	calcaratum				X					
Stylidiaceae	Stylidium	piliferum						X			
Stylidiaceae	Stylidium	repens				X				X	
Phormiaceae	Stypandra	glauca	Blind Grass					X		X	X
Proteaceae	Synaphaea	?gracillima					X				
Myrtaceae	Taxandria	linearifolia			X						
Poaceae	Tetrarrhena	laevis				X					
Orchidaceae	Thelymitra	sp. (yellow)					X				
Sterculiaceae	Thomasia	stipulosa						X			X
Anthericaceae	Thysanotus	patersonii									X
Anthericaceae	Thysanotus	sparteus					X				
Papilionaceae	Trifolium	spp.		*	X					X	
Rhamnaceae	Trymalium	ledifolium		*	X						X
Asteraceae	Ursinia	anthemoides		*		X					
Myrtaceae	Verticordia	pennigera								X	
Iridaceae	Watsonia	?marginata		*	X		X				
Xanthorrhoeaceae	Xanthorrhoea	brunonis							X		
Xanthorrhoeaceae	Xanthorrhoea	gracilis				X	X		X	X	
Xanthorrhoeaceae	Xanthorrhoea	preissii	Balga		X		X		X	X	X
Proteaceae	Xylomelum	occidentale	Woody Pear		X	X	X				
Araceae	Zantedeschia	aethiopica	Arum lily	DP	X			X		X	

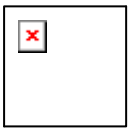
* Indicates introduced species (may be introduced to Australia or be an Australian native from another State or area)

PP Pest plant

DP Declared plant

Appendix B

Keighery Condition Scale



KEIGHERY VEGETATION RATING SCALE

The vegetation communities present were given a condition rating based on the Keighery Vegetation Condition Rating Scale (Keighery, 1994). The ratings in this scale are described as follows:

1. Pristine or nearly so.
2. Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.
3. Vegetation structure altered, obvious signs of disturbance.
4. Vegetation structure significantly altered by very obvious signs of multiple disturbance, retains basic vegetation structure or ability to regenerate it.
5. Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6. The structure of the vegetation is no longer intact and the area is completely or almost without native species.

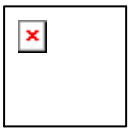
Appendix C

Fauna List

Field Survey Results

List of Fauna Recorded

Avian					
Family	**Genus**	**Species**	**Common Name**	**Status**	**Sighted /heard**
Anatidae	*Chenonetta*	*jubata*	Australian Wood Duck		s
Anatidae	*Tadorna*	*tadornoides*	Australian Shelduck		s
Anatidae	*Anas*	*gracilis*	Grey Teal		s
Anatidae	*Anas*	*superciliosa*	Pacific Black Duck		s
Podicepidae	*Tachybaptus*	*nocaehollandiae*	Australasian Grebe		s
Ardeidae	*Ardea*	*novaehollandiae*	White-faced Heron		s
Threskiornithidae	*Threskiornis*	*molucca*	Australian White Ibis (Sacred)		s
Threskiornithidae	*Threskiornis*	*spinicollis*	Straw-necked Ibis		s
Accipitridae	*Elanus*	*caeruleus axillaris*	Australian Black-shouldered Kite		s
Falconidae	*Falco*	*cenchroides*	Australian Kestrel		s
Falconidae	*Falco*	*longipennis*	Australian Hobby		s
Alcenidae	*Streptopelia*	*senegalensis*	Laughing Turtle-dove	+	s
Alcenidae	*Phaps*	*chalcoptera*	Common Bronzewing		s
Psittacidae	*Cacatua*	*roseicapilla assimilis*	Galah		s
Psittacidae	*Calyptorhyncus*	*banksii naso*	Forest Red-tailed Black Cockatoo		s
Psittacidae	*Calyptorhyncus*	*baundinii*	Baudin's Black Cockatoo	*	s
Psittacidae	*Platycercus*	*zonarius*	Australian Ringneck		s
Psittacidae	*Platycercus*	*spurius*	Red-capped Parrot		s
Tytonidae	*Tyto*	*alba*	Barn Owl		s
Halcyonidae	*Dacelo*	*novaeguineae*	Laughing Kookaburra	+	s
Climacteridae	*Climacteris*	*rufa*	Rufous Treecreeper		s
Maluridae	*Malurus*	*splendens splendens*	Splendid Fairy-wren		s
Pardalotidae	*Pardalotus*	*striatus westraliensis*	Striated Pardalote		s
Acanthizidae	*Sericornis*	*frontalis maculatus*	White-browed Scrubwren		s
Acanthizidae	*Acanthiza*	*chrysorrhoa*	Yellow-rumped Thornbill		s
Acanthizidae	*Gerygone*	*fusca*	Western Warbler (Gerygone)		s/h
Meliphagidae	*Lichmera*	*indistincta*	Brown Honeyeater		s
Meliphagidae	*Lichenostomus*	*virescens*	Singing Honeyeater		s
Meliphagidae	*Anthochaera*	*carunculata*	Red Wattlebird		s
Petroicidae	*Petroica*	*multicolor*	Scarlet Robin		s
Pachycephalidae	*Colluricincla*	*harmonica rufiventris*	Grey Shrike-Thrush		s/h
Pachycephalidae	*Pachycephala*	*pectoralis*	Golden Whistler		h
Dicuridae	*Rhipidura*	*fuliginosa priessii*	Grey Fantail		s
Dicuridae	*Rhipidura*	*leucophrys*	Willie Wagtail		s
Dicuridae	*Grallina*	*cyanoleuca*	Magpie-lark, Mudlark		s
Campephagidae	*Coracina*	*novaehollandiae*	Black-faced Cuckoo-shrike		s
Artamidae	*Artamus*	*cyanopterus*	Dusky Woodswallow		s



Cracticidae	*Cracticus*	*torquatus torquatus*	Grey Butcherbird		s
Cracticidae	*Cracticus*	*tibicen dorsalis*	Australian Magpie		s
Corvidae	*Corvus*	*coronoides*	Australian Raven		s
Hirundinidae	*Hirundo*	*neoxena*	Welcome Swallow		s
Hirundinidae	*Hirundo*	*ariel*	Fairy Martin		s
Zosteropidae	*Zosterops*	*lateralis*	Silvereye		s

Mammalia					
Family	**Genus**	**Species**	**Common Name**	**Status**	**Sighted /tracked**
Macropodidae	*Macropus*	*fuliginosus*	Western Grey Kangaroo		s
Tachyglossidae	*Tachyglossus*	*aculeatus*	Echidna		t
Peramelidae	*Isoodon*	*obeselus fusciventer*	Quenda/Southern Brown Bandicoot		t
Phalangeridae	*Trichosurus*	*vulpecula vulpecula*	Common Brushtail Possum		s (anecdotal), t
Leporidae	*Oryctolagus*	*cuniculus*	Rabbit	+	s
Canidae	*Vulpes*	*vulpes*	Red Fox	+	t
Felidae	*Felis*	*catus*	Cat	+	s

Fish					
Family	**Genus**	**Species**	**Common Name**	**Status**	**Sighted/ tracked**
None					

Amphibia					
Family	**Genus**	**Species**	**Common Name**	**Status**	**Sighted/ tracked**
Myobatrachidae	*Crinia*	*glauerti*	Glauert's Froglet		h
Myobatrachidae	*Crinia*	*georgiana*	Quacking Frog		h

Reptilia					
Family	**Genus**	**Species**	**Common Name**	**Status**	**Sighted/ tracked**
Skinkidae	*? Cryptoblepharis*	*plagiocephalus*	Climbing Skink		s
Skinkidae	*Ctenotus*	*? labilliarieri*			s
Skinkidae	*Ctenotus*	*sp.*			s
Skinkidae	*Egernia*	*kingii*	King's Skink		s
Gekkonidae	*Underwoodisauris*	*milii*	Barking Gecko		s
Varanidae	*Varanus*	*rosenburgi*	Southern Heath Monitor		s
Elapidae	*Pseudonaja*	*affinis*	Dugite		s
Elapidae	*Notechis*	*scutatus*	Tiger Snake		s (anecdotal)

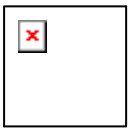
Appendix D

Fauna List

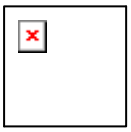
Western Australian Museum Fauna Records

Western Australian Museum Records for Fauna Collected Between 32.7326 S, 115.7785 E; and 33.0473 S, 116.0448 E

Birds	
Acanthizidae	
Acanthiza	*apicalis*
Sericonis	*frontalis*
Accipitridae	
Accipiter	*cirrocephalus cirrocephalus*
Accipiter	*fasciatus fasciatus*
Hamirostra	*isura*
Aegothelidae	
Aegotheles	*cristatus*
Anatidae	
Biziura	*lobata*
Atrichornithidae	
Atrichornis	*clamosus*
Campephagidae	
Coracina	*maxima*
Climacteridae	
Climacteris	*rufa*
Cracticidae	
Cracticus	*tibicen dorsalis*
Cracticus	*torquatus*
Strepera	*versicolor*
Cuculidae	
Chrysococcyx	*lucidus plagosus*
Cuculus	*pallidus*
Dicuridae	
Rhipidura	*leucophrys*
Halcyonidae	
Dacelo	*novaeguinae*
Dacelo	*novaeguinae novaeguinae*
Hirundinidae	
Hirundo	*neoxena*
Maluridae	
Malurus	*elegans*
Malurus	*splendens*
Stipiturus	*malachurus westernensis*
Melphagidae	
Anthochaera	*carunculata*
Motacillidae	
Anthus	*australis australis*

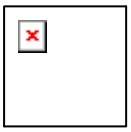


Pardalotidae	
Pardalotus striatus	
Passeridae	
Stagonipleura	*oculata*
Petroicidae	
Eopsaltria	*georgiana*
Phalacrocoracidae	
Phalacrocorax	*carbo novaehollandiae*
Podargidae	
Podargus	*strigoides*
Podocipedidae	
Tachybaptus	*novaehollandiae novaehollandiae*
Procellariidae	
Pachyptila	*belcheri*
Pachyptila	*desolata*
Pachyptila	*vittata*
Psittacidae	
Cacatua	*galerita*
Cacatua	*galerita galerita*
Calyptorhynchus	*banksii naso*
Calyptorhynchus	*baudinii*
Calyptorhynchus	*latirostris*
Neophema	*elegans*
Platycercus	*icterotis*
Platycercus	*spurius*
Platycercus	*zonarius*
Polytelis	*anthopeplus anthopeplus*
Rallidae	
Fulica	*atra australis*
Gallinula	*tenebrosa tenebrosa*
Gallinula	*philippensis mellori*
Porzana	*fluminea*
Porzana	*pusilla palustris*
Scolopacidae	
Tringa	*glareola*
Tytonidae	
Tyto	*alba*
Tyto	*alba delicatula*



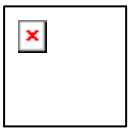
Mammals	
Burramyidae	
Cercartetus	*concinnus*
Dasyuridae	
Antechinus	*flavipes leucogaster*
Dasyurus	*geoffroii*
Phascogale	*tapoatafa tapoatafa*
Sminthopsis	*gilberti*
Sminthopsis	*griseoventer griseoventer*
Equidae	
Equus	*caballus*
Felidae	
Felis	*catus*
Muridae	
Hydromys	*chrysogaster*
Mus	*musculus*
Myrmecobiidae	
Myrmecobius	*fasciatus*
Phalageridae	
Trichosurus	*vulpecula vulpecula*
Suidae	
Sus	*scrofa*
Vespertilionidae	
Nyctophilus	*geoffroyii*
Nyctophilus	*gouldii*
Vespadelus	*regulus*

Fish	
Cyprinidae	
Carassius	*auratus*
Galaxiidae	
Galaxias	*occidentalis*
Hemiramphidae	
Hyporhampus	*regularis*
Pecichthyidae	
Bostockia	*porosa*
Petromyzontidae	
Geotria	*australis*



Amphibia	
Hylidae	
Litoria	*moorei*
Myobatrachidae	
Crinia	*georgiana*
Crinia	*insignifera*
Geocrinia	*leai*
Helioporus	*eyrei*

Reptiles	
Agamidae	
Pogona	*minor minor*
Boidae	
Morelia	*spilota imbricata*
Cheluidae	
Chelodina	*oblonga*
Elapidae	
Elapoganatus	*coronatus*
Notechis	*scutatus*
Parasuta	*gouldii*
Parasuta	*nigriceps*
Pseudonaja	*affinis affinis*
Pseudonaja	*nuchalis*
Gekkonidae	
Christinus	*marmoratus*
Crenadactylus	*ocellatus ocellatus*
Diplodactylus	*polyophthalmus*
Underwoodisaurus	*milii*
Pygopodidae	
Delma	*fraseri fraseri*
Lialis	*burtonis*
Pygopus	*lepidopodus*
Scincidae	
Acritoscincus	*trilineatum*
Ctenotus	*fallens*



Ctenotus	*labillardieri*
Egernia	*kingii*
Egernia	*napoleonis*
Egernia	*pulchra pulchra*
Glaphyromorphus	*gracilipes*
Hemiergis	*initialis initialis*
Hemiergis	*quadrilineata*
Lerista	*distinguenda*
Lerista	*elegans*
Lerista	*microtis microtis*
Menetia	*greyii*
Morethia	*lineoocellata*
Morethia	*obscura*
Typhlopidae	
Rhamphotyphlops	*australis*
Rhamphotyphlops	*pinguis*
Varanidae	
Varanus	*gouldii*
Varanus	*rosenbergi*

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