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FLORA, VEGETATION AND FAUNA SURVEY

MEADOW SPRINGS ESTATE

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&

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For

Quilty Environmental
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October 1996

N

0 200

SCALE

LEGEND

M -

Mixed eucalypt woodland of Eucalyptus marginata, E. calophylla and E. gomphocephala over mixed understorey shrubs, variable weed infestation.

T. -

Tuart woodland (Eucalyptus gomphocephala) with mixed understorey common, weed infestation widespread.

H. -

Heath with Acacia rostellifera, A. pulchella, Melaleuca acerosa, M. hueglii, Grevillea crithmifolia, G. preissii, Spyridium globulosum, Templetonia retusa and, on rocky ridges, Rhagodia baccata and Olearia axillaris prominent. Weedy throughout.

W. -

Wetland with Melaleuca rhaphiophylla, Ghania trifida, Baumea articulata, Cyperus tenuiflorus, Halosarcia sp Wilsonia backhousii and Juncus pallidus prominent.

PREPARED BY
E. M. GOBLE-GARRATT
DATE: SEPTEMBER 1996

FIGURE 1: MEADOW SPRINGS - VEGETATION MAP

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1.0 INTRODUCTION

This report covers an assessment of the flora, vegetation and vertebrate fauna of the Meadow Springs estate, near Mandurah, Western Australia. A residential subdivision is already in place in the central southern portion of Meadow Springs and a golf course has also been constructed. The current assessment focuses on additional areas proposed for residential subdivision and alternative freeway / rail reserve alignments which are proposed for the area. A small seasonal wetland in the north-eastern limits of the Project Area was also surveyed The assessments within these locations were conducted in order to permit structure planning to proceed with due attention to environmental constraints.

2.0 FLORA AND VEGETATION

2.1 Methods

The survey on which this report is based was undertaken over two days in late August and early September 1996. The first visit in the company of Ninox Wildlife Consulting was essentially a familiarisation visit and to ascertain fauna habitat types. The second day concentrated on recording species presence and vegetation boundaries and condition.

Over the two days most of the tracks on the site were traversed by vehicle or on foot. Traverses through different vegetation types were also undertaken and the wetland area at the north-eastern end of the site was explored. Note was taken of the dominant species in all areas and a record of associated species was made opportunistically. Where identification of a species could not be made in the field, a voucher specimen was taken for later identification / verification at the Western Australian Herbarium.

Prior to the site visits, reference was made to the Department of Conservation and Land Management's data base of Rare and Priority list flora for the area.

2.2 Objectives

The objectives of the flora and vegetation assessment were:

- to provide a description of the vegetation communities present on the site;
- to map the boundaries of these community types;
- to provide a checklist of the vascular flora present on the site;
- to comment on the local and regional significance of the site; and
- to make recommendations for preservation and rehabilitation of any areas considered of significance.

2.3 Results

2.3.1 Flora

A total of 116 taxa from 44 families of vascular flora were recorded during the survey. These are presented as a checklist in Appendix 1. The families best represented by native species in this opportunistic survey are the Proteaceae with 11 species, the Myrtaceae and Papilionaceae with 7 taxa each, and the Cyperaceae and Anthericaceae with six species each.

Groups most likely to be under represented in the checklist because of the opportunistic nature of the survey would include the rush and sedge families (Cyperaceae and Restionaceae). Small species of the Dicotyledonous genera such as Drosera, and Stylidium as well as several more orchids could also be expected to occur.

A diverse suite of exotic species is present on the site represented by 31 taxa (or just under 27% of the total) in the checklist.

2.3.2 Rare or Priority Species

A search of the Department of Conservation and Land Management's data base of Rare and Priority list species indicated that only one species *(Jacksonia sericea)* could be expected to occur on the site. Neither this species nor any other considered to be of special significance was encountered during the survey.

2.3.3 Vegetation Types

The vegetation on the site can be classified in broad terms into four units. These are based on physiognomy and species composition except for the composite unit representing the vegetation associated with the wetland. In addition an area in the central to north-eastern section of the site on a gentle west facing slope may have supported Banksia Woodland in the past. Only isolated individuals of *Banksia attenuata* remain over what is essentially a sea of weedy species with some native understorey shrubs. This area has been included in the Heath vegetation type on the map of the vegetation on the site (Figure 1) as there are several shared species.

The four units are listed below with a brief description of the structure and dominant species. The units are listed in descending order (by approximation) of the size of the remnants on site. Unit boundaries are to some extent arbitrary, as the boundaries between types is rarely sharp when viewed in the field.

Heath on consolidated dunes (over limestone) (see Plate 1)

Distribution

Mostly the higher areas on the site. Consolidated dunes with massive limestone often very close to the surface.

Structure

This is a variable vegetation type. Intensive survey would probably result in several sub-units being recognised. Height and density vary depending on the species present in a particular area, and on the disturbance and fire history. Density is similarly affected, but on the whole this vegetation is quite dense. A single or at the most two layers of shrubs are present, with little herbaceous groundcover except where an area has been recently burnt.

Main Species

Significant species include *Melaleuca acerosa, Melaleuca huegelii, Acanthocarpos preissii, Grevillea preissii, Grevillea crithmifolia, Acacia pulchella, Spyridium globulosum* and *Templetonia retusa. Rhagodia baccata* and *Olearia axillaris* occur on the rockiest sites. In areas that have been recently burnt *Tersonia cyathiflora* and herbaceous species such as *Hybanthus calycinus* and *Senecio lautus* occur in profusion. Dense thickets of *Acacia rostellifera* occur in places, promoted by frequent burning.

Condition

Weedy throughout with evidence of rabbit damage in places. As for other vegetation types, the areas away from the northern and southern extremities of the site are in the best condition. Much of this vegetation type has been burnt in the past few years.

Open Tuart Woodland on dunes and swales (see Plate 2)

Distribution

Generally in bands running parallel with the dunes. On the west and centre of the site this vegetation occurs in swales, whereas on the eastern side it also occurs on higher ground.

Structure

Generally quite open with the larger trees well spaced. Smaller trees of *Banksia attenuata* may be scattered throughout. A shrubby understorey may be present. Groundcover is mostly of exotic species. At the north-eastern corner of the site this woodland has been practically cleared of native understorey.

Main Species

Eucalyptus gomphocephala, Lepidosperma gladiatum, Hakea lissocarpha, Acanthocarpos preissii, Grevillea vestita, Phyllanthus calycinus, Ozothamnus cordatus. Clumps of *Acacia cochlearis* and areas of the climber *Clematis microphylla* occur occasionally.

Condition

Weedy throughout, but in better condition away from the northern and southern boundaries of the site.

Mixed Eucalypt Woodland (see Plate 3)

Distribution

Along the eastern boundary of the site on gentle east facing slope and adjoining swale.

Structure

Dense woodland with several canopy and understorey layers.

Main Species

Eucalyptus marginata, Eucalyptus calophylla, Allocasuarina fraseriana, Banksia grandis, Banksia attenuata, (some *B. menziesii* towards the northern end) *Conostylis setigera, Hibbertia hypericoides, Bossiaea eriocarpa, Conospermum triplinervium.* Small herbaceous species such as *Sowerbaea laxiflora, Burchardia umbellata,* several orchid species and climbers such as *Hardenbergia comptoniana* were noticeable during the survey as they were in full flower. *Eucalyptus gomphocephala* also occurs as scattered individuals especially towards the northern end of the site.

Condition

Generally appears to be in a better condition with respect to retention of understorey than other vegetation types, although weeds still predominate in the groundlayer in many places.

Wetland Complex (see Plates 4 and 5)

Distribution

In and around the ephemeral wetland at the north-eastern end of the site.

Structure

The centre of the wetland appears to be higher than the margins, and supports a succulent low shrubland / sedgeland. This is surrounded by dense thickets and rush beds.

Main Species

Melaleuca rhaphiophylla, Gahnia trifida, Baumea articulata, Isolepis nodosus, Cyperus tenuiflorus, Halosarcia species, *Wilsonia backhousii, Juncus pallidus* and occasional *Acacia saligna, Jacksonia furcellata, Acacia pulchella* and *Rhagodia baccata* on the outer periphery. The wetland is surrounded on the east and north by Tuart Woodland with very disturbed remnants of this vegetation type on the west.

Condition

The perimeter of the wetland is heavily weed infested, and the central drier area has been disturbed by trailbike riders and the dumping of rubbish.

2.3.4 Condition

The entire site, but especially the northern portion of the site appears to have been utilised for grazing in the past. This has led to extensive weed invasion. The proliferation and spread of the weedy species has probably been assisted by frequent fires, dumping of rubbish, and recreational uses such as horse and trailbike riding. Rabbits are also common especially on the higher ground and around the golf course.

2.4 Discussion

2.4.1 Significance of the Area

All remnants of native vegetation in and around the urban areas of the Swan Coastal Plain must be considered to have some significance as more and more areas are lost or modified. However, none of the vegetation types encountered on the site are restricted or currently considered to be under threat of becoming rare.

3.0 FAUNA

3.1 Methods

The report is based on a short but intensive survey in late August 1996. Two experienced field zoologists visited the area and spent a total of 12 personnel hours assessing its current conservation status. The assessment was carried out in association with the consulting botanist and consisted of a series of vehicle and foot transects which covered all fauna habitats in the Project Area.

Terrestrial vertebrates such as small mammals and most reptiles are mainly recorded during trapping surveys conducted over several seasons and, as a result, their potential presence was assessed by geographical distribution patterns, known habitat preferences and the condition of the local environment. Birds, however, are highly visible and all birds seen and heard were recorded, giving an insight into the conservation status of the area. Larger mammals, reptiles and amphibians were recorded opportunistically and signs of their presence such as scats, tracks and diggings were noted.

Special attention was paid to assessing the potential for rare, protected or uncommon species to occur within the Project Area. An appraisal of vertebrate micro-habitat, habitat quality and critical fauna resources was undertaken in order to facilitate the production of a list of species not recorded during the site assessment but which may be uncommon, rare, nomadic or migratory. This assisted in providing an assessment of the conservation status of specific locations and

placing the area in a regional and local perspective. A thorough literature review has also been undertaken to facilitate the production of a list of species expected to occur in the Project Area.

3.1.1 Fauna Habitat Definition

The Project Area can be regarded as a habitat continuum with very little faunal definition between the various habitat types. Vertebrate communities cannot be readily assigned to individual vegetation types or their permutations, each with an unique range of animals. Even at the extremes of vegetation structure, topography and substrate within this relatively small area, most vegetation types will have at least 70% of their vertebrates in common and, on occasions, an even greater proportion due to seasonal movements in response to breeding activity or the availability of food and water. Apart from a small group of specialised animals such as frogs, waterbirds and some habitat-specific mammals and reptiles (Appendix 1), the major difference between vegetation types will be changes in abundance of species common to most associations, rather than large, definitive suites of habitat-specific vertebrates.

The following major fauna habitats were recognised during the survey:

Habitat 1 - Tuart Woodland on dunes and swales
Habitat 2 - Mixed Eucalypt woodland on low-lying areas
Habitat 3 - Coastal heath on consolidated dunes
Habitat 4 - Seasonal wetland

Full descriptions of plant communities are given in section 2.3.3 on Flora and Vegetation.

3.2 Study Objectives

The objectives of the fauna assessment were therefore to:

- produce an inventory of the vertebrate fauna of the Meadow Springs Project Area based on the species recorded during the field assessment and species likely to occur given long-term sampling;
- review vertebrate fauna species considered to be rare, endangered, geographically restricted or occurring as outlier populations;
- provide a review of species not necessarily declared rare, but in need of special protection;
- assess the relationships between vertebrate fauna and vegetation communities, in order to clearly identify any habitats of significance;
- assess the value and significance of a wetland in the north-eastern limits of the Project Area, described on the Coastal Plain wetland register as a "Resource Enhancement" wetland;
- prepare a detailed report on the findings integrated with the flora and vegetation report.

3.3 Results

Appendix 2 lists the birds, native and introduced mammal, amphibian and reptile species recorded during the site assessment and the additional species expected to occur in the various habitats of the Project Area given long-term sampling. Also shown is the status of several species listed under the Wildlife Conservation Act 1996 as rare or specially protected. Introduced species are also indicated.

The list of species expected to occur has been constructed from a range of published and unpublished sources, including, Blakers *et al.* 1984 (birds), Strahan 1983 (mammals), Bush *et al.* 1995 (amphibians and reptiles) and the authors' unpublished records from the Mandurah area, collected over many years.

Birds: thirty-two species of bird were recorded during the site assessment (Appendix 2). An additional 62 species are expected to occur given further, more detailed, seasonal sampling.

Native Mammals: as indicated in section 3.1, small native mammals are rarely observed without intensive trapping and none were recorded during this assessment. However, the presence of two larger native mammals was confirmed. A further 16 species of native mammals are expected to occur.

Introduced Mammals: two introduced mammals were recorded. A further three are expected to occur in the Project Area.

Amphibians: four species of frog were heard calling during this assessment. An additional six species could occur in the Project Area. While none are listed as rare or threatened, the significant loss of wetlands on the Swan Coastal Plain has probably reduced the abundance of some species since European settlement. Balla (1994) states that while it is difficult to estimate exactly how many wetlands of the Swan Coastal Plain have been filled, drained or cleared of vegetation, as little as 20 to 30% may remain in a natural condition.

Other, generally burrowing species that do not require water for breeding, have probably declined in abundance due to the concentration of residential developments on the Swan Coastal Plain and the subsequent widespread use of various chemicals on gardens, predation by domestic and feral cats and landscaping with brick paving and lawns.

Reptiles: as for small mammals, most reptiles are only recorded during intensive, seasonal trapping surveys. However, given warm weather conditions, a range of species may be seen active during site assessments such as this study. The cool weather conditions experienced during this appraisal in late August were not conducive to recording reptiles and, as a result, only three were observed. A further 32 species of reptile are expected to occur in the Project Area.

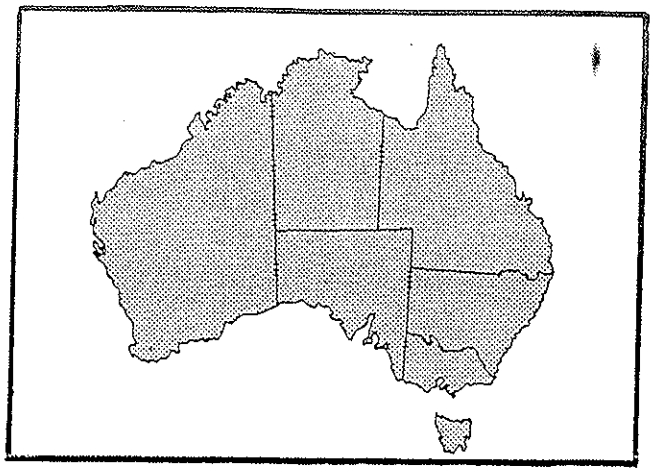
3.3.1 Rare Fauna

Two rare species, Carnaby's Black Cockatoo and the Southern Brown Bandicoot were recorded during the field assessment. Two more rare species are expected to be present based on distribution records and the habitats of the Project Area. These are the Peregrine Falcon and Baudin's Black Cockatoo.

In Western Australia, rare or endangered species are protected by Schedules 1 to 4 of the Wildlife Conservation Act (1996 amendment). Schedules 1 and 4 are relevant to this study. Schedule 1 species are described as "fauna that is rare or likely to become extinct." Schedule 4 species are "other specially protected fauna". Not all rare species are residents or equally susceptible to disturbance. Many are passage migrants, nomads, cryptic species or naturally uncommon predators at the higher levels of the food chain typified by birds of prey such as the Peregrine Falcon. Resident rare species known to occur in a given site generally have a much wider distribution than their localised records of occurrence suggest.

In this report we have attempted to take a pragmatic and unbiased approach to the rare species that are predicted to occur in the habitats of the Project Area by specifically considering the above aspects. The shaded areas in the following diagrams show the current distributions of rare species.

Peregrine Falcon *Falco peregrinus*



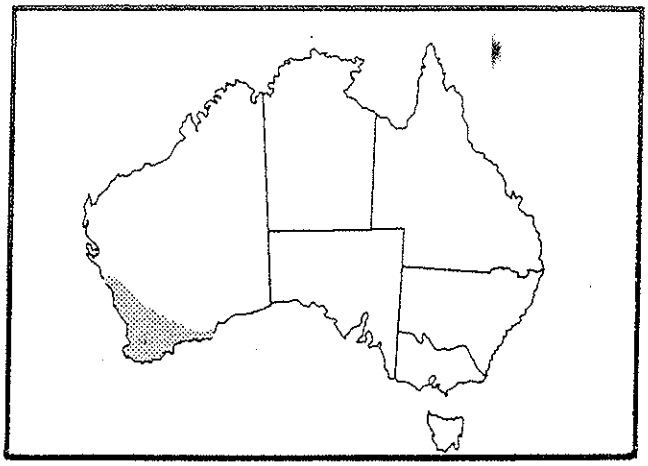
Status: Schedule 4. Resident.

Habitat: all vegetation types. This is a highly mobile bird with little apparent habitat specificity. While almost cosmopolitan in its distribution, Australia is a stronghold for this species (Blakers *et al.* 1984). Toxic insecticide residue in prey species, which prevents successful breeding through fragile eggs which will not support the bird's weight, is considered to be the main cause of its decline throughout most of its worldwide range (Hoser 1991). The Peregrine Falcon is mainly a resident and is expected to occur throughout the Project Area where its main prey will be pigeons, doves and waterbirds.

Probability of Occurrence: very high. In keeping with most large predators at the higher trophic levels of the foodchain, this species occurs in low numbers, contributing to its perceived rarity.

Project Impact: the Peregrine Falcon is not reliant on any single aspect of the Project Area for its continued existence. As long as tall trees and a reliable supply of prey species are present, this bird will persist. Overuse of insecticides to control damage to greens, however, may result in a local reduction of numbers (see above).

Carnaby's Black Cockatoo *Calyptorhynchus funereus latirostris*



Status: Schedule 1. Nomadic.

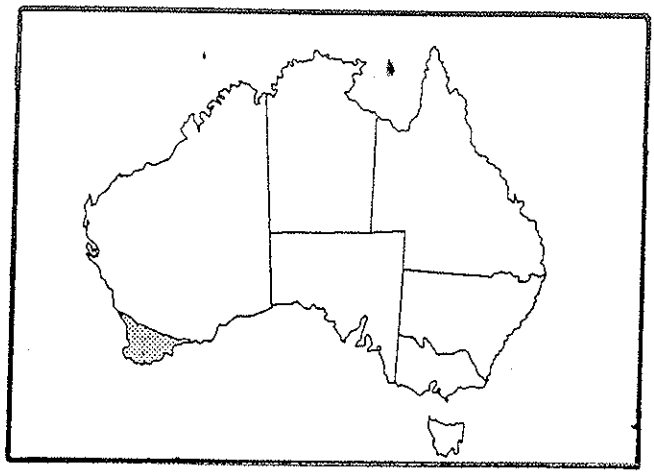
Habitat: eucalypt woodlands, tall heaths, pine plantations.

Comments: Carnaby's Cockatoo occurs mainly in the Wheatbelt region of Western Australia, but occasionally breeds as far south as Bunbury. This species is threatened by loss of nest sites (Garnett 1992). Carnaby's Cockatoo requires hollows that do not develop in Eucalypts for at least 100 years (Saunders 1974; Storr and Johnstone 1988). The major threat to its survival is loss of nesting and feeding sites due to clearing and fragmentation of its wheatbelt habitat. After breeding this bird moves to coastal areas. Forested locations provide roosting and feeding resources along the way. Since the large-scale clearing in the Wheatbelt over the past 50 years, and the consequent loss of feeding and breeding resources, the main distribution of this cockatoo has shifted considerably west and south (Storr 1991).

Probability of Occurrence: recorded during the field assessment.

Project Impact: the continued presence of this species within the Project Area is contingent upon retaining as many mature Marri and Tuart trees as possible and retaining portions of the coastal heathland as feeding areas.

Baudin's Black Cockatoo *Calyptorhynchus baudinii*



Status: Schedule 1. Nomadic.

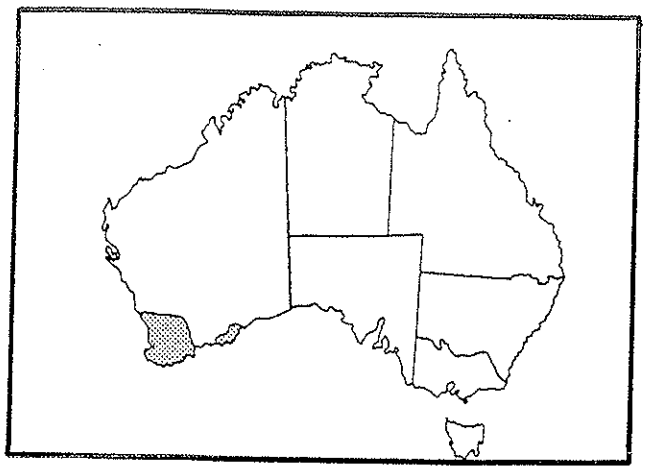
Habitat: woodlands, heath.

Comments: this cockatoo is still distributed throughout most of its earlier known range in south-western Australia. It is found in Eucalypt forests dominated by Jarrah, Marri and Karri. However, as for the previous species, this bird is also threatened by loss of nest sites in Eucalypt hollows.

Probability of Occurrence: very high. The presence of large Tuart trees with hollows may allow for breeding of this species in the Project Area.

Project Impact: the potential for local breeding by this species is contingent upon retaining as many mature Tuart, Jarrah and Marri trees as possible.

Southern Brown Bandicoot *Isoodon obesulus fusciventer*



Status: Schedule 1. Resident.

Habitat: primarily dense vegetation adjacent to water or locations of high humidity such as damplands.

Comments: this mammal requires a dense understorey, typically in wet or damp areas, to survive. The major threat to its survival is habitat loss and introduced predators such as the fox, feral cats and domestic dogs.

Probability of Occurrence: typical conical diggings of this species were recorded in an area of dense sedge on the central northern boundary of the Project Area. The seasonal wetland in the north-eastern corner of the Project Area is also an area where there is a high potential for this species to occur.

Project Impact: this omnivorous species should persist in bushland areas set aside for "unimproved" public open space. Bandicoots are also known to habitually use grassed areas such as lawns and golf courses as feeding areas where the larvae of lawn beetles, for example, are part of its diet. However, insecticide use, increased traffic, dogs and cats will markedly raise the mortality rate. This impact will be strictly local rather than regional.

3.3.2 CALM Priority Species

The CALM Priority Fauna List nominates species which have recently been removed from the list of rare fauna, that have a restricted distribution, are uncommon, declining in range and/or abundance, or for which there is insufficient information to make a reliable assessment of their status.

Three species of birds, two native mammals and two reptiles are likely to occur in the Project Area. These are the Square-tailed Kite, Brush Bronzewing, Red-tailed Black Cockatoo, Brush-tailed Phascogale, Western Brush Wallaby, Perth Lined Lerista and Black-striped Snake (Appendix 2). The continued presence of these species is dependent on the maintenance of relatively large areas of native vegetation.

3.4 Discussion

3.4.1 Regional Significance

In reality, all remaining Swan Coastal Plain habitats in reasonable condition from Fremantle to Mandurah are of regional significance to fauna because of the degree of loss and fragmentation which has taken place since European settlement. However, no single species of animal or habitat is restricted to the Project Area or the Mandurah area as a whole.

3.4.2 Local Significance

Within the Project Area, two habitats are of special significance to fauna. These are the Tuart woodland found throughout the study area and the seasonal wetland situated in the north-eastern corner. Both these habitat types have been severely impacted within and beyond the coastal plain. While wetlands are believed to be the most threatened habitat on the coastal plain, Tuart woodland is a rapidly diminishing resource which supports a greater range and diversity of vertebrate fauna than wetlands.

3.4.3 Significance of Specific Areas

Golf Course (North)

The relatively undisturbed bushland surrounded by the northern limits of the golf course supports two habitats with the capacity to maintain a representative portion of local fauna populations including the rare and priority species discussed in Sections 3.1 and 3.2. These are: Tuart woodland on dunes and swales; tall coastal heath.

Northern Boundary

Approximately half way along the northern boundary (500m east of the Fremantle Road) there is a stand of reasonably undisturbed Tuart woodland. Within this woodland are patches of sedgeland, described by Semeniuk (1987a) as Damplands. Diggings of the rare

Southern Brown Bandicoot were found in one of these damplands which are typically found in the swales between dunes.

Eastern Areas

The portion of the Project Area east of the proposed freeway reserve has the most varied series of fauna habitats and supports all vegetation types listed in Section 2.1. As a result, virtually all fauna listed in Appendix 1 will be found here.

Seasonal Wetland

The only surface water expression in the Project Area is the seasonal wetland on its north-eastern limits. While a relatively large proportion of local fauna will use this area, its main significance is as a seasonal refuge for waterbirds (Appendix 1).

4.0 GENERAL DISCUSSION AND RECOMMENDATIONS

4.1 Public Open Space

Generally speaking, residential subdivision plans leave little opportunity for retention of viable areas of native vegetation either from a conservation of flora point of view, or as specific areas suitable for native fauna habitat. Small areas of native vegetation tend to lead to intractable management problems, degrade rapidly and are of limited significance unless they are part of a planned or existing corridor system. In light of this the following recommendations are made:

- that consideration be given to retaining at least one large area of native vegetation for conservation purposes. To this end, the natural areas delimited by the northern loop of the golf course would be ideal. The vegetation here is in relatively good condition, there is a variety of habitat provided by variation in topography, and the golf course provides a degree of buffering from other disturbance. The area could be provided with nature trails and look out areas, and be a significant addition to the amenity of the surrounding residential areas by providing for passive recreation and educational needs;

- if smaller and isolated areas of public open space are decided upon, that as many of these as possible be located in areas with significant trees, and that where ever possible mature trees be retained;

- that the buffer strip proposed for the eastern margin of the site be given a high priority for retention, and that this area be connected to the wetland at the north eastern corner of the site. This area would also provide a variety of habitats for fauna, and retain a significant representation of quite diverse woodland.

4.2 Transport Corridor

The western route option passes through predominantly a heath vegetation type with occasional Tuart trees except for a short distance at the northern end of the project site where it enters open Tuart woodland and then mixed Jarrah / Marri woodland.

The eastern route option is in a heath vegetation type at the southern end of the project site, but for most of its length passes through Mixed Eucalypt woodland. Both routes will result in removal of native vegetation, with more trees affected by the eastern than the western route. The trees involved along the eastern route are mostly small Jarrah, some Marri and Sheoak.

In terms of impact on Fauna there is little to choose between the two route options. Both will result in loss of habitat for a similar range of Fauna species.

However, the eastern route is immediately adjacent to the proposed buffer strip of public open space, and also passes close to the large area of proposed public open space associated with the swamp at the north-eastern corner of the development site. The opportunity therefore arises to incorporate the transport corridor reserve into these areas to be retained for flora and fauna habitat. This will provide additional refuge for fauna in the short term prior to construction of the road or railway. With careful planning and construction of the road and railway, and sensitive rehabilitation, the transport corridor reserve could continue to enhance the fauna corridor function of the open space buffer in the long term. The link with the transport corridor also provides the possibility of forming connections to remnant vegetation outside of the project area which would increase the significance of the on site vegetation considerably. If linked to the rehabilitated swamp area the benefits, especially for fauna could be even greater.

These opportunities would not be available if the western route is chosen. It is therefore recommended:

- that from a vegetation, and particularly a fauna point of view, the eastern route be considered as it would appear to provide the most opportunities for long term benefit as a part of a linear reserve.

4.3 Seasonal Wetland

In the assessments collated and published jointly by the Water Authority of WA and the Department of Environmental Protection, the seasonal wetland at the north-east corner of the site has been evaluated as being in the "Resource Enhancement" category for management purposes. The management categories and how wetlands are assigned to them by evaluation of a range of natural attribute and human use criteria have most recently (1993) been set out in Bulletin 686 of the Environmental Protection Authority. For Resource Enhancement wetlands the planning and management objectives must be to maintain and enhance the existing natural attributes of the area involved.

Basin wetlands which are seasonally inundated have been classified by Semeniuk (1987a) as Sumplands and this particular wetland is the southernmost in a chain of wetlands occurring in the Spearwood dunes from around Navel Base southwards to just north of the Peel Inlet. This suite of wetlands is known as the Stakehill Consanguineous Wetland Suite (Semeniuk, 1987b).

The wetland is ephemeral and, consequently, its usage by waterbirds is relatively low. It mainly operates as an area where limited waterbird breeding and some roosting takes place. Its most important function from a fauna point of view is, perhaps, as a refuge area for secretive waterbirds such as crakes and rails. This wetland is an ideal candidate for resource enhancement provided that this is approached in a sensitive manner taking due account of the needs and habitat requirements of waterbirds and other wetland-associated species.

There are many measures which could be undertaken to enhance the wetland for fauna. These range from very simple ones to some which would require further planning. The following are listed for consideration:

- that a way is found to connect the wetland habitat with the proposed buffer of remnant native vegetation and the transport corridor to the west;

- that the central area of the wetland be **closed to all vehicles**, and that any rubbish present be removed. Soil compaction should be ameliorated to encourage the regeneration of the Samphires and Sedges;

- that the feasibility of deepening a portion of the wetland to transform it into a permanent waterbird habitat which can act as a summer refuge be examined. This would require details of water table depths and fluctuations in the area, and final plot boundaries and road alignments to give exact boundaries of the public open space. An ideal configuration would consist of "moat" around the perimeter structured to discourage predators such as cats, dogs and foxes whilst still providing a range of water depths through gently sloping rather than vertical banks. This treatment would increase its value to waterbirds dramatically.

This wetland is in an ideal position, is in relatively good condition, and is of a suitable size for adoption by a community group for rehabilitation and management. This could possibly be initiated and encouraged by the developers through the local council or the Royal Australian Ornithological Union or other interested body. Well rehabilitated and managed, it could provide a valuable aesthetic, recreational and educational resource for the local community as well as serving a conservation aim.

4.4 Rare Fauna

Evidence of the presence of Bandicoots was noted during the survey, and there is certain to be a resident population of the species present. The Department of Conservation and Land Management should be consulted as to the approach they require in the management of this population.

4.5 Dieback

There were no obvious visual indications of the presence of infection by the Dieback pathogens on site during the survey. Superficial visual assessment is however not particularly reliable as a diagnostic tool, especially in recently burnt or otherwise disturbed areas. The presence or absence of the Dieback fungi has implications for rehabilitation and landscaping as well as for the continued health of any native vegetation retained on site and in the area generally. This has

special relevance in relation to the proposed buffer corridor along the eastern boundary of the site, where the canopy contains Jarrah and Banksias which would all be at risk from infection. The Dieback status of this buffer and adjoining areas may have planning implications. It is therefore recommended:

- that the Department of Conservation and Land Management be consulted as to existing records of Dieback problems in the area, and for specialist advice on the potential risk and attendant management guidelines for the eastern buffer, and for development on neighbouring land;

- that dependent on the results of these enquiries a dieback hygiene plan be prepared for development of areas adjacent to the eastern buffer.

4.6 General

General recommendations for helping to maintaining fauna in the Project Area are provided below. It is recommended that:

- within the bounds of public safety as many mature trees as possible be retained. Large trees such as Tuarts take many decades to form hollows. Hollows act as breeding sites and essential refuge areas for many birds and some native mammals;

- local native shrubs be considered for planting in public areas throughout the development to provide additional shelter and food sources for bird life;

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Plate 1. Typical View of Heathland within the Project Area

Plate 2 Open Tuart Woodland with well spaced mature trees

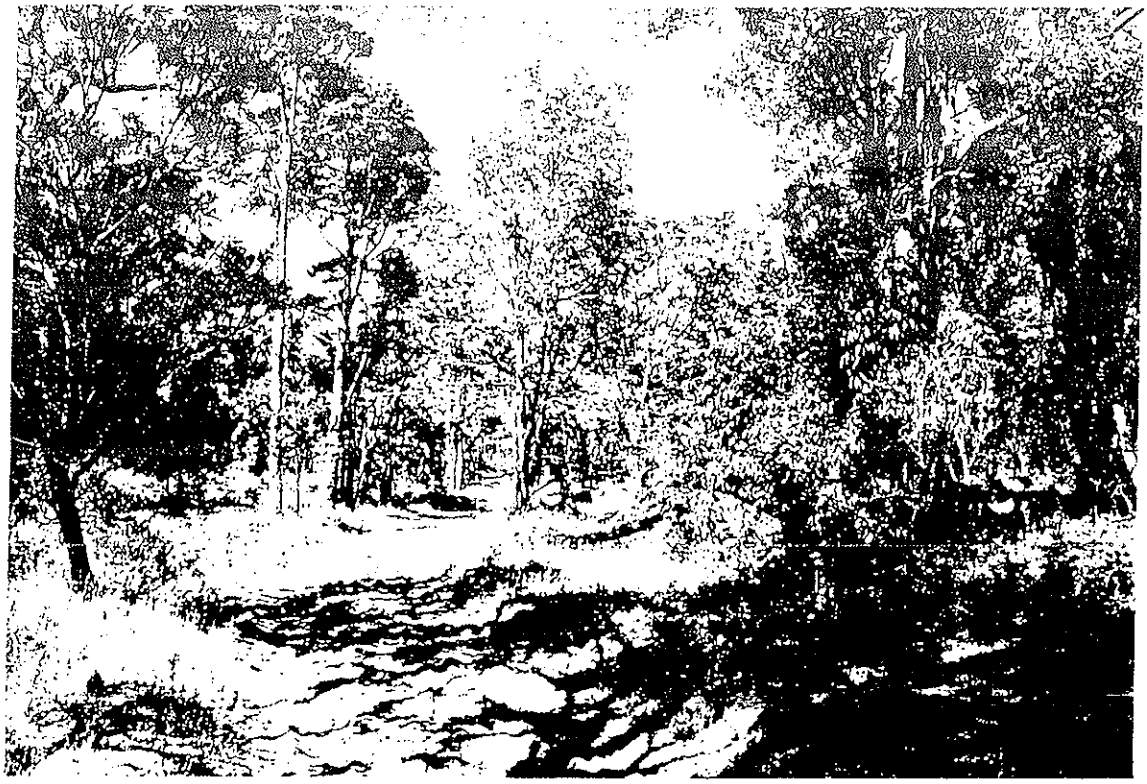

Plate 3 View of the Mixed Eucalypt Woodland near the northern end of the Site. Weeds are prevalent along the edge of the path

Plate 4 View of the Melaleuca thickets on the edge of the Wetland (south-west corner)

Plate 5. Central area of the Wetland with low Samphires and Sedges. This shows the compaction resulting from vehicle access

Appendix 1 *Checklist of the Vascular Flora on the Meadow Springs site.*

Note: Taxa not native to the site are indicated with and asterisk (*)

FAMILY ZAMIACEAE

Macrozamia riedlei

FAMILY TYPHACEAE

* Typha orientalis

FAMILY POACEAE

* Avena species
* Briza maxima
* Bromus diandrus
* Cynodon dactylon
* Ehrharta longiflora
* Lolium perenne
* Phalaris species
* Stenotaphrum secundatum

FAMILY CYPERACEAE

Baumea articulata
* Cyperus tenuiflorus
Gahnia trifida
Isolepis nodosus
Isolepis stellata
Lepidosperma species
Schoenus grandiflorus

FAMILY RESTIONACEAE

Loxocarya flexuosa

FAMILY JUNCACEAE

Juncus pallidus

FAMILY DASYPOGONACEAE

Acanthocarpus preissii
Lomandra maritima

FAMILY XANTHORRHOEACEAE

Xanthorrhoea preissii

FAMILY PHORMIACEAE

Dianella ?revoluta

FAMILY ANTHERICACEAE

Caesia micrantha
Chamaescilla corymbosa
Corynotheca micrantha
Sowerbaea laxiflora
Thysanotus species
Tricoryne elatior

FAMILY ASPHODELACEAE

* Trachyandra divaricata

FAMILY COLCHICACEAE

Burchardia umbellata

FAMILY HAEMODORACEAE

Anigozanthos humilis
Anigozanthos manglesii
Conostylis setigera

FAMILY ORCHIDACEAE

Caladenia flava
Caladenia latifolia
Caladenia speciosa
Diuris corymbosa

FAMILY CASUARINACEAE

Allocasuarina fraseriana
Allocasuarina humilis

FAMILY PROTEACEAE

Banksia attenuata
Banksia grandis
Banksia menziesii
Conospermum triplinervum
Dryandra nivea
Grevillea crithmifolia
Grevillea preissii subsp. preissii
Grevillea vestita
Hakea lissocarpha
Hakea prostrata
Hakea trifurcata

FAMILY SANTALACEAE

Exocarpos sparteus

FAMILY POLYGONACEAE

* Rumex pulcher

FAMILY CHENOPODIACEAE

Halosarcia ?pergranulata
Rhagodia baccata
Suada australis

FAMILY AMERANTHACEAE

Ptilotus polystachyus

FAMILY GYROSTEMONACEAE

Tersonia cyathiflora

FAMILY AIZOACEE

* Carpobrotus edulis

FAMILY CARYOPHYLLACEAE

* Cerastium glomeratum
* Petrorhagia velutina

FAMILY RANUNCULACEAE

Clematis microphylla

FAMILY BRASSICACEAE

* Brassica tournefortii
* Heliophila pusilla

FAMILY DROSERACEAE

Drosera macrantha

FAMILY CRASSULACEAE

Crassula colorata

FAMILY MIMOSACEAE

Acacia cochlearis
Acacia cyclops
Acacia pulchella
Acacia saligna

FAMILY PAPILIONACEAE

Bossiaea eriocarpa
Gompholobium tomentosum
Hardenbergia comptoniana
Isotropis cuneifolia
Jacksonia furcellata
Kennedia prostrata
* Lupinus species
* Ornithopus compressus
Templetonia retusa
* Trifolium campestre
* Trifolium hirtum

FAMILY GERANIACEAE

* Erodium botrys
Geranium retrorsum
* Pelargonium capitatum

FAMILY EUPHORBIACAEA

Adriana quadripartita
* Euphorbia peplus
Phyllanthus calycinus

FAMILY RHAMNACEAE

Spyridium globulosum
Trymalium ledifolium

FAMILY DILLENIACEAE

Hibbertia hypericoides
Hibbertia subvaginata

FAMILY VIOLACEAE

Hybanthus calycinus

FAMILY MYRTACEAE

Eucalyptus calophylla
Eucalyptus gomphocephala
Eucalyptus marginata

Melaleuca acerosa
Melaleuca cuticularis
Melaleuca huegelii
Melaleuca rhaphiophylla

FAMILY APIACEAE

Eryngium rostratum
* Hydrocotyle ranunculoides

FAMILY EPACRIDACEAE

Leucopogon species

FAMILY ASCLEPIADACEAE

* Gomphocarpus fructicosus

FAMILY CONVOLVULACEAE

Wilsonia backhousei

FAMILY SOLANACEAE

* Solanum sodomeum

FAMILY MYOPORACEAE

Eremophila glabra

FAMILY RUBIACEAE

Opercularia hispidula

FAMILY GOODENIACEAE

Scaevola anchusifolia

FAMILY ASTERACEAE

* Arctotheca calendula
* Carduus species
* Hypochaeris glabra
Olearia axillaris
Ozothamnus cordatus
Podolepis gracilis
Senecio lautus
* Ursinia anthemoides

Appendix 2 ***Full listing of the birds, mammals, frogs and reptiles for the native vegetation of the Meadow Springs Project Area. Species recorded during the August 1996 survey are indicated, as are species protected under the Wildlife Conservation Act. Habitat specific fauna are linked to the habitat number given in Section 3.1.1.***

BIRD SPECIES	STATUS	HABITAT SPECIFIC	RECORDED
DROMAIIDAE			
Emu			
ARDEIDAE			
White-faced Heron		4	
ANATIDAE			
Australian Shelduck		4	
Pacific Black Duck		4	X
Grey Teal		4	
Hardhead		4	
Maned Duck		4	
ACCIPITRIDAE			
Black-shouldered Kite			
Square-tailed Kite	CALM Priority List		
Whistling Kite			
Brown Goshawk			
Collared Sparrowhawk			
Wedge-tailed Eagle			
Little Eagle			
Marsh Harrier		4	
FALCONIDAE			
Peregrine Falcon	Rare List		
Australian Hobby			
Brown Falcon			
Australian Kestrel			X
PHASIANIDAE			
Brown Quail			
TURNICIDAE			
Painted Button-quail			
RALLIDAE			
Australian Crake		4	
Spotless Crake		4	
Black-tailed Native-hen		4	
Dusky Moorhen		4	X
Purple Swamphen		4	
Eurasian Coot		4	
CHARADRIIDAE			
Black-fronted Plover			
COLUMBIDAE			
Feral Pigeon	Introduced		X
Spotted Turtle-Dove	Introduced		X
Laughing Turtle-Dove	Introduced		X
Common Bronzewing			
Brush Bronzewing	CALM Priority List		
CACATUIDAE			
Red-tailed Black-Cockatoo	CALM Priority List		
Baudin's Black-Cockatoo	Rare List		
Carnaby's Black-Cockatoo	Rare List		X
LORIIDAE			
Purple-crowned Lorikeet			
POLYTELITIDAE			
Regent Parrot			X
PLATYCERCIDAE			
Red-capped Parrot			X
Western Rosella			
Port Lincoln Ringneck			X
Elegant Parrot			
CUCULIDAE			
Pallid Cuckoo			
Fan-tailed Cuckoo			
Horsfield's Bronze-Cuckoo			X
Shining Bronze-Cuckoo			X
STRIGIDAE			
Southern Boobook			

	STATUS	HABITAT SPECIFIC	RECORDED
TYTONIDAE			
Barn Owl			
PODARGIDAE			
Tawny Frogmouth			
AEGOTHELIDAE			
Australian Owlet-nightjar			
ALCEDINIDAE			
Laughing Kookaburra	Introduced		X
Sacred Kingfisher			
MEROPIDAE			
Rainbow Bee-eater			
HIRUNDINIDAE			
White-backed Swallow			
Welcome Swallow			
Tree Martin			
MOTACILLIDAE			
Richard's Pipit			
CAMPEPHAGIDAE			
Black-faced Cuckoo-shrike			X
MUSCICAPIDAE			
Scarlet Robin			
Western Yellow Robin			
Golden Whistler			X
Rufous Whistler			
Grey Shrike-thrush			X
Grey Fantail			X
Willie Wagtail			
MALURIDAE			
Splendid Fairy-wren			X
White-winged Fairy-wren		3	
Variegated Fairy-wren		3	
Southern Emu-wren		3	
ACANTHIZIDAE			
White-browed Scrubwren			X
Weebill			X
Western Gerygone			X
Inland Thornbill			
Western Thornbill			
Yellow-rumped Thornbill			X
NEOSITTIDAE			
Varied Sittella			
MELIPHAGIDAE			
Red Wattlebird			X
Little Wattlebird			
Singing Honeyeater			
White-naped Honeyeater			X
Brown Honeyeater			X
New Holland Honeyeater			X
White-cheeked Honeyeater			
Tawny-crowned Honeyeater		3	
Western Spinebill			
DICAEIDAE			
Mistletoebird			
PARDALOTIDAE			
Spotted Pardalote			X
Striated Pardalote			X
ZOSTEROPIDAE			
Silvereye			X
GRALLINIDAE			
Australian Magpie-lark			X
ARTAMIDAE			
Black-faced Woodswallow			
Dusky Woodswallow			X
CRACTICIDAE			
Grey Butcherbird			X
Australian Magpie			X
Grey Currawong			
CORVIDAE			
Australian Raven			X

		STATUS	HABITAT SPECIFIC	RECORDED
MAMMAL SPECIES				
TACHYGLOSSIDAE	Monotremes			
Tachyglossus aculeatus	Echidna			
DASYURIDAE	Native Carnivores			
Phascogale tapoatafa	Brush-tailed Phascogale	CALM Priority List	1,2	
Sminthopsis griseoventer	Grey-bellied Dunnart			
PERAMELIDAE	Bandicoots			
Isoodon obesulus	Southern Brown Bandicoot	Rare List	4	X
PHALANGERIDAE				
Trichosurus vulpecula	Common Brushtail Possum		1,2	
BURRAMYIDAE	Pygmy Possums			
Cercartetus concinnus	Western Pygmy-possum			
TARSIPEDIDAE	Honey Possums			
Tarsipes rostratus	Honey-possum		3	
MACROPODIDAE	Kangaroos			
Macropus irma	Western Brush Wallaby	CALM Priority List		
M. fuliginosus	Western Grey Kangaroo			X
MOLOSSIDAE	Mastiff-bats			
Tadarida australis	White-striped Mastiff-bat			
Mormopterus planiceps	Little Mastiff-bat			
VESPERTILIONIDAE	Bats			
Nyctophilus major	Greater Long-eared Bat			
N. gouldi	Gould's Long-eared Bat			
N. geoffroyi	Lesser Long-eared Bat			
Chalinolobus gouldii	Gould's Wattled Bat			
Chalinolobus morio	Chocolate Wattled Bat			
Falsistrellus mackenziei	Great Pipistrelle			
Eptesicus regulus	Little Brown Bat			
MURIDAE	Rodents			
Rattus rattus	Black Rat	Introduced		
Mus musculus	House Mouse	Introduced		
LEPORIDAE	Rabbits/Hares			
Oryctolagus cuniculus	Rabbit	Introduced		X
CANIDAE	Carnivores			
Vulpes vulpes	Fox	Introduced		X
FELIDAE	Cats			
Felis catus	Feral Cat	Introduced		
AMPHIBIAN AND REPTILE SPECIES				
MYOBATRACHIDAE	Ground Frogs			
Crinia georgiana	Red-thighed Froglet		4	
C. glauerti	Glauert's Froglet		4	
C. insignifera	Sandplain Froglet		4	X
Heleioporus eyrei	Moaning Frog			
H. psammophilus	Marbled Burrowing Frog			
Limnodynastes dorsalis	Western Banjo Frog		4	X
Myobatrachus gouldii	Turtle Frog			
Pseudophryne guentheri	Guenther's Toadlet			X
HYLIDAE	Tree Frogs			
Litoria adelaidensis	Slender Tree Frog		4	X
L. moorei	Western Green Tree Frog		4	
GEKKONIDAE	Geckos			
Phyllodactylus marmoratus	Marbled Gecko			X
Underwoodisaurus milii	Barking Gecko			
PYGOPODIDAE	Legless Lizards			
Aprasia repens	South-western Sandplain Worm Lizard			
Delma fraseri	Fraser's Legless Lizard			
D. gravii	Gray's Legless Lizard			
Lialis burtonis	Burton's Snake-lizard			
Pygopus lepidopodus	Common Scaly-foot			
AGAMIDAE	Dragon Lizards			
Pogona m. minor	Western Bearded Dragon			
SCINCIDAE	Skinks			
Bassiana trilineata	South-western Cool Skink		4	
Cryptoblepharus plagiocephalus	Fence Skink			X
Ctenotus fallens	West Coast Ctenotus			
C. impar	South-western Odd-striped Ctenotus			
C. lesueurii	Western Limestone Skink			
Egernia napoleonis	South-western Crevice Egernia			
Hemiergis quadrilineata	Two-toed Earless Skink			
Lerista elegans	West Coast Four-toed Lerista			
L. lineata	Perth Lined Lerista	CALM Priority List	3	
L. praepedita	Western Worm Lerista			

		STATUS	HABITAT SPECIFIC	RECORDED
Menetia greyii	Common Dwarf Skink			
Morethia lineoocellata	Western Pale-flecked Morethia			
M. obscura	Southern Pale-flecked Morethia			
Tiliqua occipitalis	Western Bluetongue			
T. r. rugosa	Bobtail			X
VARANIDAE	**Monitors**			
Varanus gouldii	Gould's Monitor			
V. rosenbergi	Southern Heath Monitor			
TYPHLOPIDAE	**Blind Snakes**			
Ramphotyphlops australis	Southern Blind Snake			
ELAPIDAE	**Elapid Snakes**			
Drysdalia coronata	Crowned Snake			
Neelaps bimaculatus	Black-naped Snake*			
N. calonotus	Black-striped Snake	CALM Priority List	3	
Notechis scutatus occidentalis	Tiger Snake			
Pseudonaja a. affinis	Dugite			
Rhinoplocephalus gouldii	Gould's Hooded Snake			
R. nigriceps	Black-backed Snake			
Simoselaps bertholdi	Jan's Banded Snake			
S. semifasciatus	Southern Half-girdled Snak			