

Maddington - Kenwick Strategic Industrial Area

Environmental Review Flora, Vegetation, Fauna and Wetlands

Prepared for: City of Gosnells

Prepared by: Cardno BSD PTY LTD
Cardno BSD Centre, 2 Bagot Road
PO Box 155, Subiaco, WA, 6904
Telephone (08) 9273 3888
Facsimile (08) 9388 3831

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EXECUTIVE SUMMARY

The City of Gosnells intends to progress an intensive process for a possible new industrial area in the rural areas in Maddington and Kenwick (**Figure 1**). The study area is approximately 348 hectares and is located approximately 10 kilometres southeast of the Perth, bounded by Tonkin Highway and the local government boundary to the east, Bickley Road to the west and Roe Highway to the north.

The study area has been marked as a future ‘Strategic Industrial Area’ at a state level in *Metroplan*, and at a local level in the City of Gosnells *Foothills Structure Plan*. It is envisaged that an Outline Development Plan (ODP) will be prepared to facilitate amendments to both the Metropolitan Region Scheme and the local Town Planning Scheme.

A botanist from BSD Consultants undertook the field-based assessment over one day in October 2004. The proposal area was surveyed by traversing the areas of remnant vegetation on foot, using a compass and GPS unit. Field investigations for fauna habitat and fauna, discussions and report preparation were carried out by Dr Mike Bamford (*B.Sc.(Hons.), Biol; Ph.D. Biol.*).

A total of 199 taxa, comprising 53 families and 145 genera were recorded in the project area (**Appendix A**). Species representation was greatest among the Myrtaceae, Papilionaceae and Cyperaceae families. Sixty introduced (weed) species were collected. Weeds were abundant in the Poaceae (grasses), Iridaceae (irises) and Papilionaceae (pea flowers) families. Two Declared Rare Flora, one Priority 1 and one Priority 3 species were identified within the study area.

Twenty-two local vegetation communities were described in the area, most being locally rare due to long-term clearing in the area. Five Threatened Ecological Communities (TECs) were identified in the area.

The fauna of the study area is depauperate because of habitat loss, the degraded state of most remaining habitat and the absence of large tracts of undisturbed habitat immediately adjacent. The study area also lacks species-rich habitats such as banksia woodland on sand. However, the study area does support extensive, albeit degraded, seasonal wetlands, and its location is important for linkage, or potential linkage, between habitat corridors on the coastal plain (Canning River and rehabilitation along the Roe and Tonkin Highways) and extensive habitats along the Darling Escarpment. Its location is also important because the study area surrounds two Bush Forever sites, with the Greater Brixton Street Wetland (Bush Forever Site 387) of particular significance.

The majority of the study area is mapped by the Department of Environment (DoE) as wetlands. Excluding Bush Forever areas, four ‘Conservation’ Category wetlands (CCWs) are mapped in the study area. Five wetlands are recommended by this study for referral for re-classification from the DoE’s existing management category. A larger area of Resource Enhancement Wetland (REW) could potentially be reclassified, however a more detailed surface hydrology and groundwater study would be required to establish interactions between these areas and significant CCW areas within the Brixton Street Wetlands.

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1. INTRODUCTION

The City of Gosnells intends to progress the planning process for a possible new industrial area to be situated in rural areas in Maddington and Kenwick (**Figure 1**). The study area is approximately 348 hectares and is located approximately 10 kilometres south-east of the Perth, bounded by Tonkin Highway and the local government boundary to the east, Bickley Road to the west and Roe Highway to the north.

The study area has been marked as a future ‘Strategic Industrial Area’ at a state level in *Metroplan*, and at a local level in the City of Gosnells *Foothills Structure Plan*. It is envisaged that an Outline Development Plan (ODP) will be prepared to facilitate amendments to both the Metropolitan Region Scheme and the local Town Planning Scheme.

A critical element in formulating the ODP is an understanding of the prevailing environmental opportunities and constraints that exist within the study area, and how these can be addressed during the planning process to the satisfaction of the key State and Commonwealth environmental regulators (Environmental Protection Authority and the Department of Environment and Heritage respectively), and to satisfy the City’s own sustainable development objectives.

Clearing in the eastern Swan Coastal Plain has had significant impact on the vegetation communities in the area leaving many with less than 10% of pre-European extent or disturbed beyond the ability to recover. Beard (1990) noted that natural vegetation on the eastern side of the Swan Coastal Plain was so restricted that there was no undisturbed vegetation left. Due to this, within the City of Gosnells there are a large number of significant environmental factors such as Threatened Ecological Communities (TECs), protected wetlands and significant flora.

The conservation significance of the area is exemplified by the two Bush forever sites within the study area, Bush Forever site 387 - Greater Brixton Street Wetlands, Kenwick and Bush Forever site 53 – Clifford Street Bushland, Maddington. Both sites combined support one TEC recognised at a federal level, five TECs recognised at a state level and a number of threatened flora species and migratory bird species. Bush Forever sites were excluded from this strategic industrial area environmental study by the City of Gosnells.

In addition, Bush Forever site 387 – Greater Brixton Street Wetlands is listed on the Register of the National Estate as a natural feature. According to the Australian Heritage Database (2004); “*Brixton Street and associated wetlands is an outstanding place of high botanical and educational significance and is listed in the Australian Register of Significant Wetlands. The place contains the last substantial wetland plant community found on the claypans of the Swan Coastal Plain.*”

Generally, the study area is highly disturbed and used predominantly for light rural industry and horse agistment. Areas of remnant vegetation are mostly small, disturbed and threatened by surrounding uses and therefore an understanding of the sensitivity and ecology of the area is critical when approaching strategic planning for the area. This report details ecological survey undertaken by Cardno BSD in order to provide initial environmental assessment that will form a critical input into the ODP development process.

2. AIM AND METHODS

The aim of this survey was to produce a flora/vegetation, fauna and wetlands assessment to provide environmental information to support the ODP process for the Maddington/Kenwick Strategic Industrial Area.

The objectives of the project brief are to:

- To provide an understanding of the wetland values within the study area;
- To provide an understanding of floristic values within the study;
- To provide a review of fauna values within the study area;
- To provide sufficient level of information to enable land use planning that will meet the City's sustainable development objectives, and satisfy the development's likely formal Environmental Impact Assessment by the EPA; and
- Produce a report summarising the findings.

2.1 FLORA SURVEY METHODOLOGY

A botanist from BSD Consultants undertook the field-based assessment over one day in October 2004. The proposal area was surveyed by traversing the areas of remnant vegetation on foot, using a compass and GPS unit.

2.1.1 *Flora*

The flora survey and assessment was carried out in accordance with the following guidance and position statements:

- EPA Position Statement No. 2 - *Environmental Protection of Native Vegetation in Western Australia* (EPA 2001a).
- EPA Position Statement No. 3 - *Terrestrial biological surveys as an element of biodiversity protection* (EPA 2001b).
- EPA Guidance statement No. 10 - *Level of assessment for proposals affecting natural areas within the System 6 Region and Swan Coastal Plain portion of the System 1 Region* (EPA 2003a).
- EPA Guidance statement No. 51 - *Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia* (EPA 2003b).

Prior to fieldwork, a desktop analysis was conducted of the existing information for the Declared Rare and Priority Flora database records on species known to occur in the region (CALM 2002). Relevant species were examined at the Western Australian Herbarium prior to the field survey being undertaken. A literature review was also undertaken to review the flora and vegetation previously described for the area.

Plot-based recording of the flora was undertaken in each major vegetation community type, located within areas of good quality vegetation, using a 10 x 10 metre monitoring plots. Recording plots were not permanently constructed. For each survey site, the flora was systematically recorded and collections of plant specimens were made where further identification was required. Non-quantitative opportunistic

recordings/collections were then made outside of the plot (within the same vegetation community type) of species that were not recorded within the monitoring plot. The recordings from each plot, photographic representation and opportunistic collections within the same community types are set out in the appendices.

All plant specimens collected during the field survey were handled and identified in accordance with the requirements of the Western Australian Herbarium. Where necessary, specimens were compared with pressed specimens housed at the Western Australian Herbarium. Nomenclature of recorded species follows that recommended by the Western Australian Herbarium protocols. Voucher specimens of Declared Rare Flora and Priority specimens/records identified will be lodged with the Western Australian Herbarium.

2.1.2 *Vegetation*

The vegetation communities occurring within the proposal area were described in detail in October 2004. The use of a standard data collection form ensured that the data was collected in a systematic and consistent manner. At each site the following records were made: condition rating, disturbance, topography, percentage litter cover, soil ratio, percentage bare ground, outcropping rocks and their type, and age since fire. For each species recorded, the average height and percent foliage cover of species were noted.

Aerial photography was used to extrapolate and map plant communities at a scale of 1:5000, in combination with running notes made during the course of the survey. Vegetation condition was also recorded at each plot-based assessment and through running notes made while traversing the proposal area.

2.1.3 *Vegetation Condition*

Many bushland remnants in urban areas have been historically subject to ongoing degradation and are especially susceptible to disturbances arising as a result of indirect impacts from surrounding developments and human activity. Degradation is caused by a wide range of factors, including isolation and edge effects, weed invasion, plant diseases, changes in fire frequency and behaviour, landscape fragmentation, decrease in species richness and general modification of ecological function. These issues can affect the biodiversity rating and ecological viability of areas of remnant vegetation and should be assessed in line with conservation values.

Vegetation condition was rated according to the vegetation condition scale commonly used in the Perth Metropolitan Region (Government of WA 2000), and is summarised further in **Table 1**.

Table 1: Vegetation Condition Scale (Taken from Bush Forever (Government of WA 2000))

Vegetation Condition	Definition
Pristine (1)	Pristine or nearly so, no obvious signs of disturbance.
Excellent (2)	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good (3)	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
Good (4)	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded (5)	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded (6)	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

2.1.4 *Vegetation Significance Analysis*

To determine the conservation and reservation status of the vegetation type defined for the site, a comparison was made with vegetation community types identified in Gibson *et al.* (1994) and Heddle *et al.* (1980).

An analysis of species recorded on the site was compared with the database produced from the Gibson *et al.* (1994) survey of the Swan Coastal Plain. Species found on the site were added to a column in the database and a simple true/false formula compared the presence of the species in the survey area and each Floristic Community Type (FCT) column. The true/false result was then converted to either 0 or 1 with another formula and added to give the number of flora species in each FCT that were the same as those occurring in the survey area.

Regional vegetation mapping in the area (Heddle *et al.* 1988) was compared with poorly conserved vegetation types outlined in the EPA Guidance statement No. 10 - *Level of assessment for proposals affecting natural areas within the System 6 Region and Swan Coastal Plain portion of the System 1 Region (EPA 2003a)*.

2.1.5 *Limitations*

The limitation of the survey period is the interception of *Caladenia sp.* Jarrah Forest (S.D.Hopper 3990), listed as taxonomically similar to *Caladenia arrecta* (P4) or *Arachnorchis arrecta*, both of which are included in the EPBC Act flora lists. *Caladenia arrecta* (P4) is known to flower between August and October therefore survey in October may be a little late to intercept all flowering specimens. Additionally, *Dryandra mimica* (R) is out of its flowering period during October but is a perennial species and

identification can be made by taxonomic identification and comparison with specimens held at the Western Australian Herbarium. The botanical survey was held at the optimum time to intercept the majority of significant species.

As the study area is mostly held as private land, some access was restricted by owner's wishes and access complications (gates, dogs and horses), therefore not all the remnant vegetation within the study area was available for survey. Vegetation community, condition and wetland communities within areas not available for access have been extrapolated from close-by or adjoining remnants.

2.2 FAUNA SURVEY METHODOLOGY

2.2.1 *Site Inspection*

The fauna assessment is classified as a "Level 1 Survey" (a background research or 'desk-top' study and a reconnaissance survey) in accordance with the *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*. Guidance Statement No. 56. EPA, Perth.

The site was visited on 17th November 2004. The purpose of the site visit was to identify the habitats present, to make opportunistic records of fauna and to familiarise the consultant with the site, so that general fauna records from the region could be placed into the perspective of the fauna habitats available within the study area. Field investigations, discussions and report preparation were carried out by Dr Mike Bamford (*B.Sc.(Hons.), Biol; Ph.D. Biol.*), and a qualified and experienced terrestrial zoologist.

2.2.2 *Sources of Information*

A site inspection cannot be expected to record all species present in an area, particularly when it takes place in only one season, and therefore the observations were supplemented with records from a number of sources. The fauna of the Perth region is fairly well-known, with general information on distribution and habitats available for frogs (Tyler *et al.* 2000), reptiles (Storr *et al.* 1983, 1990, 1999 and 2002), birds (Barrett *et al.* 2003; Johnstone and Storr 1998; the Handbook of Australian and New Zealand Birds 1989 - 2003) and mammals (Menkhorst and Knight 2001; Strahan 1995). In addition, there are some publications specific to the Perth area, including Bush *et al.* (1995), van Delft (1997) and Wykes (1991). To supplement these publications, specimen records of frogs, reptiles and mammals held by the WA Museum (Faunabase) were obtained for the region bounded by 32° 07' to 32° 13'S, and 115° 52' to 115° 58'E, with further information on threatened species from the threatened fauna database maintained by the WA Department of Conservation and Land Management (CALM) and the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC) database. Both these were searched for the area 32° 05' to 32° 15'S, and 115° 50' to 116° 00'E. Finally, extensive personal records, including the results of previous site inspections in the Brixton Street Wetlands area, were accessed, while some observations from surveys of the Roe Highway wetlands were provided by Eddie Canella (pers. comm.).

These sources of information were used to create lists of species expected to occur at the site, based on the habitats available. Expected species are those that are likely to utilise the project area, and such lists exclude

species that have been recorded in the general region as vagrants or for which suitable habitat is absent. The lists also exclude locally extinct species.

Taxonomy and nomenclature for fauna species used in this report generally follow the WA Museum (2001) for amphibians, reptiles and mammals, and Christidis and Boles (1994) for birds.

2.2.3 Assessment of Conservation Significance

The conservation status of fauna species is assessed under Commonwealth and State Acts such as the EPBC Act and the *Western Australian Wildlife Conservation Act 1950*. The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994). The *WA Wildlife Conservation Act 1950* uses a set of Schedules but also classifies species using some of the IUCN categories. These categories and Schedules are described in Appendix One.

The EPBC Act also has lists of migratory species that are recognised under international treaties such as the *China Australia Migratory Bird Agreement (CAMBA)*, the *Japan Australia Migratory Bird Agreement (JAMBA)* and the *Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals)*. The list of migratory species under the EPBC Act has been revised to include listed species only, thus excluding family listings. Those species listed in JAMBA are also protected under Schedule 3 of the *WA Wildlife Conservation Act*. In addition, the EPBC Act lists marine species but this listing applies only to Commonwealth administered waters and lands.

The Department of the Environment and Heritage (DEH, formerly Environment Australia) has also supported the publication of reports on the conservation status of most vertebrate fauna species (e.g. reptiles (Cogger *et al.* 1993), birds (Garnett and Crowley 2000), monotremes and marsupials (Maxwell *et al.* 1996), rodents (Lee 1995) and bats (Duncan *et al.* 1999)). These publications use the IUCN categories, although those used by Cogger *et al.* (1993) differ in some respects as this report pre-dates the Mace and Stuart (1994) review.

In Western Australia, CALM has produced a supplementary list of Priority Fauna, being species that are not considered Threatened under the WA Act but for which the Department feels there is cause for concern. Some Priority species, however, are also assigned to the IUCN Conservation Dependent category. Levels of Priority are described in Appendix One.

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

Forever - Government of Western Australia (2000). *Bush Forever, Vol.1 & 2*. Government of Western Australia, Perth. Such species may have significance to the Maddington-Kenwick Strategic Industrial Area.

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

- *Conservation Significance (CS) 1*: Species listed under State or Commonwealth Acts.
- *Conservation Significance (CS) 2*: Species not listed under State or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by CALM.
- *Conservation Significance (CS) 3*: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

See **Appendix C** for further explanation of these conservation significance categories

2.2.4 *Limitations to Fauna Assessment*

The emphasis of the fauna review was upon vertebrate species for which patterns of distribution and habitat associations are relatively well known compared with invertebrate fauna. The fauna survey has been conducted as a preliminary assessment and is not intended to be a conclusive statement of all fauna potentially occurring in the area.

2.3 **WETLAND ASSESSMENT METHODOLOGY**

In order to determine the adequacy and accuracy of the “management category” attached to wetlands mapped in the DoE’s geomorphic wetland series, a field survey was undertaken in association with flora and vegetation survey to ‘groundtruth’ the wetland’s management category.

The DoE geomorphic wetlands mapping was used to separate mapped wetlands and each wetland was surveyed using vegetation survey techniques described in **Section 2.1.2** and **2.1.3**. Wetland vegetation complex, condition and proximity to other wetlands were used in the recommendations for potential reclassification.

3. FLORA AND VEGETATION

3.1 BACKGROUND

The proposal area lies on the Swan Coastal Plain within the Drummond Botanical Subdistrict of the Southwestern Botanical Province, as described by Beard (1990). Flora composition of the Swan Coastal Plain Subregion has been described by Beard (1990) as consisting of *Banksia* Low Woodlands on leached sands with *Melaleuca* swamps where ill drained and Woodlands of *Eucalyptus* spp. on less leached soils.

During the assessment of the natural resources of the Darling System in the late 1970s, the vegetation was described and mapped by Heddle *et al.* (1980) to reflect the influence of landform, soils and climate on the distribution of the plant communities. Based on this mapping, the vegetation complex that occurs on the proposal area is of the Guildford Vegetation Complex. Typical vegetation on the Guildford vegetation complex is Open Forest of *Corymbia calophylla* – *Eucalyptus marginata* – *Eucalyptus wandoo* on elevated areas with Woodlands of *Eucalyptus rudis* (flooded gum) – *Melaleuca raphiophylla* on the low lying areas and drainage lines that dissect the flatter unit. Understorey species common to the area are *Banksia grandis*, *Xanthorrhoea preissii*, *Kingia australis* and species of *Hardenbergia* and *Hibbertia*.

3.1.1 Declared Rare and Priority Flora

Species of flora or fauna acquire Declared Rare or Priority conservation status where populations are restricted geographically or threatened by local processes. CALM recognise these threats and subsequently applies regulations towards population protection and species conservation. CALM enforce regulations under the *Wildlife Conservation Act 1950* to conserve Declared Rare species and protect significant populations. Priority Flora species are potentially rare or threatened and are classified in order of threat. Declared Rare and Priority Flora category definitions are listed in **Table 2**.

Table 2: Definition of Rare and Priority Flora Species (CALM 2004)

Conservation Code	Category
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.
P1	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 eg road verges, urban areas, farmland, active mineral leases etc, or the plants are under threat, eg from disease, grazing by feral animals etc. Such taxa are under consideration for declaration as ‘rare flora’, but are in urgent need of further survey.
P2	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 urgently need further survey.
P3	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 need further survey.
P4	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.

3.1.2 Environment Protection and Biodiversity Conservation Act (1999)

The EPBC Act promotes the conservation of biodiversity by providing strong protection for plants at a species level. Section 178 and 179 provides the lists and categories of threatened species under the Act and is summarised in **Table 3**.

Table 3: Categories of Threatened Species (EPBC Act, Section 179, 1999)

Extinct
Taxa which is known only to survive in cultivation, in captivity or as a naturalised population, well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered
Taxa which is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
Endangered
Taxa which are not critically endangered and is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable
Taxa which is not endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation Dependant
A species that is the focus of a specific conservation program; the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

The EPBC Act (1999) also provides for the strong protection of plant communities, or TECs, which are listed under section 181 of the Act and are described as ‘Critically Endangered’, ‘Endangered’ or ‘Vulnerable’ under section 182.

3.2 THREATENED SPECIES DATABASE SEARCH

A search of CALM and Environment Australia’s threatened flora species database for the general Maddington/Kenwick area returned a number of Declared Rare and Priority Flora species (**Table 4**).

Table 4: Threatened Flora Species Potentially Occurring in the general Maddington/Kenwick Area

CALM Listed	EPBC Listed	Genus	Species
R	E	<i>Andersonia</i>	<i>gracilis</i>
R	E	<i>Calytrix</i>	<i>breviseta</i> subsp. <i>breviseta</i>
R	E	<i>Diuris</i>	<i>purdiei</i>
R	E	<i>Dryandra</i>	<i>mimica</i>
R	E	<i>Hydatella</i>	<i>dioica</i>
R	E	<i>Lepidosperma</i>	<i>rostratum</i>
R	E	<i>Thelymitra</i>	<i>stellata</i>
R	V	<i>Conospermum</i>	<i>undulatum</i>
R	V	<i>Eleocharis</i>	<i>keigheryi</i>
P1		<i>Schoenus</i>	<i>pennisetis</i>

CALM Listed	EPBC Listed	Genus	Species
P2		<i>Acacia</i>	<i>oncinophylla</i>
P2		<i>Byblis</i>	<i>gigantea</i>
P2		<i>Comesperma</i>	<i>rhadinocarpum</i>
P2		<i>Schoenus</i>	<i>capillifolius</i>
P3		<i>Acacia</i>	<i>horridula</i>
P3		<i>Aotus</i>	<i>cordifolia</i>
P3		<i>Baeckea</i>	<i>tenuifolia</i>
P3		<i>Baeckea</i>	sp. Perth Region
P3		<i>Dryandra</i>	<i>pteridifolia</i>
P3		<i>Eryngium</i>	<i>subdecumbens</i> (ms)
P3		<i>Gastrolobium</i>	<i>acutum</i>
P3		<i>Haemodorum</i>	<i>loratum</i>
P3		<i>Haloragis</i>	<i>tenuifolia</i>
P3		<i>Isopogon</i>	<i>drummondii</i>
P3		<i>Lambertia</i>	<i>multiflora</i> var. <i>darlingensis</i>
P3		<i>Leucopogon</i>	<i>glaucifolius</i>
P3		<i>Olax</i>	<i>scalariformis</i>
P3		<i>Rhodanthe</i>	<i>pyrethrum</i>
P3		<i>Schoenus</i>	<i>benthamii</i>
P3		<i>Schoenus</i>	sp. Waroona
P4		<i>Anthotium</i>	<i>junciforme</i>
P4		<i>Aponogeton</i>	<i>hexatepalus</i>
P4		<i>Astroloma</i>	<i>foliosum</i>
P4		<i>Calothamnus</i>	<i>rupestris</i>
P4		<i>Drosera</i>	<i>occidentalis</i> subsp. <i>occidentalis</i>
P4		<i>Grevillea</i>	<i>thelemanniana</i>
P4		<i>Hydrocotyle</i>	<i>lemnoides</i>
P4		<i>Lasiopetalum</i>	<i>bracteatum</i>
P4		<i>Stachystemon</i>	<i>axillaris</i>
P4		<i>Templetonia</i>	<i>drummondii</i>
P4		<i>Thysanotus</i>	<i>anceps</i>
P4		<i>Verticordia</i>	<i>lindleyi</i> subsp. <i>lindleyi</i>
P4		<i>Villarsia</i>	<i>submersa</i>

3.3 THREATENED ECOLOGICAL COMMUNITIES DATABASE SEARCH

The City of Gosnells tender brief lists one TEC in the study area. Floristic Community Type (FCT) 3a is described as *Corymbia calophylla* – *Kingia australis* woodlands on heavy soils of the Swan Coastal Plain, based on the Gibson et al. (1994) floristic survey of the southern Swan Coastal Plain. This vegetation type

has been recorded at Bush Forever site 387 - Greater Brixton Street Wetlands, Kenwick and Bush Forever site 53 – Clifford Street Bushland, Maddington and further occurrences are likely in the study area. It is listed as “Endangered” by the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

At a state level, FCT 3a is recognised as a “Critically Endangered” (CE) TEC by CALM. CALM also recognise a number of other TEC’s that are likely to occur in the general area (**Table 5**).

Table 5: Threatened Ecological Communities Potentially Occurring in the general Maddington/Kenwick Area

FCT	TEC Description	CALM Ranking	EPBC Ranking
3a	<i>Eucalyptus calophylla</i> – <i>Kingia australis</i> Woodlands on heavy soils	CE	E
3c	<i>Eucalyptus calophylla</i> – <i>Xanthorrhoea preissii</i> Woodlands and Shrublands	CE	E
20c	Eastern Shrublands and Woodlands	CE	E
10a	Shrublands on dry clay flats (most northern representation)	E	
20a	<i>Banksia attenuata</i> Woodland over species rich dense shrublands	E	
20b	Eastern <i>Banksia attenuata</i> and/or <i>Eucalyptus marginata</i> woodlands	E	
3b	<i>Corymbia calophylla</i> – <i>Eucalyptus marginata</i> woodlands on sandy clay soils	V	
7	Herb-rich saline shrublands in clay pans	V	
8	Herb-rich shrublands in clay pans	V	

3.4 FLORA

A total of 199 taxa, comprising 53 families and 145 genera were recorded in the project area (**Appendix A**). Species representation was greatest among the Myrtaceae, Papilionaceae and Cyperaceae families.

Sixty introduced (weed) species were collected. Weeds were abundant in the Poaceae (grasses), Iridaceae (irises) and Papilionaceae (pea flowers) families.

3.4.1 Declared Rare and Priority Flora

One species of Declared Rare Flora and one species of Priority Flora pursuant to subsection 2 of section 23F of the *Wildlife Conservation Act 1950* was identified within the study area.

Conospermum undulatum is listed as Declared Rare Flora by CALM and as ‘Vulnerable’ pursuant to section 178 of the EPBC Act. *Conospermum undulatum* (R) is endemic to the Perth region of the Swan Coastal

Plain. The species was located in a small population (<20) in remnant upland vegetation on Lot 25 Victoria Road.

One potential Declared Rare Flora species was recorded in the area, in association with a CCW at Lot 138 Boundary Road. *Calytrix breviseta* subsp. *breviseta* (R) is listed as ‘Vulnerable’ pursuant to section 178 of the EPBC Act. At this stage, the voucher specimen was identified to *Calytrix breviseta* subsp. ?*breviseta* (?R) as the specimen had finished flowering. It is recommended that Lot 138 Boundary Road is further surveyed at a suitable time to positively confirm the presence of this species.

As discussed in **Section 3.1.1**, Declared Rare Flora species are gazetted under subsection 2 of section 23F of the *Wildlife Conservation Act 1950* and therefore it is an offence to “take” or damage rare flora without Ministerial approval. Section 23F of the Act defines “to take” as “... to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora to cause or permit the same to be done by any means”. EPBC Act listed flora also requires application to the federal Minister for Environment to impact any species.

One Priority 1 Flora species was recorded on Lot 13 Victoria Road in association with TEC 3a. *Acacia lasiocarpa* var. *bracteolata* (P1) is endemic to the Swan Coastal Plain on the seasonally waterlogged and inundated heavy soils of the Pinjarra Plain.

One Priority 3 Flora species was also recorded at Lot 25 Victoria Road. *Isopogon drummondii* (P3) is endemic to the Swan Coastal Plain. Priority Flora do not have the same stringent application process to “take” individuals. However, CALM often demands a mitigation, such as another “like for like” Priority Flora habitat or reworking of a development application to reduce to impact to a Priority Flora species.

3.4.2 **Introduced Species**

Sixty weed (introduced) species were recorded on the site, which equates to approximately 30% of total vascular plant species recorded (**Appendix A**). The site survey revealed that the entire project area is infested with a number of common pasture weeds due to the local rural land uses.

Species include numerous invasive grasses such as Perennial Veldt Grass**Ehrharta calycina* and African Love Grass **Eragrostis curvula*, Flat weed **Hypochaeris glabra* and Cape weed, **Arctotheca calendula*.

Commonly occurring throughout the study area was **Watsonia meriana* var. *bulbifera* and Arum Lilly **Zantedeschia aethiopica*, particularly within damp areas.

3.5 **VEGETATION**

3.5.1 **Local Vegetation Communities**

Twenty-two vegetation communities were described during the flora and vegetation survey, and are described below in **Table 6**. The distribution of these vegetation communities is illustrated in **Figure 2**.

Table 6: Vegetation Communities Recorded during Study Area Survey – October 2004

Vegetation Community 1 - <i>Eucalyptus</i> Forests and Woodlands	
1a	Low Open Forest of <i>Corymbia calophylla</i> and <i>Eucalyptus marginata</i> over <i>Xanthorrhoea preissii</i> , <i>Acacia saligna</i> and <i>Spyridium globulosum</i> over * <i>Watsonia meriana</i> var. <i>bulbifera</i> , * <i>Ehrharta calycina</i> and * <i>Eragrostis curvula</i> in white sands.
1b	Low Open Forest of <i>Corymbia calophylla</i> over <i>Viminaria juncea</i> , <i>Xanthorrhoea preissii</i> and <i>Hypocalymma angustifolium</i> over <i>Lepidosperma leptostachyum</i> and <i>Mesomelaena tetragona</i> in white sands.
1c	Low Open Forest of <i>Eucalyptus marginata</i> and <i>Corymbia calophylla</i> over <i>Agonis flexuosa</i> over * <i>Freesia</i> sp., * <i>Ehrharta calycina</i> and * <i>Fumaria capreolata</i> in sandy soils.
1d	Low Open Forest of <i>Allocasuarina fraseriana</i> with <i>Eucalyptus marginata</i> over * <i>Leptospermum laevigatum</i> , <i>Jacksonia floribunda</i> and <i>Adenanthos cygnorum</i> over <i>Mesomelaena pseudostygia</i> , <i>Scaevola globulifera</i> and <i>Alexgeorgea nitens</i> in white sands.
1e	Low Woodland of <i>Corymbia calophylla</i> over <i>Xanthorrhoea preissii</i> and <i>Viminaria juncea</i> over * <i>Juncus kraussii</i> subsp. <i>australiensis</i> , * <i>Stenotaphrum secundatum</i> and * <i>Ehrharta calycina</i> in white sands.
1f	Low Open Woodland of <i>Eucalyptus rudis</i> over scattered <i>Melaleuca viminea</i> subsp. <i>viminea</i> over * <i>Watsonia meriana</i> var. <i>bulbifera</i> , * <i>Ehrharta calycina</i> and * <i>Lupinus cosentinii</i> .
Vegetation Community 2 – <i>Melaleuca</i> Forests and Woodlands	
2a	Low Closed Forest of <i>Melaleuca preissiana</i> with occasional <i>Eucalyptus rudis</i> over <i>Acacia saligna</i> , <i>Hypocalymma angustifolium</i> and <i>Regelia ciliata</i> over <i>Burchardia umbellata</i> , <i>Hypolaena exsulca</i> and <i>Patersonia occidentalis</i> in sands.
2b	Low Closed Forest of <i>Melaleuca preissiana</i> with occasional <i>Corymbia calophylla</i> and <i>Eucalyptus gomphocephala</i> over <i>Acacia saligna</i> over * <i>Medicago minima</i> , * <i>Ehrharta calycina</i> and * <i>Watsonia meriana</i> var. <i>bulbifera</i> in white sands.
2c	Low Closed Forest of <i>Melaleuca preissiana</i> over <i>Viminaria juncea</i> and <i>Xanthorrhoea preissii</i> over <i>Lepidosperma leptostachyum</i> and <i>Tetraria capillaris</i> in brown clay loam.
2d	Low Closed Forest of <i>Melaleuca preissiana</i> over * <i>Leptospermum laevigatum</i> , * <i>Fumaria capreolata</i> and * <i>Ehrharta calycina</i> in black sandy soils.
2e	Low Open Forest of <i>Melaleuca preissiana</i> with occasional <i>Eucalyptus rudis</i> over * <i>Oxalis pes-caprae</i> , * <i>Eragrostis curvula</i> , * <i>Stenotaphrum secundatum</i> and * <i>Paspalum dilatatum</i> in black sandy soils.
2f	Low Open Forest of <i>Melaleuca raphiophylla</i> over * <i>Stenotaphrum secundatum</i> , * <i>Arctotheca calendula</i> , * <i>Typha orientalis</i> and * <i>Zantedeschia aethiopica</i> in brown clay loam.
Vegetation Community 3 – <i>Banksia</i> Woodlands	
3a	Low Open Woodland of <i>Banksia attenuata</i> and <i>Banksia menziesii</i> over <i>Hakea ruscifolia</i> , <i>Xanthorrhoea preissii</i> , <i>Allocasuarina humilis</i> and <i>Jacksonia floribunda</i> over <i>Mesomelaena pseudostygia</i> , <i>Dasypogon bromeliifolius</i> and * <i>Ehrharta calycina</i> in white sandy uplands.
Vegetation Community 4 – Mixed Shrublands	
4a	Closed Tall Scrub of <i>Xanthorrhoea preissii</i> , <i>Hypocalymma angustifolium</i> , <i>Hakea varia</i> and <i>Eremaea pauciflora</i> over <i>Cyathochaeta avenacea</i> , <i>Mesomelaena tetragona</i> and <i>Desmocladius fasciculatus</i> in white sands.

4b	Closed Tall Scrub of <i>*Leptospermum laevigatum</i> over <i>Adenanthos cygnorum</i> , <i>Eremaea pauciflora</i> and <i>Xanthorrhoea preissii</i> in white sands.
4c	Tall Open Scrub of <i>Actinostrobus pyramidalis</i> with scattered <i>Melaleuca raphiophylla</i> over <i>Acacia</i> sp., <i>*Briza maxima</i> , <i>*Isolepis nodosa</i> and <i>*Avena barbata</i> in black sandy soils.
4d	Tall Shrubland of <i>Viminaria juncea</i> with scattered <i>Melaleuca raphiophylla</i> over <i>Acacia pulchella</i> , <i>Acacia saligna</i> and <i>Melaleuca viminea</i> subsp. <i>viminea</i> over <i>*Stenotaphrum secundatum</i> and <i>Lepidosperma leptostachyum</i> .
4e	Tall Shrubland of <i>Actinostrobus pyramidalis</i> over <i>Eremaea pauciflora</i> , <i>Acacia pulchella</i> and <i>Melaleuca viminea</i> subsp. <i>viminea</i> over Restionaceae sp. and <i>Hypolaena exsulca</i> in white sands.
Vegetation Community 5 – Mixed Heaths and Sedgeland	
5a	Open Low Heath of <i>Pericalymma ellipticum</i> and <i>Hypocalymma angustifolium</i> with occasional <i>Corymbia calophylla</i> over <i>*Watsonia meriana</i> var. <i>bulbiferum</i> , <i>Verticordia plumosa</i> and <i>*Eragrostis curvula</i> in grey sands.
5b	Open Low Heath of <i>Viminaria juncea</i> , <i>Jacksonia sternbergiana</i> and <i>Acacia lasiocarpa</i> over <i>Meeboldina cana</i> , <i>*Medicago minima</i> and <i>*Watsonia meriana</i> var. <i>bulbifera</i> in grey sands.
5c	Closed Sedgeland of <i>Lepidosperma leptostachyum</i> , <i>Meeboldina cana</i> and <i>Cyathochaeta avenacea</i> in brown clay loam.
C – Cleared or Mostly Cleared Vegetation	

3.5.2 *Vegetation Condition*

Vegetation condition was rated according to the vegetation condition scale used in the Bushland Plant Survey (Keighery 1994). In general, the vegetation condition was rated either ‘Degraded’ or ‘Completely Degraded’ (**Figure 3**). The best condition vegetation was found in association with CCWs adjoining Boundary and Brentwood Roads, and one small upland fragment on Victoria Road.

Community 4c was rated as ‘Very Good’ even though a fire had recently burnt out the area. Generally, it was thought that the area would be in ‘Very Good’ condition if not for the fire disturbance.

Grasses were found in every vegetation community and all areas traversed in the survey. As discussed in **Section 3.4.2**, a number of weeds from a variety of families were recorded in the study area and the level of disturbance in the area is testament to the long history of rural land use.

3.5.3 *Local Significance*

In an area approximately 90% cleared, all remnant vegetation regardless of condition is significant. Additionally, a number of the vegetation communities described are locally rare, in that they only occur in as one fragment within the study area.

Specifically, one DRF and one P3 species were located at Lot 25 Victoria Road and this area is one of the few sandy upland sites in the study area, which makes it significant in the local sense.

Although Yule Brook and associated remnant vegetation is mainly degraded, it still retains local significance being a natural greenway and drainage line for the area.

Any vegetation associated with the Greater Brixton Street wetlands is significant particularly where it is continuous from the reserve and does not contribute to weed infestation. This particularly applied to the CCW within Lots 137 and 138 Boundary Road, which supports a potential DRF as well as excellent condition wetland vegetation.

3.5.4 Regional Significance

3.5.4.1 Floristic Community Type

Species recorded within each vegetation community were compared with species occurring in Gibson *et al.* (1994) database of vegetation communities on the southern Swan Coastal Plain using the vegetation significance methodology described in **Section 2**.

The inferred Floristic Community Type (FCT) is based on the number of species matched between the vegetation community described and the Gibson *et al.* (1994) excel database and is recorded below in **Table 7**.

Table 7: Inferred Floristic Community Type for Vegetation Communities recorded in the Study Area.

Vegetation Community No.	Inferred FCT	EPBC TEC	CALM TEC
1a	3b		Vulnerable
1b	3a	Endangered	CE
1c	3b		V
1d	20a		Endangered
1e	21a		
1f	3a	Endangered	CE
2a	21c		
2b	21c		
2c	8		V
2d	21c		
2e	11		
2f	11		
3a	20a		Endangered
4a	3a	Endangered	CE
4b	20a		Endangered
4c	11		
4d	8		V
4e	8		V
5a	8		V
5b	8		V
5c	7		V

Five TEC were recorded scattered throughout the study area (**Figure 4**). The most significant is the occurrence of TEC 3a being listed as both a CALM TEC and EPBC Act TEC. Any development close to or threatening this community would be a trigger for a formal environmental assessment under both State and Commonwealth Legislation. It is likely that a formal environmental assessment would be necessary for any proposed development in the area due to the number of TEC in the study area.

3.5.4.2 *Vegetation Complex*

As an additional determination of the regional status of the vegetation types defined, a comparison was made with previous vegetation community types identified in the area by the Regional Forest Agreement (RFA) mapping (Mattiske & Havel 1999) and the vegetation communities defined for the project area, resulting in inferred vegetation communities.

As previously discussed, the vegetation within the study area is described as Guildford Vegetation Complex after Heddle *et al.* (1980) (**Section 3.1**). Bush Forever Vol. 1 (Government of Western Australia 2000) lists the Guildford Complex as 6% remaining of pre-European extent with 3% protected by Bush Forever. The percentage is below the national targets of 30% pre-European extent as outlined in the *National Objectives for Biodiversity Conservation 2001-2005* (Commonwealth of Australia 2001) and is significant in terms of biodiversity conservation on the Swan Coastal Plain.

Following EPA Guidance Statement No. 10 (2003), any impact to a vegetation complex with less than 10% pre-European extent protected will trigger the formal Environmental Impact Assessment process, pursuant to the *Environmental Protection Act 1986*.

3.6 LINKAGES

Four natural vegetation greenways exist within the study area (**Figure 5**), the most obvious being the east-west Yule Brook corridor. The potential to revegetate this site and promote use as a “living stream” is of benefit to both the City of Gosnells and other stakeholders as revegetation allows corridor movement by fauna and restores an important hydrological feature in the area.

Three potential greenways stretch from the Greater Brixton Street Wetland to the Clifford Street Bushland. The most likely is depicted in blue and stretches from Lot 139 Boundary Road (part of the Greater Brixton Street Wetlands) through a CCW and two TECs to the Clifford Street Bushland. The use of this suggested greenway has the benefit of allowing fauna movement through the two reserves and protecting three regionally significant features of the area.

The other two potential greenways are more tenuous. The greenway depicted in orange protects one TEC at Lot 25 Victoria Road but would require much more restoration before it would be beneficial as a fauna corridor.

The greenway depicted in green would protect the most area of vegetation of all suggested greenways and protects one CCW at Lots 138/138 Boundary Road as well as recorded Bandicoot habitat at Lot 501 Victoria Road but generally does not protect the best vegetation in the study area.

3.7 SUMMARY

- Two species of Declared Rare Flora were recorded within the study area. *Conospermum undulatum* is listed as Declared Rare Flora by CALM and as ‘Vulnerable’ pursuant to section 178 of the EPBC Act., while *Calytrix breviseta* subsp. *breviseta* (R) is listed as ‘Vulnerable’ pursuant to section 178 of the EPBC Act;
- One Priority 1 and one Priority 3 Flora species were also recorded within the study area;
- Sixty weed (introduced) species were recorded on the site, which equates to approximately 30% of total vascular plant species recorded;
- Twenty-two vegetation communities were described during the flora and vegetation survey,
- The vegetation condition was generally rated either ‘Degraded’ or ‘Completely Degraded’;
- Five TEC were recorded scattered throughout the study area;
- Bush Forever Vol. 1 (Government of Western Australia 2000) lists the Guildford Complex as 6% remaining of pre-European extent with 3% protected by Bush Forever. Following EPA Guidance Statement No. 10 (2003), any impact to a vegetation complex with less than 10% pre-European extent protected will trigger the formal Environmental Impact Assessment process, pursuant to the *Environmental Protection Act 1986*;
- Four natural vegetation greenways exist within the study area, the most obvious being the east-west Yule Brook corridor. Of the three other potential greenways, one forms a continuous pathway between two Bush Forever sites and protects TECs.;

The above summary highlights the highly significant vegetation within the study area. To protect this vegetation it is recommended that all remnant vegetation within the study area is retained, protected and managed to enhance its current condition.

4. FAUNA

4.1 FAUNA HABITATS

As mentioned previously the study area includes Bush Forever Sites 387 (Greater Brixton Street Wetlands) and 53 (Clifford Street) that have been described in detail in Dell and Banyard (2000). These sites mainly support seasonally damp or inundated heaths and woodlands, with Yule Brook passing through Site 387. There is limited upland vegetation in these two sites. While the Bush Forever Sites are not part of the study area in terms of any proposed development, but their presence within the study area is of great significance, from a fauna corridors point of view.

The soils of most of the study area are heavy loams associated with the Pinjarra Plain and much of the site is damp or inundated seasonally, the relief being low. Outside the Bush Forever Sites most of the study area is privately owned and has been extensively cleared. The following general fauna habitats were recognised:

- Farmland consisting largely of winter-wet pasture with scattered trees. Included in the farmland are some farm dams that may or may not be permanent.
- Seasonal wetlands supporting heath and woodland. These resemble the habitats in the Greater Brixton Street Wetlands. A good example was observed on Lot 222 Brentwood Road.
- Marri woodland. This habitat occurs mainly as remnants along some roads, particularly Grove Road and Coldwell Street, and in the east around Bickley and Kenwick Roads. There are also scattered Marri in farmland. In general, areas of Marri are highly degraded with little native understorey remaining, but often dense cover of weeds.
- Gardens occupy only a small part of the study area, as lot sizes are large. Gardens support a range of exotic plants, some potentially of value for wildlife.
- Constructed wetlands alongside Roe Highway are just within the western end of the study area but are designed as compensation basins for the management of runoff. They are therefore unlikely to be directly affected by any future industrial development. These wetlands and their surrounds have been rehabilitated to created wildlife habitat, particularly for waterbirds.

Overall, the study area can be described as largely rural with some remnant native vegetation, with much of the area being wetland or dampland. The two Bush Forever Sites are notable for supporting more or less intact native vegetation. The Greater Brixton Street Bush Forever Site extends south and loosely links with remnant habitats along the Canning River. There is also some linkage with degraded and rehabilitated habitats along Roe Highway. The Clifford Street Bush Forever Site is more isolated. Therefore, the study area has some habitat linkages to the south and north-west, but poor linkages to the east and north-east. Lesmurdie Falls National Park lies to the east and there is some linkage to this along Yule and Bickley Brooks, and in remnant vegetation along Welshpool Road, while the Hartfield country Club Golf Course and Kelvin Road Parklands provide “stepping stones” to the east.

4.2 FAUNA SPECIES

The vertebrate fauna that could potentially occur in the study area is listed in **Appendix D**. Invertebrate fauna of conservation significance is discussed in the text. Locally extinct species have not been included in the tables, but are in some cases discussed.

4.2.1 Fish

Only one fish has been recorded from the area (**Appendix D, Table 1**)(M. Bamford, personal observation in Yule Brook near Roe Highway), and this is the introduced Mosquito Fish. However, it is considered likely that this and two native species will occur in the study area at least during seasonal flooding. Mosquitofish have probably been introduced into farm dams and ponds in the area. There are almost certainly Goldfish *Carassius auratus* in domestic ponds, but these are not likely to survive elsewhere unless they are deliberately introduced into sites like the Roe Highway wetlands. Species of conservation significance and introduced species are indicated in the significance column.

The native fish are not of conservation significance. Yule Brook may be important for movements of the species between the streams of the Escarpment and the rivers of the Swan Coastal Plain, and there is a possibility of some other native species doing likewise. These would rely largely on the brook, however, rather than the seasonal wetlands of the study area. One native fish, the Black-striped Minnow *Galaxiella nigrostriata*, is classed by CALM as Priority 3 and may once have occurred in the study area. It is now extinct in the Perth region except for one population near Muchea. It is of interest as it does occur in seasonal wetlands.

Impacts of any proposed industrial development upon fish are likely to be slight, as Yule Brook is within Bush Forever Site 387, although the fish would be sensitive to changes in groundwater levels and to any water quality impacts.

4.2.2 Amphibians

The nine frog species recorded or expected to occur in the study area (**Appendix D, Table D2**) are widespread in the South West. One species, the Granite Frog, is considered to be of Conservation Significance level 3. It occurs along the escarpment in the Perth area, but may be present on the Coastal Plain where there are heavy soils such as existing in the study area. Species of conservation significance and introduced species are indicated in the significance column.

The frogs will all breed in seasonal wetlands, even when these are badly degraded, so are likely to be abundant and widespread in the area. Breeding in some species, however, is dependent upon predictable changes in water levels. Species such as the Moaning Frog and the Pobblebonk also move extensively away from wetlands outside the breeding season. Therefore, any proposed industrial development in the area could affect frogs through habitat loss, changes in groundwater levels, restrictions to dispersal (fencing) and water quality impacts.

4.2.3 *Reptiles*

The list of 36 reptile species that may occur in the study area (**Appendix D, Table D3**) is probably generous, but reptiles do appear to persist in degraded habitat in the Perth area (How and Dell 1994), so species cannot be excluded without extensive field surveys being carried out. The list would be longer if there were more extensive sandy soils present. Species of conservation significance and introduced species are indicated in the significance column.

Some of the reptile species are associated with the fringe of wetlands or wetlands themselves (eg. Long-necked Tortoise, South-West Cook Skink, Tiger Snake) or are likely to be widespread, but the majority of species are likely to be associated with areas that are not seasonally damp or inundated. This means that most reptile species are likely to have restricted distributions in the study area, such as locations where Marri are present. There is a small patch of Banksia on sandy soils in the Greater Brixton Street Bush Forever Site and this is probably important for reptiles, but there appeared to be no similar habitat outside this area.

A number of the reptile species present or expected to be present are of Conservation Significance Level 3, mainly because they are close to the limit of their distribution. These species are:

- | | | |
|--------------------------|-------------------------------|----------------|
| • Keeled Legless Lizard | <i>Pletholax gracilis</i> | southern limit |
| • Sandhill Dragon | <i>Rankinia adelaidensis</i> | southern limit |
| • Western Bluetongue | <i>Tiliqua occipitalis</i> | southern limit |
| • Rosenberg's Goanna | <i>Varanus rosenbergi</i> | northern limit |
| • Reticulated Whip-Snake | <i>Demansia psammophis</i> | southern limit |
| • Crowned Snake | <i>Elapognathus coronatus</i> | northern limit |

The main impact on reptiles of any development would be loss of habitat, although this would be greatly dependent upon the type of habitat affected. Upland areas, especially those with sandy soil, would be the most significant because they are likely to support the most reptiles and are restricted in area.

4.2.4 *Birds*

The list of 120 bird species (**Appendix D, Table D4**) includes 53 species that have been recorded; most of these recorded species come from previous work in the area (M. Bamford) and from E. Canella (pers. comm.) who monitored birds at the Roe Highway wetlands. Almost half (47) of the bird species are waterbirds and would therefore rely greatly on the few permanent water bodies, including dams, and seasonal flooding of wetlands. Some of these waterbird species are also favoured by clearing and forage in damp or even dry paddocks. For example Straw-necked and Australian White Ibis were foraging in paddocks beside Brentwood Road during the 17th November 2004 site inspection. Many of the landbirds on the list are also favoured by clearing, including the Willie Wagtail, Magpie-lark, Nankeen Kestrel and Australian Magpie. The small areas of undisturbed vegetation, remnant trees and even gardens are important for the many species that are disadvantaged by clearing. Species of conservation significance (CS) and introduced species (Int.) are indicated in the significance column. In the significance column, M indicates species listed as migratory under the EPBC Act.

Bird species of conservation significance are discussed below.

Conservation Significance 1

Australasian Bittern

Classified as Vulnerable under the WA Wildlife Conservation Act and by Garnett and Crowley (2000), this species has declined in the Perth area and some wetlands within the study area may be suitable for it. It favours wetlands with dense emergent vegetation, including Bulrush *Typha* spp.

Short-billed (Carnaby's) Black-Cockatoo

The above cockatoo is listed as endangered under the EPBC Act, the Wildlife Conservation Act and by Garnett and Crowley (2000). The Short-billed Black-Cockatoo has declined due to loss of breeding habitat in the wheatbelt and of non-breeding habitat along the west coast, partly due to urban expansion. While small areas of foraging habitat around the metropolitan area support only small numbers of birds for short periods of time, the progressive loss of such small areas is an ongoing concern for this species. The Short-billed Black-Cockatoo is likely to use the Marri trees for foraging but will feed on scattered Proteaceae, has been observed extracting grubs from *Jacksonia* sp. (M. Bamford) and will feed on pasture weeds.

Long-billed (Baudin's) Black-Cockatoo

This cockatoo is listed as vulnerable under both the EPBC Act and Wildlife Conservation Act and as 'near threatened' by Garnett and Crowley (2000). Although mainly a forest species, Baudin's Black-Cockatoo may occasionally visit the study area from the nearby escarpment. It feeds primarily on the seeds of eucalypts and is therefore likely to target the Marri trees.

Peregrine Falcon

This falcon is listed as 'other specially protected fauna' (Schedule 4) under the Wildlife Conservation Act. The Peregrine Falcon is a wide-ranging bird of prey that may be an occasional visitor to the site. The site would only be highly significant for this falcon if they were breeding on the site. This is considered unlikely given the lack of large, hollow-bearing trees.

Great Egret

The Great Egret is classified as migratory under the JAMBA, CAMBA and Bonn Convention, and as such is protected under the EPBC Act. Its listing under JAMBA also means it is protected under the WA Wildlife Conservation Act. It is likely to be a regular visitor to seasonally inundated pastures.

Rainbow Bee-eater

The Rainbow Bee-eater is classified as migratory under the JAMBA, CAMBA and Bonn Convention, and as such is protected under the EPBC Act. Its listing under JAMBA also means it is protected under the WA Wildlife Conservation Act. The Rainbow Bee-eater is known to be a breeding visitor to the study area (reported by some residents) and nests in burrows in open ground. Although a species of high conservation significance, it is abundant and versatile in its selection of nest sites.

Sandpipers

Migratory sandpipers are likely to be infrequent visitors in small numbers, as there is little suitable habitat for them.

Fork-tailed Swift

This species is migratory under JAMBA, CAMBA and the Bonn Convention, and as such is protected under the EPBC Act. Its listing under JAMBA also ensures it is protected under the WA Wildlife Conservation Act. This species is largely aerial and is unlikely to be affected by any proposed development on the site.

Conservation Significance Level 2

Little Bittern

Listed as Priority 4 by CALM, this species was formerly common in wetlands around Perth (Johnstone and Storr 1998) but is now rarely encountered. It favours wetlands with dense emergent rushes and there was a small area of apparently suitable habitat near the intersection of Bickley and Boundary Roads.

Conservation Significance Level 3

Dell and Banyard (2000) recognised a suite of bird species that have declined in the Perth area but that are not of formal conservation significance. These species are indicated as CS3 on Table 4 and 26 may be present in the study area. A few of these species are waterbirds that have declined in the Perth area due to loss of wetlands, but the majority rely upon understorey vegetation. Because of clearing in the study area these are likely to be scarce at present, but will occur in the Bush Forever sites. The majority of these species are sedentary but will utilise corridors of native vegetation.

The most significant impact of any proposed development upon birds would be the loss of seasonal wetlands and the loss of what understorey vegetation remains. For bird species dependent upon understorey vegetation, this loss could disrupt movements through the area. For example, the more mobile species may be able to travel through the study area between native vegetation on the escarpment and native vegetation along the Canning River or around the airport on the Coastal Plain. Loss of vegetation in the study area could disrupt this movement.

4.2.5 Mammals

The mammal fauna of the study area is poor (**Appendix D, Table D5**), and many of the species that may have been present are now locally extinct. The majority of species that may still be present are bats, and these are included largely because there is little information on their persistence in the Perth area, although Wykes (1991) found that most bat species are absent even from large bushland remnants around Perth. Species of conservation significance (CS) and introduced species (Int.) are indicated in the significance column.

If present, the bats are likely to shelter in tree hollows and under loose bark, or in old buildings, and to forage amongst or close to native vegetation. Of the other native mammal species expected or present, the Quenda is known to be abundant in the area and occurs where there is dense understorey vegetation, although it thrives amongst weeds as well as amongst native plants. The Brush-tailed Possum may occur amongst old buildings, while the Rakali may be present along Yule Brook and, if present, would disperse into seasonal wetlands during winter. The remaining mammal species are introduced and probably most abundant in disturbed and partly cleared areas.

All the native species can be considered to be at least of local significance (CS3) but three species are of CS2 as they are listed as Priority by CALM.

The Quenda is Conservation Dependent and is known to be common in the general area. Its reliance on dense vegetation cover makes it sensitive to clearing and to fragmentation of habitat. The Western False Pipistrelle is normally associated with forest (Strahan 1995) but there is a recent record from woodland near Jandakot (Hosken and O’Shea 1994), so the possibility that it occurs in the study area cannot be discounted. The Rakali is semi-aquatic and, as noted above, is likely to be restricted to wetland areas.

The mammal fauna of the study area would be sensitive to habitat loss, particularly removal of trees and the loss of any dense, low vegetation, whether composed of weeds or native species. In some rehabilitation projects where Quendas were present, removal of weeds has been staggered to allow native vegetation to functionally replace the weeds, thus avoiding adversely affecting the Quendas. For the Quendas in particular, continuity of cover is important for allowing animals to move around, linking populations and avoiding the local extinction of the species in small reserves. Of the three native, non-flying species, the Rakali is probably least likely to be adversely affected by development as long as major watercourses are undisturbed and water quality unaffected.

4.2.6 Invertebrates

In addition to vertebrate species, a number of threatened invertebrate species are recorded on CALM’s Threatened Fauna Database for the general region. The native bees *Leioproctus douglasiellus* and *Neopasiphae simplicior* are listed under Schedule 1 of the *WA Wildlife Conservation Act (1950)* and have been recorded at Armadale Golf Course and Lake Forrestdale, while another native bee *L. contrarius* is listed as Priority 3 by CALM, and has been recorded at Forrestdale and Murdoch. The latter species may be more widespread than this listing justifies. *L. douglasiellus* has been recorded only from flowers of *Goodenia filiformis*, *N. simplicior* only from flowers of *G. filiformis*, *Lobelia tenulor* and *Angianthus preissianus*, and *L. contrarius* only from flowers of Goodeniaceae. All these plants are shrubs of heath and woodland and in general shrubs are poorly represented in the study area because of clearing and grazing.

4.3 FAUNA CONSERVATION STRATEGIES

The fauna of the study area is depauperate because of habitat loss, the degraded state of most remaining habitat and the absence of large tracts of undisturbed habitat immediately adjacent. The study area also lacks species-rich habitats such as banksia woodland on sand. However, the study area does support extensive, albeit degraded, seasonal wetlands, and its location is important for linkage, or potential linkage, between habitat corridors on the coastal plain (Canning River and rehabilitation along the Roe and Tonkin Highways) and extensive habitats along the Darling Escarpment. Its location is also important because the study area surrounds two Bush Forever sites, with the Greater Brixton Street Wetland (Bush Forever Site 387) of particular significance.

The study area supports or is expected to support a number of species at different levels of conservation significance (CS) as follows (see Tables 3, 4 and 5 for details):

Table 8: Conservation Significance of Species within the Study Area

	Invertebrates	Reptiles	Birds	Mammals
CS 1 (protected under legislation)	1	-	11	-
CS 2 (listed as of interest)	1	-	2	3
CS 3 (regional or local significance)	-	6	26	9

These species have differing requirements and some are likely to be irregular visitors in small numbers, but among those species for which the site is important (or potentially important), there are some common patterns to indicate the best approach for their conservation within the site in the event of future development. For example, many of the species (invertebrates, reptiles, some of the birds, the Quenda) have a requirement for shrubs either in heath or as understorey in woodland, while some of the birds require wetland habitats of shallow water and emergent vegetation. A few of the significant birds, notably the Short-billed Black-Cockatoo, utilise the Marri trees, and bats also rely on trees for shelter. Importantly, many of the birds listed as Conservation Significance Level 3 have declined in the Perth area due to habitat loss and fragmentation, and the study area is in a location where it has the potential to contribute to the local persistence of these species.

4.4 SUMMARY

The aim of a fauna conservation strategy could be to protect and even enhance fauna values within the context of industrial development. Key considerations for this fauna conservation strategy must incorporate requirements of threatened and other fauna and can be summarised as follows:

- Protection and enhancement of remnant habitats, particularly heaths and woodland with understorey. Where understorey currently consists of weeds, there is a need for progressive replacement with native species to avoid temporary loss of habitat.
- Retention and rehabilitation of habitats needs to be planned to ensure linkage with native vegetation that forms wildlife corridors along Roe and Tonkin Highways.
- Protection of water quality and groundwater levels.
- Retention of at least some areas of seasonally inundated pasture, possibly with some rehabilitation to create areas of emergent vegetation.
- Protection of stands of native trees wherever possible. Note that some of these stands are concentrated in road verges.
- Development of fauna habitat within developments through landscaping, use of local plant species and minimisation of sterile habitats, such as lawn. Landscaping within development should be designed to link with remnant natural habitats along road verges.

5. WETLANDS

5.1 INTRODUCTION

Wetlands of the Swan Coastal Plain exist mostly as expressions of the water table due to the sandy nature of the underlying soils. Pressure from development and water extraction of the two major aquifers (Gnangara and Jandakot Mounds) in the region have had degrading effects on wetland processes and it is widely acknowledged that 80% of wetlands on the Swan Coastal Plain have been destroyed and the remaining areas degraded to varying extents (EPA 1991).

Much of the Swan Coastal Plain is categorised by wetland environments. Conservation and management of these resources have required that classification systems be developed in order to group and describe the variations in wetland types. One recognised system is that of Semeniuk (1988) based on geomorphic setting and hydrological processes. The resultant classification allocates individual wetlands with shared characteristics to wetland suites.

Large discrepancies in the condition of wetlands has added further classification systems, such as that detailed in Hill *et al.* (1996), which is based on a range of characteristics of individual wetlands including size, condition, physical, hydrological and biological functions, and human use attributes. The mapping and discussion of the wetlands impacted by the proposal are based on the results of this mapping system. The data has been updated over the intervening years by the Department of Environment, and the current data from 2004 has formed the basis for the following assessments.

The wetland management categories as set out in Hill *et al.* (1996) are defined in **Table 14**.

Table 9: Wetland Management Categories and Management Objectives

Management Category	Description of Wetland	Management Objectives
Conservation (C)	Wetlands which support high levels of attributes and functions.	To preserve wetland attributes and functions through reservation in national parks, crown reserves, state owned land and protection under environmental protection policies.
Resource Enhancement (R)	Wetlands which have been partly modified but still support substantial functions and attributes.	To restore wetlands through maintenance and enhancement of wetland functions and attributes by protection in crown reserves, state or local government owned land and by environmental protection policies, or in private property by sustainable management.
Multiple Use (M)	Wetlands with few attributes which still provide important wetland functions.	Use, development and management should be considered in the context of water, town and environmental planning through land care.

In general, the wetland areas classified as being in the ‘Multiple Use’ management category are totally or mostly cleared, and are used for agricultural purposes. These wetlands still serve hydrological functions, such as groundwater recharge and flood mitigation. The wetlands that are designated ‘Resource

Enhancement’ have some native vegetation remaining, but are also often used for grazing or agistment of horses or other stock. They can be considered to have hydrological functions but limited biological significance. Only the wetlands in the ‘Conservation’ management category support relatively intact vegetation and have a range of natural attributes that render them significant.

5.2 WETLAND EVALUATION

The majority of the study area is mapped by the Department of Environment as wetlands (**Figure 6**). **Table 10** presents the wetlands occurring in the study area and their potential for reclassification and drainage purposes. Management category referred to in the table below is MU (Multiple Use), RE (Resource Enhancement) and C (Conservation).

Table 10: Evaluation of Wetlands within the Maddington/Kenwick Strategic Industrial Area

Lot/Street Location	DoE Wetland Mapping Number	Managt. Category	Area (ha)	Re-class	New Cat.	Potential Drainage
Northern study area	13362	MU	202	N		Y
Lot 5 Grove Road	7632	MU	0.4	N		Y
Lot 13 Grove Road	7633	MU	0.8	N		Y
Lot 68 Brook Road	7774	C	21.6	Y	RE	N
	7777	MU	2.2	N		Y
	7778	MU	1.0	N		Y
	7778	C	0.3	Y	RE	Y
	7779	MU	2.1	N		Y
Lot 74 Brook Road	7634	RE	1.3	N		Y
Lot 4 Bickley Road Lot 8 Grove Road	7635	RE	6.3	N		Y
Lots 6 & 7 Grove Road	7636	RE	7.6	N		Y
Lot 279 Bickley Road	7645	RE	1.4	N		Y
	7647	C	0.7	Y	RE	Y
South of Greater Brixton Street Wetlands	13540 13542	RE	116	N		N
Lot 3 Boundary Road Lot 4 Brentwood Road	7798	MU	0.6	Y		Y
Lot 137 Boundary Road	7785	C	0.7	N		N
Pt Lot 42 Boundary Road	8033	C	0.7	N		N
	8034	RE	1.2	N		Y
Lot 218 & 219 Brentwood Road	8036	RE	1.5	N		N
Lot 222 Brentwood Road	13825	Null	3.4	Y	C	N
	13826	Null	0.7	Y	C	
	13827	Null	3.0	Y	C	
	8038	RE	2.3	Y	C	
Lot 228 Brentwood Road	13541	MU	4.1	N		Y
Lot 227 Brentwood Road	7799	MU	3.6	N		Y
Lot 272 Victoria Road	8045	RE	0.3	N		N

Lot/Street Location	DoE Wetland Mapping	Managt. Category	Area (ha)	Re-class	New Cat.	Potential Drainage
Lot 502 Victoria Road	8046	MU	0.3	N		Y
	8047	MU	1.3	N		Y
Lot 235 Victoria Road	7805	MU	1.4	N		Y
Lot 234 Victoria Road	7800	MU	0.5	N		Y
Lot 237 Bickley Road	8051	MU	0.1	N		
	8054	MU	0.1	N		
Lot 238 Bickley Road	8052	MU	1.2	N		Y
	8053	MU	0.3	N		Y
Lot 243 Victoria Road	8049	MU	1.3	N		Y
Lot 13 & 14 Victoria Road	8050	RE	1.3	Y	C	N
Lot 15 Victoria Road	8048	MU	0.7	N		
Southern Study Area	13369	MU	41.5	N		Y
Lot 5 Kenwick Road	8056	MU	0.2	N		Y
	7961	MU	0.6	N		Y
	7962	MU	0.5	N		Y
Lot 253 Clifford Street	12115	MU	8.0	N		N
Southern Corner of Study Area	Part-13370	MU	~40.0	N		Y

The majority of the wetlands mapped by the DoE were representative of their assigned management category. Five wetlands were not representative of their management categories and have been recommended for re-classification. Three wetlands have been recommended for downgrading of management category.

5.3 CURRENT CONSERVATION CATEGORY WETLANDS

Excluding Bush Forever areas, four ‘Conservation’ Category Wetlands (CCWs) have been mapped in the study area. Wetlands are referenced by lot number/street name on which the wetland is located and by the DoE wetland mapping number.

Two CCWs are highly diverse and support vegetation similar to that within the Greater Brixton Street Wetlands. It is recommended that these wetlands be retained as “Conservation” category and protected. The remnant vegetation associated with these wetlands should be completely retained. Due to the degraded areas surrounding all four wetlands, no vegetated dryland buffers are possible.

The CCW on Lot 137 Boundary Road (7785) is mapped as a much smaller area than actually exists on the ground (0.7ha). Field survey revealed that the remnant vegetation within Lots 137 and 138 are actually wetland dependent and continuous. With the proximity of a Bush Forever reserve to the east (Lots 139/140 Boundary Road), potential exists to use this area as an offset for other works in the area and contribute to the conservation estate in the area.

Lot 222 Brentwood Road (13827) is currently mapped as a CCW (**Figure 6**), while the vegetation to the west is mapped as a Resource Enhancement wetlands (**Figure 10**). Fieldwork revealed that the remnant

vegetation is in “Excellent” condition (**Figure 3**) and has a structure unique to other wetlands within the study area. The wetland is isolated due to clearing on all sides, however it is close to Bush Forever sites to the north (> 50m).

As a CCW, the two areas have some existing protection and will not count as a mitigation offset alone, even though they are privately owned and therefore “threatened”. Mitigation for any development of wetland areas or remnant vegetation will need to consist of a few offsets within the area. It is possible that no areas of remnant vegetation or wetland will be able to be impacted however given the large size of cleared land in the study area, this should not be an important factor.

The two remaining CCWs are recommended for reclassification to Resource Enhancement, which are discussed further in **Section 5.4.2**.

5.4 RECLASSIFICATION RECOMMENDATIONS

Four wetlands within the study area meet the criteria for reclassification (**Figures 7 – 11**).

5.4.1 Conservation Category Wetlands

One wetland within the southern study area met the criteria to be reclassified to CCWs (**Figure 11**).

Lots 13 &14 Victoria Road (8050) is currently mapped as a Resource Enhancement wetland (**Figure 11**). Field survey found that the vegetation on the site is a “Critically Endangered” TEC as recognised by CALM and an Endangered TEC as listed by the EPBC Act 1999. The TEC is described as FCT 3a *Corymbia calophylla/Kingia australis* Woodlands on heavy soils. On this basis, the wetland should be upgraded to CCW and listed as an occurrence of FCT 3a.

5.4.2 Resource Enhancement Wetlands

The CCW located on Lot 279 Bickley Road (7647) is approximately 0.7 hectares in area (**Figure 8**). The wetland has been extensively understorey cleared and has little native understorey, however, it still retains many *Melaleuca raphiophylla*. It is generally used for grazing by horses and is dissected by a firebreak.

There is potential to reclassify this wetland to “Resource Enhancement” management category. The wetland’s present state does not reflect a CCW, currently it represents a “Multiple Use” wetland being highly degraded and modified. Its vicinity to the Greater Brixton Street Wetlands increases its importance in terms of hydrological function.

Two small areas of Lot 68 Brook Road are also listed as CCWs (**Figure 7**). The wetlands are seen as a continuation from the Greater Brixton Street Wetlands. This area is highly modified and used as a soil dump. The wetlands on the lot are more reflective of a Resource Enhancement wetland.

Currently, a large area (116 hectares) south of the Greater Brixton Street Wetlands is mapped as Resource Enhancement wetlands (13540 & 13542). The majority of this area is highly degraded and is more

representative of a Multiple Use wetland, however its hydrological value to the Greater Brixton Street Wetlands may support the higher management category.

5.5 BUFFERS

Buffers are important in protecting wetlands from potential disturbance and degradation from surrounding land uses. Generally the buffer is measured from the edge of the wetland dependant vegetation. The size of the buffers are dependent on the land use, the minimum being 50 metres from the edge of wetland dependent vegetation. **Table 11** gives examples of recommended buffer distances for different land uses.

Table 11: Wetland Buffers and Land Uses (Adapted from Water and Rivers Commission Position Statement on Wetlands of the Swan Coastal Plain 2001)

Purpose of Buffer	Land Use Example	Recommended Buffer Width
Protection from nutrient inputs	Market Garden	200m on transmissive soils, 100m on non-transmissive soils
Protection from Pollution	Mechanical Workshop	200m
Protection from heavy metal contamination	Mineral Processing Operation	200m
Protection of Groundwater Quality	Agricultural Composting Facility	2000m in direction of groundwater flow for transmissive soils
Protection from weed infestation	Residential housing	50 – 100m

A more recent draft document prepared for the Department for Planning and Infrastructure (DPI) by Essential Environmental Services (2004) provides a framwerk for the determination of wetland buffer requirements during the land use planning process. The recommendations provided in this document for both CCW and REW areas are provided below in **Table 12**.

Table 12: CCW and REW separation measures and separation area management (taken from Essential Environmental Services (2004)).

Key Threatening Processes	Recommended Separation Measure	Separation Area Management
Conservation Category Wetlands		
Alterations to the water regime	Regulation of groundwater abstraction as catchment management measure.	Area to be vegetated with deep-rooted perennial vegetation.
Habitat modification	100m weed infestation. Up to 100m for avifauna habitat dependant on extent of utilisation. 6-50m firebreak. Fence for controlling exotic fauna access. >= 100m to minimise edge effects.	Preferably native plant communities. 6m firebreak minimum, inside of fence. Fence to limit vehicle, stock, exotic fauna access. Clear perimeter outside of fence (path, firebreak, road).
Inappropriate recreational activities	>=50m for improving aesthetics. >= 50m for barrier. Fence, paths for controlling access.	Fire control to maintain habitat and species diversity. Minimise track access/clearing, maximise native vegetation.
Alteration to water quality	Drainage inflows eliminated or managed. Where proposal may affect wetland water quality, particularly through un-channelised flow, detailed site specific work should be undertaken to determine the specific separation measures required, including management measures.	Management for water quality outcomes as required.
Resource Enhancement Wetlands		
Alterations to the water regime	Regulation of groundwater abstraction as catchment management measure.	Area to be vegetated with deep-rooted perennial vegetation. Limited open areas of grass.
Habitat modification	50m weed infestation. 50m avifauna habitat. 6m firebreak.	Controlled access to wetland (paths). 6m firebreak minimum, inside of fence (if required).
Inappropriate recreational activities	10-50m for improving aesthetics. 10-50m for barrier. Fence, paths for controlling access.	Fence to limit vehicle, stock access. Clear perimeter outside of fence (path, road).
Alteration to water quality	Drainage inflows eliminated or managed. Where proposal may affect wetland water quality, particularly through un-channelised flow, detailed site specific work should be undertaken to determine the specific separation measures required, including management measures.	Fire control to minimise hazards and maintain habitat diversity. Management for water quality outcomes as required.

Buffers will need to be determined during the subsequent planning process depending on the nature of proposed activities within the proposed industrial areas. It is also recommended that buffer rehabilitation (with locally occurring native vegetation species) be undertaken during the development process.

5.6 SUITABLE LANDUSES WITHIN WETLAND BUFFERS

The question of suitable landuses within wetland buffers is primarily driven by the conservation status of the wetland in question to which the buffer applies. Generally speaking it is important from a wetland management and conservation point of view that the landuse within the buffer will not lead to a decline in the attributes of the wetland given that the buffer is in itself a tool to provide a separation between the wetland core and nearby incompatible landuses.

In the case of the study area it is assumed that only CCW and REW areas will require wetland buffers. While there may be some areas of MUW retained in Multiple Use Corridor (MUC) areas, these would not require buffers in the context of ensuring a viable future industrial development. It is also assumed that in the process of progressing detailed planning for the industrial area, the appropriate wetland management categories would be secured (see **Section 5.4**) through referrals to DoE for reclassification, and where wetland boundary revisions are required this also be finalised through the same process. In this way the buffers being applied will be based on the finalised management categories and wetland boundaries, rather than on the existing DoE Geomorphic Wetland Series mapping.

Table 12 above outlines an approach for dealing with wetland separation distances (buffers) for both CCW and REW areas. It is clear from this that the requirements for buffer management for CCW areas are based on preserving and encouraging natural areas wherever possible. Generally this would involve restoration and revegetation with locally occurring native species, and largely excluding other uses except for some access on defined pathways. REW buffers can incorporate more “grassed” areas (although limited) and this may be targeted for areas that are currently cleared. It is acknowledged that areas passive recreation areas and Public Open Space (POS) are not required within commercial/industrial subdivision developments.

There may be opportunities to use wetland buffers for stormwater management purposes, but only where these are not “end-of-pipe” type solutions and it can be demonstrated that the stormwater management infrastructure will not have a significant impact on either the natural conservation values of the buffer area or water quality in local groundwater or the wetland itself.

5.7 WETLAND MITIGATION

General guiding principals of wetland development are to avoid impacts on Conservation category wetlands where possible, to minimise and maintain the functions and management category of wetlands not directly affected by the proposal; and depending on the circumstances acquire, enhance and create, to an appropriate level, the wetland categories and functions lost. It is a general principal that any impact to wetlands of Resource Enhancement and higher will require some form of mitigation.

Principles of wetland replacement (creation, enhancement and acquisition) for each wetland management category are summarised below from previous advice from the Water and Rivers Commission:

‘C’ – Conservation Category

- Focus on protection via acquisition of sites or alteration of proposal.
- Mitigation assessed on function and value rather than areal replacement but area is still a key consideration.
- Mitigation also possible through enhancement of an area of ‘R’ to ‘C’ via management measures such as fencing, feral control, weed eradication, revegetation.

‘R’ – Resource Enhancement Category

- Mitigation measures negotiable.
- Function could be traded against area.
- Mitigation measures included rehabilitation of existing wetlands (‘M’ upgraded to ‘R’), compensation basins with suitable design criteria, acquisition (and revegetation) of buffers or corridor areas adjacent to or linking ‘C’ category wetlands.
- Acquisition of a lesser area of ‘C’ category wetland also possible. Exchange ratio to be negotiated.

‘M’ – Multiple Use

- Mitigation measures not required as hydrological function replaced through best practice drainage design in study area.

5.8 SUMMARY

- Twenty-eight DoE mapped wetlands occur within the study area.
- Five are recommended for reclassification, two upgraded to CCWs and three downgraded to various categories.
- Any impact to wetlands of Resource Enhancement and higher require some form of mitigation.
- Buffers will need to be determined during the subsequent planning process depending on the nature of proposed activities within the proposed industrial areas.
- Buffer rehabilitation should be undertaken during the development process.

6. REVIEW AND INTEGRATION WITH DRAINAGE INVESTIGATION

As part of the overall industrial area planning process, GHD Pty Ltd. was commissioned by the City of Gosnells to undertake an engineering feasibility study for the proposed Maddington-Kenwick Strategic Industrial Area. A major consideration within this study was the development of a drainage, groundwater and nutrient management strategy for the proposed development. This involved the investigation of the use of MUC areas to convey stormwater from the outlets of each major subcatchment to the current discharge locations as exists currently.

At the outset of the overall planning process, it was acknowledged that there was benefits associated with cross referencing the environmental investigations undertaken by Cardno BSD and the engineering investigations undertaken by GHD. This was largely associated with the ultimate locations for MUC providing both conservation and stormwater management functions.

Based on a review of the GHD Engineering Feasibility Study Report (GHD, 2004), there is currently proposed to be five (5) MUC areas, as depicted in Figure 5 of the report. Cardno BSD identified four (4) potential “greenways”, which were areas that were identified based on a combination of the following:

- The location of known TECs;
- Linkages between TECs with existing native remnant vegetation;
- Linkages between Bush Forever sites; and
- The Yule Brook.

The potential greenway located along Yule Brook and connecting with Bush Forever Site 387 contains a significant amount of vegetation “Good” and “Very Good” condition and also contains TEC 3a. this could also be extended at its northern extent to include TEC 8 and reconnect into Bush Forever Site 387. It is unlikely that this area will be developed due to State Government riparian setback requirements (in this case likely to be 50 meters from both sides). This area is also to provide a stormwater management function although it has not been identified as a MUC in the GHD report.

MUC 2, MUC 3, and MUC 4 could be incorporated into the southern-most “greenway” as shown on **Figure 5** (marked in green). This leaves two “greenways”, which are shown on **Figure 5** in blue and orange. Given the locations of TEC communities and the existing condition of vegetation it is likely that the blue “greenway” is a higher priority, although there does not currently appear to be any opportunities to link this with current MUCs, unless the green and blue greenway could be combined and a MUC placed between them. This approach would preclude a significant area from development and would require further engineering and environmental investigations to progress or otherwise. The orange “greenway” does not contain TECs but does support some remnant vegetation, and is the lowest priority of the four identified “greenways”.

7. RECOMMENDATIONS

7.1 FLORA

- All mapped remnant vegetation within the study area is protected and enhanced; and
- Additional Spring surveys are undertaken within mapped remnant vegetation to complete baseline study.

7.2 FAUNA

- Protection and enhancement of remnant habitats, particularly heaths and woodland with understorey. Where understorey currently consists of weeds, there is a need for progressive replacement with native species to avoid temporary loss of habitat;
- Retention and rehabilitation of habitats needs to be planned to ensure linkage with native vegetation that forms wildlife corridors along Roe and Tonkin Highways;
- Protection of water quality and groundwater levels;
- Retention of at least some areas of seasonally inundated pasture, possibly with some rehabilitation to create areas of emergent vegetation;
- Protection of stands of native trees wherever possible. Note that some of these stands are concentrated in road verges;
- Development of fauna habitat within developments through landscaping, use of local plant species and minimisation of sterile habitats, such as lawn; and
- Landscaping within development should be designed to link with remnant natural habitats along road verges.

7.3 WETLANDS

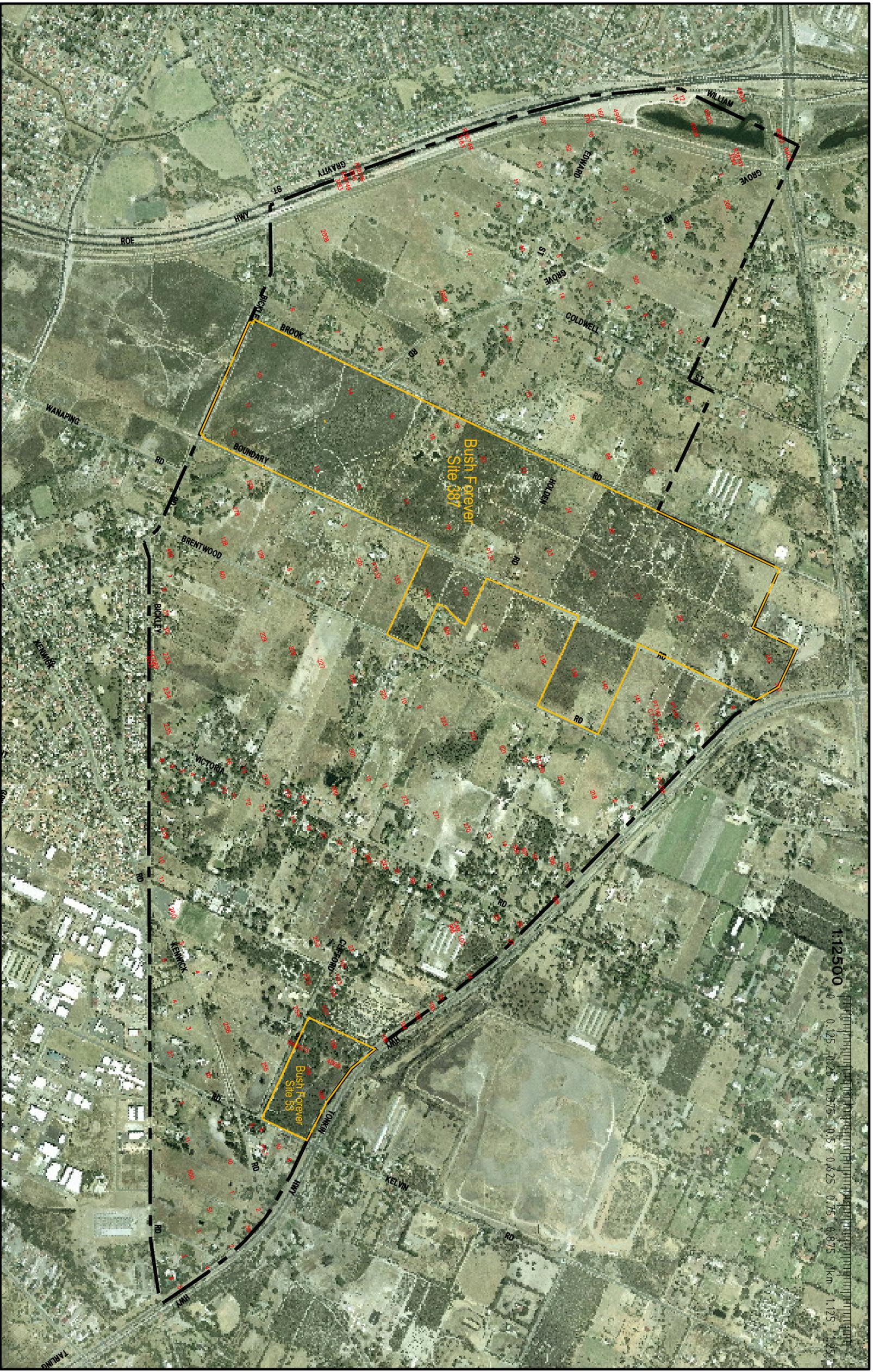
- Five wetlands to be reclassified as recommended following DoE reclassification guidelines;
- CCWs to be protected and enhanced;
- Buffers will need to be determined during the subsequent planning process depending on the nature of proposed activities within the proposed industrial areas; and
- Buffer rehabilitation should be undertaken during the development process.

8. REFERENCES

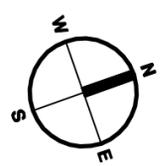
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FIGURES



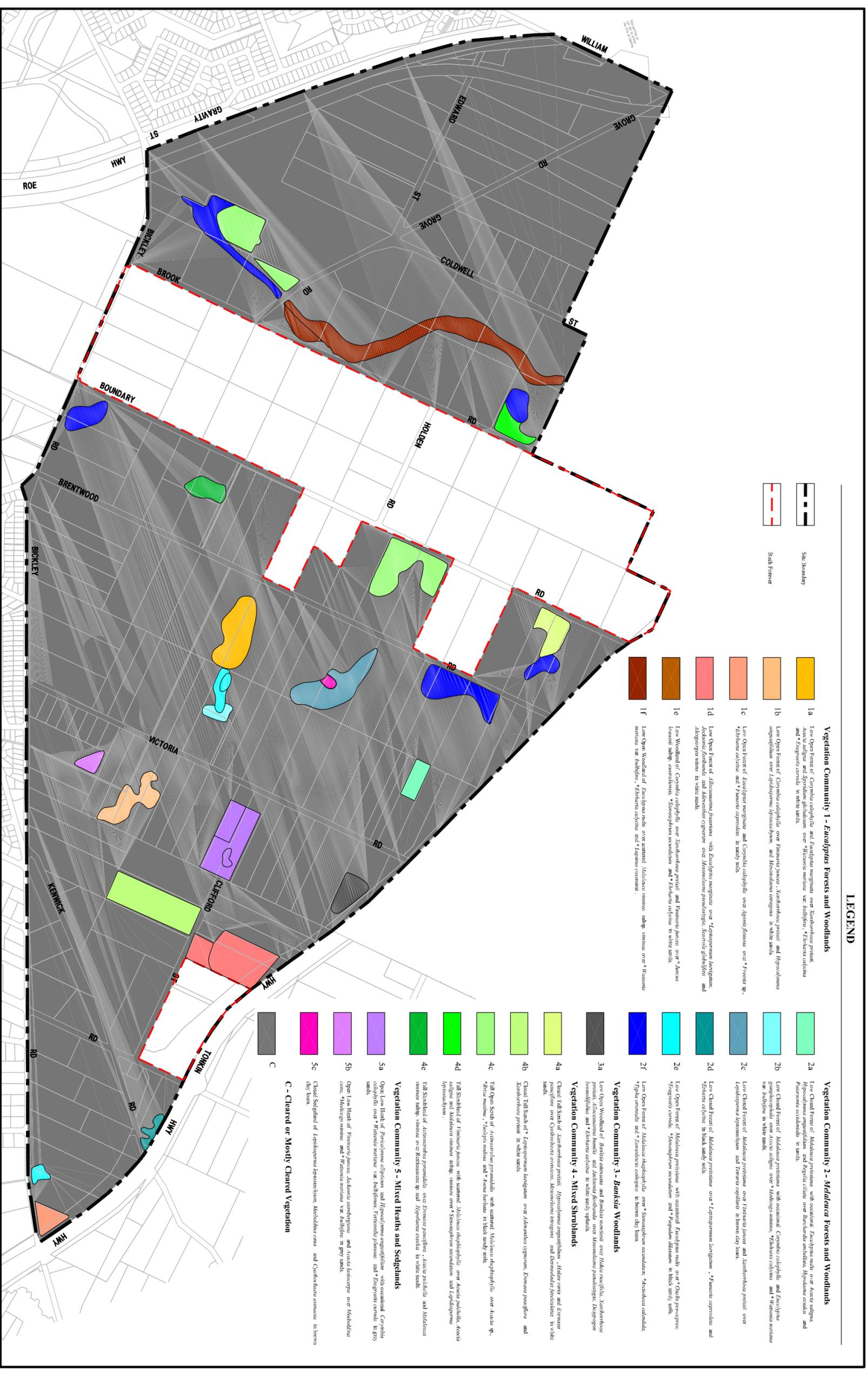
CITY OF GOSNELLS
 MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
 MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
 FIGURE 1 : AERIAL PHOTOGRAPHY OF MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA



Project Number
 V040719
 Drawing Number
 V196-SK01
 Revision

1:12500





LEGEND

- Site Boundary
- Bush Forest

- Vegetation Community 1 - Eucalyptus Forests and Woodlands**
- 1a Low Open Forest of *Corymbia colophylla* and *Eucalyptus marginata* over *Xanthorrhoea prenitens*, *Acacia saligna* and *Sporobolus glaberrimus* over *Thlaspi medium* var. *bulbiferum*; *Ephedra arbuscula* and *Erigeron crinitus* in white sands.
 - 1b Low Open Forest of *Corymbia colophylla* over *Fimbraria tenax*, *Xanthorrhoea prenitens* and *Hydrocotyllum angustifolium* over *Lepidosperma leptospermum*, and *Mesembryanthemum* in white sands.
 - 1c Low Open Forest of *Eucalyptus marginata* and *Corymbia colophylla* over *Alysicarpus* sp. over *Fimbraria tenax* and *Fimbraria capillaris* in sandy soils.
 - 1d Low Open Forest of *Allocasuarina fraxinea* with *Eucalyptus marginata* over *Lepidosperma longispinum*, *Jacksonia foeniculata* and *Adiantum cyclosum* over *Mesembryanthemum*, *Sarcobola globulifera* and *Alysicarpus* sp. in white sands.
 - 1e Low Woodland of *Corymbia colophylla* over *Xanthorrhoea prenitens* and *Fimbraria tenax* over *Fimbraria tenax* subsp. *australensis*; *Sarcobola globulifera* and *Fimbraria tenax* in white sands.
 - 1f Low Open Woodland of *Eucalyptus radiata* over scattered *Melicope viminea* subsp. *viminea* over *Fimbraria tenax* var. *bulbiferum*; *Fimbraria colchica* and *Lagotis costarum*.

- Vegetation Community 2 - Melaleuca Forests and Woodlands**
- 2a Low Closed Forest of *Melaleuca prestita* with occasional *Eucalyptus radiata* over *Acacia saligna*, *Fimbraria tenax*, *Leptocarpus* sp. and *Psidium siliqua* over *Banksia attenuata*, *Hydrocotyllum angustifolium* and *Paracetium occidentale* in sands.
 - 2b Low Closed Forest of *Melaleuca prestita* with occasional *Corymbia colophylla* and *Eucalyptus gonipocarpoides* over *Acacia saligna* over *Melicope viminea*, *Fimbraria colchica* and *Fimbraria tenax* var. *bulbiferum* in white sands.
 - 2c Low Closed Forest of *Melaleuca prestita* over *Fimbraria tenax* and *Xanthorrhoea prenitens* over *Lepidosperma leptospermum* and *Fimbraria capillaris* in brown clay loam.
 - 2d Low Closed Forest of *Melaleuca prestita* over *Lepidosperma longispinum*; *Fimbraria capillaris* and *Fimbraria tenax* in black sandy soils.
 - 2e Low Open Forest of *Melaleuca prestita* with occasional *Eucalyptus radiata* over *Quilicium prostratum*, *Erigeron crinitus*, *Sarcobola globulifera*, *Sarcobola globulifera* and *Paracetium occidentale* in black sandy soils.

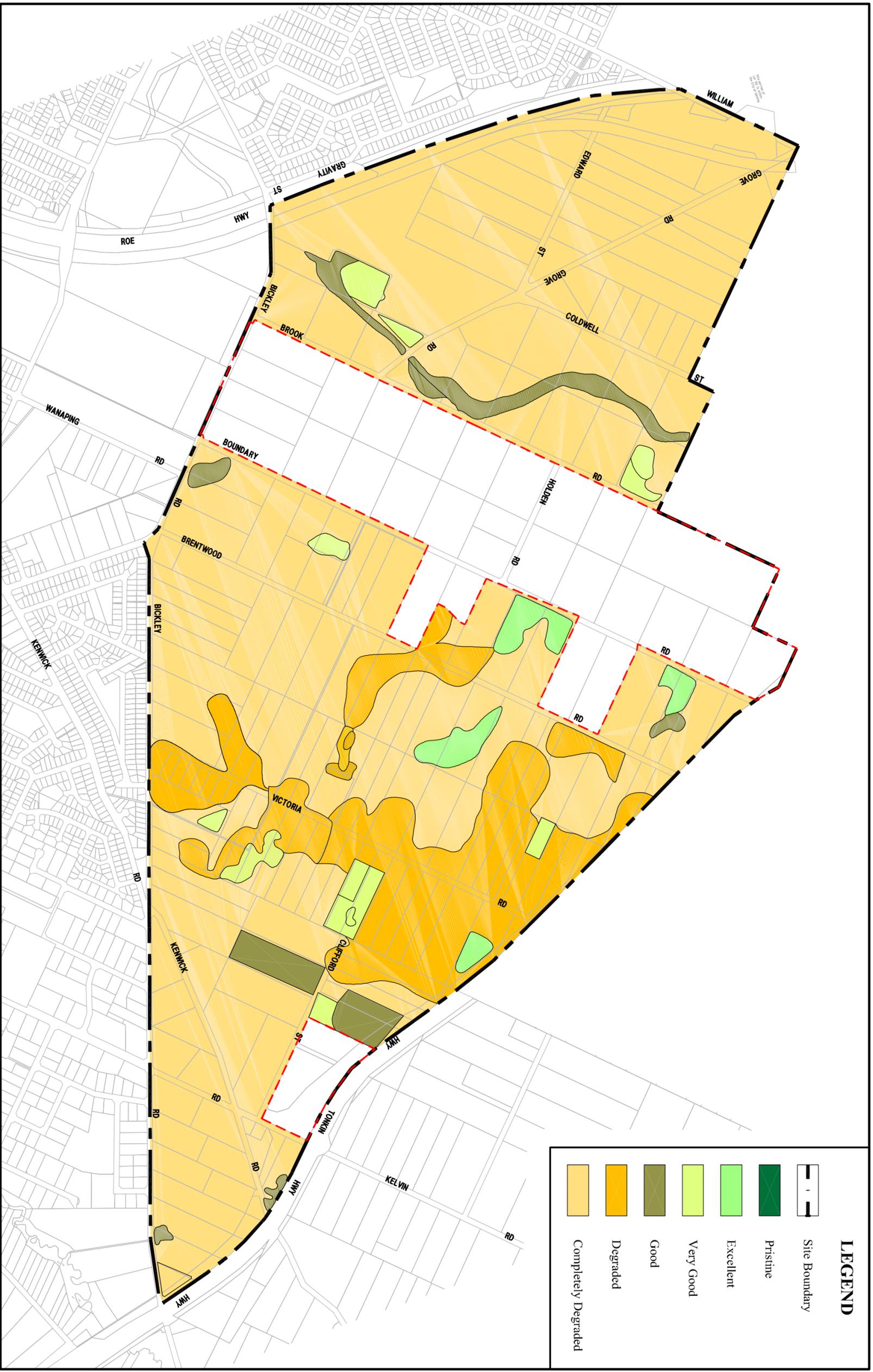
- Vegetation Community 3 - Banksia Woodlands**
- 3a Low Open Woodland of *Banksia attenuata* and *Banksia menziesii* over *Hakea macgregoriae*, *Xanthorrhoea prenitens*, *Allocasuarina humilis* and *Jacksonia foeniculata* over *Mesembryanthemum*, *Leptocarpus* sp. and *Fimbraria colchica* in white sandy spurs.
- Vegetation Community 4 - Mixed Shrublands**
- 4a Closed Tall Scrub of *Xanthorrhoea prenitens*, *Hydrocotyllum angustifolium*, *Hakea stricta* and *Erigeron crinitus* over *Cymbopogon strictus*, *Mesembryanthemum* and *Drosera rotundifolia* in white sands.
 - 4b Closed Tall Scrub of *Lepidosperma longispinum* over *Adiantum cyclosum*, *Erigeron crinitus* and *Xanthorrhoea prenitens* in white sands.
 - 4c Tall Open Scrub of *Acrotenax pyramidalis* with scattered *Melicope viminea* over *Acacia saligna*, *Briza media*, *Styris nodosa* and *Hydrocotyllum* in black sandy soils.
 - 4d Tall Scrubland of *Yucca stricta* with scattered *Melicope viminea*, *Acacia saligna* and *Melaleuca prestita* over *Sarcobola globulifera* and *Lepidosperma leptospermum*.
 - 4e Tall Scrubland of *Acrotenax pyramidalis* over *Erigeron crinitus*, *Acacia saligna* and *Melaleuca prestita* over *Sarcobola globulifera* and *Lepidosperma leptospermum*.

- Vegetation Community 5 - Mixed Heaths and Sedgeland**
- 5a Open Low Heath of *Pericallis filiformis* and *Erigeron crinitus* with occasional *Corymbia colophylla* over *Fimbraria tenax* var. *bulbiferum*, *Pericallis filiformis* and *Erigeron crinitus* in grey sands.
 - 5b Open Low Heath of *Fimbraria tenax*, *Jacksonia foeniculata* and *Acacia saligna* over *Melaleuca prestita*, *Melicope viminea* and *Fimbraria tenax* var. *bulbiferum* in grey sands.
 - 5c Closed Sedgeland of *Lepidosperma leptospermum*, *Melicope viminea* and *Cymbopogon strictus* in brown clay loam.
- C - Cleared or Mostly Cleared Vegetation**
- C

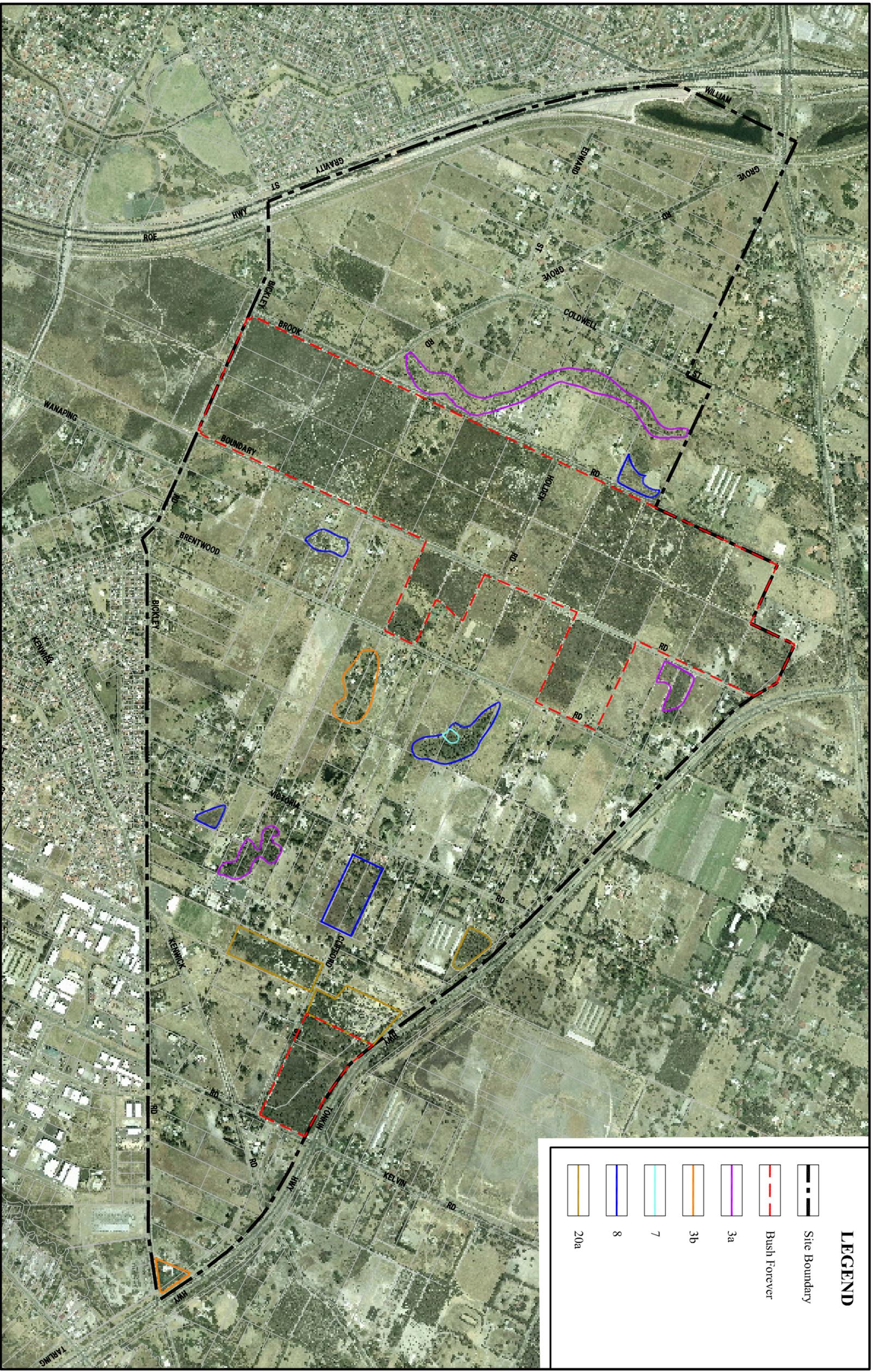
CITY OF GOSNELLS
MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
FIGURE 2 : VEGETATION COMMUNITY MAPPING

1:125000 0 0.125 0.25 0.375 0.5 0.625 0.75 0.875 1km 1.125 1.25





CITY OF GOSNELLS
MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
FIGURE 3 : VEGETATION CONDITION MAPPING

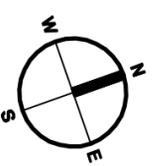


LEGEND

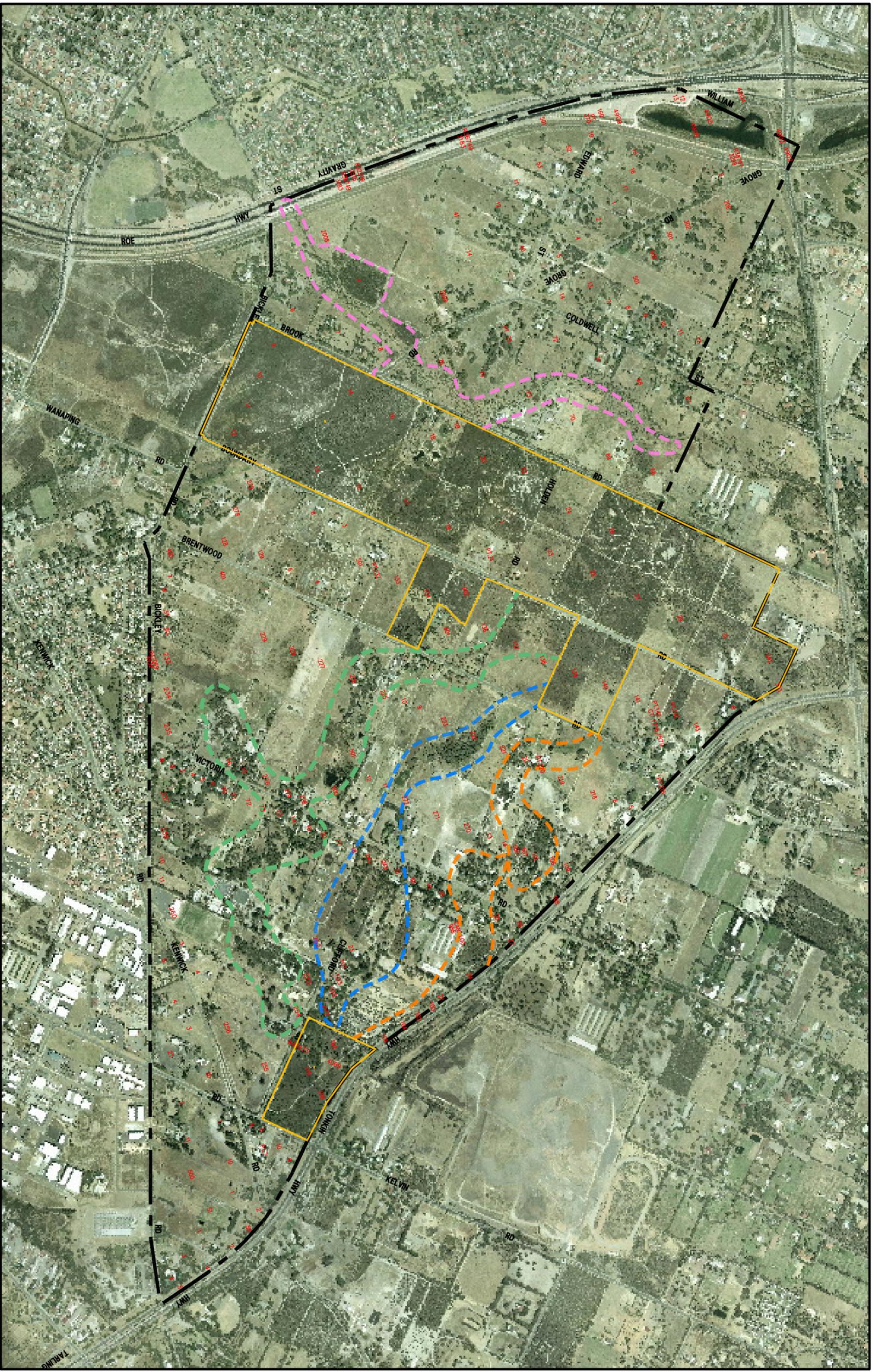
-  Site Boundary
-  Bush Forever
-  3a
-  3b
-  7
-  8
-  20a

**CITY OF GOSNELLS
MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
FIGURE 4 : TEC MAPPING**

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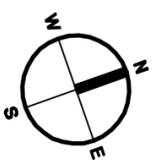


Project Number
V04019
Drawing Number
V196-SK06
Revision

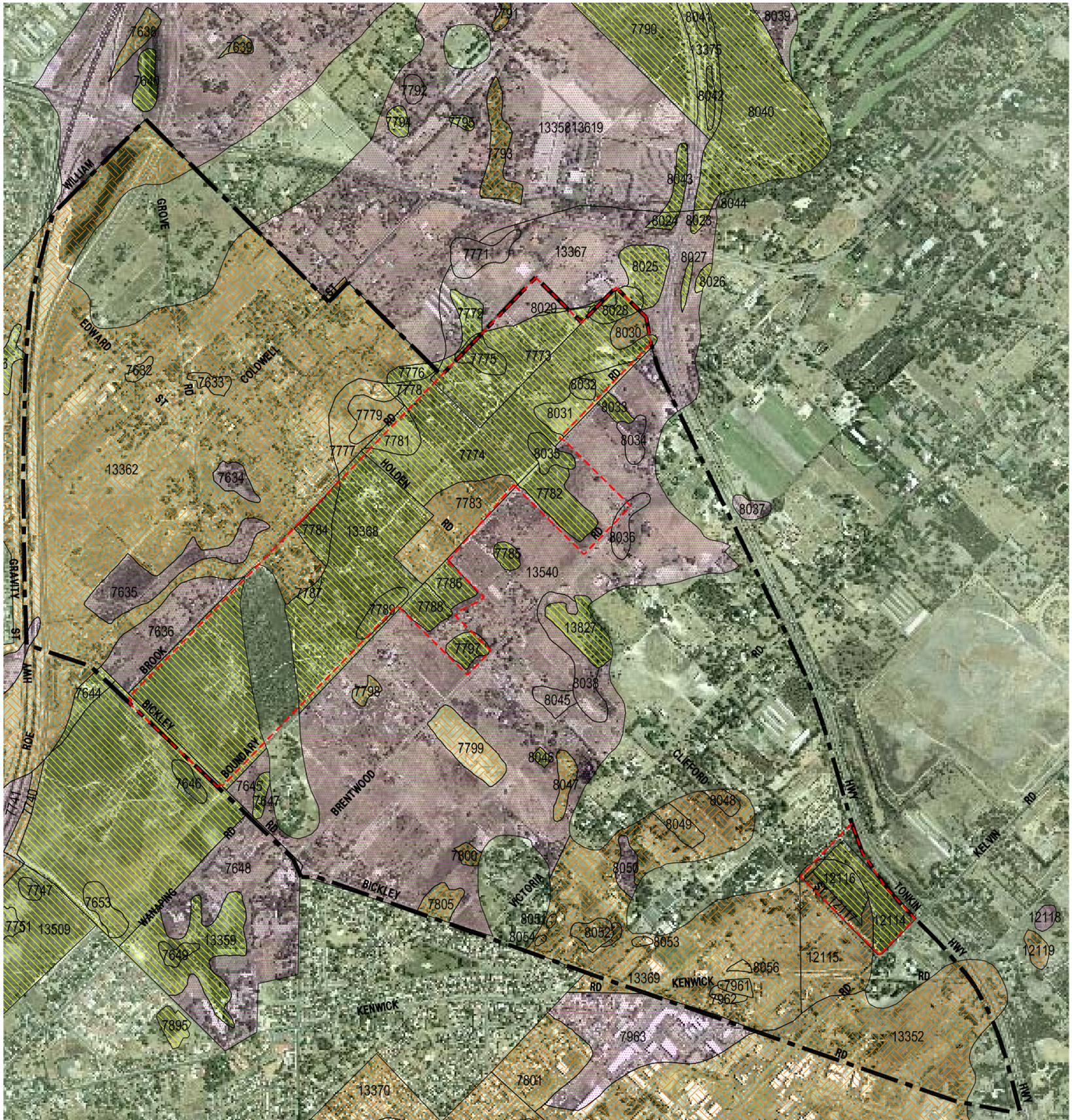


CITY OF GOSNELLS
 MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
 FIGURE 5 : POTENTIAL GREENWAYS

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 V166-SK05
 Revision



LEGEND

STUDY AREA

BUSH FOREVER

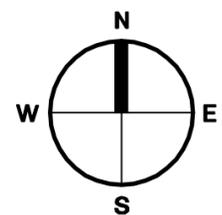
GEOMORPHIC WETLAND MAPPING

CONSERVATION

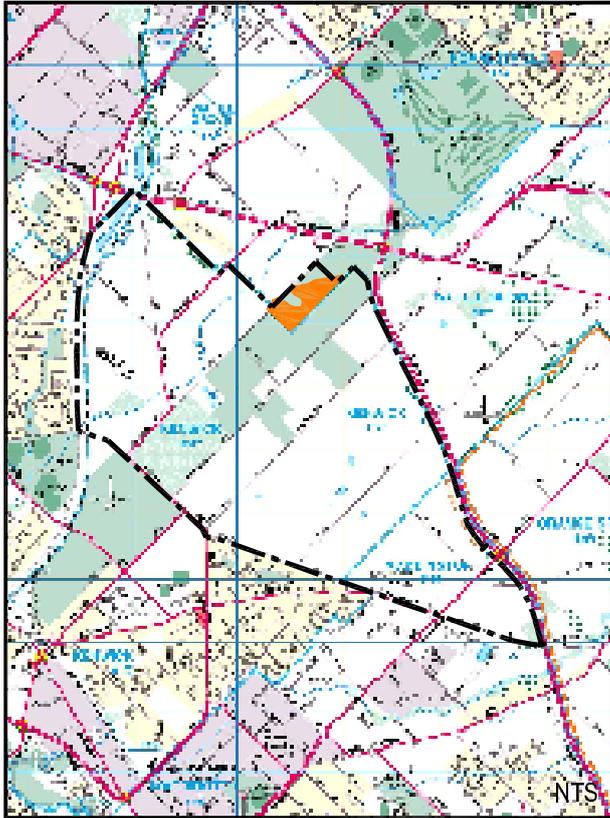
RESOURCE ENHANCEMENT

MULTIPLE USE

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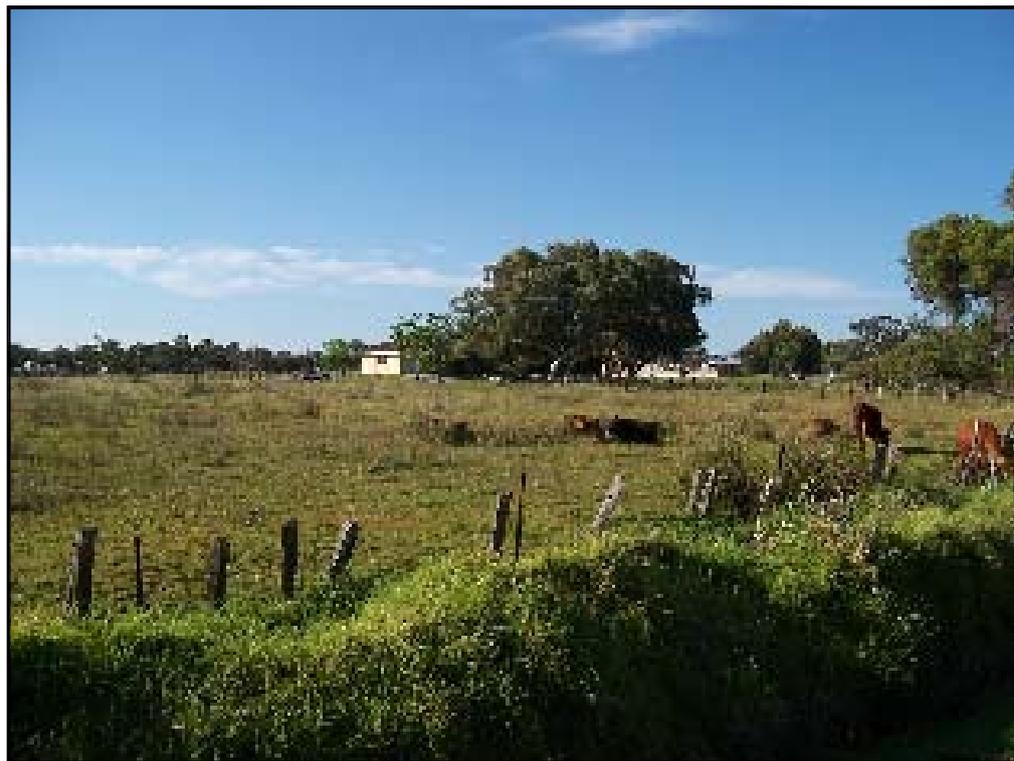
**CITY OF GOSNELLS
MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
FIGURE 6 : GEOMORPHIC WETLANDS MAPPING**



LEGEND

 SITE BOUNDARY

 WETLAND BOUNDARY

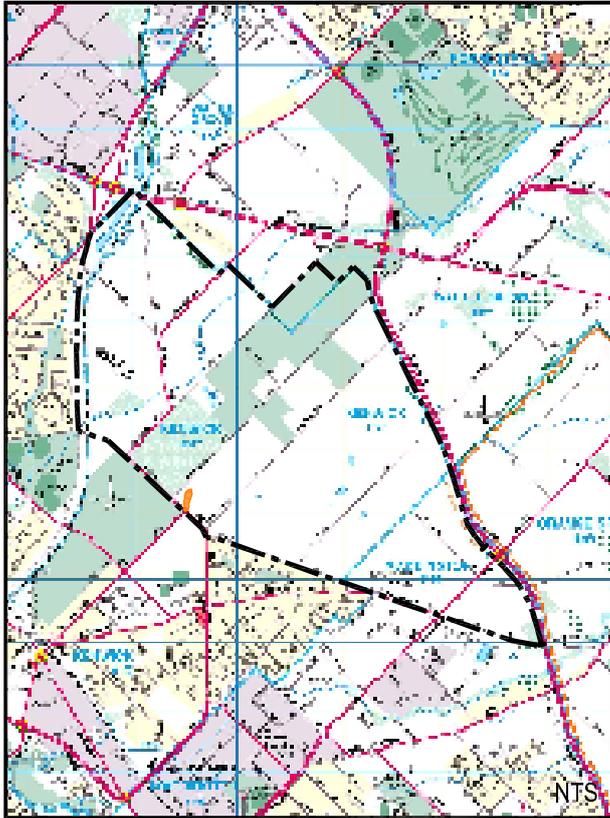


CITY OF GOSNELLS
MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
FIGURE 7 : WETLAND EVALUATION - WETLAND 7778



Project Number
V04019
 Drawing Number
V196-SK08
 Revision





LEGEND

 SITE BOUNDARY

 WETLAND BOUNDARY

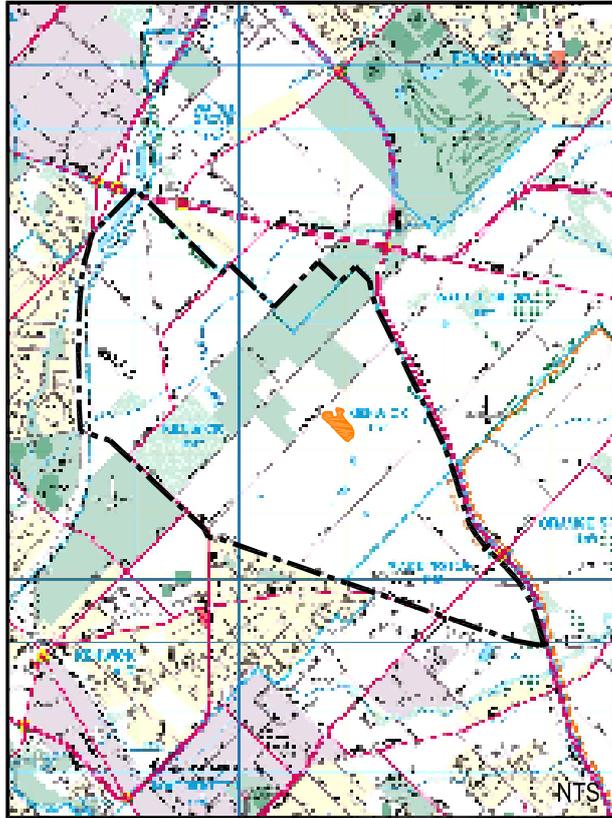


CITY OF GOSNELLS
MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
FIGURE 8 : WETLAND EVALUATION - WETLAND 7647



Project Number
V04019
 Drawing Number
V196-SK09
 Revision





LEGEND

 SITE BOUNDARY

 WETLAND BOUNDARY

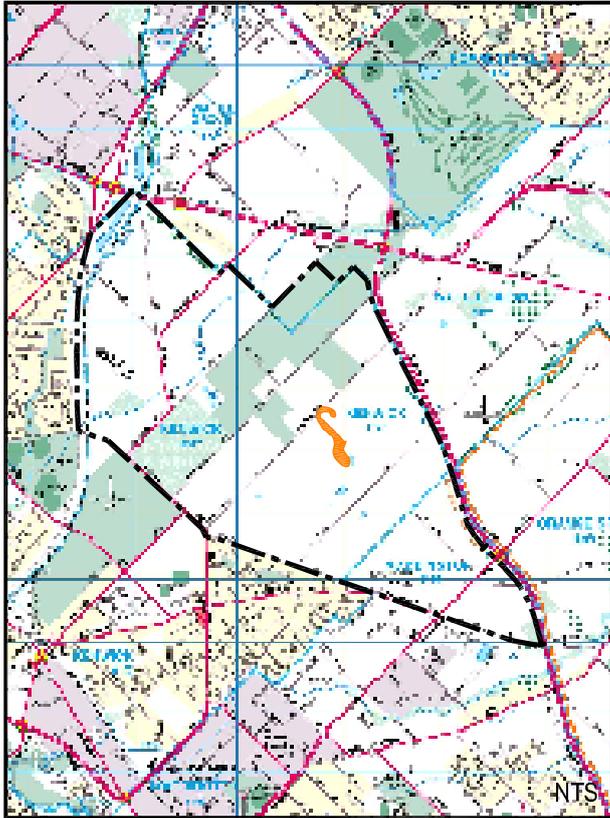


CITY OF GOSNELLS
MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
FIGURE 9 : WETLAND EVALUATION - WETLANDS 13825,
13826 & 13827



Project Number
V04019
 Drawing Number
V196-SK10
 Revision





LEGEND

- SITE BOUNDARY
- WETLAND BOUNDARY

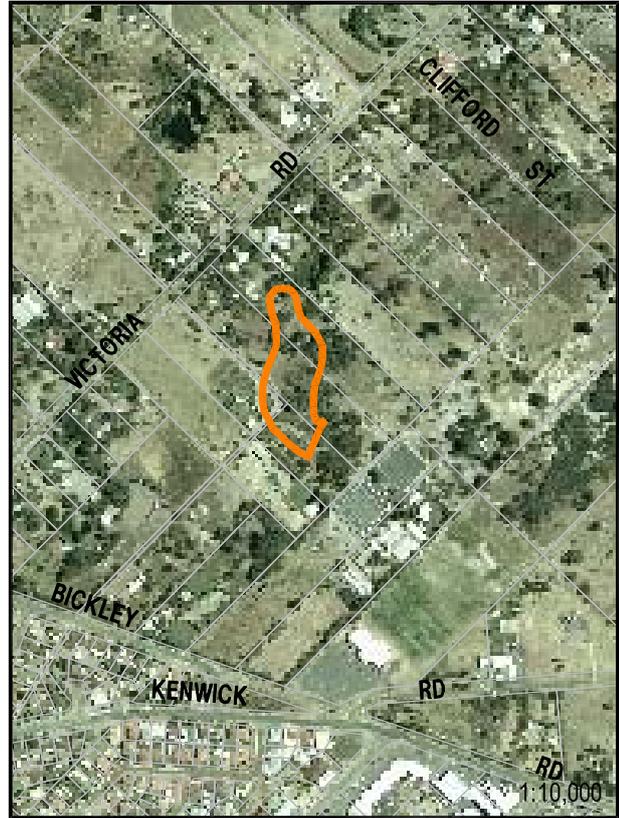
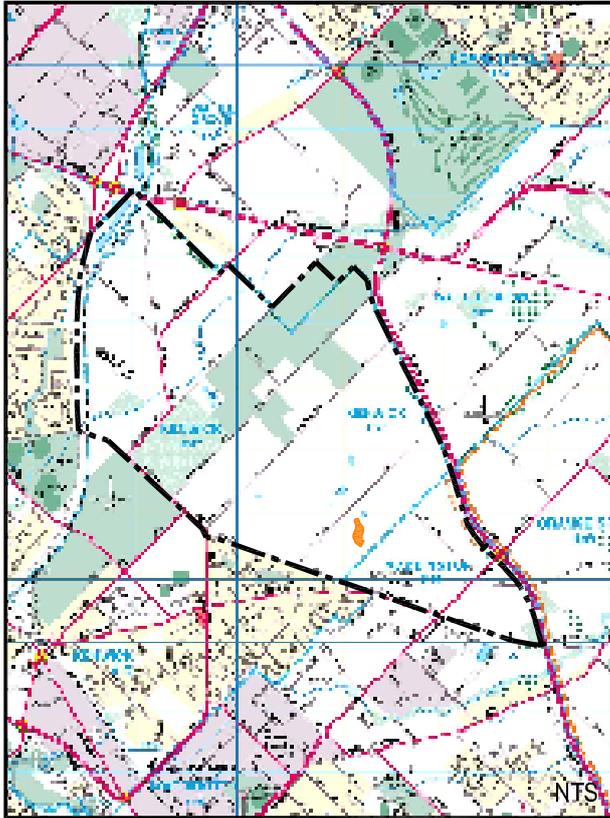


CITY OF GOSNELLS
MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
FIGURE 10 : WETLAND EVALUATION - WETLAND 8038



Project Number
V04019
 Drawing Number
V196-SK11
 Revision





LEGEND

- SITE BOUNDARY
- WETLAND BOUNDARY



CITY OF GOSNELLS
MADDINGTON / KENWICK STRATEGIC INDUSTRIAL AREA
FIGURE 11 : WETLAND EVALUATION - WETLAND 8050



Project Number
V04019
 Drawing Number
V196-SK12
 Revision



PHOTOGRAPHIC PLATES



8.1.1.1 *Photograph 1: Community 1a*

Low Open Forest of *Corymbia calophylla* and *Eucalyptus marginata* over *Xanthorrhoea preissii*, *Acacia saligna* and *Spyridium globulosum* over **Watsonia meriana* var. *bulbifera*, **Ehrharta calycina* and **Eragrostis curvula* in white sands.



Photograph 2: Community 1b

Low Open Forest of *Corymbia calophylla* over *Viminaria juncea*, *Xanthorrhoea preissii* and *Hypocalymma angustifolium* over *Lepidosperma leptostachyum* and *Mesomelaena tetragona* in white sands.



Photograph 3: Community 1c

Low Open Forest of *Eucalyptus marginata* and *Corymbia calophylla* over *Agonis flexuosa* over **Freesia* sp., **Ehrharta calycina* and **Fumaria capreolata* in sandy soils.



8.1.1.2

8.1.1.3 *Photograph 4: Community 1d*

Low Open Forest of *Allocasuarina fraseriana* with *Eucalyptus marginata* over **Leptospermum laevigatum*, *Jacksonia floribunda* and *Adenanthos cygnorum* over *Mesomelaena pseudostygia*, *Scaevola globulifera* and *Alexgeorgea nitens* in white sands.

8.1.1.4



8.1.1.5 *Photograph 5: Community 1e*

Low Woodland of *Corymbia calophylla* over *Xanthorrhoea preissii* and *Viminaria juncea* over **Juncus kraussii* subsp. *australiensis*, **Stenotaphrum secundatum* and **Ehrharta calycina* in white sands.



8.1.1.6 *Photograph 6: Community 1f*

Low Open Woodland of *Eucalyptus rudis* over scattered *Melaleuca viminea* subsp. *viminea* over
**Watsonia meriana* var. *bulbifera*, **Ehrharta calycina* and **Lupinus cosentinii*.



8.1.1.7 *Photograph 7: Community 2a*

Low Closed Forest of *Melaleuca preissiana* with occasional *Eucalyptus rudis* over *Acacia saligna*,
Hypocalymma angustifolium and *Regelia ciliata* over *Burchardia umbellata*, *Hypolaena exsulca* and
Patersonia occidentalis in sands.



Photograph 8: Community 2b

Low Closed Forest of *Melaleuca preissiana* with occasional *Corymbia calophylla* and *Eucalyptus gomphocephala* over *Acacia saligna* over **Medicago minima*, **Ehrharta calycina* and **Watsonia meriana* var. *bulbifera* in white sands.



8.1.1.8 *Photograph 9: Community 2c*

Low Closed Forest of *Melaleuca preissiana* over *Viminaria juncea* and *Xanthorrhoea preissii* over *Lepidosperma leptostachyum* and *Tetraria capillaris* in brown clay loam.



Photograph 10: Community 2d

Low Closed Forest of *Melaleuca preissiana* over **Leptospermum laevigatum*, **Fumaria capreolata* and **Ehrharta calycina* in black sandy soils.



Photograph 11: Community 2e

Low Open Forest of *Melaleuca preissiana* with occasional *Eucalyptus rudis* over **Oxalis pes-caprae*, **Eragrostis curvula*, **Stenotaphrum secundatum* and **Paspalum dilatatum* in black sandy soils.



Photograph 12: Community 2f

Low Open Forest of *Melaleuca raphiophylla* over **Stenotaphrum secundatum*, **Arctotheca calendula*, **Typha orientalis* and **Zantedeschia aethiopica* in brown clay loam.



Photograph 13: Community 3e

Low Open Woodland of *Banksia attenuata* and *Banksia menziesii* over *Hakea ruscifolia*, *Xanthorrhoea preissii*, *Allocasuarina humilis* and *Jacksonia floribunda* over *Mesomelaena pseudostygia*, *Dasypogon bromeliifolius* and **Ehrharta calycina* in white sandy uplands.



Photograph 14: Community 4a

Closed Tall Scrub of *Xanthorrhoea preissii*, *Hypocalymma angustifolium*, *Hakea varia* and *Eremaea pauciflora* over *Cyathochaeta avenacea*, *Mesomelaena tetragona* and *Desmocladius fasciculatus* in white sands.



Photograph 15: Community 4b

Closed Tall Scrub of *Leptospermum laevigatum* over *Adenanthos cygnorum*, *Eremaea pauciflora* and *Xanthorrhoea preissii* in white sands..



8.1.1.9 *Photograph 16: Community 4c*

Tall Open Scrub of *Actinostrobos pyramidalis* with scattered *Melaleuca raphiophylla* over *Acacia* sp.,
**Briza maxima*, **Isolepis nodosa* and **Avena barbata* in black sandy soils.



8.1.1.10 *Photograph 17: Community 4d*

Tall Shrubland of *Viminaria juncea* with scattered *Melaleuca raphiophylla* over *Acacia pulchella*, *Acacia saligna* and *Melaleuca viminea* subsp. *viminea* over **Stenotaphrum secundatum* and *Lepidosperma leptostachyum*.



8.1.1.11 *Photograph 18: Community 4e*

Tall Shrubland of *Actinostrobos pyramidalis* over *Eremaea pauciflora*, *Acacia pulchella* and *Melaleuca viminea* subsp. *viminea* over Restionaceae sp. and *Hypolaena exsulca* in white sands.



Photograph 19: Community 5a

Open Low Heath of *Pericalymma ellipticum* and *Hypocalymma angustifolium* with occasional *Corymbia calophylla* over **Watsonia meriana* var. *bulbiferum*, *Verticordia plumosa* and **Eragrostis curvula* in grey sands.



8.1.1.12 *Photograph 20: Community 5b*

Open Low Heath of *Viminaria juncea*, *Jacksonia sternbergiana* and *Acacia lasiocarpa* over *Meeboldina cana*, **Medicago minima* and **Watsonia meriana* var. *bulbifera* in grey sands.



Photograph 21: Community 5c

Closed Sedgeland of *Lepidosperma leptostachyum*, *Meeboldina cana* and *Cyathochaeta avenacea* in brown clay loam.



Photograph 22: Excellent Condition Vegetation.



Photograph 23: Very Good Condition Vegetation



8.1.2

Photograph 24: Good Condition Vegetation



Photograph 25: Degraded Condition Vegetation



Photograph 26: Completely Degraded Vegetation/Cleared or Mostly Cleared

APPENDIX A
VASCULAR PLANT SPECIES RECORDED AT MADDINGTON
KENWICK STRATEGIC INDUSTRIAL AREA, OCTOBER 2004

NB: * denotes introduced (weed) species

Family	Species
AGAVACEAE	* <i>Agave americana</i>
ANACARDIACEAE	* <i>Schinus terebinthifolia</i>
ANTHERICACEAE	<i>Ptilotus polystachyus</i> <i>Thysanotus manglesianus</i> <i>Thysanotus multiflorus</i> <i>Thysanotus</i> sp. <i>Tricoryne elatior</i>
APIACEAE	<i>Daucus glochidiatus</i>
ARACEAE	* <i>Zantedescia aethiopica</i>
ASPARAGACEAE	* <i>Asparagus asparagoides</i>
ASTERACEAE	* <i>Arctotheca calendula</i> * <i>Conyza bonariensis</i> <i>Cotula coronopifolia</i> * <i>Hypochaeris glabra</i> <i>Podolepis gracilis</i> <i>Senecio</i> sp. <i>Siloxerus humifusus</i> <i>Ursinia anthemoides</i> <i>Asteraceae</i> sp.
BORAGINACEAE	* <i>Echium plantagineum</i>
BRASSICACEAE	* <i>Brassica</i> sp. * <i>Raphanus raphanistrum</i>
CAMPANULACEAE	* <i>Wahlenbergia capensis</i>
CASUARINACEAE	<i>Allocasuarina fraseriana</i> <i>Allocasuarina humilis</i>

CENTROLEPIDACEAE	<i>Centrolepis polygina</i>
CHENOPODIACEAE	<i>Halosarcia halocnemoides</i>
COLCHICACEAE	<i>Burchardia umbellata</i>
CONVOLVULACEAE	* <i>Ipomea</i> sp.
CUPRESSACEAE	<i>Actinostrobus pyramidalis</i>
CYPERACEAE	<i>Cyathochaeta avenacea</i> * <i>Cyperus laevigatus</i> * <i>Cyperus tenellus</i> <i>Ficinia nodosa</i> <i>Gahnia trifida</i> * <i>Isolepis marginata</i> <i>Juncus kraussii</i> subsp. <i>australiensis</i> <i>Lepidosperma leptostachyum</i> <i>Lepidosperma squamatum</i> <i>Mesomelaena pseudostygia</i> <i>Mesomelaena tetragona</i> <i>Tetraria capillaris</i> Cyperaceae sp.
DASYPOGONACEAE	<i>Acanthocarpus canaliculatus</i> <i>Dasypogon bromeliifolius</i> <i>Kingia australis</i> <i>Lomandra</i> sp.
DILLENACEAE	<i>Hibbertia hypericoides</i>
DROSERACEAE	<i>Drosera</i> sp.
EPACRIDACEAE	<i>Leucopogon conostephioides</i>
EUPHORBIACEAE	* <i>Euphorbia peplus</i> * <i>Euphorbia terracina</i> * <i>Ricinus communis</i>
FRANKENIACEAE	<i>Frankenia pauciflora</i>
FUMARIACEAE	* <i>Fumaria capreolata</i>

GERANIACEAE	* <i>Pelargonium capitatum</i>
GOODENIACEAE	<i>Lechenaultia floribunda</i> <i>Scaevola canescens</i> <i>Scaevola globulifera</i> <i>Scaevola repens</i>
HAEMODORACEAE	<i>Anigozanthos manglesii</i> <i>Conostylis aculeata</i> <i>Conostylis aurea</i> <i>Conostylis setigera</i> <i>Haemodorum spicatum</i> <i>Tribonanthes australis</i>
IRIDACEAE	* <i>Freesia</i> sp. * <i>Gladiolus caryophyllaceus</i> * <i>Homeria flaccida</i> * <i>Ixia</i> sp. <i>Patersonia</i> sp. (swamp form) * <i>Watsonia meriana</i> var. <i>bulbifera</i> Iridaceae sp.
LAURACEAE	<i>Cassytha</i> sp.
LOBELIACEAE	<i>Isotoma scapigera</i>
LORANTHACEAE	<i>Nuytsia floribunda</i>
MIMOSACEAE	<i>Acacia alata</i> <i>Acacia lasiocarpa</i> var. <i>bracteolata</i> (P1) <i>Acacia pulchella</i> * <i>Acacia pycnantha</i> <i>Acacia saligna</i> <i>Acacia</i> sp.
MOLLUGINACEAE	<i>Macarthuria australis</i>
MYRTACEAE	<i>Agonis flexuosa</i> <i>Baeckea</i> sp. <i>Beaufortia elegans</i> <i>Callistemon</i> sp. <i>Calothamnus quadrifidus</i> <i>Calothamnus sanguineus</i> <i>Calytrix breviseta</i> subsp. ? <i>breviseta</i> (?R)

	<ul style="list-style-type: none"> * <i>Chamelaucium uncinatum</i> <i>Corymbia calophylla</i> <i>Eremaea pauciflora</i> <i>Eucalyptus ?drummondii</i> <i>Eucalyptus gomphocephala</i> <i>Eucalyptus marginata</i> <i>Eucalyptus rudis</i> <i>Eucalyptus tottiana</i> <i>Hypocalymma angustifolium</i> <i>Hypocalymma robustum</i> <i>Kunzea glabrescens</i> <i>Leptospermum erubescens</i> * <i>Leptospermum laevigatum</i> <i>Melaleuca huegelii</i> <i>Melaleuca preissiana</i> <i>Melaleuca rhapsiophylla</i> <i>Melaleuca viminea</i> subsp. <i>viminea</i> <i>Pericalymma ellipticum</i> <i>Regelia ciliata</i> <i>Scholtzia involucrata</i>
MYRTACEAE (Cont.)	<ul style="list-style-type: none"> <i>Verticordia acerosa</i> var. <i>acerosa</i> <i>Verticordia plumosa</i> var. <i>plumosa</i>
ONAGRACEAE	<ul style="list-style-type: none"> * <i>Oenothera</i> sp. * <i>Oenothera stricta</i>
ORCHIDACEAE	<ul style="list-style-type: none"> <i>Caladenia paludosa</i> <i>Diuris laxiflora</i> <i>Microtis media</i>
OROBANCHACEAE	<ul style="list-style-type: none"> * <i>Orobanche minor</i>
PAPILIONACEAE	<ul style="list-style-type: none"> <i>Aotus gracillima</i> <i>Bossiaea eriocarpa</i> * <i>Chamaecytisus palmensis</i> <i>Daviesia decurrens</i> <i>Daviesia divaricata</i> <i>Gastrolobium capitatum</i> <i>Gastrolobium ebracteolatum</i> <i>Gompholobium tomentosum</i> <i>Jacksonia floribunda</i> <i>Jacksonia furcellata</i> <i>Jacksonia sternbergiana</i> * <i>Lupinus cosentinii</i>

- * *Medicago minima*
- * *Oxalis pes-caprae*
- * *Trifolium angustifolium*
- * *Vicia sativa*
- Viminaria juncea*

PINACEAE

- * *Pinus* sp.

POACEAE

- * *Aira caryophylla*
- Austrostipa compressa*
- Austrostipa elegantissima*

POACEAE (Cont.)

- * *Avena barbata*
- * *Briza maxima*
- * *Briza minor*
- * *Bromus diandrus*
- * *Cortaderia selloana*
- * *Cynadon dactylon*
- * *Ehrharta calycina*
- * *Eragrostis curvula*
- * *Holcus lanatus*
- * *Lolium perenne*
- * *Paspalum dilatatum*
- * *Pennisetum clandestinum*
- * *Polypogon monspeliensis*
- * *Secale cereale*
- * *Stenotaphrum secundatum*
- * *Vulpia myuros*
- Poaceae sp.

POLYGONACEAE

- * *Rumex crispus*

PORTULACACEAE

Calandrinia eremaea

PRIMULACEAE

- * *Anagallis arvensis* var. *arvensis*
- * *Anagallis arvensis* var. *caerulea*

PROTEACEAE

Adenanthos cygnorum
Banksia attenuata
Banksia menziesii
Banksia telmatiaea
Conospermum undulatum (R)
Dryandra lindleyana subsp. *lindleyana*
Dryandra nivea
Grevillea diversifolia

	<i>Grevillea</i> sp.
	<i>Hakea</i> ? <i>ceratophylla</i>
	<i>Hakea ceratophylla</i>
	<i>Hakea ruscifolia</i>
PROTEACEAE (Cont.)	<i>Hakea trifurcata</i>
	<i>Hakea varia</i>
	<i>Isopogon drummondii</i> (P3)
	<i>Petrophile linearis</i>
	<i>Petrophile macrostachya</i>
	<i>Stirlingia latifolia</i>
RESTIONACEAE	<i>Alexgeorgia nitens</i>
	<i>Desmocladius fasciculatus</i>
	<i>Hypolaena exsulca</i>
	<i>Lepidobolus preissianus</i>
	<i>Lyginia imberbis</i>
	<i>Meeboldina cana</i>
	<i>Meeboldina scariosa</i>
	<i>Tremulina tremula</i>
	Restionaceae sp.
RHAMNACEAE	<i>Spyridium globulosum</i>
RUTACEAE	<i>Philotheca spicata</i>
SOLANACEAE	* <i>Physalis peruviana</i>
	* <i>Solanum nigrum</i>
STYLIDIACEAE	<i>Stylidium piliferum</i>
	<i>Stylidium repens</i>
	<i>Stylidium</i> sp.
THYMELAEACEAE	<i>Pimelea sulphurea</i>
	<i>Pimelea</i> sp.
TREMANDRACEAE	<i>Tetratea</i> sp.
TYPHACEAE	* <i>Typha orientalis</i>
XANTHORRHOEACEAE	<i>Xanthorrhoea preissii</i>

APPENDIX B
VASCULAR PLANT SPECIES RECORDED IN VEGETATION
COMMUNITIES, MADDINGTON KENWICK STRATEGIC
INDUSTRIAL AREA, OCTOBER 2004

NB: * denotes introduced (weed) species

Species	1a	1b	1c	1d	1e	1f	2a	2b	2c	2d	2e	2f	3a	4a
<i>Acacia lasiocarpa</i> var. <i>bracteolata</i>		x												
<i>Acacia pulchella</i>														
* <i>Acacia pycnantha</i>											x			
<i>Acacia saligna</i>	x	x			x		x		x					
<i>Acacia</i> sp.														
<i>Acanthocarpus canaliculatis</i>														
<i>Actinostrobos pyramidalis</i>														
<i>Adenanthos cygnorum</i>				x									x	
* <i>Agave americanus</i>										x				
<i>Agonis flexuosa</i>			x											
* <i>Aira caryophylla</i>														
<i>Alexgeorgia nitens</i>				x									x	x
<i>Allocasuarina fraseriana</i>				x										
<i>Allocasuarina humilis</i>				x									x	
* <i>Anagallis arvensis</i> var. <i>arvensis</i>												x		
* <i>Anagallis arvensis</i> var. <i>caerulea</i>													x	
<i>Anigozanthos manglesii</i>													x	x
<i>Aotus gracillima</i>									x					x
* <i>Arctotheca calendula</i>												x	x	
* <i>Asparagus asparagoides</i>											x			
<i>Austrostipa compressa</i>				x										
<i>Austrostipa elegantissima</i>														
* <i>Avena barbata</i>	x				x				x					
<i>Baeckea</i> sp.									x					
<i>Banksia attenuata</i>													x	
<i>Banksia menziesii</i>				x									x	
<i>Banksia telmatiaea</i>														
<i>Beaufortia elegans</i>														
<i>Bossiaea eriocarpa</i>				x										
* <i>Brassica</i> sp.														
* <i>Briza maxima</i>	x	x					x	x			x		x	
* <i>Briza minor</i>									x					x
* <i>Bromus diandrus</i>					x				x					
<i>Burchardia umbellata</i>							x		x				x	
<i>Caladenia paludosa</i>														
<i>Calandrinia eremaea</i>														
<i>Calothamnus quadrifidus</i>				x										
<i>Calothamnus sanguineus</i>													x	
<i>Calytrix brevisetis</i> subsp. <i>?brevisetis</i> (?R)														
<i>Cassytha</i> sp.														x
* <i>Centrolepis polygina</i>									x					x

* <i>Brassica</i> sp.				X			
* <i>Briza maxima</i>		X	X	X	X		
* <i>Briza minor</i>		X		X	X		
* <i>Bromus diandrus</i>					X		
<i>Burchardia umbellata</i>							
<i>Caladenia paludosa</i>				X			
<i>Calandrinia eremaea</i>				X			
<i>Calothamnus quadrifidus</i>							
<i>Calothamnus sanguineus</i>	X			X			
<i>Calytrix brevisetis</i> subsp. <i>?brevisetis</i> (?R)				X			
<i>Cassutha</i> sp.							
* <i>Centrolepis polygina</i>				X			
* <i>Chamaecytisus palmensis</i>		X					
* <i>Chamelaucium uncinatum</i>	X						
<i>Conospermum undulatum</i> (R)							
<i>Conostylis aculeata</i>							
<i>Conostylis aurea</i>							
<i>Conostylis setigera</i>							
<i>Conyza bonariensis</i>							
* <i>Cortadema selloana</i>							
<i>Corymbia calophylla</i>		X			X	X	
<i>Cotula coronipifolia</i>							
<i>Cyathochaeta avenaceae</i>				X			
* <i>Cynadon dactylon</i>							
<i>Cyperaceae</i> sp.				X			
* <i>Cyperus laevigatus</i>		X					
* <i>Cyperus tenellus</i>							
<i>Dasyogon bromeliifolius</i>	X						
<i>Daucus glochidiatus</i>							
<i>Daviesia decurrens</i>							
<i>Daviesia divaricata</i>							
<i>Desmocladius fasciculatus</i>	X						
<i>Diuris laxifolia</i>				X			
<i>Drosera</i> sp. (climbing)							
<i>Dryandra lindleyana</i> subsp. <i>lindleyana</i>							
<i>Dryandra nivea</i>							
* <i>Echium plantagineum</i>		X			X		
* <i>Ehrharta calycina</i>	X	X	X	X		X	
* <i>Eragrostis curvula</i>					X	X	
<i>Eremaea pauciflora</i>	X			4			
<i>Eucalyptus ?drummondii</i>					X		
<i>Eucalyptus gomphocephala</i>							
<i>Eucalyptus marginata</i>							
<i>Eucalyptus rudis</i>		X					
<i>Eucalyptus todtiana</i>	X						
* <i>Euphorbia peplus</i>							

* <i>Euphorbia terracina</i>							
<i>Ficinia nodosa</i>		X					
<i>Frankenia pauciflora</i>			X	X			
* <i>Freesia</i> sp.							
* <i>Fumaria capreolata</i>		X					
<i>Gahnia trifida</i>				X			
<i>Gastrolobium capitatum</i>							
<i>Gastrolobium ebracteolatum</i>							
* <i>Gladiolus caryophyllaceus</i>							
<i>Gompholobium tomentosum</i>							
<i>Grevillea diversifolia</i>				X			
<i>Grevillea</i> sp.							
<i>Haemodorum spicatum</i>							
<i>Hakea ?ceratophylla</i>							
<i>Hakea ceratophylla</i>							
<i>Hakea ruscifolia</i>							
<i>Hakea varia</i>						X	
<i>Halosarcia halocnemoides</i>				3			
<i>Hibbertia hypericoides</i>							
* <i>Holcus lanatus</i>							
* <i>Homeria flaccida</i>			X	X			
<i>Hypocalymma angustifolium</i>					X	X	
<i>Hypocalymma robustum</i>		X		X			
* <i>Hypochoeris glabra</i>		X					
<i>Hypolaena exsulca</i>				X			X
* <i>Ipomea</i> sp.			X				
<i>Iridaceae</i> sp.				X			
* <i>Isolepis marginata</i>		X					
<i>Isopogon drummondii</i> (P3)							
<i>Isotoma scapigera</i>							
* <i>Ixia</i> sp.		X		X			
<i>Jacksonia floribunda</i>							
<i>Jacksonia furcellata</i>							
<i>Jacksonia sternbergiana</i>						X	
<i>Juncus kraussii</i> subsp. <i>australiensis</i>							X
<i>Kingia australis</i>							
<i>Kunzea glabrescens</i>					X		
<i>Lechenaultia floribunda</i>							
<i>Lepidobolus preissianus</i>				X			
<i>Lepidosperma leptostachyum</i>			X	X			X
<i>Lepidosperma squamatum</i>							
<i>Leptospermum erubescens</i>				X			
<i>Leptospermum laevigatum</i>	X				X		
<i>Leucopogon conostephioides</i>							
* <i>Lolium perenne</i>			X	X			X
<i>Lomandra</i> sp.				X			

* <i>Lupinus cosentinii</i>							
<i>Lyginia imberbis</i>	x						
<i>Macarthuria australis</i>							
* <i>Medicago minima</i>		x	x	3	x	x	x
<i>Meeboldina cana</i>				x		x	x
<i>Meeboldina scariosa</i>			x			x	x
<i>Melaleuca huegelii</i>							
<i>Melaleuca preissiana</i>							
<i>Melaleuca raphiophylla</i>		x	x				
<i>Melaleuca viminea</i> subsp. <i>viminea</i>		x	x	3			
<i>Mesomelaena pseudostygia</i>							
<i>Mesomelaena tetragona</i>							
<i>Microtis media</i>							
<i>Nuytsia floribunda</i>	x						
* <i>Oenothera</i> sp.				x			
* <i>Oenothera stricta</i>							
* <i>Orobanche minor</i>							
* <i>Oxalis pes-caprae</i>							
* <i>Paspalum dilatatum</i>						x	
<i>Paterosnia</i> sp. (swamp form)							
* <i>Pelargonium capitatum</i>							
* <i>Pennisetum clandestinum</i>			x				
<i>Pericalymma ellipticum</i>	x				x		
<i>Petrophile linearis</i>							
<i>Petrophile macrostachya</i>							
<i>Philothea spicata</i>							
* <i>Physalis peruviana</i>							
<i>Pimelea</i> sp.							
<i>Pimelea sulphurea</i>							
<i>Pinus</i> sp.							
Poaceae sp.							
<i>Podolepis gracilis</i>				x			
* <i>Polypogon monspeliensis</i>			x				
<i>Ptilotus polystachyus</i>							
* <i>Raphanus raphanistrum</i>							
<i>Regelia ciliata</i>							
Restionaceae sp.				3	x	x	
* <i>Ricinus communis</i>			x				
* <i>Rumex crispus</i>		x	x				
<i>Scaevola canescens</i>				x			
<i>Scaevola globulifera</i>							
<i>Scaevola repens</i>							
* <i>Schinus terebinthifolia</i>							
<i>Scholtzia involucrata</i>							
* <i>Secale cereale</i>		x	x				
<i>Senecio</i> sp.		x					

<i>Siloxerus humifusus</i>				X			
* <i>Solanum nigrum</i>							
<i>Spyridium globulosum</i>							
* <i>Stenotaphrum secundatum</i>			X			X	
<i>Stirlingia latifolia</i>	X						
<i>Stylidium piliferum</i>							
<i>Stylidium repens</i>				X			
<i>Stylidium</i> sp.				X			
<i>Tetragia capillaris</i>							
<i>Tetragia</i> sp.				X			
<i>Thysanotus manglesianus</i>		X	X	X			
<i>Thysanotus multiflorus</i>		X					
<i>Tremulina tremula</i>							
<i>Tribonanthes australis</i>				X			
<i>Tricoryne elatior</i>							
* <i>Trifolium angustifolium</i>		X					
* <i>Typha orientalis</i>							
* <i>Ursinia anthemoides</i>				X	X		
<i>Verticordia acerosa</i> var. <i>acerosa</i>				X			
<i>Verticordia plumosa</i> var. <i>plumosa</i>				X	X	X	
* <i>Vicia sativa</i>			X				
<i>Viminaria juncea</i>			X			X	
* <i>Vulpia myuros</i>		X					
* <i>Wahlenbergia capensis</i>							
* <i>Watsonia meriana</i> var. <i>bulbifera</i>		X		X	X	X	
<i>Xanthorrhoea preissii</i>	X	X					
* <i>Zantedescia aethopica</i>		X					

APPENDIX C

**CATEGORIES USED IN THE ASSESSMENT OF CONSERVATION
STATUS**

APPENDIX C: Categories used in the assessment of conservation status.

Environmental Protection and Biodiversity Conservation Act and the WA Wildlife Conservation Act (categories mainly from IUCN, based on review by Mace and Stuart 1994).

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

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

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

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

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

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

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

Other Specially Protected Fauna (WA Act only).

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

Least Concern. Taxa that are not Threatened.

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

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

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

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

Priority 4. Taxa in need of monitoring.

APPENDIX D

FAUNA ASSESSMENT SPECIES LIST

Table D1

Species	Status	Significance
Galaxiidae (native minnows or jollytails)		
Western Minnow <i>Galaxias occidentalis</i>		
Gobiidae (gobies)		
Swan River Goby <i>Pseudogobius olorum</i>		
Poeciliidae (livebearers)		
Mosquitofish <i>Gambusia holbrooki</i>	+	Introduced
Number of species observed or expected:	3	

Table D2

Species	Status	Significance
Myobatrachidae (ground frogs)		
Quacking Frog <i>Crinia georgiana</i>		
Glauert's (Clicking) Frog <i>Crinia glauerti</i>		
Granite Frog <i>Crinia pseudinsignifera</i>		CS3
Sandplain Froglet <i>Crinia insignifera</i>	+	
Moaning Frog <i>Heleioporus eyrei</i>	+	
Pobblebonk <i>Limnodynastes dorsalis</i>		
Guenther's Toadlet <i>Pseudophryne guentheri</i>		
Hylidae (tree frogs)		
Slender Tree Frog <i>Litoria adelaidensis</i>		
Motorbike Frog <i>Litoria moorei</i>		
Number of species observed or expected:	9	

Table D3

Species	Status	Significance
Chelidae (long-necked tortoises)		
Oblong-shelled Long-necked Tortoise <i>Chelodina oblonga</i>		
Gekkonidae (geckoes)		
Southern Spiny-tailed Gecko <i>Strophurus spinigerus</i>		
Marbled Gecko <i>Christinus marmoratus</i>		
Pygopodidae (legless lizards)		
Sand-Plain Worm-Lizard <i>Aprasia repens</i>		
Fraser's Legless Lizard <i>Delma fraseri</i>		
Gray's Legless Lizard <i>Delma grayii</i>		
Burton's Legless Lizard <i>Lialis burtonis</i>		

Keeled Legless Lizard	<i>Pletholax gracilis</i>	+	CS3
Common Scalyfoot	<i>Pygopus lepidopodus</i>		
Agamidae (dragon lizards)			
Western Bearded Dragon	<i>Pogona minor</i>		
Sandhill or Heath Dragon	<i>Rankinia adelaidensis</i>	+	CS3
Varanidae (monitors or goannas)			
Gould's Sand Goanna	<i>Varanus gouldii</i>		
Rosenberg's Goanna	<i>Varanus rosenbergi</i>	+	CS3
Scincidae (skink lizards)			
South-West Cool Skink	<i>Acritoscincus trilineatum</i>		
Fence Skink	<i>Cryptoblepharus plagiocephalus</i>	+	
West Coast Ctenotus	<i>Ctenotus fallens</i>		
Odd-striped Ctenotus	<i>Ctenotus impar</i>		
Western Limestone Ctenotus	<i>Ctenotus australis</i>		
King's Skink	<i>Egernia kingii</i>		
Salmon-bellied Skink	<i>Egernia napoleonis</i>		
Two-toed Earless Skink	<i>Hemiergis quadrilineata</i>		
West Coast Four-toed Lerista	<i>Lerista elegans</i>		
Dwarf Skink	<i>Menetia greyii</i>	+	
West Coast Morethia	<i>Morethia lineocellata</i>		
Dusky Morethia	<i>Morethia obscura</i>		
Western Bluetongue	<i>Tiliqua occipitalis</i>		CS3
Bobtail	<i>Tiliqua rugosa</i>	+	
Typhlopidae (blind snakes)			
Southern Blind Snake	<i>Ramphotyphlops australis</i>		
Elapidae (front-fanged snakes)			
Half-ringed Snake	<i>Brachyuropsis semifasciata</i>		
Reticulated Whip Snake	<i>Demansia psammophis</i>		CS3
Species		Status	Significance
Crowned Snake	<i>Elapognathus coronatus</i>		CS3
Black-naped Snake	<i>Neelaps bimaculatus</i>		
Tiger Snake	<i>Notechis scutatus</i>	+	
Dugite	<i>Pseudonaja affinis</i>		
Gould's Snake	<i>Parasuta gouldii</i>		
Jan's Bandy-Bandy	<i>Simoselaps bertholdi</i>		
Number of species observed or expected:		36	

Table D4

Species	Status	Significance
Anatidae (ducks, geese and swans)		
Musk Duck <i>Biziura lobata</i>	+	CS3
Blue-billed Duck <i>Oxyura australis</i>		CS3
Freckled Duck <i>Stictonetta naevosa</i>	+	CS2
Black Swan <i>Cygnus atratus</i>	+	
Australian Shelduck <i>Tadorna tadornoides</i>	+	
Pacific Black Duck <i>Anas superciliosus</i>	+	
Grey Teal <i>Anas gibberifrons</i>	+	
Australasian Shoveler <i>Anas rhynchotis</i>	+	CS3
Pink-eared Duck <i>Malacorhynchus membranaceus</i>		CS3
Hardhead <i>Aythya australis</i>	+	CS3
Australian Wood Duck <i>Chenonetta jubata</i>	+	
Podicipedidae (grebes)		
Great Crested Grebe <i>Podiceps cristatus</i>	+	
Australasian Grebe <i>Tachybaptus novaehollandiae</i>	+	
Hoary-headed Grebe <i>Poliiocephalus poliocephalus</i>	+	
Ardeidae (herons and egrets)		
White-faced Heron <i>Egretta novaehollandiae</i>	+	
White-necked Heron <i>Ardea pacifica</i>	+	
Great Egret <i>Ardea alba</i>		CS1 (M)
Nankeen Night Heron <i>Nycticorax caledonicus</i>		CS3
Little Bittern <i>Ixobrychus minutes</i>		CS2
Australasian Bittern <i>Botaurus poiciloptilus</i>		CS1
Phalacrocoracidae (cormorants)		
Little Pied Cormorant <i>Phalacrocorax melanoleucos</i>	+	
Plataleidae (ibis and spoonbills)		
Glossy Ibis <i>Plegadis falcinellus</i>		
Australian White Ibis <i>Threskiornis molucca</i>	+	
Straw-necked Ibis <i>Threskiornis spinicollis</i>	+	
Yellow-billed Spoonbill <i>Platalea flavipes</i>	+	
Accipitridae (kites, hawks and eagles)		
Black-shouldered Kite <i>Elanus notatus</i>	+	
Square-tailed Kite <i>Lophoictinia isura</i>		CS3
Whistling Kite <i>Haliastur sphenurus</i>		CS3
Swamp Harrier <i>Circus approximans</i>		
Brown Goshawk <i>Accipiter fasciatus</i>		CS3
Collared Sparrowhawk <i>Accipiter cirrhocephalus</i>	+	CS3
Species	Status	Significance

Wedge-tailed Eagle	<i>Aquila audax</i>		CS3
Little Eagle	<i>Hieraaetus morphnoides</i>		CS3
Falconidae (falcons)			
Peregrine Falcon	<i>Falco peregrinus</i>		CS1
Brown Falcon	<i>Falco berigora</i>	+	
Australian Hobby	<i>Falco longipennis</i>	+	
Nankeen Kestrel	<i>Falco cenchroides</i>	+	
Rallidae (crakes and rails)			
Buff-banded Rail	<i>Gallirallus philippensis</i>		
Baillon's Crake	<i>Porzana pusilla</i>		
Australian Spotted Crake	<i>Porzana fluminea</i>		
Spotless Crake	<i>Porzana fusca</i>		
Purple Swampphen	<i>Porphyrio porphyrio</i>		
Dusky Moorhen	<i>Gallinula tenebrosa</i>		CS3
Eurasian Coot	<i>Fulica atra</i>	+	
Scolopacidae (sandpipers)			
Marsh Sandpiper	<i>Tringa stagnatilis</i>		CS1 (M)
Common Greenshank	<i>Tringa nebularia</i>		CS1 (M)
Common Sandpiper	<i>Tringa hypoleucos</i>		CS1 (M)
Red-necked Stint	<i>Calidris ruficollis</i>		CS1 (M)
Long-toed Stint	<i>Calidris subminuta</i>		CS1 (M)
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>		CS1 (M)
Recurvirostridae (stilts and avocets)			
Black-winged Stilt	<i>Himantopus himantopus</i>	+	
Charadriidae (plovers and lapwings)			
Red-capped Plover	<i>Charadrius ruficapillus</i>		
Black-fronted Dotterel	<i>Elseyaornis melanops</i>	+	
Red-kneed Dotterel	<i>Erythrogonys cinctus</i>		
Banded Lapwing	<i>Vanellus tricolor</i>		
Laridae (gulls and terns)			
Silver Gull	<i>Larus novaehollandiae</i>	+	
Columbidae (pigeons and doves)			
Rock Dove (feral pigeon)	<i>Columba livia</i>		Int.
Spotted Turtle-Dove	<i>Streptopelia chinensis</i>	+	Int.
Laughing Turtle-Dove	<i>Streptopelia senegalensis</i>	+	Int.
Common Bronzewing	<i>Phaps chalcoptera</i>		
Crested Pigeon	<i>Ocyphaps lophotes</i>		
Cacatuidae (cockatoos)			
Short-billed Black-Cockatoo	<i>Calyptorhynchus latirostris</i>		CS1
Long-billed Black-Cockatoo	<i>Calyptorhynchus baudinii</i>		CS1
Species		Status	Significance

Corella	<i>Cacatua</i> spp.		Int.
Galah	<i>Cacatua roseicapilla</i>	+	
Psittacidae (lorikeets and parrots)			
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>		Int.
Purple-crowned Lorikeet	<i>Glossopsitta porphyrocephala</i>		
Red-capped Parrot	<i>Purpureicephalus spurius</i>		
Australian Ringneck (twenty-eight)	<i>Barnardius zonarius</i>	+	
Elegant Parrot	<i>Neophema elegans</i>		
Cuculidae (cuckoos)			
Pallid Cuckoo	<i>Cuculus pallidus</i>		
Fan-tailed Cuckoo	<i>Cuculus pyrrhophanus</i>		
Horsfield's Bronze-Cuckoo	<i>Chrysococcyx basalis</i>		
Shining Bronze-Cuckoo	<i>Chrysococcyx lucidus</i>		
Strigidae (hawk-owls)			
Southern Boobook Owl	<i>Ninox novaeseelandiae</i>		
Tytonidae (barn owls)			
Barn Owl	<i>Tyto alba</i>		
Podargidae (frogmouths)			
Tawny Frogmouth	<i>Podargus strigoides</i>		
Apodidae (swifts)			
Fork-tailed Swift	<i>Apus pacificus</i>		CS1 (M)
Halcyonidae (forest kingfishers)			
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	+	Int.
Sacred Kingfisher	<i>Todiramphus sanctus</i>	+	
Meropidae (bee-eaters)			
Rainbow Bee-eater	<i>Merops ornatus</i>	+	M
Maluridae (fairy-wrens)			
Splendid Fairy-wren	<i>Malurus splendens</i>		CS3
Pardalotidae (pardalotes)			
Spotted Pardalote	<i>Pardalotus punctatus</i>		
Striated Pardalote	<i>Pardalotus striatus</i>	+	
White-browed Scrubwren	<i>Sericornis frontalis</i>		CS3
Western Gerygone	<i>Gerygone fusca</i>	+	
Inland Thornbill	<i>Acanthiza apicalis</i>		CS3
Western Thornbill	<i>Acanthiza inornata</i>		CS3
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>	+	CS3
Meliphagidae (honeyeaters)			
Red Wattlebird	<i>Anthochaera carunculata</i>	+	
Western Wattlebird	<i>Anthochaera lunulata</i>		
Singing Honeyeater	<i>Lichenostomus virescens</i>	+	
Species		Status	Significance

Brown Honeyeater	<i>Lichmera indistincta</i>	+	
White-naped Honeyeater	<i>Melithreptus lunatus</i>		CS3
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>		CS3
White-cheeked Honeyeater	<i>Phylidonyris nigra</i>		CS3
Tawny-crowned Honeyeater	<i>Phylidonyris melanops</i>		CS3
Western Spinebill	<i>Acanthorhynchus superciliosus</i>		
Petroicidae (Australian robins)			
Scarlet Robin	<i>Petroica multicolor</i>		
Neosittidae (sittellas)			
Varied Sittella	<i>Daphoenositta chrysoptera</i>		CS3
Pachycephalidae (whistlers)			
Rufous Whistler	<i>Pachycephala rufiventris</i>	+	
Golden Whistler	<i>Pachycephala pectoralis</i>		CS3
Grey Shrike-thrush	<i>Colluricincla harmonica</i>		CS3
Dicruridae (flycatchers)			
Magpie-lark	<i>Grallina cyanoleuca</i>	+	
Grey Fantail	<i>Rhipidura fuliginosa</i>	+	
Willie Wagtail	<i>Rhipidura leucophrys</i>	+	
Campephagidae (cuckoo-shrikes)			
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	+	
White-winged Triller	<i>Lalage sueurii</i>		
Artamidae (woodswallows)			
Black-faced Woodswallow	<i>Artamus cinereus</i>	+	CS3
Grey Butcherbird	<i>Cracticus torquatus</i>	+	
Australian Magpie	<i>Gymnorhina tibicen</i>	+	
Corvidae (ravens and crows)			
Australian Raven	<i>Corvus coronoides</i>	+	
Motacillidae (pipits and true wagtails)			
Richard's Pipit	<i>Anthus novaeseelandiae</i>	+	
Dicaeidae (flower-peckers)			
Mistletoebird	<i>Dicaeum hirundinaceum</i>		
Hirundinidae (swallows)			
White-backed Swallow	<i>Cheramoeca leucosternus</i>		
Welcome Swallow	<i>Hirundo neoxena</i>	+	
Tree Martin	<i>Hirundo nigricans</i>	+	
Sylviidae (Old World warblers)			
Clamorous Reed-Warbler	<i>Acrocephalus stentoreus</i>		
Little Grassbird	<i>Megalurus gramineus</i>		
Zosteropidae (white-eyes)			
Silvereye	<i>Zosterops lateralis</i>	+	

Table D5

Species	Status	Significance
Peramelidae (bandicoots)		
Quenda (Southern Brown Bandicoot) <i>Isoodon obesulus</i>	+	CS2
Phalangeridae (possums)		
Brush-tailed Possum <i>Trichosurus vulpecula</i>		CS3
Mollosidae (mastiff bats)		
White-striped Bat <i>Tadarida australis</i>		CS3
Western Freetail Bat <i>Mormopterus planiceps</i>		CS3
Vespertilionidae (vesper bats)		
Gould's Wattled Bat <i>Chalinolobus gouldii</i>		CS3
Chocolate Wattled Bat <i>Chalinolobus morio</i>		CS3
Western False Pipistrelle <i>Falsistrellus mackenziei</i>		CS2
Southern Forest Bat <i>Vespedalus regulus</i>		CS3
Lesser Long-eared Bat <i>Nyctophilus geoffroyi</i>		CS3
Gould's Long-eared Bat <i>Nyctophilus gouldii</i>		CS3
Greater Long-eared Bat <i>Nyctophilus timoriensis</i>		CS3
Muridae (rats and mice)		
Rakali or Water-rat <i>Hydromys chrysogaster</i>		CS2
House Mouse <i>Mus musculus</i>	+	Int.
Black Rat <i>Rattus rattus</i>		Int.
Leporidae (rabbits and hares)		
Rabbit <i>Oryctolagus cuniculus</i>	+	Int.
Canidae (foxes and dogs)		
European Red Fox <i>Vulpes vulpes</i>		Int.
Felidae (cats)		
Feral Cat <i>Felis catus</i>		Int.
Number of species observed or expected:	16	