



CONSERVATION AREA MANAGEMENT PLAN

Austin Cove, Phase 2

Pt Lot 1, Lot 2 and Lot 3 South Yunderup

Shire of Murray





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Shire of Murray**

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1.0 INTRODUCTION

1.1 The Project

Pt Lot 1 and Lots 2 and 3 South Yunderup are located near the eastern shoreline of the Peel Inlet and south of the Murray River in the locality of South Yunderup in the Shire of Murray (Figure 1).

The subject land comprises 526ha that has historically been used for grazing livestock. Other activities that currently occur on site include bee-keeping and a small scale palm cultivation operation on one lot.

Phase 2 of the proposed urban development of Austin Cove (hereafter referred to as 'the site') is located in the south-western portion of the subject land and covers approximately 271ha of Pt Lot 1 and Lots 2 and 3 South Yunderup.

The site is bounded to the east and south by farming operations. The remaining area immediately west of the site is the Peel Regional Park, which consists of remnant vegetation and small wetlands, while further to the west is the Peel Inlet. The Yunderup canals and Murray River are located north of the site.

1.2 Outline Development Plan

An Outline Development Plan (ODP) for Phase 2 has been prepared by project planners Chappell Lambert Everett (Figure 2), showing the proposed urban development within the site.

The ODP illustrates a range of residential densities between R10 and R60, with linear Public Open Space (POS) areas separating pockets of residential areas from one another. A long linear lake approximately 1.4km in length is proposed in the north-south aligned POS area in the eastern portion of the site.

A large parks and recreation reserve and private recreation reserve under the Peel Region Scheme (PRS), consisting of remnant vegetation, wetlands and grazing pastures, separates Phase 2 from Phase 1, which lies to the north-west.

The development area (phase one and two) is zoned 'Special Development' under the provisions of the Shire of Murray Town Planning Scheme No 4. The 'Special Development' zone allows subdivision and development generally in accordance with an approved ODP. The current provisions of Schedule 7 of Scheme No 4, adopted through Amendment 115, set out specific provisions applying to the subject land with reference to the 1997 Murray Lakes Golf Course Estate Outlined Development Plan.

Subsequently, Amendment 218 was initiated to the Shire of Murray Scheme to remove the outdated provisions relating to the 1997 Murray Lakes Golf Course Estate ODP and insert the necessary provisions to enable the Austin Cove ODP.

Amendment 218 was referred to the EPA by the Shire of Murray in late February 2007 and in mid-May 2007 the EPA determined that Amendment 218 should be treated as 'Scheme Not Assessed – Advice Given Under S48a (1)(A) (no appeals)' on the basis that the likely environmental impacts were not so severe to warrant a formal environmental assessment.

I.3 Other Documentation

This Conservation Area Management Plan should be read in conjunction with the *Environmental Assessment Report Austin Cove Phase II* (RPS Bowman Bishaw Gorham, 2007) which has an extensive description of the site's existing environment, and the following management plans which were produced in support of the site's rezoning:

- Urban Water Management Strategy.
- Wetland Management Plan.
- Lake Management Plan.
- Mosquito Management Plan.

2.0 OBJECTIVES

As a part of Amendment 218 and the Austin Cove ODP, a list of statutory provisions within Amendment 218 and the ODP were drafted to ensure effective management of the environmental impacts to the site.

The key objective and scheme provision for the preparation of a Conservation Area Management Plan (CAMP) is outlined below:

Prior to final approval of the Outline Development Plan, a Conservation Area Management Plan over the estuary foreshore reserve adjoining the subject lots and interface to the Peel Region Park shall be prepared and implemented to the satisfaction of the Shire of Murray, on advice from the DEC to adequately demonstrate protection of the estuary foreshore reserve and Peel Regional Park in an appropriate and sustainable manner.

Furthermore, the Austin Cove ODP outlines that the Conservation Area Management Plan shall include but is not limited to the following:

- I. Description of existing environmental values, site constraints and opportunities (such as landscape and landforms, water dependent ecosystems, vegetation and flora).
- II. Clear delineation of significant areas to be protected.
- III. Appropriate buffer/setback to built development, to ensure the preservation, protection and ongoing sustainability of the Peel Regional Park and foreshore area and its estuarine functions.
- IV. Construction, location and management of walking trails.
- V. Control of pedestrian and vehicle access.
- VI. Management of fire, weeds and dieback.
- VII. Identification of management aims, objectives and actions.
- VIII. Contribution to management and ecological restoration activities.
- IX. Contingency measures to be implemented in the event that the management of the estuary foreshore and Peel Regional Park is not achieving agreed sustainability targets.
- X. Implementation Plan including roles, responsibilities, funding and maintenance arrangements.

3.0 CONSERVATION AREA ENVIRONMENT

The conservation area can be broken up into two separate portions identified as being the Parks and Recreation reserve (Figure 2) within the central-western portion of the site (but outside the urban zoned areas) and the 'Austin Bay Nature Reserve', which is adjacent to the Part Lot 1 and Lot 2. Both areas are reserved as Parks and Recreation in the Peel Region Scheme, however for the purposes of distinguishing the different conservation areas this plan will refer to the lots north and north-east as Parks and Recreation reserve and the remaining conservation area will be referred to as the Austin Bay Nature Reserve. These areas are shown on Figure 3.

Both of these areas contain sensitive wetland areas, and are considered important habitat areas for migratory waterbirds. The two conservation areas are linked at the western edge of the property.

3.1 Significance

3.1.1 Geomorphic Wetland Mapping

Both conservation areas contain areas of wetland that have been classified by the Department of Environment and Conservation (DEC) as being Conservation Category Wetlands (CCWs), with some areas categorised as Resource Enhancement (RE) wetlands. See Figure 4.

CCWs are considered to be the highest priority of wetland classification with the objective of preserving wetland attributes and functions through various mechanisms, including protection under *Environmental Protection Act 1986* and reservation in national parks, crown reserves and state owned land (WRC, 2001a). Consequently, the EPA requires that decision making authorities and proponents refer to the EPA any development proposal or subdivision likely to significantly impact the environmental values of a CCW.

RE wetlands are those that have been partially modified but still support substantial ecological attributes and functions. The ultimate objective is for management, restoration and protection towards improving their conservation value. These wetlands have the potential to be restored to CCW status (WRC, 2001a).

3.1.2 Austin Bay Nature Reserve

The western conservation area makes up part of the Austin Bay Nature Reserve, which is recognised as a significant migratory bird habitat region under the Peel-Yalgorup Ramsar wetland system (Figure 5). The reserve is 1,659ha in total size, and was gazetted a Nature Reserve by the Federal Government Department of Environment and Heritage in 1973.

Both conservation areas – the Austin Bay Nature Reserve, and the Parks and Recreation reserve – form part of the Peel Regional Park (Figure 3). The Peel Regional Park was established in 2003, through release of the Peel Region Scheme. These areas were included within the park due to their significant environmental, landscape and recreation values to both the Peel Region and the south-west of Western Australia (ERM, 2005).

In addition, the Peel and Harvey estuaries, Lake McLarty and adjacent low-lying areas have international significance due to their listing as Ramsar wetlands. These areas also provide important habitat for migratory bird species listed under the Chinese Australia Migratory Bird Agreement (CAMBA) and Japan Australia Migratory Bird Agreement (JAMBA)(ERM, 2005).

The key outcome of the reservation of the Peel Regional Park as Parks and Recreation under the Peel Region Scheme includes statutory provisions to (ERM, 2005):

- Reserve the land and waterways that will make up the Peel Regional Park.
- Acquire land and waterways for inclusion in the park.
- Compensate affected landowners.
- Control the use and development of land within the park.

3.2 Topography, Landform and Soils

The conservation areas are predominantly low-lying wetland areas, and vary in height from 1.5 to 0mAHD. Most of the conservation areas are subject to inundation.

While the Austin Cove development area falls within the mapped catchment of the Murray River, site drainage does not discharge to the Murray River, but rather discharges to the west and towards the Peel Inlet.

The soil units of the conservation areas are part of the Vasse Estuarine and Lagoonal System, which is characterised by poorly drained plains that are subject to inundation adjacent to the Peel Inlet, Harvey Estuary and coastal lake systems. These soils are mapped as having a high risk of actual or potential acid sulfate soils (ASS) at depths less than 3m from the surface (WAPC, 2003).

3.3 Groundwater

Within the Peel-Harvey region, the superficial aquifer is recharged directly by rainfall and in sections is also recharged by upward leakage from the underlying Leederville Formation. Groundwater (within the superficial aquifer) in the vicinity of the site generally flows in a westerly direction towards Peel Inlet (WAPC, 1999).

In January 2006 a full sampling run was undertaken on all forty-one bores. These results were subsequently reviewed and a subset of twenty-seven bores was selected for ongoing monthly monitoring.

Nutrients were typically low in groundwater, with the averages across the site being of the same order of magnitude as the applicable Freshwater Guideline criteria (FWG). The mean total phosphorus concentration was ~0.12mg/L, twice the guideline, while the reactive phosphorus concentration was 0.012mg/L, which is less than the FWG of 0.03mg/L. The average total nitrogen concentration of 1.7mg/L and the NO_x concentration of 0.68mg/L are equivalent to the FWG values.

Groundwater pH is generally in the range of 5.0 to 7.5 across the site. Contouring of January 2006 data identifies a trend to more alkaline groundwater (pH 6.81 to 7.56) within the Guildford Formation soils on the eastern and southern boundaries of the site, consistent with the mapped low risk acid sulphate soils. This trend is consistent across the full year's data.

Average groundwater salinity across all bores throughout the year is 10,560mg/L, indicating predominantly saline conditions, although there was marked variation between bores and seasons.

From available data and site inspection it is known that the groundwater table occurs at or close to the ground surface over much of the site during the winter months. The maximum groundwater levels are modified to some extent by the extensive network of shallow drainage channels that cross the site.

The on-site bore measurements and the DEC bore data suggest an annual water table variation of between 0.5m and 1.0m.

3.4 Vegetation

In 2006, RPS botanists undertook two flora and vegetation surveys on the site during early October and November. The survey methodology was based on a Level 2 Flora and Vegetation Survey as outlined in Guidance Statement 51 (EPA, 2004a) and is consistent with methodology established in Keighery *et al.*, (1994) for the Swan Coastal Plain.

Only the conservation area immediately north of the Phase 2 development area was surveyed. However the vegetation communities are thought to be similar between the area surveyed, and the adjacent conservation areas west of the site.

Following the surveys in 2006, it is thought the climatic conditions at the time of the initial surveys may have caused a reduction in species diversity. Many ephemeral species were missing from the expected list and there were few species recorded from the Lily family.

Therefore, re-scoring the floristic plots in the survey area was undertaken to ensure the data collected meets Level 2 survey standards where 'one or more visits in the main flowering season and visits in other seasons should be undertaken' to score replicate plots in each vegetation type (EPA, 2004).

Subsequently, RPS undertook a third vegetation and flora survey in September 2007, which had the following objectives:

- Plot re-monitoring and any further updates to vegetation and condition mapping through the use of relevés.
- Update the species list by aiming to identify species of which the taxonomy could not be confirmed in 2006 and undertaking opportunistic sampling whilst re-monitoring the 2006 plots.
- Re-analyse the plot data with regional data (PATN Analysis with the Swan Coastal Plain data set of Floristic Community Types).
- Produce a report presenting the updated species list, maps of vegetation and condition and conclusions of the PATN analysis (Assignment of FCTs, including Threatened Ecological Communities).

The current flora and vegetation report, dated February 2007, is in the process of being updated with the results of the survey undertaken in September 2007.

3.4.1 Vegetation Complexes

Hedde *et al.* (1980) mapped the area as Vasse Complex: 'Mixture of closed scrub of *Melaleuca* spp. Fringing woodland of Flooded Gum *Eucalyptus rudis* – *Melaleuca* spp. and open forest of Tuart *E. gomphocephala* – Jarrah *E. marginata* – Marri *E. (Corymbia) calophylla*.'

3.4.2 Condition of Vegetation

The intact vegetation in the survey area (Associations A, B and C) (Figure 6) are generally in very good condition for remnant bushland on the Swan Coastal Plain. Weed invasion is low and this is probably due to the clay soil, which is more resistant to weed invasion than sand. Sandier areas that are present in Association C were slightly more prone to weed invasion. Areas that had historically been grazed (bushland not protected by fencing at the southern edge of Community B) also tended to have more weeds.

Historical photographs indicate that salinity has increased since parts of the site were cleared for pasture. The progression of vegetation communities from *Melaleuca* shrubland to samphire in the southern clay-pans also supports this. The changes have

been slow enough for a natural progression of native species to occur, and the resulting samphire Shrubland and Herbland was mapped as Good to Very Good Condition, despite the fact it is a result of rising salinity.

3.4.3 Vegetation Communities

The following vegetation communities were defined and are shown in Figure 6:

River and Channel Wetlands (A)

- Open Woodland to Open Forest *Eucalyptus rudis* subsp. *rudis* over Low Open Woodland to Low Open Forest of *Melaleuca raphiophylla* over Very Open Sedgeland to Sedgeland dominated by *Lepidosperma longitudinale*, *Juncus kraussii* subsp. *australiensis* (Murray River delta). **(A1)**.
- Occasional to Woodland of *Eucalyptus rudis* subsp. *rudis* over Low Woodland of *Melaleuca raphiophylla* over Sedgeland dominated by *Lepidosperma longitudinale* (Seasonally wet shallow channels and old oxbow lakes). **(A2)**.

Dampland and Wetland Mosaic on Clay-pans (B)

- Closed Tall Scrub of *Melaleuca osullivanii* ms over Open Sedgeland *Meeboldina roycei* over mixed Herbland. **(B1)**.
- Closed to Open Heath of *Kunzea micrantha* subsp. *micrantha*, *Calothamnus lateralis* and *Pericalymma ellipticum* over Very Open Sedgeland of *Meeboldina roycei* and Very Open Herbland (mixed). **(B2)**.
- Low Woodland of *Eucalyptus rudis* subsp. *rudis* over Tall Shrubland of *Kunzea glabrescens* and *Melaleuca osullivanii* ms over Open Shrubland *Kunzea micrantha* subsp. *micrantha* and *Pericalymma ellipticum* var. *floridum* over mixed Very Open Sedgeland and Herbland dominated by *Borya scirpoidea*. **(B3)**.
- Samphire *Halosarcia lepidosperma* Low to Low Open Shrubland and Herbland dominated by *Triglochin* spp. and *Asteraceae* spp. **(B4)**.
- Open Water on Clay-pans with *Melaleuca* species over Aquatics *Triglochin linearis* and *Schoenus natans*. **(B5)**.
- Bare Clay-pans. **(B6)**.
- Woodland to Open Forest of Swamp Sheoak *Casuarina obesa* over Low Open Forest *Melaleuca raphiophylla* over Very Open Herbland (mixed). **(B7)**.

- Tall Open Scrub *Melaleuca viminea* subsp. *viminea* over Herbland dominated by *Hydrocotyle alata*, *Pogonolepis stricta* and **Crassula natans* var. *minus*. **(B8)**.

Low Sandy Rises **(C)**

- Open Woodland of Flooded Gum *Eucalyptus rudis* subsp. *rudis* over Tall Open Scrub Spearwood *Kunzea glabrescens* over Very Open Sedgeland dominated by *Lyginia imberbis* and *Lepidosperma longitudinale* and Very Open Herbland (mixed). **(C1)**.

Pasture (Parkland Cleared) **(D)**

- Scattered to Open Woodland of predominantly *Eucalyptus rudis* subsp. *rudis* over pasture weeds. **(D1)**.

Inlet Foreshore **(E)**

- Low Open Woodland to Low Open Forest of *Casuarina obesa* over Open Low Heath *Threlkeldia diffusa* and Open Herbland of weed species. **(E1)**.
- Low Open Woodland to Low Open Forest of *Casuarina obesa* over Open Low Heath of Samphire *Sarcocornia quinqueflora*. **(E2)**.

3.4.4 Conservation Significance - Vegetation

No Threatened Ecological Communities (TECs) under the Federal EPBC Act (DEH, 2007) are known from the survey area. None were recorded during the surveys, and no suitable habitat or vegetation was observed.

The PATN analysis was inconclusive and showed that some vegetation communities had affinities with TECs listed under state legislation. Additionally, some vegetation communities potentially represent new floristic communities not currently represented in existing data (Gibson *et al.*, 1994). This predominantly applies to Vegetation Communities B1-B8 and C1: (Figure 6).

TECs under state legislation have limited protection under the Wildlife Conservation Act, 1950 (as amended) under the clause 'prevention of extinction'. The proposed Biodiversity Conservation Act (in preparation) will offer specific protection to state listed TECs. The TECs that potentially occur in Communities B1 – B8 are:

TEC 32 SCP07	Herb rich saline shrublands in clay-pans (Vulnerable).
TEC 33 SCP08	Herb rich shrublands in clay-pans (Vulnerable).
TEC 34 SCP09	Dense shrublands on clay flats (Vulnerable).
TEC 35 SCPI0a	Shrublands on dry clay flats (Endangered).

The late dry winter in 2006 is a possible reason why the PATN analysis was inconclusive. The herbs in sites were often stunted or sparser than would be expected, so this probably means that there were species that did not emerge at all. The greatest anomaly between the Gibson *et al.* (1994) data and the data presented in this report was the low numbers of herbs recorded, particularly species from the lily families. In either instance, whether they represent TECs or new floristic communities, Communities B1-B8 and C1 are conservation significant.

The study area is in the Vasse Complex¹ (Hedde *et al.*, 1980), which in pre-settlement consisted of 11,190 hectares of which in 1998 3,287 hectares remained (29%). In 2002, 1,227 hectares was in secure tenure (EPA, 2006). The Austin Bay Nature Reserve to the south-west of the site is likely to contain similar communities as the survey area, however this cannot be confirmed. A search of the Department of Conservation and Environment TEC database revealed known occurrences of TEC 32 SCP07: Herb rich saline shrublands in clay-pans within the Austin Bay Nature Reserve.

3.5 Flora

3.5.1 Flora of Conservation Significance

State Legislation

Declared Rare Flora (DRF) are flora that have been adequately surveyed and are considered to be in danger of extinction, rare or otherwise in need of special protection within Western Australia. DRF are protected under the *Wildlife Conservation Act 1950* (as amended).

Additionally in Western Australia there are four categories of Priority Flora, which are not specifically covered under current legislation, but their conservation status warrants some protection. Three categories of Priority Flora are allocated to species that are poorly known (Priority 1 to 3). These require more information to be assessed for inclusion as DRF. The categories are arranged to give an indication of the priority for undertaking further surveys based on the number of known sites, and the degree of threat to those populations. A fourth category of priority (Priority 4) is included for those species that have been adequately surveyed and are considered to be rare but not currently threatened.

¹ which is characterised by mixture of the closed scrub of *Melaleuca* spp. Fringing woodland of *E. rudis*-*Melaleuca* spp. And open foresee of *E. gomphocephala*-*E. marginata*-*E. calophylla*.

Other Species of Conservation Significance

Guidance Statement 51 (EPA, 2004) lists species other than DRF and Priority Flora as of conservation significance where a species has:

- A keystone role.
- Relictual status.
- Anomalous features indicating a potential new discovery.
- A representation of a species range (range extensions, extremes or an outlier population).
- Status as a restricted subspecies, variety, or naturally occurring hybrid.
- Poor reservation.
- Status as a local endemic or has a restricted distribution.

This document states that conservation significance includes these criteria, but is not limited to them. In this instance, it includes flora that are poorly represented in the Western Australian Herbarium (WAH) and short range endemic flora (those with a known range less than 200km).

3.5.2 Results of Flora Survey

A total of 238 taxa were recorded from the survey area. This is an estimated >80% of the flora species likely to exist at the site. Seventy-four percent (177) of the species recorded were native. This represents six percent of the native taxa known from the Swan Coastal Plain and 2.1% of the taxa known from the south-west of Western Australia (Florabase, 2007a).

The 238 species represented sixty-one families and 166 genera. The families represented by the largest number of species are shown in Table 1. The genera represented by the largest number of species are shown in Table 2.

Table 1: Dominant Vascular Plant Families Present in the Study Area

Family	Common Name	Native	Introduced	Total Species
POACEAE	Grasses	10	17	27
MYRTACEAE	-	18	1	19
CYPERACEAE	Sedges	18	1	19
ASTERACEAE	Daisies	9	8	17
ORCHIDACEAE	Orchids	16	1	17
PAPILLIONACEAE	Peas	6	4	10

Table 2: Dominant Vascular Plant Genera Present in the Study Area

Genus	Common Name	Native	Introduced	Total Species
<i>Melaleuca</i>	Paperbarks	10		10
<i>Stylidium</i>	Trigger Plants	6		6
<i>Schoenus</i>	(sedges)	6		6
<i>Acacia</i>	Wattles	4	1	5
<i>Drosera</i>	Sundews	4		4
<i>Isolepis</i>	(sedges)	4		4
<i>Thelymitra</i>	Sun Orchids	4		4
<i>Villarsia</i>	-	3		3
<i>Crassula</i>	Stonecrops	2	1	3
<i>Caladenia</i>	Spider Orchids	3		3
<i>Baumea</i>	(sedges)	3		3

3.5.3 Declared Rare and Priority Flora

Declared Rare Flora

No Declared Rare Flora (DRF) were recorded within the survey area.

Priority Flora

One Priority 3 flora species *Dillwynia dillwynioides* and three Priority 4 species *Eucalyptus rudis* subsp. *cratyantha*, *Schoenus natans* and *Villarsia submersa* were recorded from the survey area. There is also potentially a Priority 3 species *Chamaescilla gibsonii* and a Priority 4 *Rumex drummondii* present, however these have some uncertainty attached to their identity. This is due to taxonomic ambiguity or poor material.

In relation to the area of intact vegetation present at the site, there was a relatively high number of Priority Flora recorded. These were largely restricted to Vegetation Communities C1 and B1-B8 (Figure 6) and often were dominant and/or typical species within the community.

It is also possible that additional DRF and Priority Flora are present within the intact bushland at the site. Some of the DRF flora identified in the DEC rare flora search are short-lived ephemerals that may be affected by seasonal factors. This may have meant that they were not actively growing during the surveys.

The Priority Flora recorded were well represented in the WA Herbarium collections, with the exception of *Eryngium ferox* ms (P3), which had only been collected eight times (Table 3).

The existing records for Priority Flora in the WA Herbarium were predominantly from the Swan Coastal Plain (SCP) (Table 3), and the status of these populations in light of ongoing clearing of vegetation is unknown. Many of the collections were made prior to 1990 and dating back to the early 1900s. The status of Priority Flora with old records,

in areas subject to large scale clearing is therefore difficult to determine. Many of the more recent records were collections made as part of clearing applications, and the continued existence of these populations is also unknown. Priority 4 is generally considered to be well surveyed and to not be under immediate threat, but Priority 1 to 3 are given to taxa whose status is not well known.

Table 3: Priority Flora Collection Numbers in the Western Australian Herbarium

Species	Cons. Status	IBRA Bioregion	Collections WA Herbarium		
			Pre-1990	Post-1990	Total
<i>Chamaescilla ?gibsonii</i>	P3	SCP, JF	8	10	18
<i>Dillwynia dillwynioides</i>	P3	SCP, JF	11	18	29
<i>Eryngium ferox ms</i>	P3	SCP, JF	0	8	8
<i>Eucalyptus rudis</i> subsp. <i>cratyantha</i>	P4	SCP, JF	9	6	15
<i>Rumex ?drummondii</i>	P4	SCP, EP, AW	3	13	16
<i>Schoenus natans</i>	P4	SCP, WAR, JF, AW	0	43	43

SCP = Swan Coastal Plain JF = Jarrah Forest EP = Esperance Plains & AW = Avon Wheatbelt, WAR = Warren (Environment Australia, 2000)

3.5.4 Other Flora Species of Conservation Significance

Other taxa recorded from the survey area that have conservation significance, as defined by EPA (2004) include the range representations shown in Table 4.

Table 4: Other Taxa of Conservation Significance

Taxa	Significance
<i>Acacia trigonophylla</i>	At SW extent of known range.
<i>Actinotus pyramidalis</i>	At SW extent of known range.
<i>Diuris magnifica</i>	Swan Coastal Plain endemic. Short range endemic (<200km).
<i>Eryngium ?ferox ms</i> (Priority 3)	At N extent of known range.
<i>Microtis brownii</i>	At SW extent of known range.
<i>Myriocephalus helichrysoides</i>	Swan Coastal Plain endemic.
<i>Spergularia marina</i>	At SW extent of known range

3.6 Fauna and Habitat

A fauna and habitat assessment for the study area was undertaken by Bamford Consulting Ecologists (2008). Site inspections were conducted on 7 September 2006 and 19 December 2007. The site has been visited previously in October, November and December 2006 for the purpose of waterbird surveys in Austin Bay.

Extracts from Bamford Consulting Ecologists (2008) Fauna Report on the key conclusions are provided below. Please refer to Appendix 2 for the detailed fauna assessment report.

3.6.1 Habitats

The following fauna habitats in the project area can be recognised:

- The main area of shrubland within the floodway.
- The tree-lined watercourses.
- The conservation category wetland in the north-west of the property.
- Farmland with scattered trees.

The proposed development is largely restricted to flood fringe areas which support farmland with scattered trees, and avoids constraints such as conservation category wetlands. It also avoids most areas of remnant vegetation, while public open space within the development has the potential to provide some wildlife habitat. The shrubland within the floodway to the west, and the conservation category wetland in the north-west, are indicated as being incorporated into the Peel Regional Park that extends along the eastern shoreline of Peel Inlet.

3.6.2 Survey Results

3.6.2.1 Reptiles

Table 2 of Appendix 2 lists thirty-seven reptile species considered likely to occur in the general region, but indicates that only twenty-five of these may be present in the project area. This approach has been taken because the project area has virtually no intact habitat away from wetlands, and a lot of the reptile species are usually associated with banksia and eucalypt woodlands on sand. However, some of these may persist in the shrubland of the floodway area.

3.6.2.2 Frogs

The seven frog species (Table 1 – Appendix 2) recorded in the area are all widespread and while many of the wetlands in the project area are under some influence from the estuary, the conservation category wetland in the north of the area is fresh, while the paddocks are probably partly inundated with freshwater in winter. Freshwater is also likely to pond around the margins of saline water in the floodway. During the site inspection, several specimens of Glauert's Frog were found under fallen branches in the shrublands of the floodway.

3.6.2.3 Birds

Table 2 of Appendix 2 lists 145 bird species considered likely to occur in the general region, but indicates that only 116 of these may be present in the project area regularly. Twenty-two species were seen during the site inspection.

Fifty-six species are waterbirds, likely to occur on the conservation category wetland, the riverine channels and the open shallows in the floodway area. Waterbirds will also use the paddocks when these flood, with some species, such as the ibis, foraging on dry pastures, and species such as the White-faced Heron nesting in isolated paddock trees.

The bird assemblage also includes land birds that will use or even rely upon the farmland environment. Species such as the Australian Magpie, Richard's (Australian) Pipit and Nankeen Kestrel may only be present because of the farmland environment, while many other species will utilise the paddock trees. A suite of species, however, including most of those identified as having declined in the Perth area (Government of Western Australia, 2000) and therefore listed as CS3, are dependent upon more or less intact native vegetation, so will be largely restricted to this environment.

3.6.2.4 Mammals

Table 3 of Appendix 2 lists twenty-three mammal species considered likely to occur in the general region, of which nineteen are expected to be present in the project area regularly. Five of these regular species are introduced and eight are bats, so only six species of non-flying native mammals are expected to be regularly present. A number of other species are regionally extinct and are not considered here.

3.6.3 **Conservation Significance**

The following section identifies the conservation significance of some of the expected species at the site. The conservation code refers to the level of conservation significance as determined by the WA Wildlife Conservation Act, which is summarised as follows:

- Schedule 1. Rare and Likely to become Extinct (CS1).
- Schedule 2. Extinct (CS2).
- Schedule 3. Migratory species listed under international treaties (CS3).
- Schedule 4. Other Specially Protected Fauna (CS4).

3.6.3.1 Reptiles

Few reptiles of conservation significance are expected to be present. These are summarised in Table 4 of Appendix 2. The South-West Carpet Python is the only reptile species of high significance (CS1) is unlikely to be present but, if present, will be restricted to large areas of native vegetation that are to be retained.

Species of lower levels of significance are similarly unlikely to be present, mainly due to the absence of banksia and eucalypt woodland on sand, with the exception of the Black-headed Tree Goanna (CS3). This species has been found in trees in parkland-cleared paddocks (M. Bamford pers. obs) and is at the southern limit of its range in the project area. In other projects, this species has been rescued during removal of large trees in paddocks during clearing for urban development, with animals being translocated to nearby habitat.

3.6.3.2 Birds

There are many birds of conservation significance: twenty-one CS1 (seventeen of these migratory); three CS2 and forty CS3. Details on these are summarised in Table 4 of Appendix 2. Many are migratory waterbirds, such as Sandpipers, which are abundant nearby and may make occasional use of wetlands for foraging and roosting. The wetlands are to be retained within Peel Regional Park and POS, although disturbance may be a concern and therefore management of human activities in these areas may be necessary.

Of the significant land birds, most are species of native vegetation that will be retained and therefore impacts are expected to be low. The ability of these species to be able to disperse through the development may be important for the long-term persistence of populations as noted above.

A few significant species (Black-shouldered Kite, Brown Goshawk and Collared Sparrowhawk) may nest in paddock trees so could lose nest sites, so the retention of large trees where possible is desirable. The paddock trees were generally paperbarks and Flooded Gums, many of which were multi-stemmed, suggesting they may have regrown after clearing, and there appeared to be no trees large enough to contain hollows suitable for use by the black-cockatoos or the CS2 Masked and Barking Owls.

The migratory (therefore CS1) Rainbow Bee-eater may lose nesting habitat, as it constructs burrows in open areas including paddocks. Although significant because of its migratory habit, this is a widespread and abundant species so while the impact is considered moderate (Table 4 – Appendix 2), the local impact is not considered to be significant.

3.6.3.3 Mammals

The Chuditch is the only mammal species of high conservation significance (CS1) that may be present, and it is probably only an infrequent visitor. Three species are of CS2, however: the Quenda, Western False Pipistrelle and Rakali. The Quenda is present (identified by characteristic diggings in native vegetation in the floodway area), the Rakali is considered likely to be present around wetlands and the False Pipistrelle is also considered likely to be present.

A further four species are of CS3, but of these only the Echidna and the Brush-tailed Possum are considered likely to be present. All are likely to be restricted to native vegetation.

3.6.4 Waterbirds in Austin Bay

A waterbird study was undertaken in the nearby Austin Bay in the south-east of Peel Inlet from September 2006 to April 2007 by Bamford Consulting Ecologists. The purpose of this study was to examine the distribution and abundance of waterbirds in Austin Bay and to determine if there are likely to be any impacts from the proposed residential development.

Extracts from Bamford Consulting Ecologists Waterbird report on the key conclusions are provided below. Please refer to Appendix 3 for the detailed waterbird report.

3.6.4.1 Survey Results

Austin Bay is part of the Peel-Yalgorup Ramsar site, listed largely because of its significance for waterbirds, and the bay regularly supports a large proportion of the waterbirds present on the overall site.

During the 2006/2007 study, the highest single count was 13,570 waterbirds, and the pooled maximum counts of all species provided a pooled maximum count of 18,696. Comparison with data previously collected in Austin Bay in 1981-1985, 1996-1997 and 1998-99 indicated that while some birds do appear to have declined in abundance, probably due to the influence of the Dawesville Channel but also to factors such as declining rainfall and therefore declining freshwater wetlands in the region, the bay remains very important for waterbirds.

3.6.4.2 Waterbird Distribution

The distribution of waterbirds in Austin Bay in 2006/2007 revealed that foraging was widespread and that small migratory shorebirds tended to forage most in the north of the bay, while herons, ducks and the longer-legged shorebirds tended to forage more in the south (please refer to Figure 4 of Appendix 3). Roosting was more restricted in distribution, with a number of small offshore sandbars being used (please refer to Figure 3 of Appendix 4). Again, migratory shorebirds tended to roost in the north of the bay, and other waterbirds in the south.

3.6.4.3 Waterbird Management

Major foraging and roosting areas for waterbirds, particularly the small migratory shorebirds, lie in the north of Austin Bay and therefore closest to potential increases in levels of disturbance.

It is therefore recommended that levels of human activity and disturbance of waterbirds in Austin Bay be monitored, and furthermore that infrastructure be established in anticipation of managing increased levels of human usage. This could include signage concerning birds, disturbance and dogs, pathways and low fencing to guide pedestrians and any local bylaw changes required to ensure that vehicle access to the shoreline and dogs not on leads are prohibited.

4.0 POTENTIAL IMPACTS TO CONSERVATION AREAS

The two Conservation areas are subject to potential impacts from future residential development. The following is a list of the potential impacts that may arise as a result of development and construction nearby, and the indirect effects of long-term human habitation on the conservation areas.

4.1 Vegetation/Habitat Degradation

Degradation of vegetation and habitat through development associated impacts, such as weed invasion, edge effects and rubbish dumping can occur without proper management and will impact on the longevity of the ecosystems within the conservation areas.

4.2 Changes to Wetland Hydrology

The wetland areas within the Conservation Areas rely on groundwater through flow and surface run-off for much of their water requirements. With the development of the site, the hydrological regime will shift towards a more groundwater-dominated system with lower peak flows, but the total quantity of water leaving the site and its direction of discharge will remain much the same. (JDA, 2007).

Groundwater previously intercepted and converted to surface flow in the agricultural drains will now pass through several metres of adsorptive yellow sand before being captured by the subsoil drains and discharged to the Multiple Use Corridor or secondary swales in the wetland buffers. No direct drainage is proposed into the wetland buffers, instead run-off from storms larger than 1-year ARI will progressively overflow into secondary swales within the wetland buffers, where it will be further filtered by vegetation before entering the wetlands.

The water levels and seasonal water cycle in the wetlands are expected to remain similar to current levels. The quality of water, especially in surface flow, entering the wetlands is expected to substantially improve with the implementation of the WSUD measures described in this UWMS.

4.3 Pollution

Human habitation is likely to result in some level of pollution, which can occur through hydrocarbon run-off from driveways, or from irresponsible littering. This can impact on fauna populations utilising habitat near or adjacent to the proposed development area through increasing the level of nutrients and pollutants in adjacent wetlands and groundwater.

4.4 Fire Risk

Increased human activity will increase fire risk through associated human activities such as littering and the use of volatile equipment such as petrol operated motor vehicles, and vandalism or deliberate fire lighting.

5.0 CONSERVATION AREA MANAGEMENT

For future management purposes, the wetland areas and buffers within the Phase 2 boundary will be created as separate lots as part of future subdivisions.

To effectively mitigate and manage the potential indirect impacts to the conservation areas, the following subsections details the management commitments to be implemented to prevent potential indirect impacts occurring to these areas.

5.1 Management of Buffers/POS Areas adjacent to Conservation Areas

All wetlands and conservation areas adjacent to the Phase 2 development area will be provided with appropriately sized and configured vegetated buffers. The buffer widths have been nominally set at 50m for CCWs and 30m for REWs (Figures 2 and 4). The ODP provides sufficient flexibility to enable the width and shape of buffers to be modified prior to subdivision.

The buffer area surrounding the CCW and RE wetland within the urban zoned portion of Phase 2 will be set aside for conservation (Figure 2). This will allow for control and management of the buffer area to prevent edge effects, assist in weed control, and limit impacts to wetland associated vegetation.

Passive recreation opportunities within the buffers may include walk trails, boardwalks and shelters. Interpretive signage (outlined in more detail below) will be located along footpaths and/or boardwalks, informing users of the importance of the wetlands and highlighting local flora and fauna.

Stormwater run-off from rainfall events greater than the 1 in 1 year ARI event will overflow from the primary infiltration swales within the development site into the wetland buffers, where it will be further filtered by vegetation before entering the wetlands.

Specific details of stormwater management are addressed in the Urban Water Management Strategy for Phase 2 of the estate and later at the subdivision stage in the Urban Water Management Plan.

5.2 Access

Currently, uncontrolled vehicle access within the Austin Bay Nature Reserve, especially close to the estuary foreshore has resulted in degradation to the vegetation in many places. Additional associated impacts such as weed invasion and littering have also reduced the value of this landscape.

The area clearly has an attraction to local residents. The provision of controlled access to the foreshore areas that people wish to visit would be beneficial and provide an appropriate balance between allowing visitation and minimising the impact on this environment.

This would be best achieved by providing a Dual Use Path network through the Austin Bay Nature Reserve, linking the Phase 1 development area to the Phase 2 development area, and linking both phases to the foreshore reserve. Vehicle access to these areas will be restricted through the installation of timber bollards along the areas where vehicles are able to gain access at the northern edge, near the link to the greater South Yunderup settlement.

Consideration to flood levels will be given to ensure access is provided during periods of inundations in the winter months. This will be achieved by constructing the path at grade to the 1 in 100 year storm event. The final alignment and construction of the DUP will be verified through consultation with the DEC and Shire of Murray.

The DUP will be constructed to allow emergency vehicle access.

5.2.1 Restricting Access

For a large part of the Austin Bay Nature Reserve located south of the Phase 2 development area, fencing (Figure 3) will be erected to prevent any uncontrolled vehicle or pedestrian access as well as excluding some domestic and feral animals as described in Section 5.7 below. The fence will be constructed to the satisfaction of the DEC to prevent access. If required, gates will be installed at strategic locations to allow emergency vehicle access to the conservation area.

In relation to the foreshore, a viewing platform, signage, low fencing as well as a boardwalk will be strategically located along the foreshore with the purpose of controlling public access to adjacent sensitive areas, including the Austin Bay Nature Reserve. The detailed design and specification will be determined in consultation with the DEC.

5.3 Community Education

5.3.1 Interpretive Signage

Interpretive signage along the path networks adjacent to the wetland areas, and within the conservation areas, is an effective way to educate local residents on appropriate behaviour when visiting these sensitive environments. Signage will also provide information on the local native flora and fauna that may increase the appreciation of the local environment for local residents.

The signage will detail information on the surrounding flora and fauna based on the specific signage location points through the conservation areas, for example signage along the foreshore area may detail interesting information on the migratory birds that visit Austin Cove, whilst signage in the middle of the bush may outline facts on the endemic bushland flowering flora species.

5.3.2 Community Awareness

In addition to signage, the proponent will undertake an extensive community education awareness program, as is outlined below:

5.3.2.1 Leaflet/Brochures

This method of community education involves providing residents with brochures and information packs as part of a welcome gift when buying into the development, which will introduce them to the concept of sustainable living and conscientious behaviour among sensitive environmental areas within the development area and surrounds.

Based on this advice, the developer will prepare a brochure to accompany a welcome gift pack upon purchase of property within the development. The main concepts outlined in the brochure will include, but not be limited to:

- Pet impacts and control requirements.
- Benefits of a native garden.
- Appropriate watering and fertiliser regimes for private gardens.
- Impacts of littering and fire.
- General information on the local endemic plants and wildlife in the area.

It is acknowledged that any residents that obtain the land secondarily by private sale, will most likely not receive a welcome information pack. Alternative community education initiatives as outlined in this section will compensate for this.

5.3.2.2 Primary School Contributions

A school education program at the local primary school within the Phase 2 development area, is also proposed. This program will include the provision of financial contributions to the education of the local school children to assist in the establishment of environmentally sustainable initiatives, allowing for school children to be involved in rehabilitation projects and other 'hands on' activities. It is expected that this kind of investment into the community of its younger members will directly benefit the local environment and allow for an increased appreciation of the conservation areas by local residents.

The finer details of the program will be developed through consultation with the DEC and the Department of Education and Training WA.

5.4 Rehabilitation and Ecological Restoration

Rehabilitation will be undertaken strategically within the Parks and Recreation area, focussing on areas of degradation. Rehabilitation works within salt affected areas is a developing science, and success is dependant on long-term monitoring and a staged approach for re-vegetation. Therefore, due to the complexities in rehabilitating these areas, a Rehabilitation Plan (with input from the DEC and Shire of Murray) will be prepared separate to the CAMP.

Rehabilitation and ecological restoration will be undertaken at strategic locations identified as being degraded through human associated activities, such as grazing livestock and uncontrolled vehicle access.

All rehabilitation works will be carried out in accordance with the EPA's Guidance Statement No. 6 – *Rehabilitation of Terrestrial Ecosystems* (2006), which outlines the following standard objectives for consideration prior to undertaking rehabilitation:

- Safe, stable and resilient landforms and soils.
- Appropriate hydrology.
- Providing visual amenity, retaining heritage values and suitable for agreed land uses.
- Resilient and self-sustaining vegetation comprised of local provenance species.
- Reaching agreed numeric targets for vegetation recovery.
- Comprising habitats capable of supporting all types of biodiversity.

5.4.1 Saline Areas

Examination of Aerial Photography between 1957 and 2000 suggests that the large expanses of cleared or degraded salt scarred areas have occurred as a result of human associated clearing for agriculture. The site does not show any evidence of salt scarring prior to the commencement of agricultural activities (Appendix I).

Analysis of the monitoring results of surface water at the site (obtained from drainage lines and free standing water after rain) suggests that the salinity is varied (between 1,500 and 30,000mg/L), which is considered brackish to saline. This coupled with the results from groundwater quality monitoring (see Section 2.3 above) seems to indicate that the lower-lying areas of the site may be subject to salt scarring as a result of rising water tables through surrounding clearing and agricultural activities.

Additionally, the UWMS states that agricultural drains in the south of the survey area are removing rising saline groundwater from pastoral land and converting it to surface flow, which is discharged through vegetation in the conservation area (JDA, 2007). The pattern of vegetation death and salt scalds supports this, if it is assumed that the surface flow moved from the drains down slope into the Peel-Harvey Inlet.

Therefore, rising groundwater and saline surface flow are likely to be the cause of increased salinity. The effect on the natural vegetation in these saline areas has been a slow progression from Melaleuca shrublands over Herbland on winter wet clay flats to Samphire (Saltbush) and Herbland flats.

The UWMS states that development will return the hydrological regime to that much more closely resembling the original uncleared state of the site. However, it will take some time after reinstatement of the original hydrological regime for the salt affected areas to be flushed of excess salt.

A more detailed rehabilitation plan will be provided separate to this document which will establish the most effective method of rehabilitation and will ensure compliance with up to date rehabilitation practices and with input and approval from the DEC and the Shire of Murray.

5.5 Weed Control

Weeds will be controlled using methods described in Water Note 'Herbicide Use in Wetlands' (WRC, 2001b). Methods will include physical removal (including hand weeding and slashing prior to seeding) or using a herbicide applied by hand spray or wand.

In order to minimise the risks associated with herbicide use near wetland areas the following will be undertaken:

- Herbicides will be applied at the recommended rate.
- Apply spray at the correct time of year (when growth is strong and seeds have not set).
- Provide follow up weed treatment to minimise repeat herbicide application requirements.
- Application to be avoided at times when plants are under stress (such as very hot days and dry to dusty condition) to assist with maximum herbicide uptake.
- Avoid spray application on windy days or when rain is likely.
- Avoid the use of surfactants.

Weed control will commence prior to re-vegetation works in the areas identified containing weeds.

5.6 Fire Management

A draft Fire Management Plan FMP has been developed by Fire Plan WA for Phase 2 of the proposed development.

Along the western boundary of the proposed Phase 2 development the following fire protection measures will be implemented (Fire Plan WA, 2008):

- A road on the outside of the urban development will be installed.
- A fifty metre area of wetland buffer will be provided between the Peel Regional Park & Austin Bay Nature Reserve and the road reserve on the outside of the urban development.
- A portion of this buffer is to be maintained as a low fuel area and will comply with the standard required of the building protection zone (as detailed in Section 6.8 of the FMP).
- A twenty metre area building protection zone is to be established between the housing area and the wetland buffer adjacent the Peel Regional Park & Austin Bay Nature Reserve to consist of manicured open space and/or road reserve/access way (see Section 6.8 of the FMP for Building Protection Zone standards).
- This area of wetland buffer may have pathways/walkways, recreation facilities such as playgrounds and parklands established along the interface with the housing area.

Fire hydrants located in the streets surrounding wetlands (typically at 200m spacing) will be available for use in fighting fires within the adjacent bushland.

Emergency vehicle access will be finalised through liaison with the Fire and Emergency Services Authority prior to the erection of any fences.

5.7 Domestic/Feral Animal Control

Cats, when allowed to roam freely, can be detrimental to local wildlife as they are able to kill or injure endemic fauna, especially birds and small reptiles and mammals. They are considered to be a serious issue in Australia for many species of native wildlife.

Whilst dogs are not as likely to catch and kill native wildlife, if given the opportunity they are able to chase and frighten many species. They are also able to kill slower larger mammals and reptiles.

The Shire of Murray will ultimately be responsible for enforcing domestic animal control within the project area. The Shire, like most Local Governments, does not have legislation or regulations governing cat control, or legislative powers to enforce cat owners to control their pets, or to pick them up if they are spotted roaming the streets during the evening.

Dog control is enforceable under the *Dog Control Act 1976* for Local Governments. Despite this, Shire Rangers are not able to ensure ultimate control of every stray or unsupervised dog.

One effective method in domestic animal control is to educate residents and visitors regarding the implications of allowing domestic animals out of a controlled environment. Essentially cat and dog owners must be responsible for the control of their pets and must be made aware of the implications of negligent pet control. Interpretive signage is an effective way to get this message across, especially in the areas where dogs are walked.

5.7.1 Physical Control

Fencing will be erected around the perimeter of a section of the Austin Bay Nature Reserve, south of the Phase 2 development area (Figure 3) to minimise domestic and feral animal disturbance to this conservation portion.

The fence will be mesh fence erected at 1.8m high with 200mm buried underground, and will be made of galvanised material.

5.8 Habitats

The following actions will be undertaken and/or encouraged to ensure that there is minimal impact on habitats within the Conservation area:

- Existing habitats will be retained within the conservation area.
- POS and road verges will be planted to create wildlife habitat.
- Residents encourages to use native plants species within gardens (refer to Section 5.3.2).
- Weed control to prevent gradual deterioration of the habitat (refer to Section 5.5).
- Control public access to conservation areas (refer to Section 5.2).
- Residents responsible for domestic pets (refer to Section 5.7).

5.9 Ecological Linkage

Ecological linkages are known as non-contiguous natural areas that connect larger natural areas by forming stepping stones that allow the movement over time of fauna between larger natural areas (Perth Biodiversity Project, 2004). The value of linkages to fauna is highly dependent on the quality of habitat including availability of food sources and nesting sites. Small and isolated fragments of native vegetation are important for reptiles, and as 'stepping stones' for birds.

These areas are essential features for conservation value, particularly within the urban context. The roles of linkages include the protection of water quality, vegetation retention and provide an educational and aesthetic value (ATA, 1998).

The Peel Regional Park is part of a regional network of national and regional parks that extends from the Perth Metropolitan Region through to the Peel Region and beyond (WAPC, 1997). The Peel Region Inner Structure Plan identifies the site as being part of a regional ecological linkage and greenbelt which runs east/west through the site.

The conservation area within the site provides an east/west linkage from the Peel Regional Park to the Murray River. This regional linkage value will remain and is incorporated within the ODP design and is protected in the long-term due to its reservation as Parks and Recreation and Private Recreation under the Peel Region Scheme.

5.10 Peel Regional Park

It is understood that a draft management plan for Peel Regional Park is being prepared and will be released shortly. Following this release, the Conservation Area Management Plan will be reviewed and any amendment will be made to the following sections within the Conservation Area Management Plan to ensure consistency of the draft Peel Regional Park Management Plan:

- Management.
- Monitoring.
- Contingency Planning.
- Implementation, Timing, Roles and Responsibilities.

5.11 Protection of Wetland Hydrology

The water levels and seasonal water cycle in the wetlands are expected to remain similar to current levels. The quality of water, especially in surface flow, entering the wetlands is expected to substantially improve with the implementation of the WSUD measures described in the UWMS (JDA, 2007).

Further to this, an Urban Water Management Plan (UWMP) will be prepared for each stage of subdivision. With one of their key requirements being to ensure the adjacent wetlands (including their buffers) are protected from future development and any significant changes to wetland hydrology through more detailed design, modelling, investigation and implementation of management measures.

5.11.1 Groundwater Levels

The AAMGL at the site will not be lowered by subsoil drainage as the fill required to raise the natural surface or flood protection will also provide sufficient clearance between finished land surface and groundwater levels. However, subsoil drains will be employed to prevent excessive groundwater rise following development, as described below (JDA, 2007).

Water-dependent ecosystems in wetlands and floodways adjacent to the development rely on groundwater through flow and surface run-off for much of their water requirements. With the development of the site, the hydrological regime will shift towards a more groundwater-dominated system with lower peak flows, but the total quantity of water leaving the site and its direction of discharge will remain much the same (JDA, 2007).

The UWMS provides suitable management for the maintenance of groundwater level and quality.

5.11.2 Feature Lake

The centrepiece of the development will be a 27ha park containing a 15.9ha lined lake within the eastern section of the estate, which will serve active and passive recreation, landscape, irrigation and urban water management functions (JDA, 2007).

The lake will be lined with PVC and will be disconnected from the superficial aquifer. The lake will have a constant water level and a maximum depth of 3m. The lake level will be maintained in summer by sub-potable groundwater water obtained from a deep aquifer bore located within the open space. In winter the lake will receive water from direct rainfall and roof run-off as well as from the bore (if required). Under normal conditions no stormwater run-off will enter the lake; however under high rainfall conditions (greater than approximately a 5-year ARI storm event), excess water from the drainage infiltration basins will overflow into the lake (JDA, 2007).

Excess water from the lake will overflow at the south-eastern corner into a multiple use corridor that runs west through the development area before discharging into the floodway within the Parks and Recreation reserve. Overflow from the lake will occur regularly in winter during significant storm events (JDA, 2007).

The feature lake will be used as an irrigation water source during the early part of summer when the salinity is less than that of the available bore water (nominally 1,600 mg/L TDS)(JDA, 2007).

Further details of the lake design, operation and management is provided in the Lake Management Plan.

5.12 Construction Management

A Construction Management Plan will be prepared prior to the commencement of bulk earthworks and implemented to ensure the protection of adjacent wetland remnant vegetation, fauna and their associated habitat during construction.

The completed Construction Management Plan will include:

- Minimisation of clearing and vegetation disturbance.
- Protection of wetland areas.
- Control and monitoring of dust, noise and smoke.
- Prevention and control of the spread of dieback.
- Inclusion of environmental protection specifications in all construction related contracts.

The Construction Management Plan will be submitted to the Shire of Murray and DEC for comment and approval.

6.0 MONITORING

6.1 Groundwater

In January 2006 a full sampling run was undertaken on all forty-one bores. These results were subsequently reviewed and a subset of twenty-seven bores was selected for ongoing monthly monitoring.

The overall aim of the monitoring program is to provide data to confirm that groundwater quality at the site continues to maintain its existing characteristics, during and immediately after subdivision completion.

Groundwater enters the site from a variety of sources and catchments, which are beyond the control of the developer. This project does not propose any direct discharge of stormwater to the adjacent wetlands. Stormwater overflows and subsoil drainage flowing down the multiple use corridor will exit from the site into the area of the salt scald before finding their way, via existing drainage lines, into the Peel Inlet.

Monitoring and management of groundwater quality is detailed in the UWMS.

6.1.1 Monitoring Schedule

Monitoring of water levels will be carried out about six times per year, with the measurements timed to 'bracket' the expected highest and lowest groundwater levels. Groundwater sampling and analysis will be carried out twice yearly, timed to target maximum and minimum groundwater levels. The monitoring will be undertaken on a subset of the original forty-one bores. Monitoring records from 2006 are currently being reviewed to select suitable bores for the future program. Some bores may require reinstatement or minor relocation following earthworks.

6.1.2 Groundwater Level and Quality Criteria

As detailed in the UWMS, preliminary groundwater level and quality criteria based on monitoring data to date and advice from the DoW are as follows:

- The average winter maximum groundwater level across the site should not exceed the pre-development average annual maximum groundwater level by more than 10% for two successive years.
- The average summer minimum groundwater level in the vicinity of wetlands should not fall below the pre-development annual average minimum groundwater level by more than 10% for two successive years.
- The concentration of any major nutrient or acid sulphate soil species in any bore, and for the site overall, should not exceed the average pre-development concentration by more than 10% on two successive sampling occasions.

6.1.3 Reporting

As required by the UWMS, the developer will submit annual monitoring reports to the Shire of Murray and the DEC throughout the twelve year construction period and for a further two years after final completion. The reports will contain the results of all monitoring undertaken during the previous monitoring period and a discussion of any breaches of criteria and actions taken. The reports will also review the water level and water quality criteria in the light of monitoring results and suggest any revision of the criteria deemed necessary.

6.2 Vegetation

The health of the vegetation within the conservation areas will be monitored annually until handover following completion of construction. A pre-development survey will be undertaken in 2008. Transects will be established through the Conservation areas with monitoring to consist of:

- Assessment of the composition, structure and health of the remnant vegetation.
- Assessment of the presence of weeds including species type and extent of invasion. Recommendations to be made regarding appropriate control methods if required.

The monitoring method will be similar to the following method recommended by the DEC:

- Establish a transect across each wetland with permanent markers on either end, and pegs (such as dumpy pegs) located at 10m intervals between them.
- Establish the location of the permanent markers using differential Global Positioning System. The reduced level should be determined at 0.5m intervals between permanent markers.
- Record annually all the taxa that intersect the transect, at 5cm intervals.
- Collect a good voucher specimen of every taxon encountered, and lodge it with the WA Herbarium (cost of vouchering needs to be considered). Any new taxa recorded each year should also be vouchered.
- Take photographs from each end of the transect with a standard lens at each monitoring period.
- Control transect across wetlands that are unlikely to be impacted by human induced hydrological changes that would provide comparison to determine the intensity of natural changes.

6.2.1 Reporting

Annual monitoring reports detailing the results and conclusions drawn from the above monitoring programs will be prepared and submitted to the DEC until project completion. The need for any adjustments to the program if required will be included in the report conclusion.

7.0 CONTINGENCY PLANNING

7.1 Groundwater/Wetland Hydrology

The initial response to a significant change in results compared against baseline data (data established prior to construction) will be to investigate the breach by means of additional sampling, or any other appropriate means, to determine:

- Whether the breach is genuine.
- Whether the breach is outside the natural variability of groundwater and wetland levels and quality.
- Whether there were any external events adjacent to the site that would affect the groundwater quality levels.
- Whether the breach signifies a real decline in the quality of the groundwater or is simply an isolated occurrence.
- What contingency measures, if any, need to be taken such as fertiliser and irrigation reduction within the residential estate.
- Whether the criteria need to be revised to better reflect the variability of the system.

If the initial groundwater investigation proves that the breach of criteria has occurred into the Peel-Harvey Catchment system, the checklist above will be assessed and completed.

In addition, should the groundwater quality exported from the subdivision not improve over time (to be determined one year after the commencement of site works), and it is established that the source of excess nutrients is a direct result of development on the site, then a water quality program will be prepared. This program is to be developed in consultation with the Shire of Murray and the DEC/DoW, and will be produced and implemented at the cost of the developer

7.2 Vegetation

The survey results will be compared to results from the previous years, including the pre-development survey. If significant deterioration of the composition, structure or health of the vegetation is observed, then the likely cause of this deterioration will be investigated.

Should the investigation reveal that the adjacent development has resulted in significant deterioration of the wetland or buffer zone vegetation, the following contingency measures will be put in place:

- Planting of tube or seed stock to replace any plant deaths.
- Undertake weed eradication should increased weed invasion be detected.
- Increased monitoring frequency of groundwater levels and quality to assess the situation should these factors be identified as contributing factors.
- Education of the local residents as to the value of the conservation area and the need to protect the vegetation through preventing physical disturbance, minimising nutrient inputs to the local groundwater and being water wise with garden bores.

8.0 IMPLEMENTATION, TIMING, REPORTING AND RESPONSIBILITY

As the developer of Pt Lot 1 and Lots 2 and 3 South Yunderup, Satterley Property Group will undertake, manage and fund the establishment of the wetland infrastructure (including paths) and rehabilitation, and will continue to manage the area until project completion.

For the Conservation areas, continuing management and maintenance will be undertaken by the Shire of Murray/DEC staff or contractors following the end of the maintenance period. This transfer of responsibility will be subject to the transferred areas being in sound condition under self-sustaining vegetation at the end of the maintenance period. The Shire of Murray/DEC must be satisfied that the Conservation Area Management Plan has been fully implemented prior to handover.

The implementation strategy is outlined overleaf.

Table 5: Implementation Strategy

Issue/ Parameter	Management Commitment	Source/Method	Responsibility	Frequency	Timing
Weed Management	Weed Control	Weed identification and removal/eradication.	Developer	Ongoing	Monitor and control until project completion.
Access Control	Construction of Dual Use Pathways and Access Road	Construction of dual use paths through the conservation areas for foreshore access.	Developer	Once	During construction of civil works.
	Construction of Viewing Platform and Boardwalk	Construction of viewing platform and strategic boardwalk along foreshore.	Developer	Once	During construction of civil works.
	Fencing of Conservation Reserve	Fencing of designated Austin Bay Nature Reserve.	Developer	Once	Prior to the commencement of civil works.
	Fencing along Foreshore	Strategic low fencing along foreshore.	Developer	Once	Prior to the commencement of civil works.
	Feral Animal Control	Work with DEC to control feral animals from designated conservation reserve.	Developer/DEC	Ongoing	During and post-construction.
Rehabilitation	Rehabilitation of Degraded Areas	Preparation of a Rehabilitation Plan for re-vegetation and rehabilitation of degraded areas.	Developer	Ongoing	Before and after construction for civil works, monitor and control until project completion.
	Rehabilitation of Degraded Salt Scald Areas	Preparation of a Rehabilitation Plan for re-vegetation and rehabilitation of degraded salt scald areas.	Developer	Ongoing	Prior to stormwater discharge into salt scald areas, monitor and control until project completion.

Issue/ Parameter	Management Commitment	Source/Method	Responsibility	Frequency	Timing
Environmental Education	Environmental Education	Educational brochures will be prepared and distributed to all land buyers within the subdivision, explaining the importance of responsible behaviour and the environmental and social attributes of the wetlands within the development extending into the Peel Regional Park.	Developer	As required	Prior to lots being listed on the market
		Undertake a school education program at the local primary school. Program will include financial contributions to the education of local school children to assist in the establishment of environmentally sustainable initiatives, such as rehabilitation projects and other 'hands on' activities.	Developer	As required	After primary school is built and established.
	Community Education and Awareness (signage)	Install environmental educational signage at strategic locations.	Developer	Once	Erection after construction of dual use pathways.
Monitoring	Groundwater Quality and Level Control	Monitoring of groundwater and implementation of contingency actions should trigger values be exceeded.	Developer	Ongoing	Before and after construction for civil works and monitor and control until project completion
	Vegetation	Monitoring of vegetation health and establishment	Developer	Once per year	Commence before construction for civil works and monitor annually until project completion
General Management	Management of Conservation Area	General management of conservation area interface, DUP network and signage.	Developer/DEC	Ongoing	Before, during and after construction for civil works until project completion
Reporting	Annual Reporting for Vegetation and Groundwater	Annual reporting on vegetation health and groundwater levels/quality, will be prepared and submitted to the Shire of Murray and DEC.	Developer	Once per year	Annually until project completion

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FIGURES

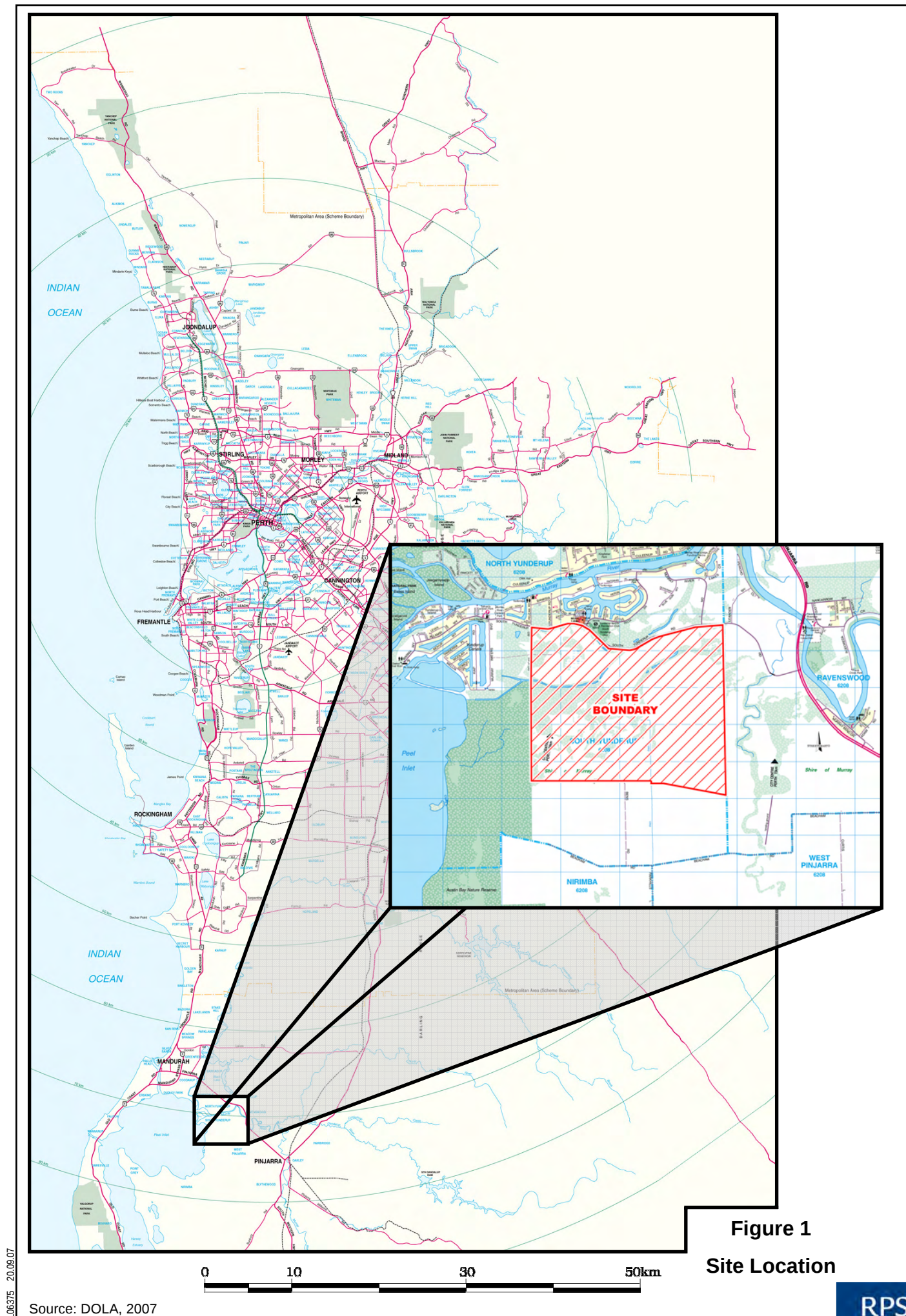
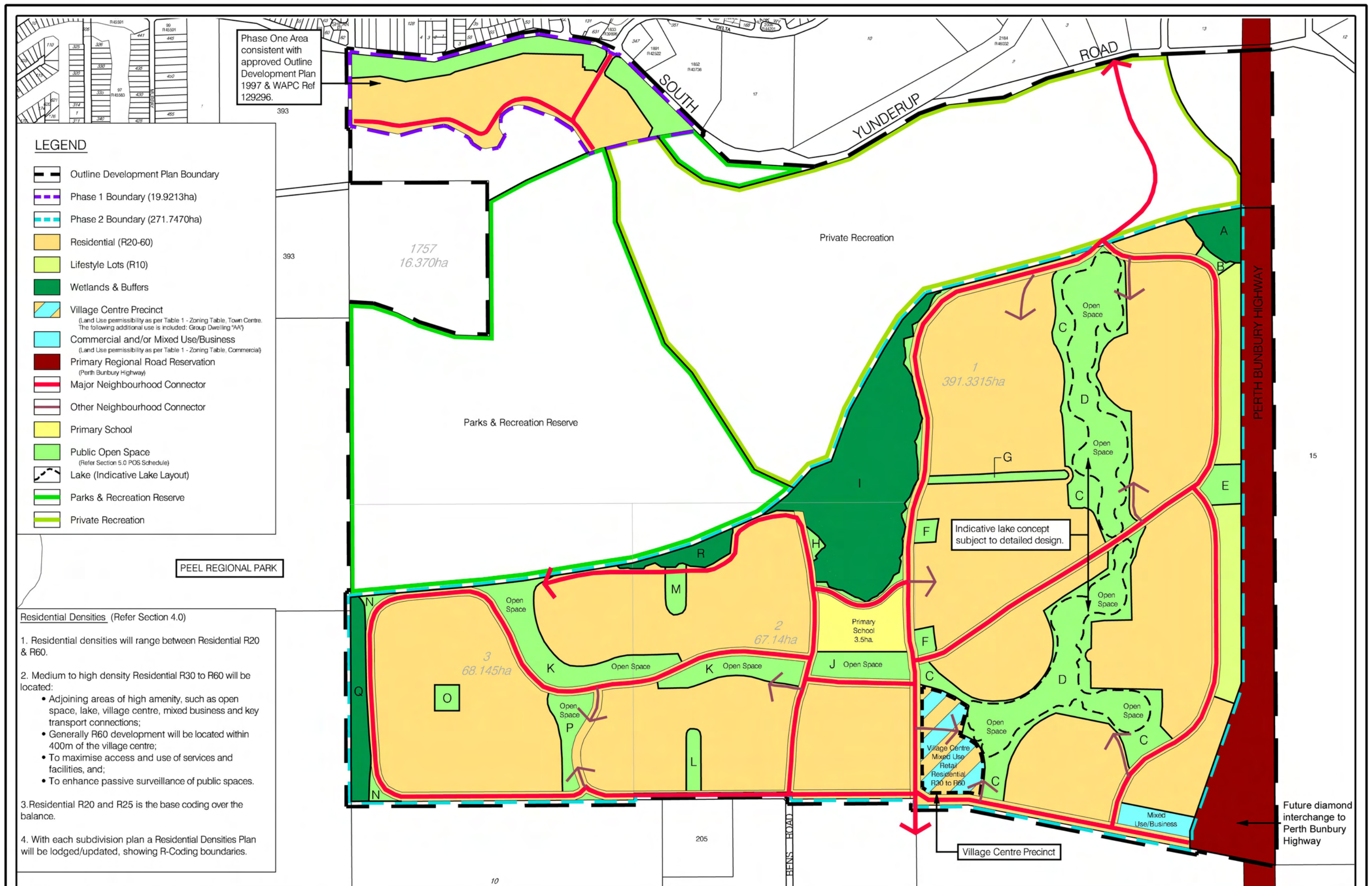


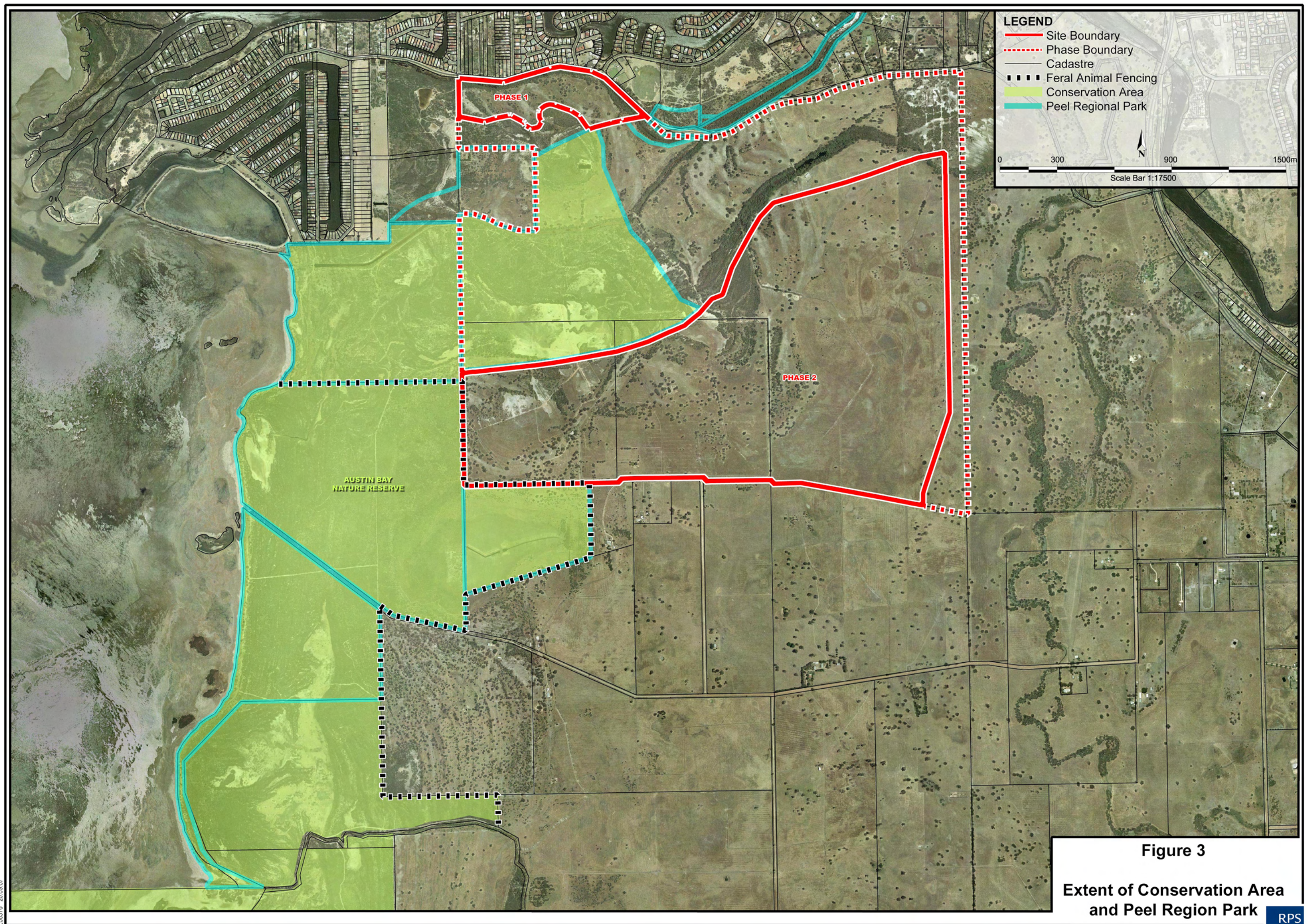
Figure 1
Site Location



Source: Chappell and Lambert, 2006

Figure 2

Outline Development Plan



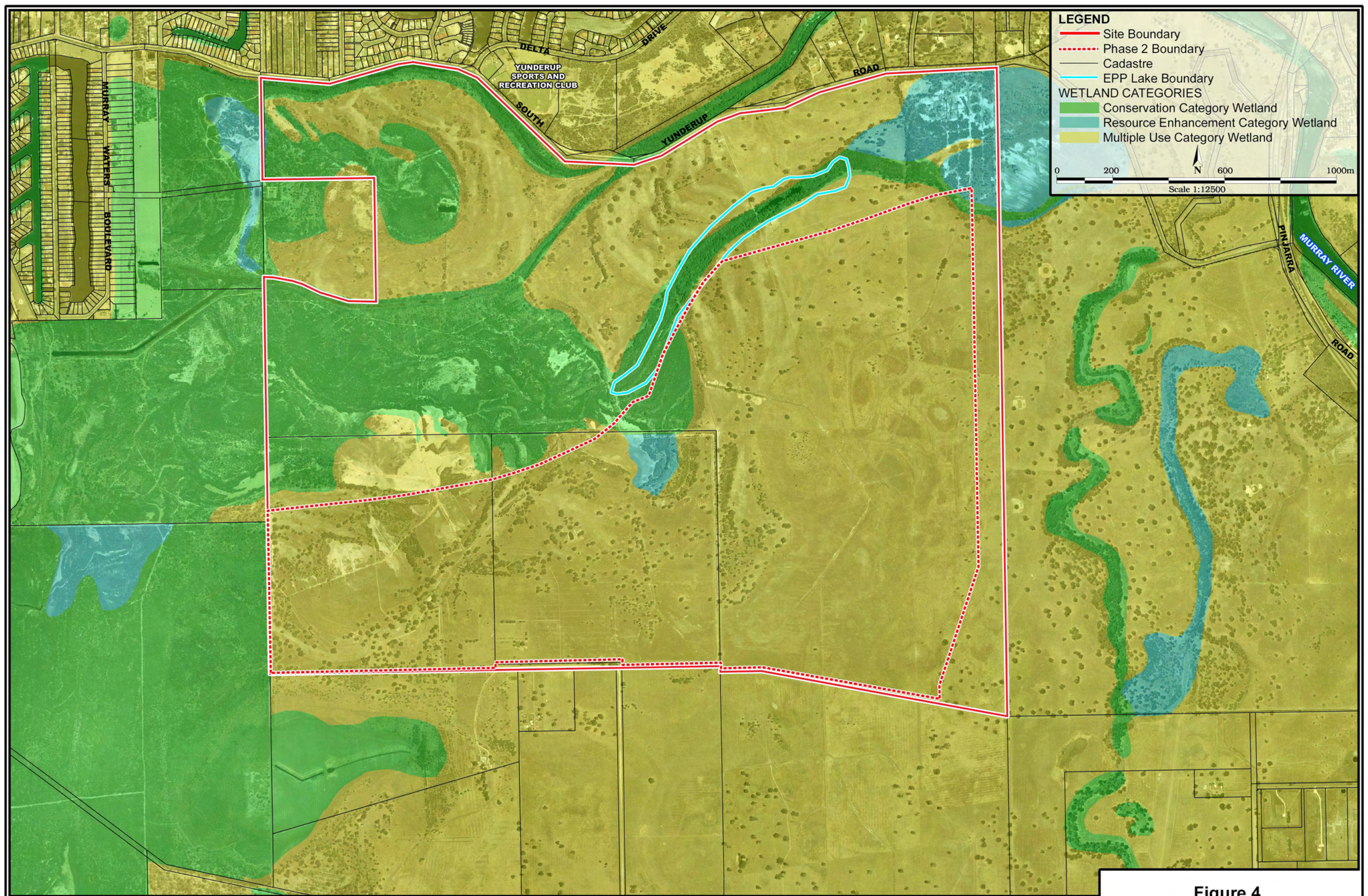


Figure 4

Wetland Mapping

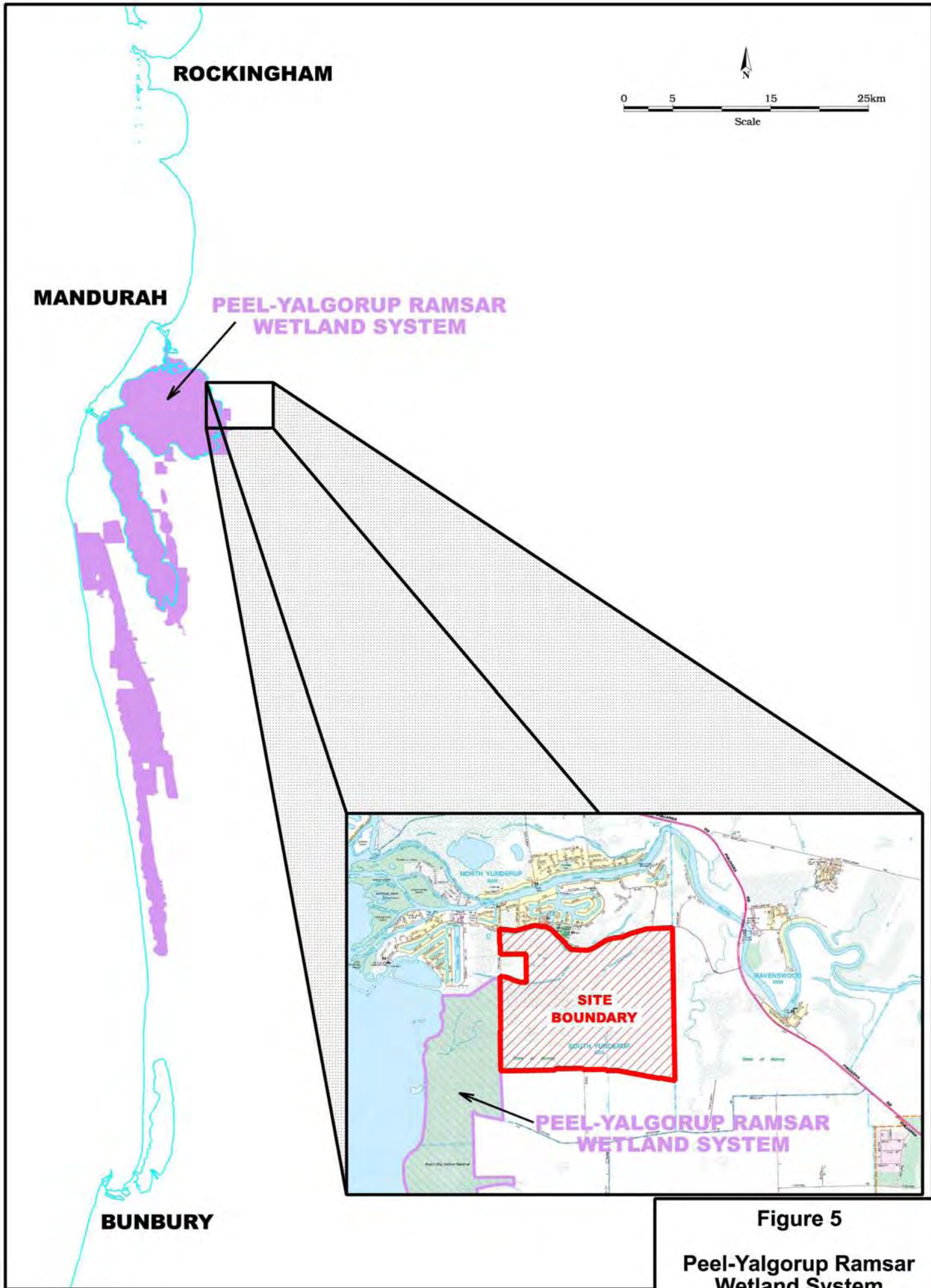


Figure 5
Peel-Yalgorup Ramsar
Wetland System

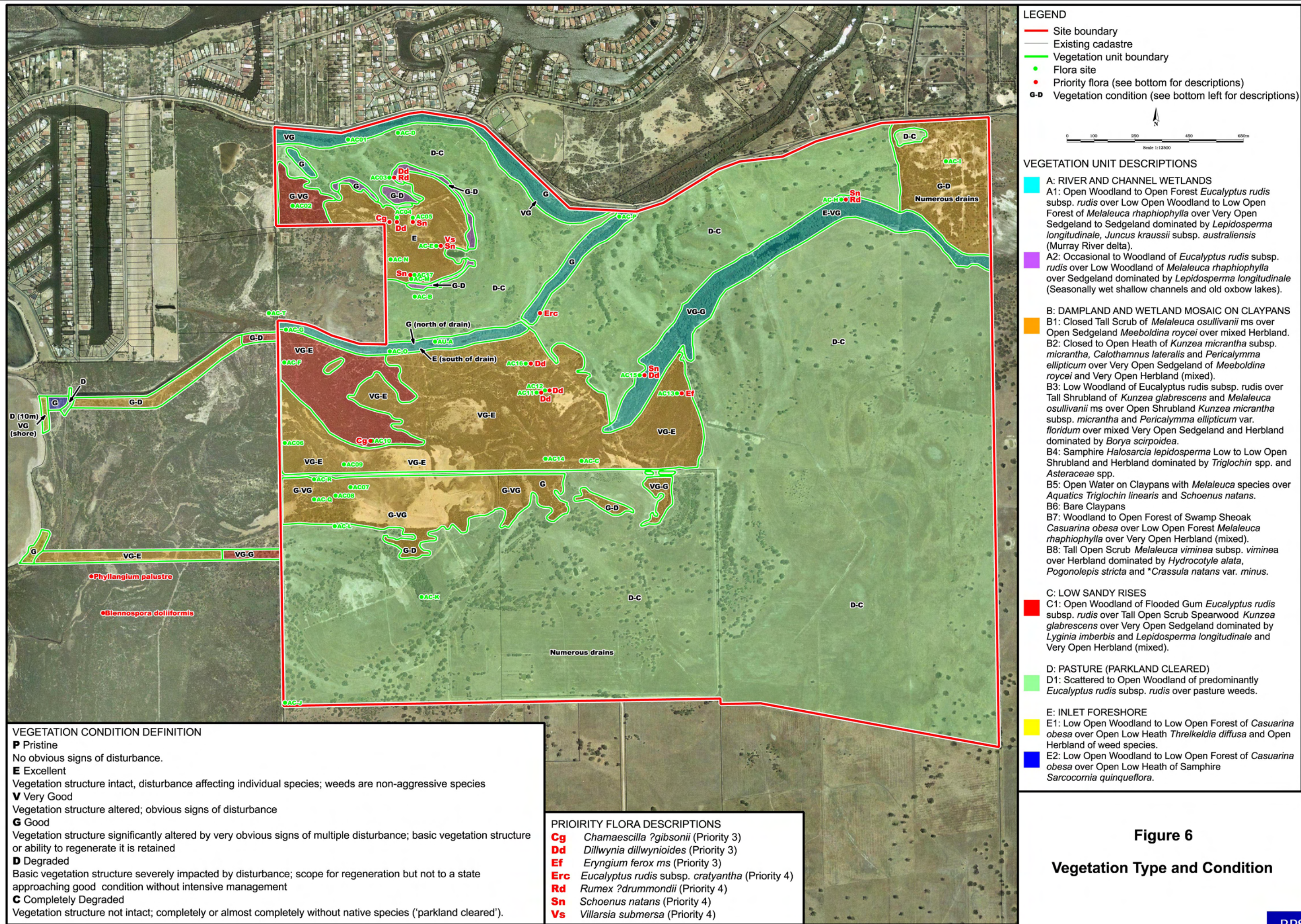


Figure 6

Vegetation Type and Condition

APPENDIX I

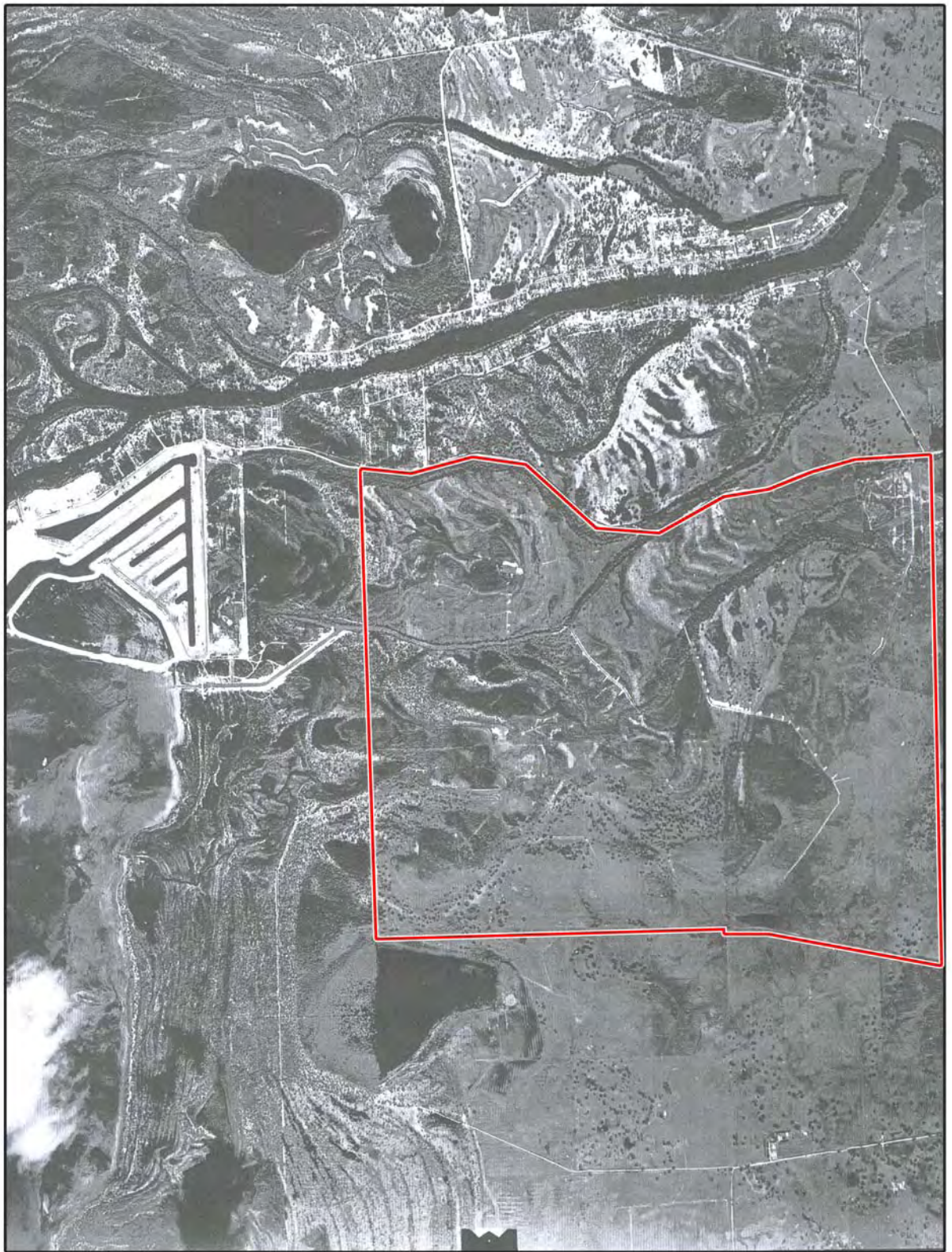
Historical Aerial Photography



Aerial Photograph

1968





Aerial Photograph

1974

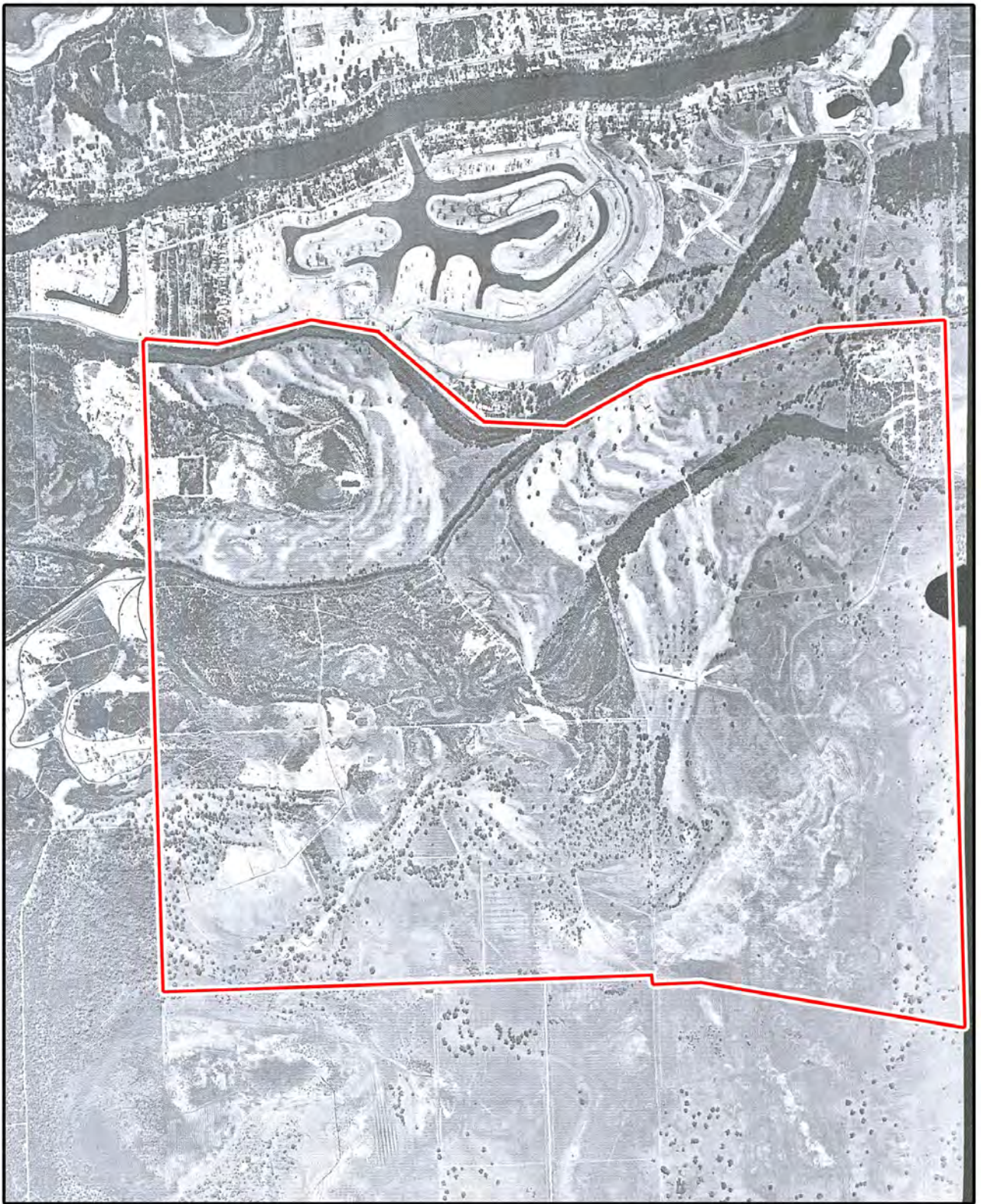




Aerial Photograph

1979





Aerial Photograph

1985





Aerial Photograph 1989

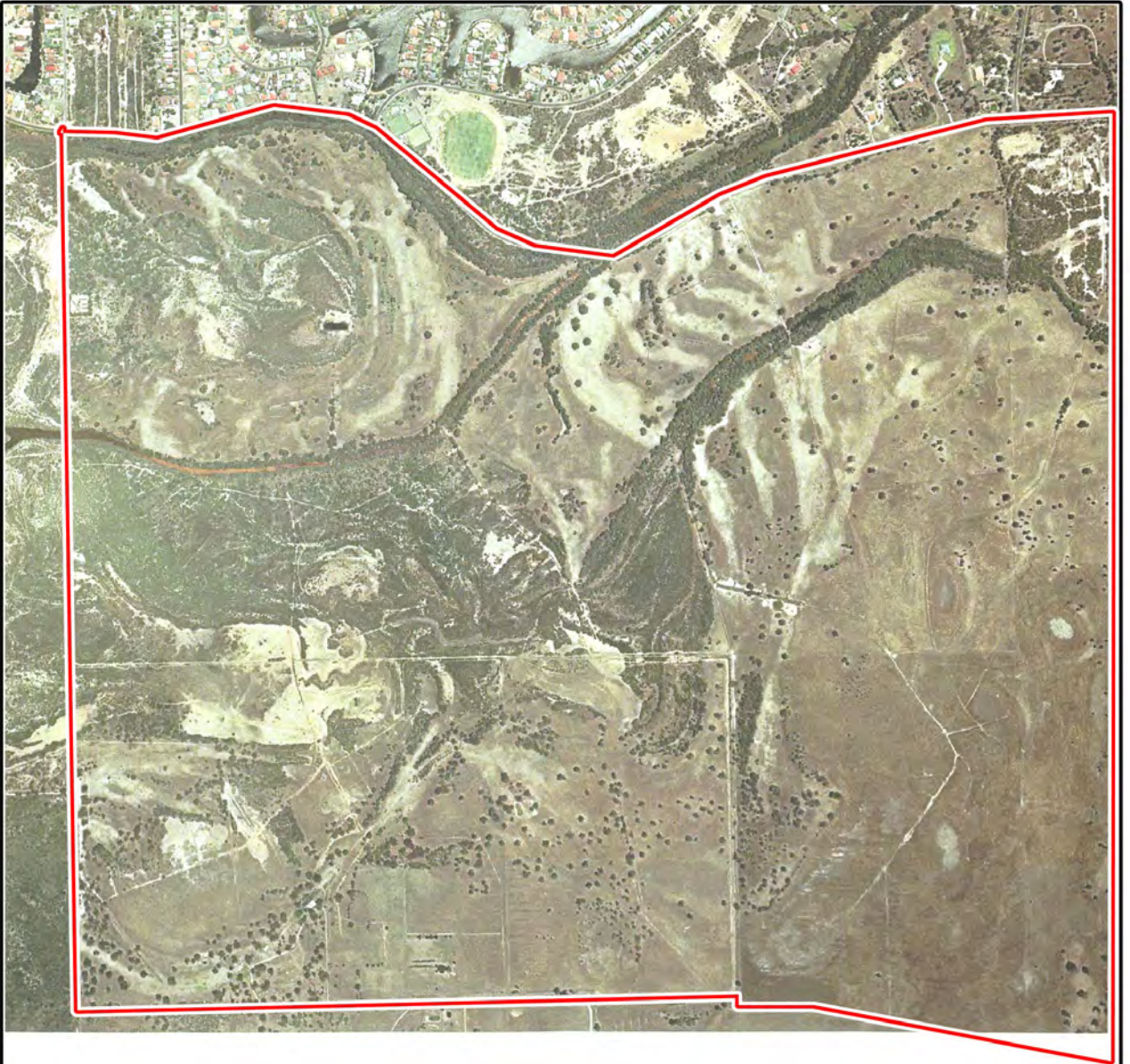




Aerial Photograph

1995





Aerial Photograph

2000



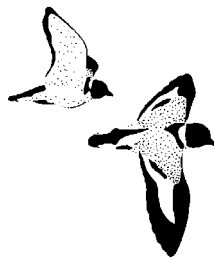
APPENDIX 2

Austin Cove: Assessment of Fauna and Fauna Habitats (Bamford Consulting Ecologists, 2008)

Austin Cove:
assessment of fauna and fauna habitats

Prepared for: RPS Bowman Bishaw Gorham,
PO Box 465,
Subiaco, WA, 6904

Prepared by: M.J. & A.R. Bamford,
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23rd January 2008

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INTRODUCTION

As part of the environmental assessment process for the proposed Austin Cove development, on the eastern side of Peel Inlet near Yunderup, Bamford Consulting Ecologists was commissioned to undertake an investigation into the fauna and fauna habitats of the site. The aims of this investigation were:

- List species likely to occur on the site;
- List and discuss significant species likely to occur on the site;
- Identify significant habitats on the site;
- Discuss impacts on biodiversity, significant habitats and ecological processes; and
- Provide recommendations for fauna conservation and the management of impacts.

Note that fauna investigations for environmental impact assessment are not intended to produce a complete or near-complete list of species confirmed to be present. Many studies have demonstrated that it can take years of intensive field-work to locate all vertebrate species within a site. The intentions of an assessment are as listed in the aims above.

This fauna and fauna habitat assessment is being carried out in conjunction with detailed and ongoing surveys of waterbirds in Austin Bay between Yunderup and the southern end of Austin Bay Nature Reserve.

METHODS

Approach and level of assessment

The fauna assessment and report preparation were carried out with reference to guidance and position statements published by the WA Environmental Protection Authority (EPA) on fauna surveys and environmental protection, and Commonwealth Biodiversity Legislation (e.g. EPA 2002; EPA 2004). The report synthesises the results of a literature review and a site inspection, and is classified as a Level 1 survey (desktop study, reconnaissance survey) according to the EPA Position Statement No. 3 (EPA 2002).

The study area falls within the Swan Coastal Plain Bioregion which is within the Bioregion Group 1 classification of EPA (2004). This grouping may be relevant for environmental impact assessment purposes.

The site inspection was conducted on 7th September 2006 but the site had been visited previously, and was visited in October, November and December 2006 for the purpose of waterbird surveys in Austin Bay.

Another site inspection was undertaken for the afternoon of 19th December 2007 by Dr Mike Bamford. The purpose of this site inspection was to identify if the Rainbow Bee-eater *Merops ornatus*, a listed migratory species under the EPBC Act, uses the site for breeding. The Rainbow Bee-eater is a very conspicuous species and its burrows are readily located. Mid-December represents the middle of the breeding season in southern

Australia, when laying is usually completed and nestlings may already be present (Higgins 1999). Active nests had been found in parkland-cleared paddocks at North Dandalup, 20km north of Austin Cove, in late November (M. Bamford pers. obs.).

The latest visit to the site involved walking across the paddocks, watching and listening for birds, and searching the ground for tell-tale piles of loose sand at the entrance of burrows. Searching focussed on paddocks close to areas of vegetation, including the slightly raised edges of soil under fence-lines and along firebreaks, as the birds often locate their burrows in such positions. With three hours spent on site and searching carried out at a slow walk, ca. 6km were walked across the area.

Personnel

Site inspection and report preparation were carried out by Dr Mike Bamford *BSc(Biol.), Hons(Biol.), PhD(Biol.)*. Mr Luke Rogers of RPS Bowman Bishaw Gorham assisted with the site inspection in September 2006. Dr Mike Craig and Mr Bill Rutherford have assisted with waterbird surveys and were therefore able to contribute further observations on the Austin Cove site.

Licences and permits

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

Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's *Checklist of the Vertebrates of Western Australia*. The authorities used for each vertebrate group are: amphibians and reptiles (Aplin and Smith 2001), birds (Christidis and Boles 1994; Johnstone 2001), and mammals (How *et al.* 2001). Where available, English common names follow Christidis and Boles (1994) for birds and Bush *et al.* (1995) for amphibians and reptiles.

Assessment of conservation significance

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

The EPBC Act also has lists of migratory species that are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). The list of migratory species under the EPBC Act has been revised to include species only, thus excluding family listings (DEH, pers. comm.). Those species listed in JAMBA are also

protected under Schedule 3 of the *WA Wildlife Conservation Act*. There is a separate list of marine species under the EPBC Act, but this only applies to land and waters under Commonwealth management. Therefore, marine listings are not included in this report.

The Department of the Environment and Heritage (DEH, formerly Environment Australia) has also supported the publication of reports on the conservation status of most vertebrate fauna species: reptiles (Cogger *et al.* 1993), birds (Garnett and Crowley 2000), monotremes and marsupials (Maxwell *et al.* 1996), rodents (Lee 1995) and bats (Duncan *et al.* 1999). The Threatened Species and Communities Section of Environment Australia has also produced a list of Threatened Australian Fauna, although this list is effectively a precursor to the list produced under the EPBC Act. These publications also use the IUCN categories, although those used by Cogger *et al.* (1993) differ in some respects because this report pre-dates categories reviewed by Mace and Stuart (1994) and revisited since by IUCN (2001).

In Western Australia, the Department of Conservation and Land Management (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 1. Assessments in this report are based on the most recent version of the CALM priority list (June 2005).

Fauna species included under conservation acts and/or agreements are formally recognised as of conservation significance under state or federal legislation. Species listed only as Priority by 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 of conservation significance, although this level of significance has no legislative or published recognition and is based on interpretation of distribution information. The WA Department of Environment (formerly the Department of Environmental Protection, DEP) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Perth Bushplan (DEP 2000).

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

- *Conservation Significance (CS) 1:* Species listed under State or Commonwealth Acts.
- *Conservation Significance (CS) 2:* Species not listed under State or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by 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. This level may have links to preserving biodiversity at the genetic level (EPA Position Statement No. 3, EPA 2002). For example, if a population is

isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3. Species listed as having declined around Perth area in Perth Bushplan (DEP 2000) are considered to be CS3 in the Perth area.

In addition to these statuses, species that have been introduced (INT) are indicated.

Sources of information

Lists of fauna expected to occur in the study area were produced using information from a number of sources. These included publications that provide information on general patterns of distribution of frogs (Tyler *et al.* 2000), reptiles (Storr *et al.* 1983, 1990, 1999 and 2002, Bush *et al.* 1995), birds (Barrett *et al.* 2003; Johnstone and Storr 1998), and mammals (Menkhorst and Knight 2001; Strahan 1995). In addition, records for the Mandurah area were sought from databases managed by the WA Museum (faunabase), the Department of Environment and Conservation (threatened fauna database), Birds Australia (Atlas II Database) and the Department of the Environment and Heritage (EPBC Protected Matters database). The search area for databases was 32° 20' to 32° 40'S, and 115° 45' to 116° 05'E except for the Atlas II database, for which the search area was 32° 00' to 33° 00'S and 115° 00' to 116° 00'E. Personal records (M. Bamford) from work carried out in the region since the mid 1980s were also used in the desktop review.

These sources of information were used to create lists of species expected to occur at the site. As far as possible, 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. Particularly among the birds, for example, vagrants can be recorded almost anywhere.

Site description

The project area lies on the eastern side of the Peel Inlet, about 1km inland of Austin Bay, and is south-east of Yunderup and south of the Murray River. The area is generally low-lying and extensively cleared, and includes riverine channels that are probably former courses of the Murray River. Nearly half the site has been identified as subject to flooding and the remainder is classified as flood fringe (based on Floodway Mapping from the Water and Rivers Commission 1983).

Cleared areas are pasture with scattered trees, mostly paperbarks *Melaleuca* spp. and Flooded Gums *Eucalyptus rudis*. Uncleared areas are associated with the riverine channels, a wetland in the north and a large area of shrubland within the floodway in the west; this is continuous with vegetation fringing Austin Bay of the Peel Inlet. This area of shrubland has some channels and open areas that are temporarily inundated during high tides and possibly after heavy rainfall.

The following fauna habitats in the project area can therefore be recognised:

- The main area of shrubland within the floodway;
- The tree-lined watercourses;
- The conservation category wetland in the north-west of the property; and
- Farmland with scattered trees.

The proposed development is largely restricted to flood fringe areas which support farmland with scattered trees, and avoids constraints such as conservation category wetlands. It also avoids most areas of remnant vegetation, while public open space within the development has the potential to provide some wildlife habitat. The shrubland within the floodway to the west, and the conservation category wetland in the north-west, are indicated as being incorporated into the Peel Regional Park that extends along the eastern shoreline of Peel Inlet.

FAUNA OF THE PROJECT AREA

Invertebrates

The only information on invertebrate fauna is for threatened species listed in the Threatened Fauna Database maintained by the Department of Environment and Conservation. The only species listed for the Mandurah area is the Graceful Sun-Moth *Synemon gratiosa* (Castniidae). This is noted as occurring in few locations from Wanneroo to Mandurah and to be threatened by land clearing. The Graceful Sun-Moth is listed as Priority 1 under the *WA Wildlife Conservation Act*. Its habitat requirements are unknown but it occurs in Banksia woodland so is probably absent from the project area.

Other significant invertebrate species known from south of Perth are also associated with banksia woodland, although it is not known if they might occur in other vegetation types. These include the bee *Neopasiphe simplicior* (Schedule 1 of the *WA Wildlife Conservation Act*), the cricket *Throscodectes xiphos* (Priority 1) and the bees *Leioproctus douglasiellus* and *Hylaeus globuliferus* (Priority 3). While not known from the project area, this may be a result of inadequate sampling, so their possible presence in native vegetation in the area needs to be considered.

In addition, the potential exists for short-range endemics to occur in the area. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. The shrublands within the floodway are small and fragmented within a regional context, so are the sort of habitat that may support short range endemic invertebrates.

Vertebrates

Overview of the vertebrate assemblage

The literature and data review identified 212 species of vertebrate that may occur in the vicinity of the proposed development. In the following sections, an attempt has been made to differentiate between species likely to occur in the general region between Mandurah and Pinjarra, and those that are likely to use the project area regularly. This is based upon the sorts of habitats present and relies extensively on personal experience with the environment and faunal assemblage. This approach indicates that the project area can be expected to regularly support appreciably fewer species than occur in the general region.

Freshwater fish

Estuarine fish are beyond the scope of this review and are unlikely to be impacted by the proposed development unless there were massive impacts upon water quality in the adjacent Peel Inlet. Several species of freshwater fish do occur in wetlands in the area, however, and could be affected by the development if they occurred on the site. Wetlands in the project area appear to be seasonal and subject to regular incursions from the estuary, so may only support estuarine fish irregularly and probably do not support

freshwater species. The almost ubiquitous introduced Mosquitofish *Gambusia holbrooki* was not observed but is very likely to be present.

The creation of artificial wetlands within public open space is part of the proposal. The Mosquitofish will almost certainly find its way into these wetlands but the introduction of native species such as the Swan River Goby *Pseudogobius olorum* and Western Pygmy Perch *Edelia vittata* could be considered.

Frogs

The seven frog species (Table 1) recorded in the area are all widespread and while many of the wetlands in the project area are under some influence from the estuary, the conservation category wetland in the north of the area is fresh, while the paddocks are probably partly inundated with freshwater in winter. Freshwater is also likely to pond around the margins of saline water in the floodway. During the site inspection, several specimens of Glauert's Frog were found under fallen branches in the shrublands of the floodway.

Frogs may lose some breeding habitat with the development of the low-lying paddocks and could be sensitive to any hydrological and water quality changes. Some frogs also move long distances and the development may restrict such movements between the Peel Regional Park and wetlands to the east of the development. Overall, however, the development avoids impacts on areas of native vegetation and wetlands most likely to be important for frogs.

None of the frog species is of conservation significance.

Reptiles

Table 2 lists 37 reptile species considered likely to occur in the general region, but indicates that only 25 of these may be present in the project area. This approach has been taken because the project area has virtually no intact habitat away from wetlands, and a lot of the reptile species are usually associated with banksia and eucalypt woodlands on sand. However, some of these may persist in the shrubland of the floodway area.

Most reptile species are likely to be restricted to areas of native vegetation which are largely going to be retained as part of the Peel Regional Park or within Public Open Space within the development. Impacts of the development upon reptiles can therefore be expected to be low, although incursions of domestic pets into the regional park may be a concern.

Few reptiles of conservation significance are expected to be present. These are summarised in Table 4. The South-West Carpet Python is the only reptile species of high significance (CS1) is unlikely to be present but, if present, will be restricted to large areas of native vegetation that are to be retained. Species of lower levels of significance are similarly unlikely to be present, mainly due to the absence of banksia and eucalypt woodland on sand, with the exception of the Black-headed Tree Goanna (CS3). This species has been found in trees in parkland-cleared paddocks (M. Bamford pers. obs) and

is at the southern limit of its range in the project area. In other projects, this species has been rescued during removal of large trees in paddocks during clearing for urban development, with animals being translocated to nearby habitat.

Birds

Table 2 lists 145 bird species considered likely to occur in the general region, but indicates that only 116 of these may be present in the project area regularly. Twenty-two species were seen during the site inspection.

Fifty-six species are waterbirds, likely to occur on the conservation category wetland, the riverine channels and the open shallows in the floodway area. Waterbirds will also use the paddocks when these flood, with some species, such as the ibis, foraging on dry pastures, and species such as the White-faced Heron nesting in isolated paddock trees. The bird assemblage also includes landbirds that will use or even rely upon the farmland environment. Species such as the Australian Magpie, Richard's (Australian) Pipit and Nankeen Kestrel may only be present because of the farmland environment, while many other species will utilise the paddock trees. A suite of species, however, including most of those identified as having declined in the Perth area (DEP 2000) and therefore listed as CS3, are dependent upon more or less intact native vegetation, so will be largely restricted to this environment.

Because of the reliance of most bird species on native vegetation, impacts of the development upon birds will generally be low. Species likely to be affected are those of the farmland environment and this is well-represented regionally. Loss of paddock trees may reduce the ability of some birds to move across the landscape, but the development includes linear public open space that will provide for such movement, especially if POS is planted with local native trees and shrubs. Predation by domestic pets may be a concern for some species, particularly small, sedentary species such as fairy-wrens.

There are many birds of conservation significance: 21 CS1 (17 of these migratory); 3 CS2 and 40 CS3. Details on these are summarised in Table 4. Many are migratory waterbirds, such as sandpipers, which are abundant nearby and may make occasional use of wetlands for foraging and roosting. The wetlands are to be retained within Peel Regional Park and POS, although disturbance may be a concern and therefore management of human activities in these areas may be necessary. Of the significant landbirds, most are species of native vegetation that will be retained and therefore impacts are expected to be low. The ability of these species to be able to disperse through the development may be important for the long-term persistence of populations as noted above. A few significant species (Black-shouldered Kite, Brown Goshawk and Collared Sparrowhawk) may nest in paddock trees so could lose nest sites, so the retention of large trees where possible is desirable. The paddock trees were generally paperbarks and Flooded Gums, many of which were multi-stemmed, suggesting they may have regrown after clearing, and there appeared to be no trees large enough to contain hollows suitable for use by the black-cockatoos or the CS2 Masked and Barking Owls.

Carnaby's Black-Cockatoo largely breeds in the Wheatbelt from late winter to early summer and migrates to coastal woodlands for the rest of the year. It has declined because of loss of breeding and foraging habitat in the Wheatbelt due to agricultural clearing, and is also threatened by loss of coastal woodlands due to clearing for agriculture and urban development. Despite this, it has shown some ecological flexibility, utilizing pine plantations and trees in urban areas for foraging, with a recent trend for some birds to breed in the hollows of large eucalypts near the coast instead of migrating to traditional inland breeding sites. The species was not observed at Austin Cove during site inspections but is likely to be a regular visitor in small numbers. There is some foraging habitat in the conservation area (*Hakea* and *Acacia*) and some mature Marri trees mostly within the proposed multiple-use corridor. Marri trees are a foraging resource and can also provide nest hollows, although the trees in the proposed multiple-use corridor did not appear to contain hollows of suitable size. Development areas are mostly cleared but with scattered trees too small to contain hollows suitable for the cockatoos. Because Carnaby's Black-Cockatoos visit established urban areas to forage, the potential to create new foraging habitat in urban areas by tree planting is high.

The migratory (therefore CS1) Rainbow Bee-eater is expected to be a common breeding visitor from mid spring to early autumn. However, no Rainbow Bee-eaters were observed during the December 2008 site visit and a single old nest, probably abandoned several weeks earlier, was found ((50) 387 865E, 6 393 400N, datum WGS84). While some earthworks were being carried out on and adjacent to the site, mostly related to highway construction, it is considered unlikely that disturbance was a factor in the absence of the birds, as they are often observed in areas of high human, livestock and vehicular activity.

It would appear that at least in the 2007 breeding season, the Austin Cove project area was little-used by Rainbow Bee-eaters for breeding. The discovery of one probably abandoned nest suggests that at least one pair may have attempted to breed at the site, and a few others pairs may also have attempted breeding. A single active nest may also have been overlooked. However, it is very unlikely that the site supported any sort of nesting aggregation, as then the birds are very conspicuous.

Higgins (1999) notes that the species is often site faithful from year to year, so the absence of a breeding aggregation in 2007 suggests that the site has not supported a locally important breeding colony in recent years. Rainbow Bee-eaters do change breeding locations from one year to the next at least occasionally, however, so it cannot be concluded that the site will never be used by the birds in locally significant numbers. With development nearby, areas suitable for nesting may be adopted by Rainbow Bee-eaters and the Austin Cove project area does appear suitable for them. Retention of the margins of conservation areas as open, sparsely-vegetated ground close to trees should ensure that nesting habitat remains available in the area. Although significant because of its migratory habit, this is a widespread and abundant species so the impact is considered to be low (Table 4) and the local impact is not considered to be significant.

Mammals

Table 3 lists 23 mammal species considered likely to occur in the general region, of which 19 are expected to be present in the project area regularly. Five of these regular species are introduced and eight are bats, so only six species of non-flying native mammals are expected to be regularly present. A number of other species are regionally extinct and are not considered here.

Native mammals, including the bats, are likely to be dependent upon more or less intact native vegetation. However, the Grey Kangaroos and at least some of the bats, particularly the White-striped Mastiff Bat and Gould's Wattled Bat, will make extensive use of farmland. For bats, paddock trees may be important in facilitating movement across farmland and in providing roosts in small hollows.

The Chuditch is the only mammal species of high conservation significance (CS1) and is effectively extinct in the region of Austin Cove but vagrants may occur in the area, probably when juveniles disperse from the forests of the Darling Scarp 20km to the east. The only suitable habitat for the species is within the conservation area. The decline of the species appears to be due to predation by the introduced Fox, probably exacerbated by clearing and habitat fragmentation. The conservation area will ensure that habitat remains to enable Chuditch to move around the eastern side of the Peel/Harvey Inlet.

Three species are of CS2, however: the Quenda, Western False Pipistrelle and Rakali. The Quenda is present (identified by characteristic diggings in native vegetation in the floodway area), the Rakali is considered likely to be present around wetlands and the false pipistrelle is also considered likely to be present. A further four species are of CS3, but of these only the Echidna and the Brush-tailed Possum are considered likely to be present. All are likely to be restricted to native vegetation.

IMPACTS UPON THE FAUNA

Although the development is extensive, it is concentrated in areas that are cleared or parkland cleared, so impacts and fauna are expected to be much lower than might otherwise be the case. Impacts are reviewed in Table 5 using the categories of Guidance Statement 56 (EPA 2004). Impacts are low in all categories except for linkage, where impacts may be low to moderate because of the possible value of farmland trees for wildlife. There are some other factors to consider with respect to impacts, however, and major issues for fauna conservation and impacts relate to:

- The value of remnant habitat, mainly scattered trees, in the pasture areas. These are important as habitat for a few species and may provide linkage for species such as some birds and bats. The woodlands that line the riverine channels are also likely to be important for linkage and, while they are to be retained, degradation of these through weed invasion is already a concern.
- Impacts of disturbance from people and pets. Existing wetlands may occasionally be important for roosting by waterbirds and disturbance of these areas could be an issue. Increased human populations in the area could also lead to increased levels of disturbance in Austin Bay, where counts of over 12,000 waterbirds have been made recently, including over 4,000 birds in the north end of the bay closest to the proposed development (M. Bamford unpubl. data).
- Some of the fauna in the native vegetation in areas to be retained are sensitive to predation by cats, including the Quenda and a number of bird species.

Further to these adverse impacts, there may be some benefits to wildlife from the proposed development. These are:

- Habitats in the area are currently being degraded through off-road vehicle use and weed invasion. The proposed development may provide the opportunity to better manage these factors. Current disturbance of wildlife, especially waterbirds, in Austin Bay, may also be addressed by the increased need to manage human activities in the area.
- The Public Open Space in the development is linear, aligned both east-west and north-south, and therefore has the potential to facilitate fauna movement through the area. The POS also includes wetlands that may be developed to support wildlife.

RECOMMENDATIONS

Given the above impacts, the following recommendations to minimise adverse impacts and maximise benefits to fauna are made:

- Habitat should be retained where possible, including individual large trees within the development area;
- POS and road verges should be planted to create wildlife habitat, using native (local) plant species to form shrublands and woodlands that provide linkage for wildlife;
- Residents should be encouraged to create habitat for wildlife in gardens;

- Weed control is necessary in some of the native vegetation to be retained to prevent gradual deterioration of the habitat;
- Public access to areas of conservation value will need to be controlled to prevent disturbance;
- Restrictions on the exercising of dogs will be necessary, especially around wetlands (including Austin Bay);
- Residents need to be responsible with pets, in particular keeping cats inside or at least inside at night.

Table 1. Frogs and reptiles of the general region of the Austin Cove project area. Species observed on the site (*), species likely to occur on the site (+) and species unlikely to occur on the site (-) are indicated. The conservation status is described in Methods (see above).

Species	Presence	Cons Status
FROGS		
Myobatrachidae (ground frogs)		
Glauert's Froglet <i>Crinia glauerti</i>	+	
Squelching Frog <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)		
Motorbike Frog <i>Litoria moorei</i>	+	
Slender Tree Frog <i>Litoria adelaidensis</i>	+	
REPTILES		
Chelidae (freshwater tortoises)		
Long-necked Tortoise <i>Chelodina oblonga</i>	+	
Gekkonidae (geckoes)		
Marbled Gecko <i>Christinus(Phyllodactylus) marmoratus</i>	+	
Spiny-tailed Gecko <i>Strophurus spinigerus</i>	+	
Pygopodidae (legless lizards)		
Sandplain Worm Lizard <i>Aprasia repens</i>	+	
Fraser's Legless Lizard <i>Delma fraseri</i>	+	
Grey's Legless Lizard <i>Delma greyii</i>	-	
Burton's Legless Lizard <i>Lialis burtonis</i>	+	
Keeled Legless-lizard <i>Pletholax gracilis</i>	-	CS3
Common Scalefoot <i>Pygopus lepidopodus</i>	-	
Agamidae (dragon lizards)		
Western Bearded Dragon <i>Pogona minor</i>	+	
Varanidae (monitors or goannas)		
Gould's Sand Goanna <i>Varanus gouldii</i>	+	
Rosenberg's Goanna <i>Varanus rosenbergi</i>	+	
Black-headed Tree Goanna <i>Varanus tristis</i>	+	CS3
Scincidae (skink lizards)		
South-West Cool Skink <i>Acritoscincus trilineatum</i>	+	
Fence Skink <i>Cryptoblepharus plagiocephalus</i>	*	
Western Ctenotus <i>Ctenotus australis</i>	+	
South-west Odd-striped Ctenotus <i>Ctenotus impar</i>	-	
Red-legged Skink <i>Ctenotus labillardieri</i>	-	CS3
King's Skink <i>Egernia kingii</i>	+	
Western Swamp Egernia <i>Egernia luctuosa</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>	+	

Table 1 (cont.)

Species		Presence	Cons Status
Dwarf Skink	<i>Menetia greyii</i>	+	
Western pale-flecked Morethia	<i>Morethia lineoocellata</i>	+	
Southern pale-flecked Morethia	<i>Morethia obscura</i>	-	
Bobtail	<i>Tiliqua rugosa</i>	*	
Typhlopidae (blind snakes)			
Southern Blind Snake	<i>Ramphotyphlops australis</i>	+	
Boidae (pythons)			
South-West Carpet Python	<i>Morelia spilota imbricata</i>	-	CS1
Elapidae (front-fanged snakes)			
Bardick	<i>Echiopsis curta</i>	-	
Crowned Snake	<i>Elapognathus coronata</i>	+	
Black-naped Snake	<i>Neelaps bimaculatus</i>	-	
Black-striped Snake	<i>Neelaps calonotos</i>	-	CS2
Tiger Snake	<i>Notechis scutatus</i>	+	
Dugite	<i>Pseudonaja affinis</i>	+	
Gould's Snake	<i>Parasuta(Rhinoplocephalus) gouldii</i>	+	
Jan's Bandy-Bandy	<i>Simoselaps(Vermicella) bertholdi</i>	-	

Table 2. Birds of the general region of the Austin Cove project area, indicating species observed on the site (*), species likely to occur on the site (+) and species unlikely to occur on the site (-). The superscript ^w indicates waterbirds. The conservation status is described in Methods (see above).

Species	Presence	Cons Status
Phasianidae (pheasants and quails)		
Brown Quail <i>Coturnix ypsilophora</i>	-	
Stubble Quail <i>Coturnix pectoralis</i>	+	
Anatidae (ducks, geese and swans)		
Black Swan <i>Cygnus atratus</i> ^w	+	
Freckled Duck <i>Stictonetta naevosa</i> ^w	-	CS3
Australian Shelduck <i>Tadorna tadornoides</i> ^w	*	
Pacific Black Duck <i>Anas superciliosus</i> ^w	*	
Grey Teal <i>Anas gibberifrons</i> ^w	*	
Chestnut Teal <i>Anas castanea</i> ^w	+	
Australasian Shoveler <i>Anas rhynchotis</i> ^w	+	CS3
Pink-eared Duck <i>Malacorhynchus membranaceus</i> ^w	+	CS3
Hardhead <i>Aythya australis</i> ^w	+	CS3
Australian Wood Duck <i>Chenonetta jubata</i> ^w	*	
Musk Duck <i>Biziura lobata</i> ^w	+	CS3
Blue-billed Duck <i>Oxyura australis</i> ^w	-	CS3
Podicepsidae (grebes)		
Great Crested Grebe <i>Podiceps cristatus</i> ^w	-	
Hoary-headed Grebe <i>Poliocephalus poliocephalus</i> ^w	-	
Australasian Grebe <i>Tachybaptus novaehollandiae</i> ^w	+	
Anhingidae (darters)		
Darter <i>Anhinga melanogaster</i> ^w	+	
Phalacrocoracidae (cormorants)		
Great Cormorant <i>Phalacrocorax carbo</i> ^w	-	
Pied Cormorant <i>Phalacrocorax varius</i> ^w	-	
Little Black Cormorant <i>Phalacrocorax sulcirostris</i> ^w	+	
Little Pied Cormorant <i>Phalacrocorax melanoleucos</i> ^w	+	
Ardeidae (herons and egrets)		
White-faced Heron <i>Egretta novaehollandiae</i> ^w	+	
Little Egret <i>Egretta garzetta</i> ^w	+	
White-necked Heron <i>Ardea pacifica</i> ^w	+	
Great Egret <i>Egretta alba</i> ^w	+	CS1
Nankeen Night Heron <i>Nycticorax caledonicus</i> ^w	+	CS3
Little Bittern <i>Ixobrychus minutus</i> ^w	-	CS2
Black Bittern <i>Ixobrychus flavicollis</i> ^w	-	CS3
Australasian Bittern <i>Botaurus poiciloptilus</i> ^w	-	CS1

Table 2 (cont.)

Species		Presence	Cons Status
Plataleidae (ibis and spoonbills)			
Glossy Ibis	<i>Plegadis falcinellus</i> ^w	-	CS1
Australian White Ibis	<i>Threskiornis molucca</i>	+	
Straw-necked Ibis	<i>Threskiornis spinicollis</i>	+	
Yellow-billed Spoonbill	<i>Platalea flavipes</i> ^w	+	
Accipitridae (kites, hawks and eagles)			
Osprey	<i>Pandion haliaetus</i>	+	CS1
Black-shouldered Kite	<i>Elanus notatus</i>	+	
Square-tailed Kite	<i>Lophoictinia isura</i>	+	CS3
Whistling Kite	<i>Haliastur spheonurus</i>	+	CS3
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	+	CS1
Swamp Harrier	<i>Circus approximans</i>	+	
Brown Goshawk	<i>Accipiter fasciatus</i>	+	CS3
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>	+	CS3
Wedge-tailed Eagle	<i>Aquila audax</i>	+	CS3
Little Eagle	<i>Hieraaetus morphnoides</i>	+	CS3
Falconidae (falcons)			
Peregrine Falcon	<i>Falco peregrinus</i>	+	CS1
Australian Hobby	<i>Falco longipennis</i>	+	
Brown Falcon	<i>Falco berigora</i>	+	CS3
Nankeen Kestrel	<i>Falco cenchroides</i>	+	
Turnicidae (button-quails)			
Painted Button-quail	<i>Turnix varia</i>	-	CS3
Rallidae (crakes and rails)			
Buff-banded Rail	<i>Rallus philippensis</i> ^w	+	
Baillon's Crake	<i>Porzana pusilla</i> ^w	+	
Spotless Crake	<i>Porzana tabuensis</i> ^w	+	
Australian Crake	<i>Porzana fluminea</i> ^w	+	
Dusky Moorhen	<i>Gallinula tenebrosa</i> ^w	-	CS3
Purple Swampphen	<i>Porphyrio porphyrio</i> ^w	+	
Eurasian Coot	<i>Fulica atra</i> ^w	+	
Scolopacidae (sandpipers)			
Bar-tailed Godwit	<i>Limosa lapponica</i> ^w	-	CS1
Whimbrel	<i>Numenius phaeopus</i> ^w	-	CS1
Marsh Sandpiper	<i>Tringa stagnatalis</i> ^w	+	CS1
Common Greenshank	<i>Tringa nebularia</i> ^w	+	CS1
Common Sandpiper	<i>Tringa hypoleucos</i> ^w	+	CS1
Great Knot	<i>Calidris tenuirostris</i> ^w	-	CS1
Red Knot	<i>Calidris canutus</i> ^w	-	CS1
Sanderling	<i>Calidris alba</i> ^w	-	CS1
Red-necked Stint	<i>Calidris ruficollis</i> ^w	+	CS1
Sharp-tailed Sandpiper	<i>Calidris acuminata</i> ^w	+	CS1
Curlew Sandpiper	<i>Calidris ferruginea</i> ^w	+	CS1

Table 2 (cont.)

Species	Presence	Cons Status
Recurvirostridae (stilts and avocets)		
Black-winged Stilt <i>Himantopus himantopus</i> ^w	+	
Banded Stilt <i>Cladorhynchus leucocephalus</i> ^w	+	
Red-necked Avocet <i>Recurvirostra novaehollandiae</i> ^w	+	
Charadriidae (lapwings and plovers)		
Red-capped Plover <i>Charadrius ruficapillus</i> ^w	+	
Black-fronted Dotterel <i>Elseyornis melanops</i> ^w	+	
Red-kneed Dotterel <i>Erythrogonyx cinctus</i> ^w	+	CS3
Columbidae (pigeons and doves)		
Laughing Turtle-Dove <i>Streptopelia senegalensis</i>	+	INT
Common Bronzewing <i>Phaps chalcoptera</i>	+	CS3
Crested Pigeon <i>Ocyphaps lophotes</i>	+	
Cacatuidae (cockatoos)		
Forest Red-tailed Black Cockatoo <i>Calyptorhynchus banksii</i>	+	CS1
Carnaby's Black-Cockatoo <i>Calyptorhynchus latirostris</i>	+	CS1
Galah <i>Cacatua roseicapilla</i>	*	
Little Corella <i>Cacatua sanguinea</i>	+	INT
Sulphur-crested Cockatoo <i>Cacatua galerita</i>	+	INT
Psittacidae (lorikeets and parrots)		
Purple-crowned Lorikeet <i>Glossopsitta porphyrocephala</i>	-	
Regent Parrot <i>Polytelis anthopeplus</i>	+	CS3
Red-capped Parrot <i>Purpureicephalus spurius</i>	*	
Australian Ringneck <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)		
Barking Owl <i>Ninox connivens</i>	-	CS2
Southern Boobook Owl <i>Ninox novaeseelandiae</i>	+	
Tytonidae (barn owls)		
Masked Owl <i>Tyto novaehollandiae</i>	-	CS2
Barn Owl <i>Tyto alba</i>	+	
Podargidae (frogmouths)		
Tawny Frogmouth <i>Podargus strigoides</i>	+	
Aegothelidae (owlet-nightjars)		
Australian Owlet-nightjar <i>Aegotheles cristatus</i>	+	CS3
Apodidae (swifts)		
Fork-tailed Swift <i>Apus pacificus</i>	+	CS1
Halcyonidae (forest kingfishers)		
Laughing Kookaburra <i>Dacelo novaeguineae</i>	+	INT
Sacred Kingfisher <i>Todiramphus sanctus</i>	+	

Table 2 (cont.)

Species	Presence	Cons Status
Meropidae (bee-eaters)		
Rainbow Bee-eater <i>Merops ornatus</i>	-	CS1
Maluridae (fairy-wrens)		
Southern Emu-wren <i>Stipiturus malachurus</i>	-	CS3
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>	*	
Weebill <i>Smicrornis brevirostris</i>	+	CS3
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>	+	
Yellow-throated Miner <i>Manorina flavigula</i>	+	CS3
Singing Honeyeater <i>Lichenostomus virescens</i>	*	
White-naped Honeyeater <i>Melithreptus lunatus (chloropis)</i>	-	CS3
Brown Honeyeater <i>Lichmera indistincta</i>	*	
New Holland Honeyeater <i>Phylidonyris novaehollandiae</i>	+	CS3
White-cheeked Honeyeater <i>Phylidonyris nigra</i>	-	
Tawny-crowned Honeyeater <i>Phylidonyris melanops</i>	-	
Western Spinebill <i>Acanthorhynchus superciliosus</i>	+	
White-fronted Chat <i>Epthianura albifrons</i>	+	
Petroicidae (Australian robins)		
Scarlet Robin <i>Petroica multicolor</i>	+	CS3
Western Yellow Robin <i>Eopsaltria griseogularis (australis)</i>	-	CS3
Neosittidae (sittellas)		
Varied Sittella <i>Daphoenositta chrysoptera</i>	-	CS3
Pachycephalidae (whistlers)		
Golden Whistler <i>Pachycephala pectoralis</i>	+	CS3
Rufous Whistler <i>Pachycephala rufiventris</i>	*	
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>	*	
Restless Flycatcher <i>Myiagra inquieta</i>	-	CS3
Campephagidae (cuckoo-shrikes)		
Black-faced Cuckoo-shrike <i>Coracina novaehollandiae</i>	+	
White-winged Triller <i>Lalage sueurii</i>	+	

Table 2 (cont.)

Species	Presence	Cons Status
Artamidae (woodswallows)		
Black-faced Woodswallow <i>Artamus cinereus</i>	+	CS3
Dusky Woodswallow <i>Artamus cyanopterus</i>	-	CS3
Grey Butcherbird <i>Cracticus torquatus</i>	+	
Australian Magpie <i>Gymnorhina tibicen</i>	*	
Corvidae (ravens and crows)		
Grey Currawong <i>Strepera versicolor</i>	+	CS3
Australian Raven <i>Corvus coronoides</i>	*	
Motacillidae (pipits and true wagtails)		
Richard's (Australian) Pipit <i>Anthus novaeseelandiae</i>	+	
Hirundinidae (swallows)		
Welcome Swallow <i>Hirundo neoxena</i>	*	
Tree Martin <i>Hirundo nigricans</i>	+	
Sylviidae (old world warblers)		
Clamorous Reed-Warbler <i>Acrocephalus stentoreus</i> ^w	+	
Little Grassbird <i>Megalurus gramineus</i> ^w	+	
Zosteropidae (white-eyes)		
Silvereye <i>Zosterops lateralis</i>	*	

Table 3. Mammals of the general region of the Austin Cove project area, indicating species observed on the site (*), species likely to occur on the site (+) and species unlikely to occur on the site (-). Status is assigned as described in Methods.

Species		Status
Tachyglossidae (echidnas)		
Echidna <i>Tachyglossus aculeatus</i>	+	CS3
Dasyuridae		
Chuditch <i>Dasyurus geoffroii</i>	-	CS1
Peramelidae (bandicoots)		
Quenda, Southern Brown Bandicoot <i>Isodon obesulus</i>	*	CS2
Tarsipedidae (honey possum)		
Honey Possum <i>Tarsipes rostratus</i>	-	CS3
Phalangeridae (possums)		
Brush-tailed Possum <i>Trichosurus vulpecula</i>	+	CS3
Burramyidae (pygmy possums)		
Western Pygmy Possum <i>Cercartetus concinnus</i>	-	CS3
Macropodidae (kangaroos and wallabies)		
Western Grey Kangaroo <i>Macropus fuliginosus</i>	*	
Brush or Black-gloved Wallaby <i>Macropus irma</i>	-	CS2
Mollosidae (moss bats)		
White-striped Bat <i>Tadarida australis</i>	+	
Western Freetail-bat <i>Mormopterus</i> sp. (<i>M. planiceps</i> : long penis form, part). 'Species 4, population O' of Adams <i>et al.</i> (1988).	-	
Vespertilionidae (vesper bats)		
Gould's Wattled Bat <i>Chalinolobus gouldii</i>	+	
Chocolate Wattled Bat <i>Chalinolobus morio</i>	+	
Western False Pipistrelle <i>Falsistrellus mackenziei</i>	+	CS2
Southern Forest Bat <i>Vespadelus regulus</i>	+	
Lesser Long-eared Bat <i>Nyctophilus geoffroyi</i>	+	
Gould's Long-eared Bat <i>Nyctophilus gouldii</i>	+	
Greater Long-eared Bat <i>Nyctophilus major</i>	+	
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

Table 4. Species of conservation significance expected in the project area. The probable status and probable impact of the proposal are indicated.

Species	Conservation significance	Probable status on site	Probable impact of proposal
Graceful Sun-Moth <i>Synemon gratiosa</i>	Priority 1 (DEC)	Unlikely	Low
Keeled Legless-Lizard <i>Pletholax gracilis</i>	CS3. At southern limit of range	Unlikely	Low
Black-headed Tree Goanna <i>Varanus tristis</i>	CS3. At southern limit of range	Possible in large trees, including in paddocks	Low. Relocation during clearing?
Red-legged Skink <i>Ctenotus labillardieri</i>	CS3. Patchy distribution on coastal plain and taxonomic status of plain population being investigated.	Unlikely	Low
South-West Carpet Python <i>Morelia spilota imbricata</i>	CS1. Schedule 4 (other specially protected fauna) of WA Wildlife Act. Priority 4 (DEC).	Unlikely	Low
Black-striped Snake <i>Neelaps calonotos</i>	CS2. Priority 3 (DEC)	Unlikely	Low
Freckled Duck <i>Stictonetta naevosa</i>	CS3. Declined in Perth area	Infrequent visitor to wetlands	Low
Australasian Shoveler <i>Anas rhynchos</i>	CS3. Declined in Perth area	Infrequent visitor to wetlands	Low
Pink-eared Duck <i>Malacorhynchus membranaceus</i>	CS3. Declined in Perth area	Infrequent visitor to wetlands	Low
Hardhead <i>Aythya australis</i>	CS3. Declined in Perth area	Infrequent visitor to wetlands	Low
Musk Duck <i>Biziura lobata</i>	CS3. Declined in Perth area	Infrequent visitor to wetlands	Low
Blue-billed Duck <i>Oxyura australis</i>	CS3. Declined in Perth area	Infrequent visitor to wetlands	Low
Great Egret <i>Egretta alba</i>	CS1. Migratory under EPBC Act.	Regular visitor to wetlands. No evidence of breeding or roosting in the area.	Low

Species	Conservation significance	Probable status on site	Probable impact of proposal
Nankeen Night Heron <i>Nycticorax caledonicus</i>	CS3. Declined in Perth area	Regular visitor to wetlands	Low
Little Bittern <i>Ixobrychus minutus</i>	CS2. Priority 4 (DEC)	Regular visitor to wetlands	Low
Black Bittern <i>Ixobrychus flavicollis</i>	CS2. Priority 2 (DEC)	Regular visitor to wetlands	Low
Australasian Bittern <i>Botaurus poiciloptilus</i>	CS1. Schedule 1 (Vulnerable) (WA Wildlife Act)	Infrequent visitor to wetlands.	Low
Glossy Ibis <i>Plegadis falcinellus</i>	CS1. Migratory (EPBC Act)	Infrequent visitor to wetlands. No evidence of breeding or roosting in the area.	Low
Osprey <i>Pandion haliaetus</i>	CS1. Migratory (EPBC Act)	Regular visitor to wetlands. No nests were found.	Low
Black-shouldered Kite <i>Elanus notatus</i>	CS3. Declined in Perth area	Regular visitor	Low. Possible loss of nest trees
Square-tailed Kite <i>Lophoictinia isura</i>	CS3. Declined in Perth area	Regular visitor	Low
Whistling Kite <i>Haliastur sphenurus</i>	CS3. Declined in Perth area	Regular visitor	Low. Possible loss of nest trees
White-bellied Sea-Eagle <i>Haliaeetus leucogaster</i>	CS1. Migratory (EPBC Act)	Regular visitor to wetlands. No nests were found.	Low
Brown Goshawk <i>Accipiter fasciatus</i>	CS3. Declined in Perth area	Regular visitor	Low. Possible loss of nest trees
Collared Sparrowhawk <i>Accipiter cirrhocephalus</i>	CS3. Declined in Perth area	Regular visitor	Low. Possible loss of nest trees
Wedge-tailed Eagle <i>Aquila audax</i>	CS3. Declined in Perth area	Regular visitor	Low
Little Eagle <i>Hieraaetus morphnoides</i>	CS3. Declined in Perth area	Regular visitor	Low
Peregrine Falcon	CS1. Schedule 4	Regular visitor. No	Low

Species	Conservation significance	Probable status on site	Probable impact of proposal
<i>Falco peregrinus</i>	(Other Specially Protected Fauna) (WA Wildlife Act)	nests were found. Such an aerial and wide-ranging spp that the development is very unlikely to affect it	
Brown Falcon <i>Falco berigora</i>	CS3. Declined in Perth area	Regular visitor	Low
Painted Button-quail <i>Turnix varia</i>	CS3. Declined in Perth area	Regular visitor	Low
Eurasian Coot <i>Fulica atra</i>	CS3. Declined in Perth area	Infrequent visitor to wetlands	Low
Scolopacidae (11 species of sandpipers)	CS1. Migratory (EPBC Act)	Some species regular visitors to wetlands	Low
Red-kneed Dotterel <i>Erythronyx cinctus</i>	CS3. Declined in Perth area	Infrequent visitor to wetlands	Low
Common Bronzewing <i>Phaps chalcoptera</i>	CS3. Declined in Perth area	Regular visitor	Low
Forest Red-tailed Black-Cockatoo <i>Calyptorhynchus banksii</i>	CS1. Schedule 1 (Vulnerable) (WA Wildlife Act)	Regular non-breeding visitor.	Low
Carnaby's Black-Cockatoo <i>Calyptorhynchus latirostris</i>	CS1. Endangered (EPBC). Schedule 1 (Endangered) WA Wildlife Act	Regular non-breeding visitor. The species was not observed at Austin Cove during site inspections but is likely to be a regular visitor in small numbers.	Low.
Regent Parrot <i>Polytelis anthopeplus</i>	CS3. Declined in Perth area	Regular non-breeding visitor.	Low
Barking Owl <i>Ninox connivens</i>	CS2. Priority 2 (DEC)	Infrequent visitor	Low
Masked Owl <i>Tyto novaehollandiae</i>	CS2. Priority 3 (DEC)	Infrequent visitor	Low
Australian Owlet-nightjar <i>Aegotheles cristatus</i>	CS3. Declined in Perth area	Infrequent visitor	Low
Fork-tailed Swift <i>Apus pacificus</i>	CS1. Migratory (EPBC Act)	Infrequent visitor and totally aerial species.	Low
Rainbow Bee-eater <i>Merops ornatus</i>	CS1. Migratory (EPBC Act)	Seasonal breeding visitor. No Rainbow	Low

Species	Conservation significance	Probable status on site	Probable impact of proposal
		Bee-eaters were observed and a single old nest, probably abandoned several weeks earlier, was found. Very unlikely the site supports any sort of nesting aggregation.	
Splendid Fairy-wren, Southern Emu-wren, White-browed Scrub-wren, Weebill, Inland Thornbill, Western Thornbill, Yellow-rumped Thornbill, Western Yellow Robin, Grey Shrike-thrush	CS3. Declined in Perth area	Most likely to be resident in native vegetation	Low
Yellow-throated Miner, White-naped Honeyeater, New Holland Honeyeater, Scarlet Robin, Varied Sittella, Golden Whistler, Restless Flycatcher, Dusky Woodswallow, Black-faced Woodswallow, Grey Currawong	CS3. Declined in Perth area	Regular visitors in native vegetation	Low
<i>Echidna Tachyglossus aculeatus</i>	CS3. Declined in Perth area	Resident in native vegetation	Low
Chuditch <i>Dasyurus geoffroii</i>	CS1. Vulnerable (EPBC and Schedule 1 (Vulnerable) (WA Wildlife Act)	Effectively extinct in the region of Austin Cove but vagrants may occur in the area. Only suitable habitat for the species is within the conservation area	Low
Quenda, Southern Brown Bandicoot <i>Isodon obesulus</i>	CS2. Priority 5 (DEC)	Present (recorded) in native vegetation	Low
Honey Possum <i>Tarsipes rostratus</i>	CS3. Declined in region	Infrequent visitor (recorded nearby)	Low
Brush-tailed Possum <i>Trichosurus vulpecula</i>	CS3. Declined in region	Present in native vegetation	Low
Western Pygmy Possum <i>Cercartetus concinnus</i>	CS3. Declined in region	Unlikely	Low
Brush or Black-gloved	CS2. Priority 5	Infrequent visitor	Low

Species	Conservation significance	Probable status on site	Probable impact of proposal
Wallaby <i>Macropus irma</i>	(DEC)		
Western False Pipistrelle <i>Falsistrellus mackenziei</i>	CS2. Priority 4 (DEC)	Present in native vegetation and farmland	Low. Loss of paddock trees
Rakali or water rat <i>Hydromys chrysogaster</i>	CS2. Priority 4 (DEC)	Present in wetlands	Low

Table 5. The potential impacts to fauna of the proposed Austin Cove development as assessed following the guidance of the EPA's Guidance Statement No. 56 (Terrestrial fauna surveys for environmental impact assessment in Western Australia, EPA 2004).

Factor	Impact and explanation
Degree of habitat degradation or clearing within the local area or region.	Low (Project area is in region where clearing is >50%, but actual development area has little effect on remnant vegetation).
Size/scale of proposal/impact.	Moderate (1-10ha of remnant native vegetation may be disturbed - Bioregion Group 1).
Rarity of vegetation and landforms.	Low (impacted vegetation and landforms are widespread).
Refugia.	Low (impacts are not upon refuge habitats).
Fauna protected under international agreements or treaties, Specially Protected or Priority Fauna.	Low (significant fauna largely outside areas to be impacted).
Other significant fauna or fauna assemblages.	Low (significant fauna largely outside areas to be impacted).
Size of remnant and condition/intactness of habitat and faunal assemblage.	Low (little impact on remnant vegetation).
Ecological linkage.	Low to moderate (there may be some linkage values for fauna from the existing paddock trees that are in areas to be developed; but impact may be offset by plantings in POS).
Heterogeneity or complexity of the habitat and faunal assemblage.	Low (impact area lacks habitat heterogeneity).

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

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

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

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

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

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

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

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

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

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

Least Concern. Taxa that are not Threatened.

Schedules used in the WA Wildlife Conservation Act.

Schedule 1. Rare and Likely to become Extinct.

Schedule 2. Extinct.

Schedule 3. Migratory species listed under international treaties.

Schedule 4. Other Specially Protected Fauna.

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

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

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

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

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

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

APPENDIX 3

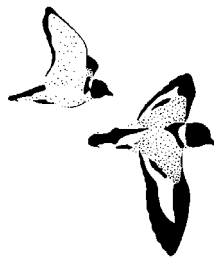
**Waterbird Monitoring in Austin Bay,
Peel Inlet, for the Proposed
Austin Cove Development, Yunderup
(Bamford Consulting Ecologists, 2007)**

Waterbird Monitoring in Austin Bay, Peel Inlet, for the proposed Austin Cove Development, Yunderup

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31st October 2007

EXECUTIVE SUMMARY

As part of environmental impact assessment for the proposed Austin Cove residential development near Yunderup, a waterbird study was undertaken in the nearby Austin Bay in the south-east of Peel Inlet from September 2006 to April 2007. The intention of this study was to examine the distribution and abundance of waterbirds in Austin Bay and to determine if there are likely to be any impacts from the proposed residential development.

Austin Bay is part of the Peel-Yalgorup Ramsar site, listed largely because of its significance for waterbirds, and the bay regularly supports a large proportion of the waterbirds present on the overall site. During the 2006/2007 study, the highest single count was 13 570 waterbirds, and the pooled maximum counts of all species provided a pooled maximum count of 18 696. Comparison with data previously collected in Austin Bay in 1981-1985, 1996/1997 and 1998/1999 indicated that while some birds do appear to have declined in abundance, probably due to the influence of the Dawesville Channel but also to factors such as declining rainfall and therefore declining freshwater wetlands in the region, the bay remains very important for waterbirds.

The distribution of waterbirds in Austin Bay in 2006/2007 revealed that foraging was widespread and that small migratory shorebirds tended to forage most in the north of the bay, while herons, ducks and the longer-legged shorebirds tended to forage more in the south. Roosting was more restricted in distribution, with a number of small offshore sandbars being used. Again, migratory shorebirds tended to roost in the north of the bay, and other waterbirds in the south.

Although the proposed Austin Cove development is unlikely to directly affect Austin Bay and its waterbirds, increased levels of human activity in the cove can be expected. This has the potential to disturb waterbirds and disturbance is recognised as a conservation issue for waterbirds close to urban areas. It is therefore recommended that levels of human usage be monitored and that management be put into place to ensure that disturbance doesn't become a conservation problem for waterbirds in Austin Bay.

INTRODUCTION

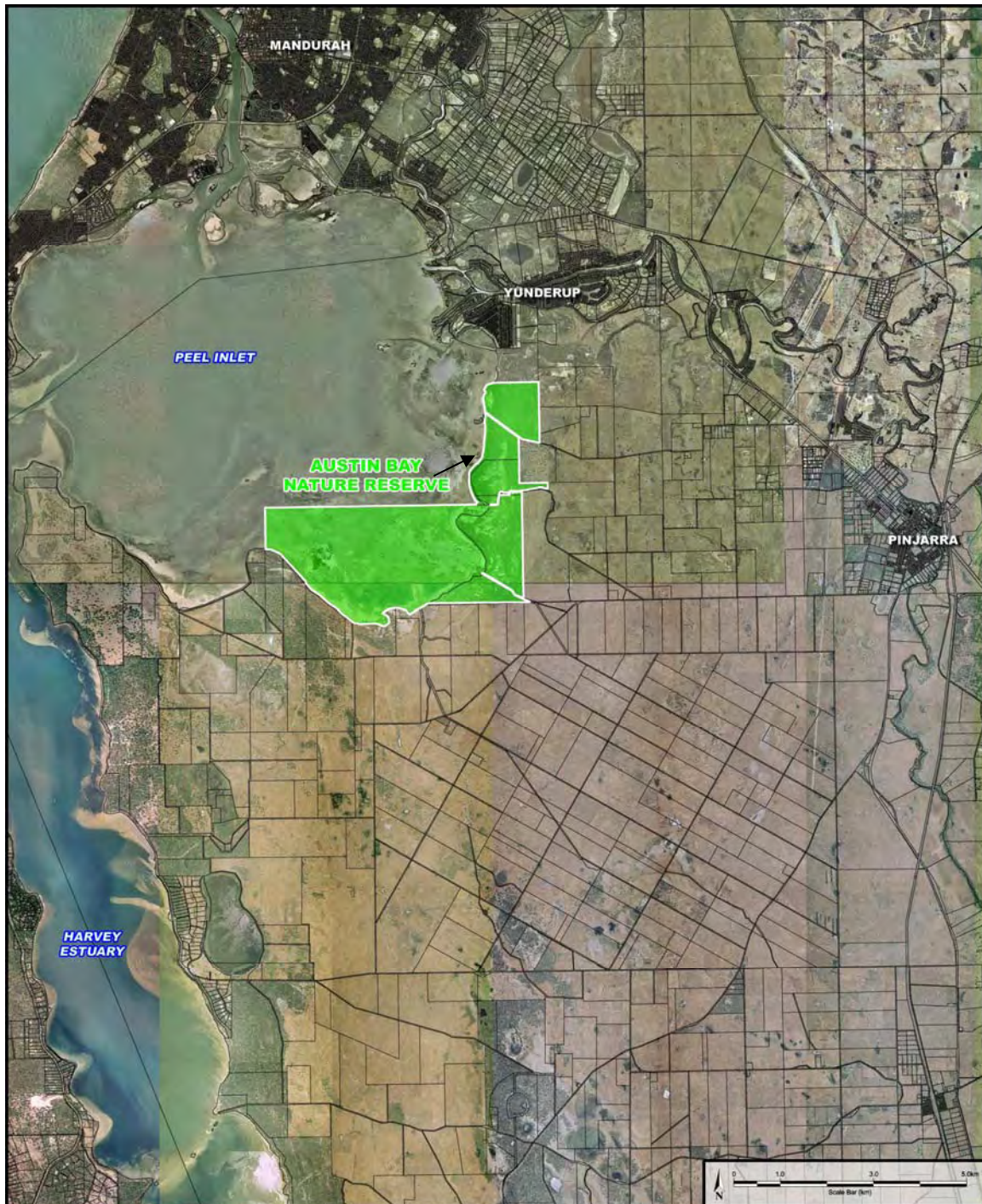
The Austin Cove residential development is proposed for a site that consists mainly of farmland south of the Murray River, near Yunderup, and a fauna assessment has been completed on terrestrial and aquatic ecosystems within the development area (Bamford 2006). In addition, however, a waterbird monitoring programme was undertaken in the adjacent Austin Bay of Peel Inlet, with the intention being to provide baseline data on waterbird distribution and abundance in an area that could potentially be subject to secondary impacts from the development, such as an increase in recreational use of the foreshore. The identification of locations significant for waterbirds, such as feeding and roosting sites, is important so that impacts on these can be managed. This report presents the results of the waterbird monitoring programme carried out from September 2006 to April 2007, and also draws upon some other sources of data for comparative purposes.

Austin Bay is part of the Peel-Yalgorup Ramsar site that is listed as a wetland of international significance in large part because of its use by waterbirds. In studies conducted in the late 1990s, Austin Bay consistently supported over half the waterbirds present within the Peel-Yalgorup region (Lane *et al.* 2002a and 2002b). The southern portion of Austin Bay is a nature reserve (Austin Bay Nature Reserve) that was been placed on the Register of the National Estate in the mid 1980s because of its value for conservation. In addition to its significance as part of a Ramsar site, Austin Bay supports some waterbirds of conservation significance, primarily species listed as migratory under international conservation treaties and therefore under the *WA Wildlife Conservation Act (1950)* and the federal *Environment Protection and Biodiversity Conservation Act (1999)*. The EPBC Act is important with respect to the proposed development by Satterley, as it provides a mechanism for the assessment and approval of projects that may have an impact upon matters of National Environmental Significance, such as listed migratory species.

STUDY AREA AND PROJECT DESIGN

Austin Bay occupies the eastern side of Peel Inlet from near the mouth of the Murray River in the north to Point Birch in the south. Austin Bay Nature Reserve occupies the southern half of the bay but includes land and fringing wetlands above high tide in much of the north of the bay (Figure 1). These fringing wetlands are seasonal and extensive, and support a mixed shrubland that includes *Callitris*, *Allocasuarina* and *Melaleuca* species. The bay is very shallow and tidal, with extensive mudflats exposed at low tides, and contains a number of small islands. Although the shoreline of the bay is undisturbed and the waters too shallow to allow entry by boats, the bay is visited by large numbers of people searching for crabs in summer. There is anecdotal evidence that Austin Bay was negatively impacted by the construction of the Dawesville Channel in the early 1990s. Impacts have mainly been due to increased tidal amplitude and frequency, resulting in the loss of some small islands and reduced periods of either high or low water.

Figure One. Location of Austin Bay (between arrows and including the Austin Bay Nature Reserve).



A number of detailed studies of the waterbird assemblage at Austin Bay have been undertaken in the past, primarily by the state nature conservation agency, now the Department of the Environment and Conservation (DEC). The methodology and count techniques followed in these previous projects, the first of which was in 1977, have been followed in this project. By following the previous count methodologies and importantly by using the count boundaries set out in the earlier counts, data from the different surveys can be compared. Previous counts of the Peel Harvey wetland system have divided the entire site into six count sectors of which Austin Bay forms the majority of sector six. Therefore, data collected in sector six during these earlier surveys are used in this report as a base for comparison and contrast with the new dataset. The main sources of previous count data were:

Jaensch *et al.* (1988): 1981-1985

Lane *et al.* (2002a): 1996/1997

Lane *et al.* (2002b): 1998/1999

Monthly surveys were undertaken from September 2006 to April 2007, although the September survey was incomplete due to inclement weather. Dates of surveys were: 7th September, 9th November (October survey), 26th November (November survey), 20th December, 24th January, 4th February, 28th March and 20th April. Figure 2 details the precise routes taken to carry out the surveys, with two surveyors used on most visits to ensure that the entire reserve was visited in as short a period of time as possible to minimize the risk of birds being counted twice. During surveys, waterbirds were counted individually when possible. This was achievable with the majority of birds and flocks of birds encountered. However, with the flocks of migratory shorebirds that on occasion numbered over 1,000 individuals, the commonly used count technique, counting in tens then hundreds, was employed. Details relating to bird behaviour were also recorded, including observations of feeding and loafing/roosting areas. All observations were transposed onto site maps and observations deemed important were logged using a GPS unit. Latitude and longitude and Northing and Easting variables were recorded. Supplementary information, particularly on the locations of roosting sites, was sourced from studies being conducted over the same time period as part of the avian influenza monitoring programme, which involves catching and banding migratory shorebirds in the Austin Bay area.

Figure Two. Routes followed during surveys of Austin Bay, September 2006 to April 2007.



RESULTS AND DISCUSSION

Waterbirds on Austin Bay

The results of monthly counts are presented in Table 1. The numbers of most species peaked in summer with a maximum total count, in January 2007, of 13,570 birds. This is approximately 70% of the 20,000 threshold set out in criterion 5 of the Ramsar Convention. Furthermore, Criterion 6 of the Ramsar Convention is met as both the December and January counts of the Red-necked Stint exceed 1% of the species' population.

The distribution of waterbirds in Austin Bay is illustrated in Figures 3 and 4. Foraging (Figure 3) was widespread across the shallows and tidal mudflats of the bay but there were differences in the distribution of species. The smaller shorebirds such as the Red-necked Stint and Sharp-tailed Sandpiper foraged mainly in the two northern feeding areas, where mudflats are extensive. Jaensch *et al.* (1988) also noted this concentration of small wader foraging in the north of Austin Bay. Larger shorebirds such as the Common Greenshank, stilts, herons and egrets foraged mainly in the two southern areas. Duck, swans and cormorants were generally roosting in the bay (see below) and foraging in deeper water offshore.

Roosting areas (Figure 4) were smaller than foraging areas with clusters of roosting sites in the north and south of the bay. Those in the north were used largely by the small shorebirds that foraged in that area, whereas the roosting areas in the south were used mainly by herons, egret, ducks and swans.

Maximum counts of each shorebird species made in the 2006/2007 study are compared with maximum counts from previous studies in Table 2. Some caution needs to be applied when making these comparisons as the sampling effort in the years from 1981/1982 to 1985/1986, and in 1996/97 and 1998/99, were almost certainly not the same as in 2006/2007, but they do give an indication of how high maximum numbers can get. The 1981/1982 to 1985/1986 data were also collected before the construction of the Dawesville Channel, which may have affected numbers of waterbirds.

The abundance of waterbirds at a single site varies in response to a number of factors. The maximum count obtained for one species at Austin Bay is likely to be affected by: progressive long term changes, such as declining rainfall and therefore changing nearby freshwater wetlands; episodic changes such as cyclonic rains elsewhere in the state, which attract waterbirds out of the South-West region in general (Ford 1958), and years when the Leeuwin current is either strong (persistent high tides) or weak (regular low tides); changing adjacent land uses and levels of disturbance; and changing management such as the construction of the Dawesville Channel. In addition, the mobility of birds and the reliance upon count data collected over a few days across a year means that there will be variation simply because a flock of birds was or was not present on a particular day.

Given all these sources of variation and the small dataset (eight maximum annual counts across a period of 25 years), it is not surprising that the abundance of waterbirds at Austin Bay has been variable, with few trends apparent. Three species, the Little Pied Cormorant, Curlew Sandpiper and Banded Stilt, may have declined as a result of effects of the Dawesville Channel, although the migratory Curlew Sandpiper is thought to have suffered an overall population decline, possibly due to deterioration of sites utilized by the species on migration through east Asia (Minton *et al.* 2003). In contrast, the White-faced Heron and Little Egret may have increased in abundance at Austin Bay. In the case of the Little Egret, this is part of a regional population increase of a species that was previously a vagrant in the South-West (Serventy and Whittell 1976). The White-faced Heron may be responding to changing conditions due to the Dawesville Channel or to other regional changes.

Counts of most species in 2006/2007 were within the ranges of previous maxima, but the number of species recorded was equal lowest and the sum of maxima was the lowest, although close to that of 1981/1982. These figures suggest that 2006/2007 was generally a poor year for birds in Austin Bay, probably because of inland rains in summer 2005/2006 (alternative wetlands outside the region) and poor local rains (therefore lack of alternative wetlands within the region that might increase the regional abundance of waterbirds).

Waterbirds on Austin Bay in Relation to the Proposed Austin Cove Development

The significance of these maximum count data is that they indicate that Austin Bay is consistently and remains very important for waterbirds. Data presented by Lane *et al.* (2002 a & b) for simultaneous counts of the entire Peel-Harvey Estuary indicate that Austin Bay regularly supports over half the waterbirds present in the entire system.

While the Austin Cove development is not likely to directly affect Austin Bay, it is probable that the development will lead to an increase in recreational usage of the nearby estuary. This is a concern, as disturbance is a major issue for waterbird conservation (eg. Davidson and Rothwell 1993). In a study on the Swan River Estuary, Bamford *et al.* (2003) found that disturbance due to pedestrians walking along the shoreline was of greatest concern, with uncontrolled dogs also an issue. In Austin Bay, usage of the shoreline by pedestrians and dogs is likely to increase, while there may also be an increase in the numbers of people walking across the shallows searching for crabs. Pedestrians, dogs and crabbers are significant in disturbing waterbirds at the nearby Coodanup area, on the north side of the Peel Inlet.

Major foraging and roosting areas for waterbirds, particularly the small migratory shorebirds, lie in the north of Austin Bay and therefore closest to potential increases in levels of disturbance. It is therefore recommended that levels of human activity and disturbance of waterbirds in Austin Bay be monitored, and furthermore that infrastructure be established in anticipation of managing increased levels of human usage. This could include signage concerning birds, disturbance and dogs, pathways and low fencing to

guide pedestrians, and any local bylaw changes required to ensure that vehicle access to the shoreline and dogs not on leads are prohibited.

Table One. Monthly counts on Austin Bay (September 2006 to April 2007).

Species	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Black Swan	400	95	12	3	14	17	45	188
Australian Shelduck		526	390	1961	1127	1449	11	32
Pacific Black Duck	200	98	288	15	39	40	179	2
Grey Teal		11	355	701	29	2002	283	0
Australasian Shoveler		6	0	0	0	0	0	0
Darter		0	0	0	1	0	0	0
Little Black Cormorant	400	0	0	3	21	0	0	5
Little Pied Cormorant		0	0	0	2	0	0	1
Australian Pelican	450	115	6	2	101	5	4	25
White-faced Heron	36	10	258	300	466	174	86	3
Little Egret	20	0	8	4	10	3	28	80
Great Egret		31	26	1	19	7	2	3
Yellow-billed Spoonbill	12	0	8	2	7	0	4	64
White-bellied Sea-Eagle		1	1	1	0	0	0	1
Swamp Harrier		0	0	1	1	0	0	0
Common Greenshank		20	55	170	305	137	14	5
Red Knot		0	0	5	0	0	35	0
Great Knot		0	0	0	0	0	0	32
Red-necked Stint	3	196	1135	4028	3937	2726	1063	2058
Sharp-tailed Sandpiper		0	46	1401	1515	136	55	0
Curlew Sandpiper		0	0	7	11	0	0	0
Black-winged Stilt		1	481	838	1670	720	1149	85
Banded Stilt		0	0	140	396	43	0	0
Red-necked Avocet		0	122	0	2	0	0	0
Grey Plover		0	0	1	0	4	10	10
Red-capped Plover		83	262	628	533	691	26	46
Silver Gull		482	985	2251	3304	281	982	35
Caspian Tern		1	0	0	0	2	0	10
Whiskered Tern		45	2	280	59	8	13	6
White-winged Black Tern		0	0	4	2	1	1	1
Crested Tern		0	0	1	7	2	0	5
Fairy Tern		1	13	13	7	123	0	0
No. of species	8	18	20	26	26	21	19	22
Grand Total	1521	1740	3466	12779	13585	8567	3976	2657

Figure Three. The principle feeding areas of migratory shorebirds and resident waterbirds at Austin Bay. (feeding areas outlined in orange stipple). Note that the two northern areas are the principle feeding areas for migratory shorebirds and the lower two are used by longer legged shorebirds and waterbirds such as stilts, herons and egrets.

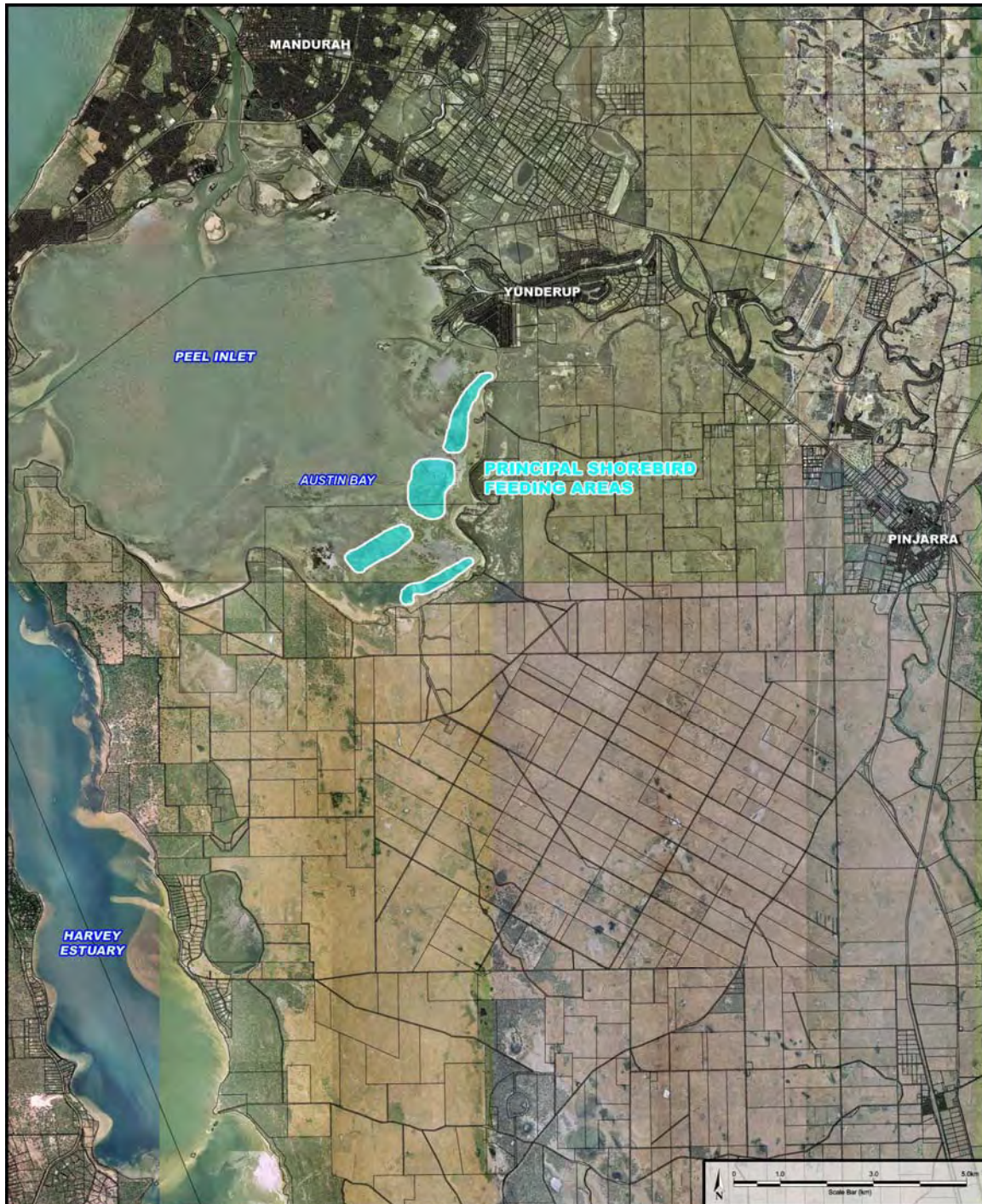


Figure Four. The roost sites located during the combined 2007 survey of Austin Bay. The two roost sites marked R1 and R2 held internationally important numbers of Red-necked Stint and nationally important numbers of Sharp-tailed Sandpiper. R1 is used as a roosting site for an additional eleven species (10 shorebirds and the White-bellied Sea-Eagle) subject to the EPBC Act, and two species of waterbird outlined in the China-Australia (CAMBA) Migratory Bird Agreement.



Table Two. Maximum count of each waterbird species in Austin Bay in 1981/1992 to 1985/1986 (unpubl. Database held by Birds Australia and Jaensch *et al.* 1988), 1996/1997 (Lane *et al.* 2002a), 1998/1999 (Lane *et al.* 2002a) and 2006/2007 (current survey). Species listed as migratory (mig) under the EPBC Act are indicated (m).

Species	81 82	82 83	83 84	84 85	85 86	96 97	98 99	06 07	Mig species
Black Swan	500	1492	1821	2402	800	1036	1125	400	
Australian Shelduck	3500	4387	2353	5664	1567	3733	3500	1961	
Pacific Black Duck	3000	336	2604	780	124	558	450	288	
Grey Teal	800	8230	2703	6918	6609	9585	4165	2002	
Chestnut Teal	2	2	1	2	-	-	-	-	
Australasian Shoveler	1500	277	561	65	-	501	100	6	
Musk Duck	-	150	55	34	-	1	-	-	
Blue-billed Duck	-	-	1200	5	-	-	-	-	
Hardhead	-	11	6	-	-	9	-	-	
Australian Wood Duck	-	1	302	4	-	-	-	-	
Pink-eared Duck	200	121	78	6	9	1	-	-	
Great Crested Grebe	-	-	-	-	-	3	-	-	
Australasian Grebe	-	-	3	-	-	-	-	-	
Hoary-headed Grebe	-	647	967	601	12	220	-	-	
Darter	15	7	17	15	7	16	8	1	
Little Black Cormorant	17	198	469	139	30	905	2011	400	
Little Pied Cormorant	17	716	369	475	40	537	10	2	
Pied Cormorant	516	8	1	2	5	-	-	-	
Great Cormorant	1	77	81	122	3	20	-	-	
Australian Pelican	60	455	471	192	151	172	361	450	
White-faced Heron	30	131	99	147	31	48	64	466	
Little Egret	1	4	4	8	1	38	40	80	
Nankeen Night Heron	-	-	-	1	-	-	-	-	
White-necked Heron	-	-	-	1	1	-	-	-	
Great Egret	30	24	161	87	-	27	33	31	m
Cattle Egret	-	-	-	1	-	-	-	-	
Straw-necked Ibis	-	-	275	25	-	-	-	-	
Australian White Ibis	8	4	30	15	-	1	-	-	
Glossy Ibis	1	-	3	-	-	-	-	-	m
Royal Spoonbill	2	1	8	-	-	-	-	-	
Yellow-billed Spoonbill	5	45	55	29	1	2	-	64	
Osprey	1	2	1	-	-	-	-	-	m
White-bellied Sea-Eagle	-	-	2	1	-	-	-	1	m
Swamp Harrier	2	1	2	2	-	1	1	1	
Purple Swamphen	-	-	1	-	-	-	-	-	
Eurasian Coot	-	18	2	2	-	-	-	-	
Species						96 97	98 99	06 07	Mig species

Table 2 (cont.)

Species	81 82	82 83	83 84	84 85	85 86	96 97	98 99	06 07	Mig species
Eastern Curlew	-	-	-	2	-	3	-	-	m
Whimbrel	-	2	-	1	-	-	-	-	m
Bar-tailed Godwit	-	-	-	7	629	2	-	-	m
Marsh Sandpiper	-	1	-	1	-	-	-	-	m
Common Greenshank	40	112	213	55	17	48	120	305	m
Terek Sandpiper						1	-	-	
Common Sandpiper	-	7	1	1	-	4	-	-	m
Grey-tailed Tattler	5	1	-	-	4	-	-	-	m
Red Knot	-	542	265	2	25	-	1	35	m
Great Knot	3	98	2	-	-	2	-	32	m
Ruddy Turnstone	-	-	9	-	-	2	-	-	m
Red-necked Stint	4000	5897	5107	8063	5777	6058	4881	4028	m
Long-toed Stint	8	1	1	2	2	-	-	-	m
Pectoral Sandpiper	3	2	1	-	-	-	-	-	m
Sharp-tailed Sandpiper	800	2119	224	450	739	126	192	1515	m
Curlew Sandpiper	150	2804	895	141	529	64	175	11	m
Ruff	1	-	-	-	-	-	-	-	m
Pied Oystercatcher	-	-	-	-	-	4	-	-	
Black-winged Stilt	125	2703	1071	1550	1142	1685	949	1670	
Banded Stilt	4000	6394	2340	3000	2596	6948	58	396	
Red-necked Avocet	60	606	183	115	544	450	329	122	
Grey Plover	1	16	15	9	5	7	1	10	m
Red-capped Plover	500	1158	761	924	630	566	1500	691	
Greater Sand Plover	4	1	-	6	-	5	-	-	m
Black-fronted Dotterel	-	2	2	5	-	-	-	-	
Hooded Plover	1	-	-	-	-	-	-	-	
Silver Gull	100	2864	3330	3213	1536	2367	1145	3304	
Gull-billed Tern	-	-	7	1	1	-	-	-	
Caspian Tern	13	4	28	4	14	22	16	10	m
Whiskered Tern	40	280	827	574	70	736	305	280	
White-winged Black Tern	1	5	1	5	-	-	-	4	m
Crested Tern	-	2	4	31	7	31	52	7	m
Fairy Tern	-	-	5	7	14	110	36	123	
No. of species	42	50	55	54	35	43	32	32	
Grand Total	20063	42966	29997	35914	23672	36698	21636	18696	

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Appendices

Appendix One. Waterbird species and numbers counted in the Austin Bay N.R. survey conducted in the austral summer of 2006/07.

Species	Month						
	Oct	Nov	Dec	Jan	Feb	Mar	Apr
L.B.Cormorant	0	0	3	21	0	0	5
L.P.Cormorant	0	0	0	2	0	0	1
W.f.Heron	10	258	300	466	174	86	3
Great Egret	31	26	1	19	7	2	3
Little Egret	0	8	4	10	3	28	80
Y.b. Spoonbill	0	8	2	7	0	4	64
Aus Pelican	115	6	2	101	5	4	25
Aus Shelduck	526	390	1961	1127	1449	11	32
Black swan	95	12	3	14	17	45	188
Grey Teal	11	355	701	29	2002	283	0
P.B.Duck	98	288	15	39	40	179	2
Aus Shoveler	6	0	0	0	0	0	0
W.b.Sea-Eagle	1	1	1	0	0	0	1
Whiskered Tern	45	2	280	59	8	13	6
Fairy Tern	1	13	13	7	123	0	0
Caspian Tern	1	0	0	0	2	0	10
Crested Tern	0	0	1	7	2	0	5
Silver Gull	482	985	2251	3304	281	982	35
Red.n. Avocet	0	122	0	2	0	0	0
B.w.Stilt	1	481	838	1670	720	1149	85
Banded Stilt	0	0	140	396	43	0	0
Greenshank	20	55	170	305	137	14	5
Sharp.t.Sandpiper	0	46	1401	1515	136	55	0
Curlew Sandpiper	0	0	7	11	0	0	0
Red Knot	0	0	5	0	0	35	0
Great Knot	0	0	0	0	0	32	0
Red-necked Stint	196	1135	4028	3937	2726	1063	2058
Grey Plover	0	0	1	0	4	10	10
Red-capped Plover	83	262	628	522	691	26	46
Totals	1722	4453	12756	13570	8570	4021	2664