Attachment 9

Wetland Management Plan (BES, 2020)

LOTS 2, 3 AND 4 MINNINUP ROAD, DALYELLUP

WETLAND MANAGEMENT PLAN

Prepared for

[redacted]

Draft Report No. J07013f
13 February 2020

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EXECUTIVE SUMMARY

Introduction

Mr Colin Piacentini has received WAPC subdivision approval for Lots 2, 3 and 4 Minninup Road, Dalyellup (the subject land). The subject land is bordered to the west by a large seasonal wetland, which occupies Lot 6 Minninup Road. The wetland is mapped by the Department of Biodiversity, Parks & Attractions (DBCA) as a Resource Enhancement Category Basin Sumpland and has a Unique Feature Identifier (UFI) of 15821.

UFI 15821 has a total area of 38.8 hectares and is owned freehold by the WAPC. It is reserved for Parks & Recreation under the Greater Bunbury Region Scheme (GBRS) and is expected to be vested in the Department of Biodiversity, Conservation and Attractions (DBCA) to be managed for conservation in accordance with a management agreement under the *Conservation and Land Management Act 1984*.

Environmental Setting

UFI 15821 is part of a long, narrow sumpland complex that extends 10km south from Dalyellup and forms part of a group of wetlands known as the Quindalup/Spearwood Interface Sumplands and Lakes. UFI 15821 extends from the northern end of Lot 3 to the southern boundary of Lot 317.

The wetland exists in an environment of declining rainfall and falling groundwater tables. The wetland is maintained primarily by groundwater throughflow, with the extent of inundation varying greatly between years depending on groundwater levels. With the long-term trend towards a drier climate in the south-west, the hydrology of the wetland is likely to become progressively drier.

The western parts of the wetland support small stands of native vegetation including paperbark thickets and native sedgelands. The middle part of the wetland contains extensive beds of Asian Bulrush, while the eastern part is mostly cleared and covered with pasture grasses, although some regrowth of native species is occurring.

The seasonally inundated parts of the wetland provide habitat for water birds and probably aquatic species (such as koonacs) that can tolerate seasonal drying. The eastern parts, which are rarely inundated, provide grazing habitat for kangaroos.

The wetland forms a degraded part of an ecological linkage between the vegetated dunes to the west and bushland areas to the east. Restoration and enhancement of this ecological linkage through the wetland is a key priority of this Wetland Management Plan.

Potential Impacts and Threats

Development of the subject land will bring an estimated human population of about 2,870 people into the area immediately east of the wetland. This will create threats to the wetland including:

- erosion and sedimentation from earthworks;
- changes in water quantity and quality from clearing, groundwater abstraction, garden fertilisers and urban drainage;
- direct disturbance of wetland habitats and wildlife from human traffic and domestic pets;
- fire risk due to accidental or deliberate fire lighting;
- antisocial behaviour including illegal vehicular access, littering and vandalism.

Wetland Management

Vision and Objectives

The overall vision of this Wetland Management Plan is to bring about a significant improvement in the ecological state of the wetland through rehabilitation, weed control and habitat creation, while creating a significant and valued landscape amenity for the local community.

The specific objectives are to:

- retain and restore native vegetation;
- remove and control weeds;
- create and enhance habitat for native fauna including western ringtail possums, black cockatoos, quokkas, kangaroos and water birds;
- maintain the wetland's hydrological regime;
- maintain water quality in the wetland;
- create an attractive landscape backdrop for the development area;
- facilitate passive public enjoyment of the wetland;
- minimise nuisance and health risks from mosquitoes and other insects; and
- minimise the risk of fire to the wetland, and from the wetland to nearby residences.

Management Strategies

Specific strategies to achieve the above objectives will include the following:

- Disturbance of acid sulphate soils and ASS-affected groundwater during construction will be avoided. Any groundwater abstracted for dewatering within 500m of the wetland during construction will be monitored and lime-dosed if necessary before discharge.

- Areas of disturbed ground near the wetland will be protected from erosion and planted as soon as practicable after disturbance.

- Degraded areas in the eastern part of the wetland and buffer totalling approximately 16.6ha will be revegetated with native wetland species. This will be part of a larger 40ha planting programme to create a continuous ecological linkage across the site from west to east and south to north.

- All runoff from the development area will be captured and infiltrated or detained in bioretention swales before being allowed to enter the wetland.

- Public Open Space areas in the development will be planted with species having low water and nutrient requirements. The soil beneath POS areas and swales will be amended if necessary to achieve a phosphorus retention index (PRI) of at least 15.

- Fire risk in the wetland will be mitigated by the high level of surveillance afforded by residences fronting Maidment Parade and street lighting along the road reserve. Fire hazard will also be managed by careful design of plantings in the wetland buffer.

- Fire hydrants and emergency vehicle access will be provided along Maidment Parade.

- Public access to the wetland and buffer will be discouraged by a 1.2m high fence along the edge of the Maidment Parade road reserve. This fence will also create a barrier to the entry of dogs to the wetland.

- A shared path along Maidment Parade will provide public viewing of the wetland while discouraging direct access to the wetland.

Implementation and Monitoring

Rehabilitation of the wetland will begin before the first stage of subdivision works with the commencement of ground preparation and planting trials. The bulk of the rehabilitation and capital works including fencing and path construction will be completed in conjunction with the subdivision works. These works will be undertaken and funded by the developer.

The developer will monitor the implementation and results of the Wetland Management Plan for up to five years from the completion of the works. The monitoring will include:

- visual monitoring of the wetland, buffer and adjacent areas for signs of erosion or sedimentation throughout the construction program;

- monitoring of any groundwater abstracted from within 500m of the wetland for pH and other acid sulphate soil parameters;

- monitoring of water levels and water quality in the wetland, upgradient bores and overflows from the stormwater system for two years after the completion of subdivision works;

- monitoring of regrowth in the rehabilitated parts of the wetland and the buffer for five years after completion;

- visual monitoring of nuisance insect (mosquito and midge) numbers at the interface between the development area and the wetland for five years after the completion of subdivision works, as well as maintenance of a register of any public complaints over insect nuisance;

- visual monitoring of vegetation height, density and fuel loads in the wetland buffer for five years after the completion of planting works; and

- visual monitoring of public use of the wetland and surrounding paths, including litter, traffic into the wetland, condition of the fences and paths.

Success Criteria

Success of the management measures outlined in this Plan will be judged on the basis of:

Geomorphology

- No direct runoff into the wetland during or after construction.
- No erosion or sediment transport into the wetland during construction.
- No disturbance of acid sulphate soils during construction.
- No release of untreated ASS-affected groundwater during construction.

Hydrology

- Achievement of the water quality targets set out in Table 5.1.

Vegetation and Flora, Fauna and Ecological Linkages

- 80% overall survival of planted vegetation after five years.
- Low level of public reports of dogs in the wetland.
- Low or moderate level of visible insect activity in public areas near the wetland.
- Low level of public complaints regarding insect nuisance.

Fire

- No or few fires in the wetland.
- Vegetation height and density in the buffer remains in the "shrubland" classification (shrubs below 2m height; trees >15m spacing).

Community Use and Amenity

- No significant damage to the wetland by foot traffic.
- No illegal vehicle (including motorcycle) traffic in the wetland.
- No significant occurrence of dogs or cats in the wetland.
- A low level of litter in the wetland and buffer.

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1.0 INTRODUCTION

Mr Colin Piacentini is the owner of Lots 2, 3 and 4 Minninup Road, Dalyellup (the subject land). The subject land is zoned Urban under the Greater Bunbury Region Scheme (GBRS) and Urban Development under the Shire of Capel Town Planning Scheme (TPS) No. 7. In February 2018 the WAPC approved a subdivision application for Lots 2, 3 and 4 in accordance with the approved structure plan for the land. The WAPC approval is attached in Appendix A.

The subject land is bordered to the west by a large seasonal wetland, formerly owned by Mr Piacentini and now owned by the WAPC. Figure 1 shows the location and an aerial photograph of the wetland. Figure 2 shows photographs from various locations within and around the wetland.

The wetland occupies Lot 6 Minninup Road. The wetland is mapped by the Department of Biodiversity, Conservation & Attractions (DBCA) as a Basin Sumpland and has a Unique Feature Identifier (UFI) of 15821. The wetland was previously mapped as Conservation category but, following a review in 2011 (BES, 2011a), the DBCA (then DPAW) changed the management category to Resource Enhancement.

UFI 15821 has a total area of 38.8 hectares and is owned freehold by the WAPC. It is reserved for Parks & Recreation under the GBRS and is expected to be vested in the DBCA to be managed for conservation in accordance with a management agreement under the *Conservation and Land Management Act 1984*. This agreement is subject to agreement over funding between the WAPC and DBCA, and no timeline for its implementation is known.

UFI 15821 does not currently contain any structures or improvements other than fences that cross at the northern and southern boundaries and a causeway at the southern boundary. With the development of housing to the east, the wetland will receive treated stormwater overflows from the residential area (discussed further in Section 5.2).

Condition 3 of the WAPC subdivision approval states:

"3. A Wetland Rehabilitation and Management Plan is to be prepared and implemented to the satisfaction of the Western Australian Planning Commission. (Department of Biodiversity, Conservation and Attractions)"

This Wetland Management Plan has been prepared in consultation with the DBCA to satisfy Condition 3. The content of the plan is based generally on the DBCA publication *Guidelines checklist for preparing a wetland management plan* (DEC, 2008).

UFI 15821 was in private ownership for many years, being owned by Mr Piacentini from [redacted] until its acquisition by the WAPC in 2016. For most of that time, the wetland was used for broadacre grazing and as a result had limited social or historical significance.

Environmentally, the wetland is significant as a part of the Muddy Lakes wetland chain, known as the Quindalup/Spearwood Interface Sumplands and Lakes (Keighery *et al.*, 2002, cited in EPA, 2003a). This is discussed further in Section 2.2.

2.0 EXISTING NATURAL ENVIRONMENT

2.1 Rainfall

2.1.1 Seasonal Patterns

Dalyellup has a strongly seasonal rainfall, with most of the annual total falling between May and September in association with winter cold fronts. Occasional heavy falls may occur from summer thunderstorms. The average annual rainfall since 1995 for Bunbury (the closest Bureau of Meteorology weather station) is 732.1mm, of which 80% falls between the months of May and September.

Figure 3 shows a rainfall occurrence chart for Bunbury.

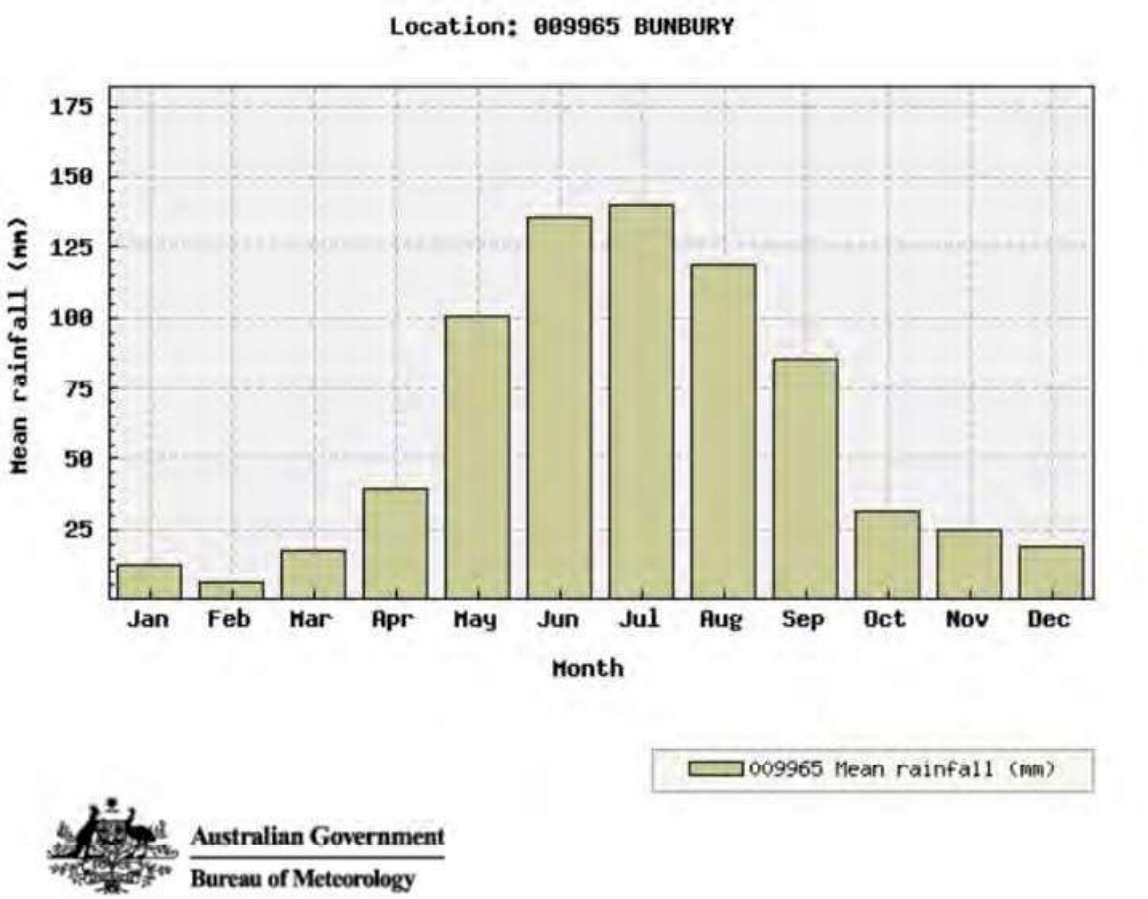

Figure 3 Bunbury Mean Rainfall

2.1.2 Historical Trends

The rainfall of the Bunbury region, like that of much of the south-west, has declined significantly since records began in 1942, with most of the decline occurring since 1974. From 1943 to 1974 the annual average rainfall at Dardanup (13km east of Dalyellup) was 987mm; since 1975 the average has been 847mm. Figure 4 shows a plot of annual rainfall at Dardanup since 1936.

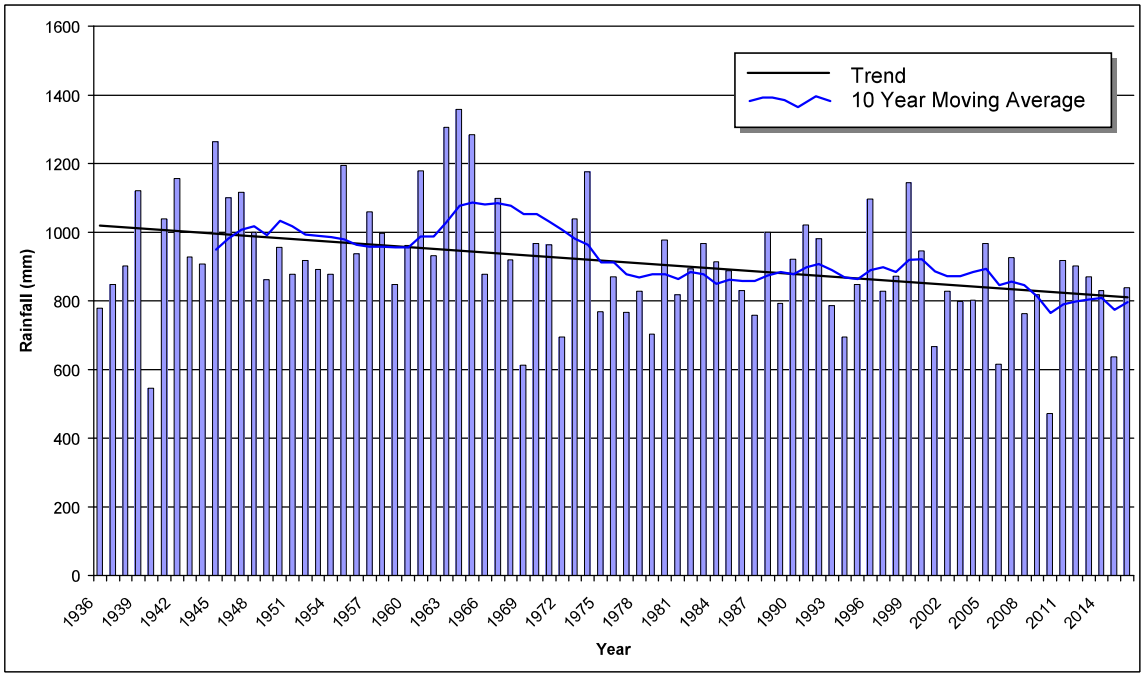

Figure 4 Dardanup Annual Rainfall 1936 - 2016

The reasons for the historical decline in rainfall in the south-west are complex and their implications for future rainfall are unclear. However, global climate modelling by the CSIRO, IPCC and others predicts that rainfall in the south-west is likely to continue to decrease due to a combination of natural and human-induced climate change (Aust. Govt, 2008). This suggests that the hydrology of UFI 15821 is likely to become progressively drier for the foreseeable future.

2.2 Regional Context

UFI 15821 is part of a long, narrow sumpland complex that extends continuously about 10km south from Dalyellup. Figure 5 shows an overall aerial view of the sumpland complex. The DEC has mapped different parts of this complex as separate wetlands on the basis of condition (management category) and tenure. The total area of the sumpland complex is approximately 258ha.

Parts of the overall sumpland complex are known variously as Muddy Lakes, Minninup Swamp and Dalyellup Lake. The complex forms part of a group of wetlands known as the Quindalup/Spearwood Interface Sumplands and Lakes (Keighery *et al.*, 2002, cited in EPA, 2003a).

UFI 15821 extends from the northern end of Lot 3 to the southern boundary of Lot 317. At that point, although the wetland physically continues further south, the DBCA has mapped a separation along the cadastral boundary, to reflect the presence of a hydrological divide (a causeway), with the wetland to the south being given a different UFI (1004) and management category (Conservation).

The Quindalup/Spearwood Interface Sumplands and Lakes complex, including UFI 15821, is mapped by Semeniuk (1988) as the Minninup Consanguineous Wetland Suite.

2.3 Physiography

The wetland chain of which UFI 15821 is a part occupies an interdunal swale between the Spearwood and Quindalup dune systems. To the east, the Spearwood system forms a large, gently sloping linear dune that extends for over 10km parallel to the coast. To the west, the Quindalup system forms a broad band of steep, irregular dunes that extends to the coast. Figure 6 shows topographic contours of the wetland and surrounds.

The western boundary of the wetland is well defined by an abrupt change in slope at the base of the Quindalup dunes. The eastern boundary of the wetland is much less well defined due to the very gentle slopes on that side. The extent of inundation and saturation on the eastern side varies significantly with inter-seasonal and inter-annual changes in groundwater level.

The soils beneath the wetland are mapped by the Geological Survey of Western Australia (GSWA, 1981) as “Swamp Deposits (Qhw): Typically dark grey or brown, fine sands or silts with varied but significant amounts of peat.” Test pitting at three transects on the eastern side of the wetland in 2008 (Figure 6) found black or dark brown peaty sand to 2m inside the wetland boundary, with grey and yellow sandy soils outside the boundary. Soil logs from the test pits are attached in Appendix B.

The wetland is mapped by the DBCA as having a high risk of acid sulphate soils (ASS) due to the presence of peaty sands and silts of lacustrine and possibly marine origin. The high ASS risk is confined to the wetland itself; the areas east and west are mapped as low ASS risk due to the presence of limestone and calcareous soils. The presence of ASS beneath the wetland is of no practical significance to the management of the wetland, since no excavation or dewatering will occur within the wetland.

Extensive excavation has occurred in the quarry north-east of the wetland. Further significant earthworking will occur east of the wetland in the development of the urban area.

2.4 Hydrology

UFI 15821 is maintained by groundwater throughflow in the superficial aquifer. Figure 6 shows average annual maximum groundwater level (AAMGL) contours based on seven bores within the development area and a long-term DoW bore located 1.2km to the east on Bussell Highway.

The wetland is seasonal, with extensive areas of saturation and smaller areas of open water occurring in winter. The extent of open water varies greatly between years depending on the groundwater level. Figure 6 shows the extent of inundation in a relatively dry winter (2010) compared with the estimated extent at the AAMGL. The wetland dries out completely by late summer.

There is no surface flow into or out of the wetland under normal conditions. Given the highly porous surface soils of the surroundings, rain falling in the catchment of the wetland would infiltrate and move through the wetland as groundwater flow.

Following development of the urban area, the wetland will receive overflow drainage from the stormwater drainage system. The runoff will be treated in bioretention basins as described in the Local Water Management Strategy (BES, 2015) and will enter the wetland via an overflow swale located in the verge of Maidment Parade (Figure 7).

A production bore is located approximately 650m east of the wetland near its northern end. The bore abstracts low volumes of water from the superficial aquifer for stock watering and dust suppression at the sand quarry.

No water quality data are available for the wetland itself, but groundwater sampling was undertaken in 2016 from bores up to 750m east, including two bores immediately adjacent to the wetland (Figure 7). These samples have shown low levels of dissolved phosphorus, the key nutrient of concern in fresh water bodies. This is to be expected given the limestone-derived soils of the site. Table 2.1 shows the results of the 2016 water sampling.

Table 2.1 Groundwater Quality 13 October 2016

Analyte	*PB1*	*PB2*	*PB3*	*Stock*
pH (no units)	6.3	7.2	7.2	7.6
Conductivity (mS/cm)	0.633	1.367	0.883	0.867
Acidity (as $CaCO_3$)	56	24	20	-
Alkalinity (as $CaCO_3$)	18	240	170	230
Chloride	130	150	110	110
Sulphate	75	210	100	83
SO_4:Cl Ratio	0.6	1.4	0.9	0.8
Total Phosphorus	0.24	0.16	0.15	0.22
Reactive Phosphorus	0.01	0.01	<0.01	0.01
Total Nitrogen	0.6	8.8	3.2	0.4
Total Kjeldahl Nitrogen	0.57	1.1	0.8	0.27
NO_X	0.03	7.7	2.4	0.13
Aluminium	<0.1	<0.1	<0.1	<0.1
Arsenic (III & V)	0.002	0.002	<0.001	0.001
Cadmium	<0.002	<0.002	<0.002	<0.002
Chromium (III & VI)	<0.01	<0.01	<0.01	<0.01
Copper	<0.01	<0.01	<0.01	<0.01

Iron	19	0.08	0.03	0.04
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01	<0.01
Zinc	<0.01	<0.01	<0.01	<0.01

2.5 Vegetation

Botanist Dr Arthur Weston mapped vegetation types and condition in and around the wetland through aerial photography interpretation and field surveys in September 2007, August-November 2008 and January 2009. The full botanical report is presented in Appendix C. Figure 9 shows the vegetation types and Figure 10 shows the vegetation condition.

The wetland is mostly dominated by alien species, especially Asian Bulrush (*Typha orientalis*) and Clubrush (*Isolepis prolifera*). However, four native species are dominants of relatively small stands of native wetland and transitional vegetation. These include an *Acacia saligna – Agonis flexuosa* Closed Low Forest in the north-east corner of the wetland and *Melaleuca rhaphiophylla* (Swamp Paperbark) Open to Closed Low Forests and *Baumea articulata* (Jointed Rush) Closed Tall Sedgelands in western parts of the wetland. Aliens are prominent in the understoreys of the Swamp Paperbark Forests, but there are few understorey plants, either native or alien, in the *Baumea articulata* Sedgelands.

The *Lepidosperma gladiatum* (Coast Sword-sedge) Open Sedgeland in the south-eastern part of the wetland has a native dominant and dense understorey but the understorey has very few, if any, native plants.

The surveys found that most (90%) of the wetland vegetation was Degraded or Completely Degraded, consisting of cleared paddocks dominated by pasture grasses and Asian Bulrush (*Typha orientalis*). Much of this area was until recently regularly slashed and/or ploughed by the property manager to maintain pasture growth and control Bulrushes.

Small pockets of wetland vegetation consisting of *Melaleuca rhaphiophylla* closed forest in Good, Very Good or Excellent condition remain in the western parts of the wetland along the margins of the Quindalup dunes.

No Declared Rare or Priority Flora or Threatened or Priority Ecological Communities are listed on DBCA or WA Herbarium databases as occurring in or near the wetland, and none were found during the vegetation surveys.

2.6 Fauna

Fauna surveys of the wetland and surrounds have been carried out by Bamford (2012), Bamford & Wilcox (2003), Elscot (2006) and Harewood (2007). Additional observations of fauna and habitats have been undertaken during botanical and other site surveys.

The western part of the wetland dominated by paperbark woodland and *Typha* beds provides seasonal nesting and feeding habitats for a range of waterbirds including ducks, grebes, herons and ibis. Migratory species are unlikely to use the wetland as it is dry in summer when most migratory species visit the region.

As well as waterbirds, the vegetation of the eastern side of the wetland (particularly the *Acacia-Agonis* thicket in the north-east corner) provides nesting and feeding habitat for bush birds and species that inhabit the fringes of wetlands.

The western part of the wetland is likely to provide habitat for aquatic species that can tolerate seasonal drying by burrowing to the water table, such as Koonacs and Gilgies. Long-necked Turtles are unlikely to be present because, although this species can aestivate when necessary by burying itself in the mud, it is unlikely to be able or willing to sustain this on an annual basis. Given the seasonal drying of the wetland, it is unlikely that any aquatic species requiring permanent surface water would survive there.

Sinclair & Hyder (2009) found evidence of quokkas in 2008 at Muddy Lake, about 2km south of UFI 15821. The evidence of quokkas was found in dense vegetation within and to the west of a wetland that had been protected from grazing for several years, where quokkas could find cover from foxes and other predators. It is possible that quokkas also persist in other parts of the wetland chain, including the western side of UFI 15821, although the heavier clearing and grazing in this area and particularly to the south makes this less likely (E. Sinclair, pers. comm.). The proposed rehabilitation works described in this document and in the Revegetation Management Plan (BES, 2018) should increase the suitability of the vegetation, particularly west of the wetland, for quokkas.

Dryland animals such as kangaroos use the cleared parts of the wetland for grazing.

2.7 Ecological Linkages

The importance of maintaining or creating ecological linkages between coastal and inland areas in the Greater Bunbury Region was identified by the Department of Environment in its "*A Strategy for the EPA to identify regionally significant natural areas in its consideration of the Greater Bunbury Region Scheme Portion of the Swan Coastal Plain"* (2002). The potential to preserve an ecological linkage from Dalyellup via Gelorup to Crooked Brook was subsequently identified by the EPA in Appendix 4 to Bulletin 1108: *Ecological Linkages in the Greater Bunbury Region* (2003).

The EPA initially recommended, in Bulletin 1108, that all of Lots 315-317 and the western parts of Lots 313 and 314 should be preserved as part of the linkage. Following an appeal by the Shire of Capel, the Minister for the Environment determined that the linkage function in this area would be sufficiently served by reserving the western parts of Lots 313 to 316 and all of Lot 317. The Urban Deferred zoning currently shown in the GBRS reflects this decision.

Under the terms of his approval under the EPBC Act 2000 for clearing 39ha of Tuart woodland on Lots 2, 3 and 4, Mr Piacentini has committed to planting approximately 11,200 Tuart, Peppermint, Banksia and other species over 28ha of Lot 317 to create enhanced feeding and breeding habitat for Western Ringtail Possums and black cockatoos. Figure 11 shows the preliminary planting area. The final layout of the planting area and the details of the planting programme are set out in the Revegetation Management Plan.

2.8 Fire

Due to its largely cleared status and private ownership, the wetland has not been subject to fire for at least several decades. The trunks of large trees on the wetland margin show no signs of fire in recent times.

Prevention of fire will be an important part of ongoing management of the wetland. Rehabilitation in areas close to residences will be designed to maintain low fuel loadings, both to protect residences and to minimise the potential for fire to spread into the wetland.

3.0 EXISTING CULTURAL AND SOCIAL VALUE AND USE

3.1 Aboriginal and European Heritage

There are no sites of Aboriginal or European heritage significance listed within the wetland or its immediate surroundings.

3.2 Current and Previous Tenure and Use

From 19__ to 2016 the wetland was owned by Mr Piacentini and used for broadacre grazing. In 2016 the land containing the wetland was purchased by the State government as part of the agreement to permit rezoning of Lots 2, 3 and 4 Minninup Rd to Urban under the GBRS. The purchased land is owned freehold by the WAPC and is expected to be vested in the DBCA to be managed for conservation. This vesting is subject to discussions over funding for management of regional parks in the Greater Bunbury region and its timing is unknown.

There is currently no authorised public use of the wetland, although unauthorised access by four-wheel drive vehicles has been and continues to be an issue. This mainly takes the form of vehicles crossing the site to reach the coast, and to date has resulted in little damage to the site apart from fences and gates. This problem is expected to diminish or cease when development of the site brings increased public surveillance of the wetland.

4.0 POTENTIAL IMPACTS AND THREATS

4.1 Geology and Geomorphology

Development of the subject land will cause no direct change to the geology or geomorphology of most of the wetland.

Battering of the Maidment Parade road reserve will extend up to about 20m into the eastern side of the wetland buffer. This battering is necessary to match the levels of Maidment Parade to the roundabout at the northern end. The width of the batter will vary between about 12m and 20m, with the gradient varying from about 1-in-10 to 1-in-6. Figure 12 shows a conceptual profile through the batter.

Prevention of erosion and sedimentation from the newly constructed batter will be a high priority during the construction programme. Measures to address this are described in Section 5.1.

4.2 Hydrology

Clearing for urban development typically causes a short-term rise in groundwater levels due to the reduction in evapotranspiration. The effect normally diminishes after development as trees, gardens and domestic bores become established in the urban area. With the considerable depths to groundwater over much of the development area, the prevalence of domestic bores may be less than usual, with the result that there may be a slight long-term rise in groundwater levels. If this occurs, it may produce a benefit for the wetland by counteracting the long-term drying trend in the wetland (Section 2.1.2).

Following development, the wetland will receive occasional surface inflows from the bioretention swales in the development area. This will not alter the overall water flows into the wetland, since these overflows would have otherwise entered the wetland as groundwater flow. The impact on the hydrology of the wetland will be minimal.

Urban development has the potential to increase the quantities of nutrients, sediments and other contaminants, originating from fertilisers and road runoff, entering the wetland. The contaminant of primary concern in freshwater ecosystems is phosphorus.

Minimisation of contaminant entry to the wetland will be a high priority of the drainage and subdivision design. Specific measures to achieve this are described in Section 5.2.2.

4.3 Vegetation and Flora

The development of the subject land will not entail any clearing or disturbance of native vegetation in the wetland but will bring considerable benefits in the form of weed removal and revegetation. Details of the rehabilitation programme are given in Section 5.3 and Appendix D.

4.4 Fauna

The development will have benefits for fauna habitat in the wetland through the permanent cessation of cattle grazing and the revegetation of the eastern part of the wetland and the buffer. Details of the rehabilitation programme are given in Section 5.3 and Appendix D. In particular, the rehabilitation is expected to benefit western ringtail possums and black cockatoos through the establishment of habitat trees. It also has potential to benefit quokkas and other small mammals through an increase in dense understorey vegetation.

The development will bring threats to the wetland including a possible increased presence of cats and dogs. Feral cats are already undoubtedly present in the wetland and surrounds, and cannot be kept out or eradicated by any means currently available in urban areas. The best means of limiting cat impacts on the wetland will be by educating residents to keep their cats inside at night and/or to fit them with bells.

Dogs will generally be under the control of their owners. Dogs and their owners will be prevented or at least discouraged from entering the wetland and buffer from the development area by a 1.2m high fence.

4.5 Disease

The development is not expected to bring any increased risk of disease to the wetland.

4.6 Fire

The increased human presence near the wetland, and the increased density of vegetation in the wetland, will cause an increased fire hazard to the wetland and nearby areas. This will be counterbalanced by the increased level of surveillance created by houses fronting the wetland interface, which will reduce the opportunities for deliberate fire lighting.

Fire hydrants located at 100m intervals along Maidment Parade will provide water for fire fighting in the wetland if necessary. Access for emergency vehicles into the wetland will be provided by gates and tracks at the northern and southern ends of Maidment Parade.

4.7 Aboriginal and European Heritage

There are no known Aboriginal or European heritage values associated with the wetland and therefore there will be no impacts in this regard from the development.

4.8 Community Use and Amenity

The wetland is intended to be an important landscape element and backdrop for the western part of the development area. Public access to the wetland will not be encouraged, although paths around the perimeter will provide views into and over the wetland.

With increased human presence will come the potential for antisocial behaviour such as littering, drinking, arson, illegal vehicle access and vandalism. All of these will be inhibited by the high level of visual surveillance provided by houses adjacent to and above the wetland.

Management of access to the wetland is discussed in Section 5.7.

5.0 WETLAND MANAGEMENT COMMITMENTS

5.1 Geology, Geomorphology and Soils

5.1.1 Objectives

- Maintain the existing geology, geomorphology and soils of the wetland.
- Avoid disturbing acid sulphate soils (ASS) or acidic groundwater during construction.
- Minimise construction impacts on the wetland.

5.1.2 Strategies

Battering of the Maidment Parade road reserve into the eastern edge of the wetland buffer will occur in the initial earthworks phase of the development. The batter will vary in width between about 12m and 20m at a gradient of 1-in-10 to 1-in-6. The existing grass and topsoil will be removed from the area of the batter before the batter is filled with clean soil from elsewhere on the site. The batter will be topsoiled, mulched and planted, probably by a combination of direct seeding and tube stock, as soon as practicable after filling in order to minimise erosion and sedimentation.

Temporary erosion control structures such as bunds, basins and sediment barriers will be established as necessary to prevent direct runoff or sediment entry into the wetland. Permanent bioretention swales will be constructed during the earthworks to ensure that no direct runoff enters the wetland from the development area.

No excavation or dewatering will occur in the wetland.

5.1.3 Monitoring

The construction site supervisor will visually monitor the wetland, buffer and adjacent upslope areas for signs of erosion or sedimentation continuously throughout the construction program.

The construction contractor will monitor any groundwater abstracted from within 500m of the wetland for pH and other acid sulphate soil parameters.

5.1.4 Performance Criteria

The performance criteria for geology, geomorphology and soils are:

- No direct runoff into the wetland during or after construction.
- No erosion or sediment transport into the wetland during construction.
- No disturbance of acid sulphate soils during construction.
- No release of untreated ASS-affected groundwater during construction.

5.1.5 Contingencies

If visual monitoring shows any erosion or sedimentation in the wetland buffer or adjacent areas during construction, temporary erosion control structures will be created or augmented to prevent direct runoff from entering the wetland.

If dewatering monitoring shows signs of ASS, an Acid Sulphate Soil Management Plan will be prepared and implemented, possibly including lime dosing of abstracted water and/or excavated soil.

5.2 Hydrology

5.2.1 Objectives

- Maintain existing hydrology, water flows and water quality in the wetland.

5.2.2 Strategies

All runoff from the development area will be captured and treated before being allowed to enter the wetland. Runoff from storms of less than 15mm rainfall (comprising approximately 98.5% of total runoff) will be captured and fully infiltrated in vegetated bioretention swales with underlying soil phosphorus retention index (PRI) of at least 15, located in POS areas throughout the development.

Excess runoff from larger storms will overflow the swales into a vegetated swale located in the Maidment Parade road reserve, from where it will progressively discharge into the wetland. Full details of the stormwater management system are provided in the UWMP. Figure 7 shows the locations of the drainage structures.

Public Open Space areas will be planted with species having low water and nutrient requirements. The soil beneath POS areas and swales will be amended if necessary to achieve a PRI of at least 15.

Documentation supplied to lot purchasers will include information on water-sensitive and nutrient-sensitive gardening practices.

5.2.3 Monitoring

The developer will monitor water levels and water quality in the wetland, upgradient bores and overflows from the stormwater system for two years after the completion of subdivision works. Figure 8 shows the proposed monitoring locations.

Bore and wetland monitoring will be carried out twice each year in winter and spring, in accordance with the DoW (2012) *Water Monitoring Guidelines for Better Urban Water Management*. Monitoring of outflows from the stormwater system to the wetland will

occur opportunistically, as flows in the drains permit. The monitoring parameters will include:

- Depth to water.
- Field parameters – temperature, pH, conductivity, salinity.
- Physical parameters – pH, TDS, TSS, hardness, acidity, alkalinity.
- Major ions – chloride, sulphate.
- Nutrients – Total P, FRP, Total N, TKN, NO_X.
- Metals – Al, As, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Zn.

5.2.4 Performance Criteria

The monitoring results will be compared with criteria and trigger values based on the pre-development monitoring and on ANZECC water quality standards for south-west freshwater wetland ecosystems. Table 5.1 summarises the adopted trigger values. The criteria have been designed to ensure that the water quality in the wetland will be as good after development as before. The trigger values will be reviewed after each round of monitoring to confirm their applicability and to assess the need for any revision.

Bores

- Target - Median of bore values should not exceed the median of all pre-development bore values by more than 20%.
- Limit - No bore should exceed twice the maximum of all pre-development bore values.

Basin Outflows

- Target - Median of basin outflow values should not exceed ANZECC criteria by more than 20%.
- Limit - No outflow should exceed twice the ANZECC criteria.

Wetland

- Target - Median of wetland values should not exceed ANZECC criteria by more than 20%.
- Limit - No wetland value should exceed twice the ANZECC criteria.

pH (all sites)

- Target - The median pH in each sample group (bores, basin overflows, wetland) should be within 20% of the median of the values in pre-development samples for that group.

5.2.5 Contingencies

The results of each round of water monitoring will be compared with the trigger values. If any limit is breached, the developer will respond as follows:

1. Initially, resample to confirm that the breach was not due to sample contamination or natural variation.

2. Inform the Shire of Capel.

3. Determine whether the breach is an isolated, project or regional occurrence.

4. Determine whether the breach is attributable to the development or to external factors.

5. Take appropriate contingency action(s) in consultation with the Shire of Capel and the DWER. These may include:

   - Identify and remove any point sources of contamination.
   - Review operational and maintenance (e.g. abstraction, fertiliser) practices.
   - Modify the stormwater system including enlarge or modify infiltration swales.
   - Reinforce community education/awareness programs.

6. Record the breach and the action taken.

7. If necessary, inform residents of any required actions and their purpose.

Table 5.1 Water Quality Trigger Values

Parameter	*Bores*		*Basin Outflows*		*Wetland*	
	Target	*Limit*	*Target*	*Limit*	*Target*	*Limit*
Physical						
pH	5.6 - 8.4	-	7.0 – 8.5	-	7.0 – 8.5	
TSS	-	-	-	-		
Conductivity	0.948	2.733	1.8	3.0	1.8	3.0
Alkalinity	29	112	-	-	-	-
Cl	168	354	-	-	-	-
SO_4	110	420	-	-	-	-
SO_4/Cl Ratio	1.0	2.8	-	-	-	-
TP	0.23	0.48	0.072	0.12	0.072	0.12
FRP	0.01	0.02	0.036	0.06	0.036	0.06
TN	2.3	17.6	1.8	3.0	1.8	3.0
TKN	0.82	2.20	-	-	-	-
NO_X	1.52	15.40	0.12	0.2	0.12	0.2
Al	0.1	0.2	0.096	0.16	0.096	0.16
As	0.002	0.004	0.113	0.188	0.113	0.188
Cd	0.002	0.004	0.0005	0.0008	0.0005	0.0008
Cr	0.01	0.02	0.0072	0.012	0.0072	0.012
Cu	0.01	0.02	0.0022	0.0036	0.0022	0.0036
Fe	0.7	38.0	-	-	-	-
Hg	0.0002	0.0004	0.0023	0.0108	0.0023	0.0108
Ni	0.01	0.02	0.0156	0.026	0.0156	0.026
Pb	0.01	0.02	0.0067	0.0112	0.0067	0.0112
Zn	0.01	0.02	0.018	0.03	0.018	0.03

5.3 Vegetation and Flora

5.3.1 Objectives

- Remove and control weeds
- Restore and maintain native wetland vegetation.

5.3.2 Strategies

Rehabilitation of native vegetation and removal of introduced weeds will be a major focus of the Wetland Management Plan. The rehabilitation works will begin in advance of the development of the urban area with the commencement of trials in the south of the subject land to test different methods of ground preparation, weed control, planting and seedling protection. The trials are described in detail in the Revegetation Management Plan (BES, 2018) and summarised in Appendix D.

Rehabilitation in the wetland will focus on the wetland buffer and the eastern parts of the wetland that are most affected by clearing and weeds. Figure 11 shows the areas of the wetland and buffer to be rehabilitated.

The general form of the rehabilitation in the wetland and buffer will be as follows:

Wetland

- Planted area approx. 8.83ha.
- Planted with trees, shrubs, sedges and herbs.

Trees

- Planting density 50/ha (15m spacing).
- Selected from the following native species:

Agonis flexuosa	*Melaleuca preissiana*
Banksia littoralis	*M. rhaphiophylla*
Eucalyptus rudis	

Shrubs

- Planting density 400/ha (5m spacing).
- Selected from the following native species:

Acacia lasiocarpa	*Melaleuca thymoides*
Beaufortia squarrosa	*Phyllanthus calycinus*
Hypocalymma angustifolium	*Xanthorrhoea preissii*
Astartea fascicularis	*Melaleuca teretifolia*
Acacia saligna	*Pericalymma ellipticum*
Kunzea glabrescens	*Regelia ciliata*
Melaleuca incana	*Viminaria juncea*

Sedges & Herbs

- Planting density 10,000/ha (1m spacing) in patches (2,500/ha overall).
- Selected from the following native species:

Baumea articulata	*Lyginia imberbis*
B. juncea	*Cassytha flava*
Ficinia nodosa	*Cyathochaeta avenacea*
Gahnia trifida	*Dasypogon bromeliifolius*
Juncus kraussii	*Hypolaena exsulca*
J. pallidus	*Patersonia occidentalis*
Lepidosperma longitudinale	*Phlebocarya ciliata*

Wetland Buffer

- Planted area approx. 3.84ha.
- Planted with sedges, herbs, low shrubs (<2m) and scattered trees (<10% cover).

Trees

- Planting density 50/ha (15m spacing).
- Species: *Melaleuca preissiana, M. rhaphiophylla, Agonis flexuosa.*

Shrubs (<2m)

- Planting density 400/ha (5m spacing).
- Selected from the following native species:

Acacia lasiocarpa	*Melaleuca thymoides*
Beaufortia squarrosa	*Phyllanthus calycinus*
Hypocalymma angustifolium	*Xanthorrhoea preissii*

Sedges & Herbs

- Planting density 10,000/ha (1m spacing) in patches (2,500/ha overall).
- Species selection as for wetland.

5.3.3 Monitoring

Regrowth in the rehabilitated parts of the wetland and the buffer will be monitored for five years after completion. For the first two years this will be carried out by the rehabilitation contractor as part of the contract. After that time the monitoring may be undertaken by the rehabilitation contractor or by another qualified contractor engaged by the developer. The monitoring program is set out in detail in Appendix D.

5.3.4 Performance Criteria

The planting program has been designed to allow for 20% attrition over five years. Success of the rehabilitation will therefore be defined as a density of at least 80% of the planted density of each stratum of vegetation in good health after five years. The performance criteria are described in detail in Appendix D.

5.3.5 Contingencies

If at any time during the first five years after planting the survival of any stratum of the vegetation (trees, shrubs or sedges/herbs) falls below 80% or the overall density falls below the criteria listed in Section 5.3.4, remedial planting will be undertaken to raise the density to the required level. Details of the contingency response are given in Appendix D.

5.4 Fauna

5.4.1 Objectives

- Create and/or enhance habitat for Western Ringtail Possums, Black Cockatoos, Quokkas and other native fauna.
- Control or exclude feral and domestic animals.
- Minimise insect nuisance to the development.

5.4.2 Strategies

Revegetation in and around the wetland will be undertaken as described in the Revegetation Management Plan and Appendix D. A key aim of the revegetation will be the creation and enhancement of habitat for native fauna.

Entry of dogs to the wetland will be discouraged by signage directed at owners and by a 1.2m fence extending the length of the wetland interface with the development. The signs will include a contact number asking members of the public to report sightings of dogs in the wetland.

5.4.3 Monitoring

Monitoring of vegetation regrowth and habitat development will be undertaken for five years after the completion of planting as set out in Appendix D.

Visual monitoring of nuisance insect (mosquito and midge) numbers at the interface between the development area and the wetland will be undertaken by the developer for five years after the completion of subdivision works. A register of public complaints about nuisance insects will also be maintained. The results of both of these will be used to assess the need for insect control measures.

5.4.4 Performance Criteria

The primary measure of success for fauna habitat creation will be the achievement of an 80% survival rate in revegetation, as detailed in Appendix D.

The success of measures to exclude dogs from the wetland will be judged by the number of public sighting reports.

The level of insect nuisance will be judged by the number of public complaints received by the developer or the Shire of Capel. Complaints regarding insects are more likely to occur during spring and early summer.

5.4.5 Contingencies

Contingencies for infill planting in the event of poor regrowth in the wetland are detailed in Appendix D.

If public reports suggest an excessive level of dog activity in the wetland, contingency measures may include extending the fence around more of the wetland boundary, patrols by Council rangers and increased public education on the need to keep dogs out of the wetland.

Contingencies in the event of an excessive level of insect nuisance will include modification of bioretention swales, modification of street lighting and, as a last resort, use of chemical control measures such as s-methoprene to inhibit breeding. Such chemical measures would only be undertaken by the Shire of Capel.

5.5 Ecological linkages

5.5.1 Objectives

- Create a continuous vegetated ecological linkage from west to east through the wetland and Lot 317.

5.5.2 Strategies

Planting of peppermint, banksias and other overstorey and understorey species across a 28ha corridor through Lot 317 and the wetland will be undertaken as detailed in the Revegetation Management Plan and Appendix D. The intention of the planting is to create a continuous vegetation canopy between Regional Open Space areas to the west and east of the subject land, in order to create habitat for Western Ringtail Possums and black cockatoos.

Revegetation of the eastern part of the wetland and the wetland buffer will further enhance ecological linkages within the subject land.

5.5.3 Monitoring

Vegetation regrowth in the planting areas will be monitored for five years as set out in Appendix D.

5.5.4 Performance Criteria

Performance criteria for the revegetation are set out in Appendix D.

5.5.5 Contingencies

Contingency actions for the revegetation programme are set out in Appendix D.

5.6 Fire

5.6.1 Objectives

- Minimise the risk of fire in the wetland.
- Protect the development area from the effects of fire in the wetland.

5.6.2 Strategies

Revegetation works in the eastern part of the wetland and the buffer will be designed to limit fuel loads while achieving full coverage of a representative range of wetland species. The plantings in this zone will feature sedges and herbs, shrubs less than 2m tall and trees at 15m or greater spacing. The planting will have a "shrubland" classification in fire hazard terms. Further details of the plantings are given in Appendix D.

Fire fighting capability for the wetland and nearby residences will be provided by fire hydrants positioned at 100m intervals along Maidment Parade. Access to the wetland for fire and emergency vehicles will be provided by gates at the northern and southern ends of Maidment Parade.

5.6.3 Monitoring

The developer will visually monitor vegetation height, density and fuel loads in the wetland buffer for five years after the completion of planting works. After that time the responsibility for monitoring will pass to the vesting agency.

Detection and reporting of fires in the wetland and buffer will depend on the public.

5.6.4 Performance Criteria

Success of fire management measures in the wetland will be judged by:

- absence of fires in the wetland and buffer; and
- vegetation height and density in the buffer remains in the "shrubland" classification (shrubs below 2m height; trees >15m spacing).

5.6.5 Contingencies

In the event that vegetation height or density in the wetland buffer exceeds that of a "shrubland" fire hazard classification during the first five years after planting, the developer will reduce the height and/or density of the vegetation by pruning or thinning. After five years, such work will be the responsibility of the vesting agency.

Response to fires within the wetland or buffer will be the responsibility of the Department of Fire and Emergency Services (DFES).

5.7 Community Use and Amenity

5.7.1 Objectives

- Provide access to the outside of the wetland while protecting the inner wetland.
- Exclude dogs and cats from the wetland.
- Create a significant landscape element for the development.
- Create a long-term low-maintenance community asset.

5.7.2 Strategies

Public access to the wetland and buffer will be discouraged by a 1.2m high fence along the edge of the Maidment Parade road reserve. The fence will nominally be constructed of black PVC-coated chain mesh on black steel posts with a steel top rail, similar to the example depicted below.

The fence will not create a complete barrier to entry but will discourage casual entry and convey the message that public access to the wetland is not encouraged. This

message will be reinforced by signs at intervals asking people not to enter the wetland. A concrete shared path will be located on the roadside, with an overflow swale between the path and the fence to further discourage access to the wetland. Gates will be placed at the northern and southern ends of Maidment Parade to provide emergency vehicle access to the wetland. Figure 12 shows the general layout of the fence, path and swale.

Park bench seats will be located at intervals along the shared path along with rubbish bins.

The EPBC offset planting area at the southern end of the wetland in Lot 317 will be fenced with a 1.8m ringlock fence for five years to exclude grazers such as kangaroos and rabbits. At the end of five years this fence may be wholly or partly removed.

5.7.3 Monitoring

The developer will visually monitor public use of the wetland and surrounding paths. The monitoring will also include litter, traffic into the wetland, condition of the fences and paths.

5.7.4 Performance Criteria

Success of the wetland management in terms of public amenity will be indicated by:

- No significant damage to the wetland by foot traffic.
- No illegal vehicle (including motorcycle) traffic in the wetland.
- No significant occurrence of dogs or cats in the wetland.
- A low level of litter in the wetland and buffer.

5.7.5 Contingencies

If excessive public access to or traffic in the wetland or buffer is seen to be occurring and causing damage to the wetland vegetation, contingency actions may include:

- increased signage at access points;
- provision of alternative routes to satisfy pedestrian “desire lines” while avoiding key areas of the wetland; and
- increased signage and public education.

If illegal vehicular entry to the wetland occurs (most likely only in the early stages when houses are not fully established fronting the wetland), extra protection measures may be taken such as installation of bollards, earth bunds or reinforced fencing.

6.0 IMPLEMENTATION AND REVIEW

6.1 Responsibility for Implementation

Mr Piacentini will undertake and fund the rehabilitation and protection works described in this management plan (including initial weed control, planting, fencing and earthworks) as part of the subdivision works on the subject land. Mr Piacentini will also undertake and fund the maintenance and monitoring activities described here for five years after the completion of wetland rehabilitation works.

At the end of the five year maintenance period, Mr Piacentini will hand over responsibility for the wetland management to the relevant vesting agency. The identity of this agency has not yet been determined, but may be the DBCA, the WAPC or the Shire of Capel.

6.2 Implementation Schedule

Rehabilitation of the wetland will begin before the start of subdivision, with the commencement of a planting trial on 5ha of batter in the wetland buffer. Figure 11 shows the location and extent of this trial, which is described in detail in Appendix D. The planting trial is expected to begin in mid-2020 with pre-battering weed control. Planting of the trial plot is expected to begin in winter 2021.

The planting trial will be monitored for twelve months to give data on the success of the trialled techniques. Full-scale rehabilitation of the wetland is likely to begin with advance weed control in 2020, with full-scale planting (informed by the findings of the trial) to begin in the winter of 2021.

Other works in and near the wetland, including fences, paths and swales, will be constructed as part of subdivision works, nominally beginning in the second half of 2021.

Post-development water monitoring in and around the wetland will begin in the winter of 2021 and continue for five years.

7.0 REFERENCES

Australian Government (2008). *Communicating Climate Change: Glimpsing Western Australia's Future Climate.* Department of Agriculture, Fisheries and Forestry, Canberra.

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BES (2011). *Pt Lots 313 to 317 Harewoods Road, Gelorup: Wetland Assessment.* Report No. J07013b prepared for Piacentini & Son Pty Ltd, Bunbury.

BES (2015). *Pt Lots 313 to 316 Maidment Parade and Lot 1 Harewoods Rd, Dalyellup: Local Water Management Strategy.* Report No. J07013c prepared for Mr Colin Piacentini, Bunbury.

BES (2018). *EPBC 2012/6274 Lots 6 & 317 Minninup Rd, Dalyellup: Revegetation Management Plan.* Report No. J07013i prepared for Mr Colin Piacentini, Bunbury.

EPA (2003a). *Statement of Reasons for level of assessment: Mr Colin Piacentini: Clearing of approximately 30 hectares of native vegetation for agriculture, Wellington Location 41, Lots 313–317 Harewood and Minninup Roads Dalyellup.* www.epa.wa.gov.au/docs/1625_PUEA_No_201472.pdf

EPA (2003b). *Greater Bunbury Region Scheme. Report and Recommendations of the Environmental Protection Authority.* Bulletin 1108. EPA, Perth.

Geological Survey of Western Australia (1981). *Bunbury–Burekup Map Sheet 2031 III – Pt 2031 II. 1:50,000 Urban Geology Series.* GSWA, Perth.

Semeniuk CA (1988). Consanguineous wetlands and their distribution in the Darling System, Southwestern Australia. *J. Roy. Soc. West. Aust. 70(3):69-87.*

Figures

Wetland Boundary (DBCA)
Development Area
Wetland Management Plan Boundary
5 Photo Location and Direction (see Figure 2)

Figure 1

AERIAL VIEW

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P1 Isolated *Typha*-dominated wetland at north-east corner

P2 Looking west from north-east corner of wetland to *Acacia-Agonis* thicket

P3 Looking south-west near north-east corner

P4 Looking south near centre of wetland

See Figure 1 for photo locations

Figure 2a

VIEWS OF THE WETLAND

bayley environmental services

P5 Looking west near centre of wetland

P6 Looking north-west near centre of wetland

P7 Looking east from edge of dunes near southern boundary

P8 Looking north near southern boundary

See Figure 1 for photo locations

Figure 2b

VIEWS OF THE WETLAND

bayley environmental services

P9 Looking south near southern boundary

P10 Looking north from edge of dunes near southern boundary

P11 Looking north-east from dunes across wetland

P12 *Typha*-dominated pool in bay at base of dunes

See Figure 1 for photo locations

Figure 2c

VIEWS OF THE WETLAND

bayley environmental services

P13 Looking north-east from dunes

P14 Paperbark pool in bay at base of dunes

P15 Looking south-east from dunes across extensive *Typha*

P16 Looking north-east from dune spur

See Figure 1 for photo locations

Figure 2d

VIEWS OF THE WETLAND

bayley environmental services

P17 Looking east from dunes

P18 Paperbark pool at base of dunes

P19 Looking north from dune spur

P20 Looking east from bay in base of dunes

See Figure 1 for photo locations

Figure 2e

VIEWS OF THE WETLAND

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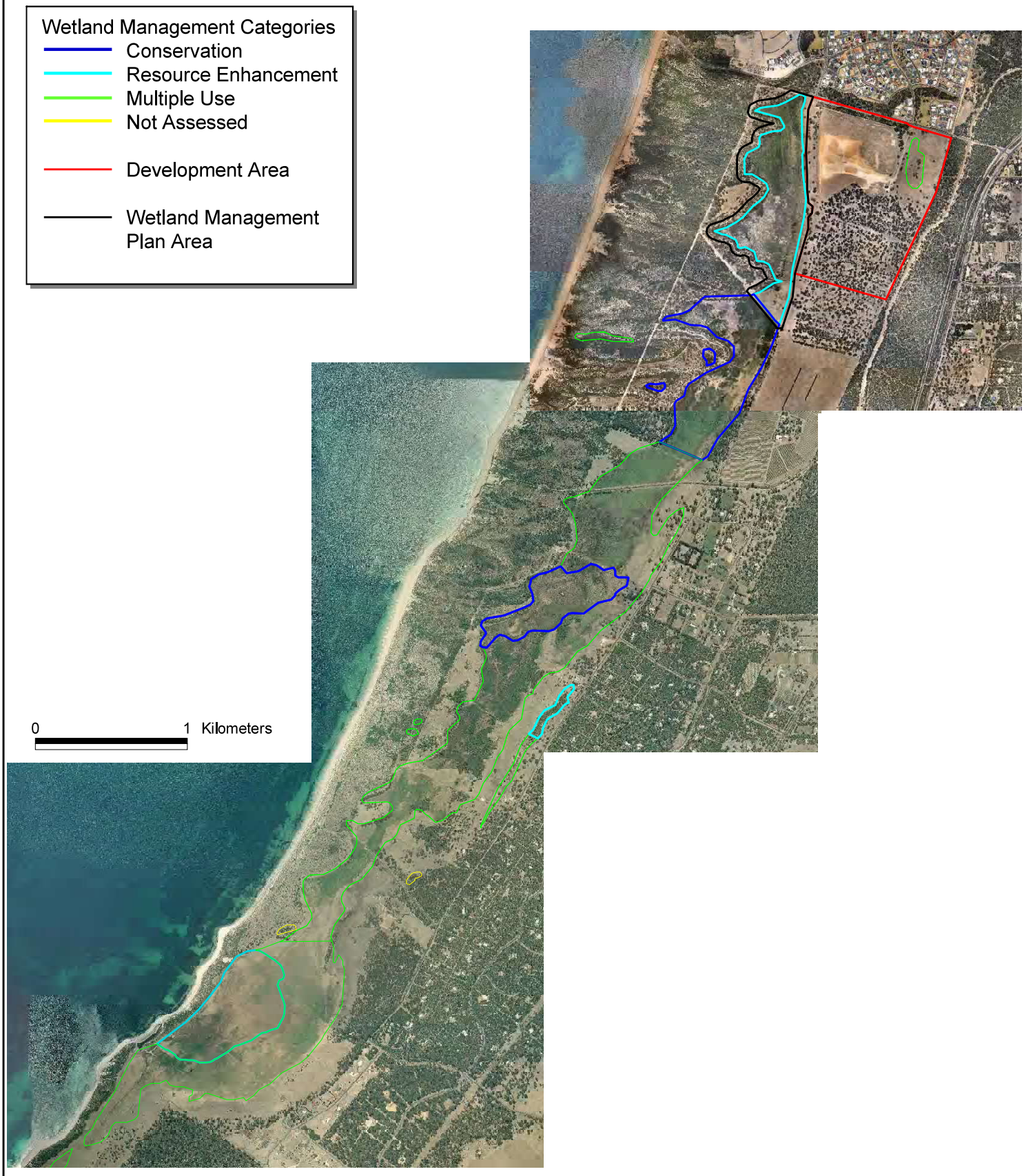
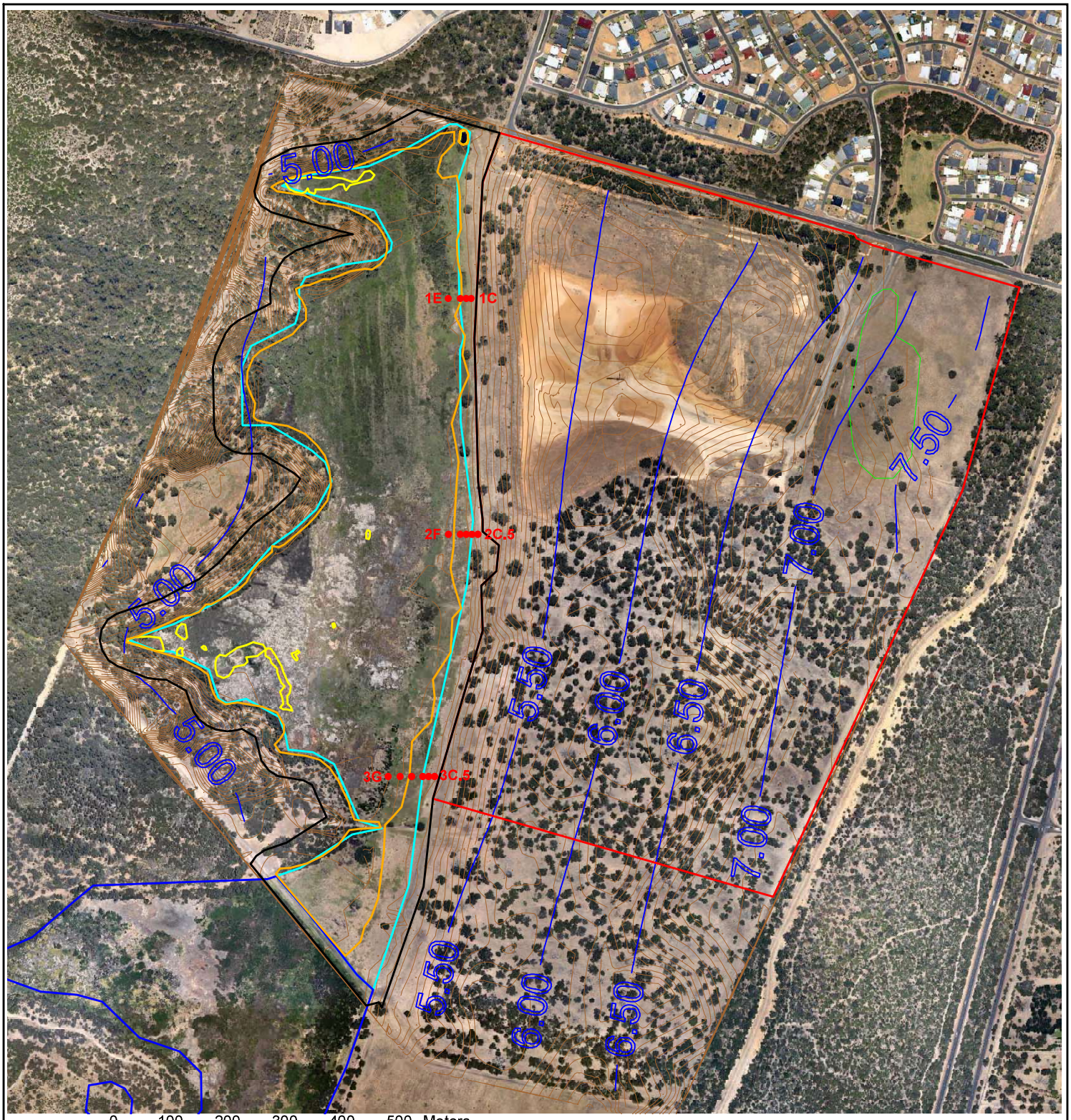


Figure 5

OVERALL VIEW OF SUMPLAND COMPLEX

bayley environmental services



- Wetland Boundary (DBCA)
- Development Area
- Wetland Management Plan Boundary
- Topographic Contour (mAHD)
- Average Annual Groundwater Level (AAMGL)
- Inundation at 26/10/2010
- Inundation at AAMGL (estimated)
- Test Pit

Figure 6

TOPOGRAPHY AND HYDROLOGY

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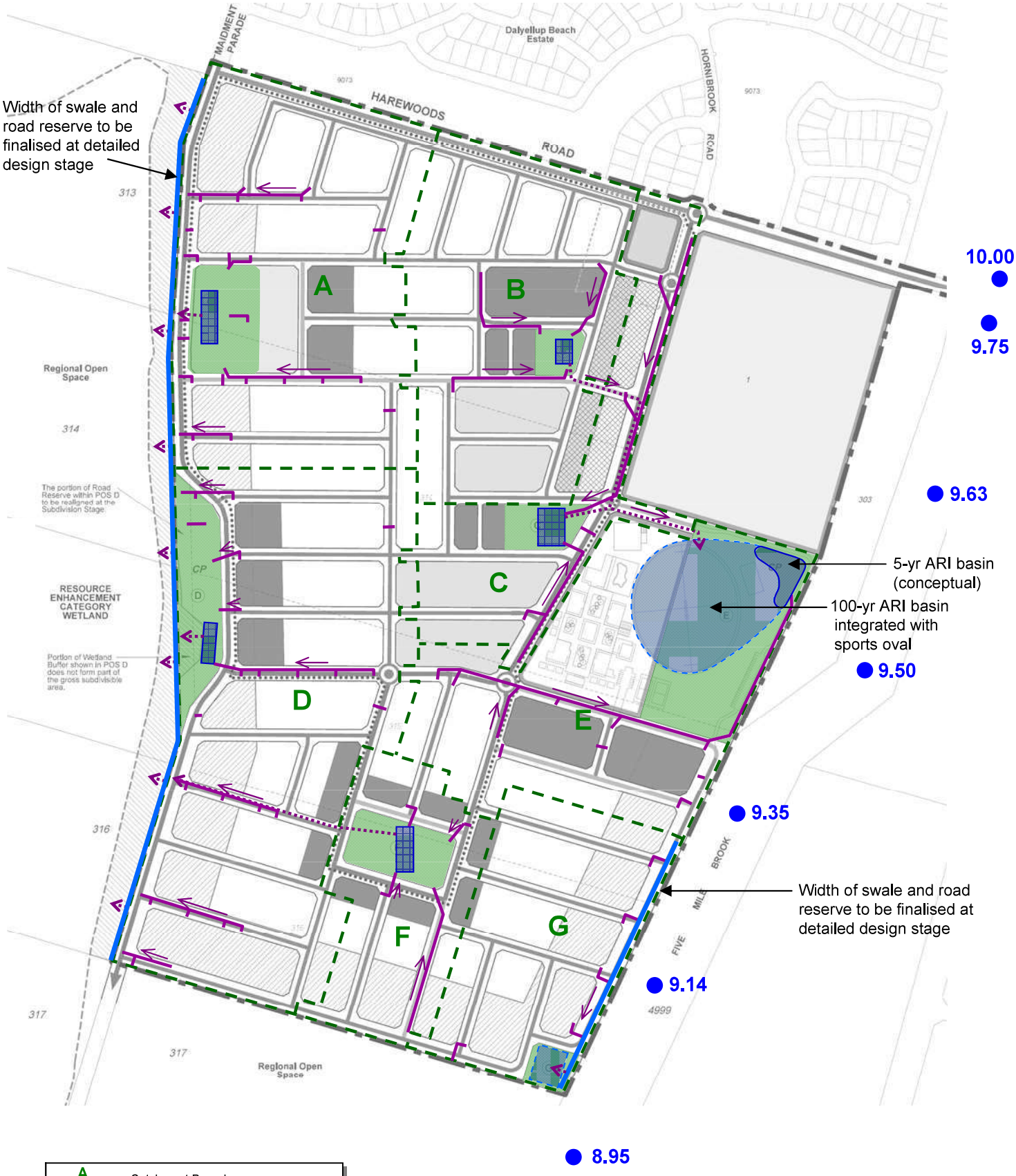

Figure 7

DRAINAGE STRUCTURES

Note: Locations of rain gardens and basins within POS areas are indicative and do not represent final locations. These will be determined at subdivision stage and documented in the UWMP.

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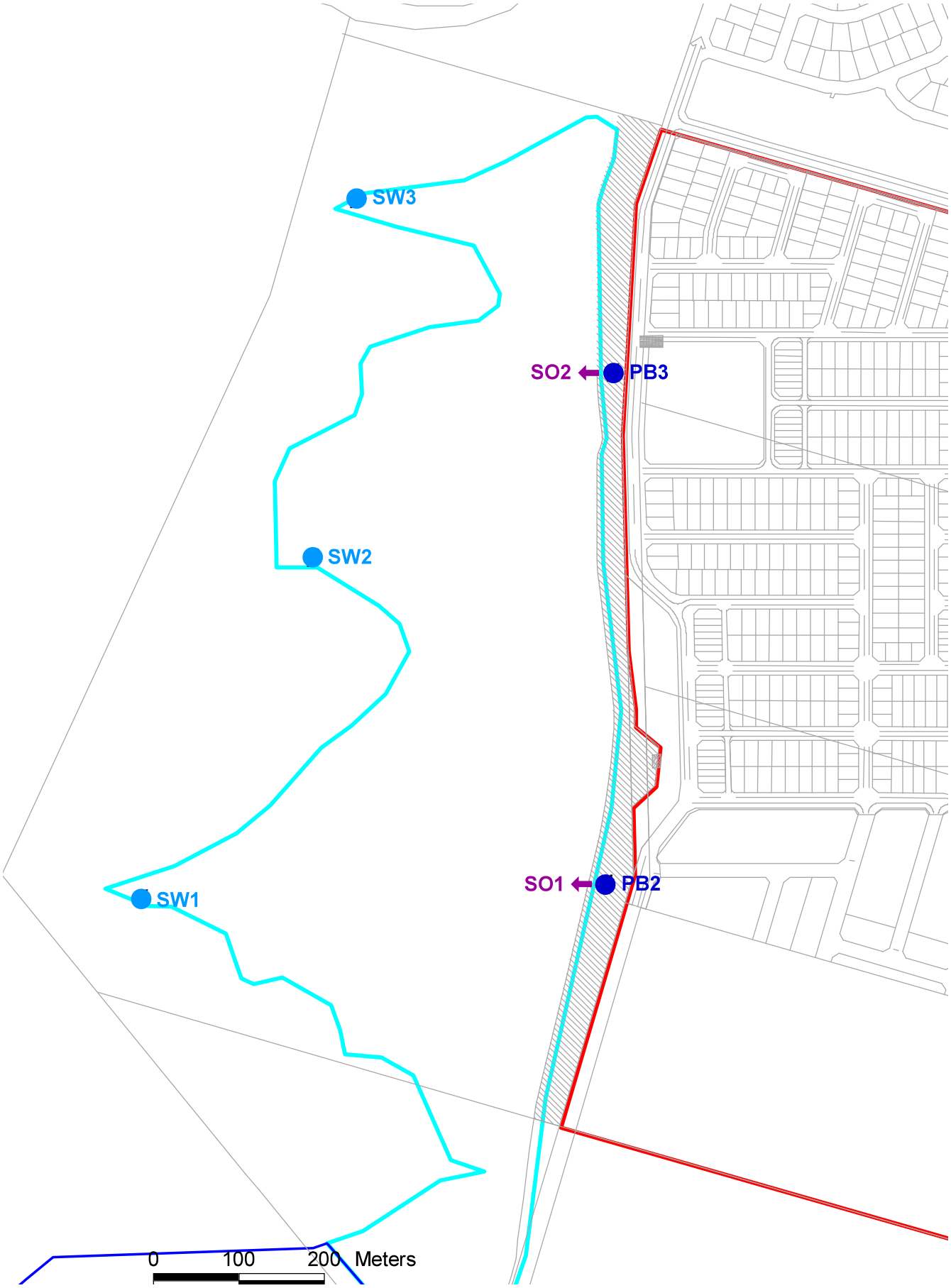

Figure 8

POST-DEVELOPMENT MONITORING LOCATIONS

- Development area boundary
- Wetland UFI 15821 boundary
- Surface water monitoring point
- Monitoring bore
- Swale overflow monitoring point (nominal)

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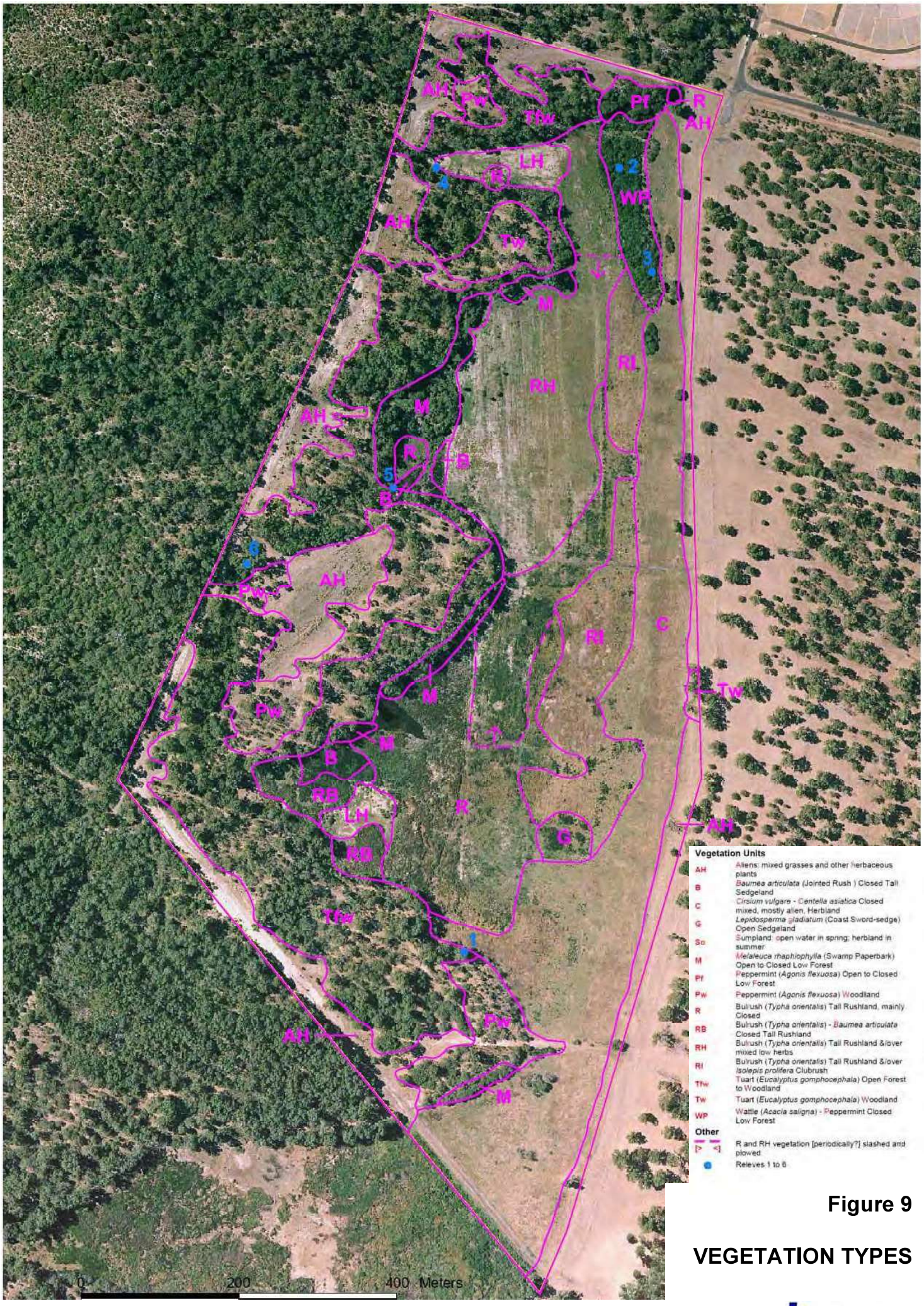

Figure 9

VEGETATION TYPES

Aerial photography: LandGate 2009
Wetland mapping: DEC 2007
Vegetation: Weston 2009

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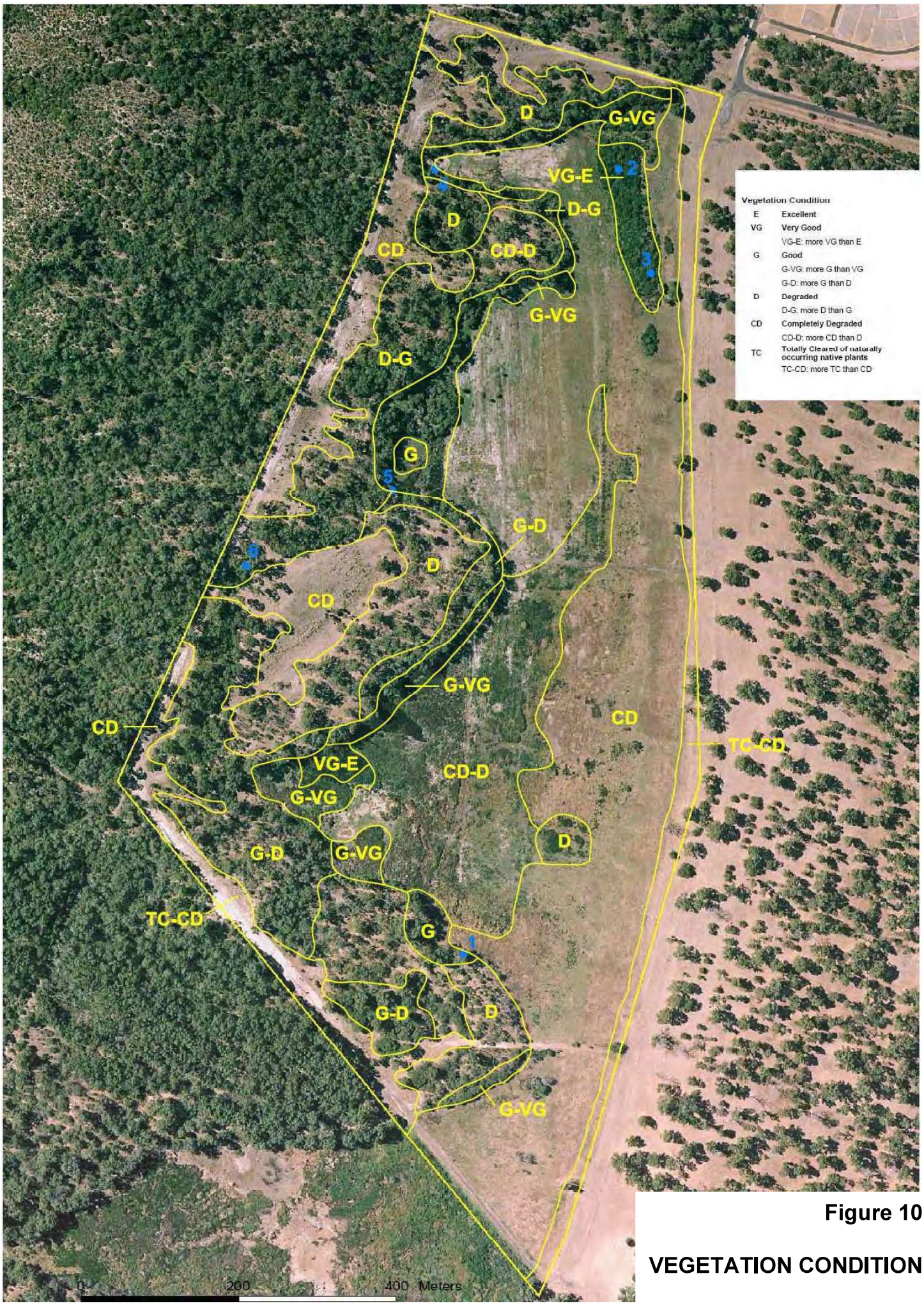

Figure 10

VEGETATION CONDITION

Aerial photography: LandGate 2009
Wetland mapping: DEC 2007
Vegetation: Weston 2009

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Development Area
(internal layout as at 28/4/2015)

Planting Zones

- Wetland
- Wetland Buffer
- Parkland POS
- Bioretention Swales
- Habitat Corridor (EPBC 2012/6274)

Figure 11

PLANTING MASTER PLAN

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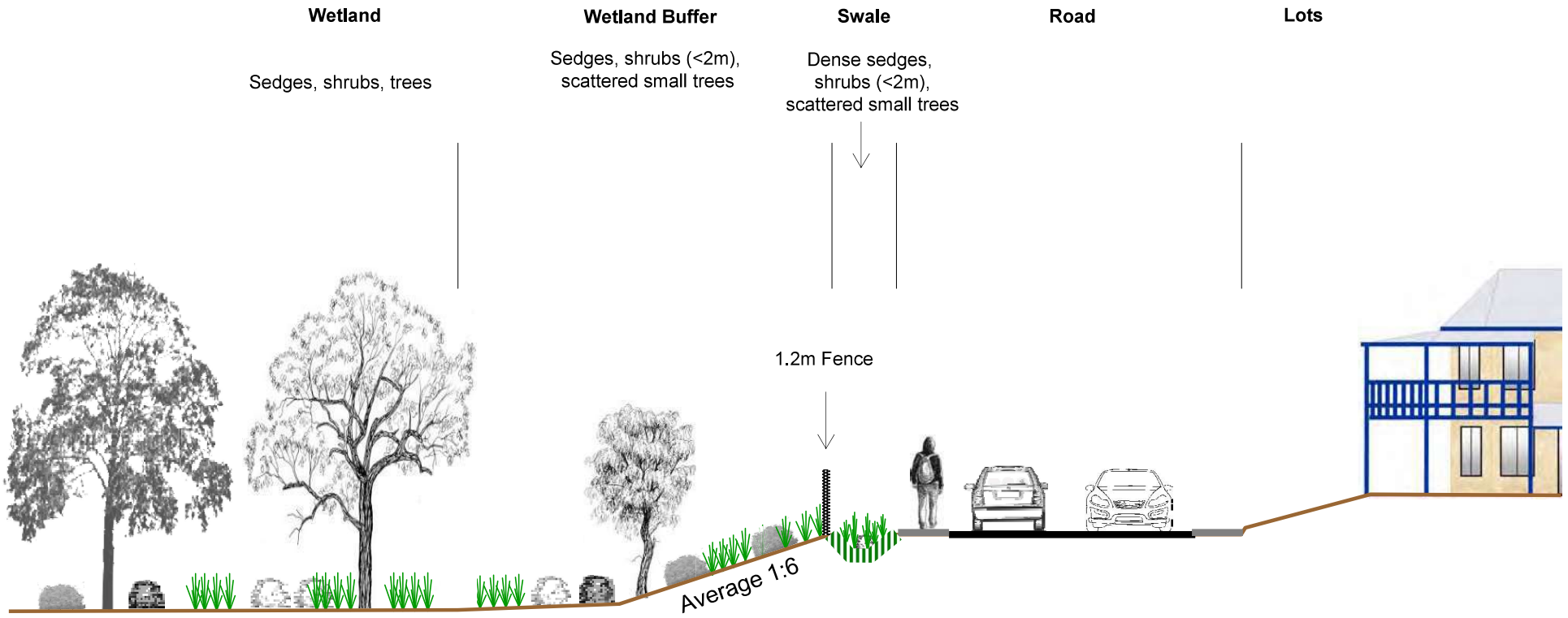

Not to scale

Figure 12

WETLAND BUFFER AND SWALE CONCEPTUAL PROFILE

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Appendix A

WAPC Subdivision Approval

Western Australian Planning Commission

Your Ref :

Lb Planning
191 Naturaliste Terrace

DUNSBOROUGH WA 6281

Approval Subject To Condition(s)
Freehold (Green Title) Subdivision

Application No : 155519

Planning and Development Act 2005

Applicant	:	Lb Planning 191 Naturaliste Terrace DUNSBOROUGH WA 6281
Owner	:	Colin Michael Piacentini Po Box 308 BUNBURY WA 6231
Application Receipt	:	2 August 2017

Lot Number	:	2,3 & 4
Diagram / Plan	:	P407125
Location	:	
C/T Volume/Folio	:	2901/250, 2901/251, 2901/252
Street Address	:	Lot 2 Maidment Parade, Dalyellup
Local Government	:	Shire of Capel

The Western Australian Planning Commission has considered the application referred to and is prepared to endorse a deposited plan in accordance with the plan date-stamped **02 August 2017** once the condition(s) set out have been fulfilled.

This decision is valid for **four years** from the date of this advice, which includes the lodgement of the deposited plan within this period.

The deposited plan for this approval and all required written advice confirming that the requirement(s) outlined in the condition(s) have been fulfilled must be submitted by **08 February 2022** or this approval no longer will remain valid.

Reconsideration - 28 days

Under section 151(1) of the *Planning and Development Act 2005*, the applicant/owner may, within 28 days from the date of this decision, make a written request to the WAPC to reconsider any condition(s) imposed in its decision. One of the matters to which the WAPC will have regard in reconsideration of its decision is whether there is compelling evidence by way of additional

information or justification from the applicant/owner to warrant a reconsideration of the decision. A request for reconsideration is to be submitted to the WAPC on a Form 3A with appropriate fees. An application for reconsideration may be submitted to the WAPC prior to submission of an application for review. Form 3A and a schedule of fees are available on the WAPC website: http://www.planning.wa.gov.au

Right to apply for a review - 28 days

Should the applicant/owner be aggrieved by this decision, there is a right to apply for a review under Part 14 section 251 of the *Planning and Development Act 2005*. The application for review must be submitted in accordance with part 2 of the *State Administrative Tribunal Rules 2004* and should be lodged within 28 days of the date of this decision to: the State Administrative Tribunal, Level 6, State Administrative Tribunal Building, 565 Hay Street, PERTH, WA 6000. It is recommended that you contact the tribunal for further details: telephone 9219 3111 or go to its website: http://www.sat.justice.wa.gov.au

Deposited plan

The deposited plan is to be submitted to the Western Australian Land Information Authority (Landgate) for certification. Once certified, Landgate will forward it to the WAPC. In addition, the applicant/owner is responsible for submission of a Form 1C with appropriate fees to the WAPC requesting endorsement of the deposited plan. A copy of the deposited plan with confirmation of submission to Landgate is to be submitted with all required written advice confirming compliance with any condition(s) from the nominated agency/authority or local government. Form 1C and a schedule of fees are available on the WAPC website: http://www.planning.wa.gov.au

Condition(s)

The WAPC is prepared to endorse a deposited plan in accordance with the plan submitted once the condition(s) set out have been fulfilled.

The condition(s) of this approval are to be fulfilled to the satisfaction of the WAPC.

The condition(s) must be fulfilled before submission of a copy of the deposited plan for endorsement.

The agency/authority or local government noted in brackets at the end of the condition(s) identify the body responsible for providing written advice confirming that the WAPC's requirement(s) outlined in the condition(s) have been fulfilled. The written advice of the agency/authority or local government is to be obtained by the applicant/owner. When the written advice of each identified agency/authority or local government has been obtained, it should be submitted to the WAPC with a Form 1C and appropriate fees and a copy of the deposited plan.

If there is no agency/authority or local government noted in brackets at the end of the condition(s), a written request for confirmation that the requirement(s) outlined in the condition(s) have been fulfilled should be submitted to the WAPC, prior to lodgement of the deposited plan for endorsement.

Prior to the commencement of any subdivision works or the implementation of any condition(s) in any other way, the applicant/owner is to liaise with the nominated agency/authority or local government on the requirement(s) it considers necessary to fulfil the condition(s).

The applicant/owner is to make reasonable enquiry to the nominated agency/authority or local government to obtain confirmation that the requirement(s) of the condition(s) have been fulfilled. This may include the provision of supplementary information. In the event that the nominated agency/authority or local government will not provide its written confirmation following reasonable enquiry, the applicant/owner then may approach the WAPC for confirmation that the condition(s) have been fulfilled.

In approaching the WAPC, the applicant/owner is to provide all necessary information, including proof of reasonable enquiry to the nominated agency/authority or local government.

The condition(s) of this approval, with accompanying advice, are:

CONDITION(S):

1. All boundaries of the subdivision area and the western boundary of Maidment Parade adjoining Regional Open Space, bushlands and wetlands are to be fenced (including provision of a gate at an agreed location) by the proponent to the standards of the Department of Biodiversity, Conservation and Attractions to control access by people, vehicles and pets. (Department of Biodiversity, Conservation and Attractions)

2. A Regional Open Space Rehabilitation and Management Plan (including wetland rehabilitation) is to be prepared and implemented to a width of 100m over the neighbouring Regional Open Space (Lot 6 and Lot 317) to the satisfaction of the Western Australian Planning Commission, in consultation with the Department of Biodiversity, Conservation and Attractions, Local Government and in accordance with EPA Advice A384782. (Department of Biodiversity, Conservation and Attractions)

3. A Wetland Rehabilitation and Management Plan is to be prepared and implemented to the satisfaction of the Western Australian Planning Commission. (Department of Biodiversity, Conservation and Attractions)

4. A Western Ringtail Possum Management Plan is to be prepared and implemented to the satisfaction of the Western Australian Planning Commission. (Department of Biodiversity, Conservation and Attractions)

5. A Black Cockatoo Management Plan is to be prepared and implemented to the satisfaction of the Western Australian Planning Commission. (Department of Biodiversity, Conservation and Attractions)

6. A Kangaroo Impact Management Plan is to be prepared and implemented to the satisfaction of the Western Australian Planning Commission. (Department of Biodiversity, Conservation and Attractions)

7. Measures being taken to ensure the identification and protection of any vegetation on the site worthy of retention that is not impacted by subdivisional works, prior to commencement of subdivisional works. (Local Government).

8. Information is to be provided to demonstrate that the measures contained in the bushfire management plan have been implemented during subdivisional works. (Local Government)

9. A Notification, pursuant to Section 165 of the *Planning and Development Act 2005* is to be placed on the certificate(s) of title of the proposed lot(s) with a Bushfire Attack Level (BAL) rating of 12.5 or above, advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan).

   The notification is to state as follows:

   'This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land' (Western Australian Planning Commission)

10. A notification, pursuant to Section 165 of the *Planning and Development Act 2005* is to be placed on the certificates of title of the proposed lot(s) advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows:

    'This lot is in close proximity to known mosquito breeding areas. The predominant mosquito species is known to carry viruses and other diseases.' (Western Australian Planning Commission)

11. A notification, pursuant to Section 165 of the *Planning and Development Act 2005* is to be placed on the certificate(s) of title of the proposed lot(s) advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows:

    'This lot is located in close proximity to a sand and limestone extraction site and may be adversely affected by virtue of noise and dust emissions from that facility.' (Western Australian Planning Commission)

12. The land denoted as proposed primary school site on the approved plan of subdivision is to be set aside as a separate lot, pending the acquisition of the land by the Department of Education. (Department of Education)

13. Arrangements being made to the satisfaction of the Western Australian Planning Commission and to the specification of Western Power for the provision of an underground electricity supply to the lot(s) shown on the approved plan of subdivision. (Western Power).

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e-mail: info@dplh.wa.gov.au; web address: http://www.dplh.wa.gov.au
ABN 35 482 341 493

14. The transfer of land as a Crown reserve free of cost to Western Power for the provision of electricity supply infrastructure. (Western Power)

15. Prior to the commencement of subdivisional works, an urban water management plan is to be prepared and approved, in consultation with the Department of Water and Environmental Regulation, consistent with the 'PT Lots 313-316 Maidment Parade and Lot 1 Harewoods Road - Dalyellup Local Water Management Strategy (Report No. J07013c, 29 April 2015'. (Local Government)

16. Engineering drawings and specifications are to be submitted and approved, and works undertaken in accordance with the approved engineering drawings and specifications and approved plan of subdivision, for the filling and/or draining of the land, including ensuring that stormwater is contained on-site, or appropriately treated and connected to the local drainage system. Engineering drawings and specifications are to be in accordance with an approved Urban Water Management Plan (UWMP) for the site, or where no UWMP exists, to the satisfaction of the Western Australian Planning Commission. (Local Government)

17. Engineering drawings and specifications are to be submitted, approved, and works undertaken in accordance with the approved engineering drawings, specifications and approved plan of subdivision, for grading and/or stabilisation of the site to ensure that:

a) lots can accommodate their intended use; and

b) finished ground levels at the boundaries of the lot(s) the subject of this approval match or otherwise coordinate with the existing and/or proposed finished ground levels of the land abutting. (Local Government)

18. The applicant making arrangements to ensure that management of mosquito breeding is incorporated into the design and ongoing maintenance of wetlands and urban drainage systems within the subdivision area to the satisfaction of the local government. (Local Government).

19. Prior to the commencement of subdivisional works, the landowner/applicant is to provide a pre-works geotechnical report certifying that the land is physically capable of development or advising how the land is to be remediated and compacted to ensure it is capable of development; and
In the event that remediation works are required, the landowner/applicant is to provide a post geotechnical report certifying that all subdivisional works have been carried out in accordance with the pre-works geotechnical report. (Local Government).

20. Drainage easements and reserves as may be required by the local government for drainage infrastructure being shown on the diagram or plan of survey (deposited plan) as such, granted free of cost, and vested in that local government under Sections 152 and 167 of the Planning and Development Act 2005. (Local Government)

21. Arrangements being made to the satisfaction of the Western Australian Planning Commission for the filling and/or capping of any bores and/or wells, or the identification of any bore and/or well to be retained on the land. (Local Government)

22. Arrangements being made with the Water Corporation or Aqwest so that provision of a suitable water supply service will be available to the lots shown on the approved plan of subdivision. (Water Corporation or Aqwest)

23. Arrangements being made with the Water Corporation so that provision of a sewerage service will be available to the lots shown on the approved plan of subdivision. (Water Corporation)

24. The proposed reserve(s) shown on the approved plan of subdivision being shown on the diagram or plan of survey (deposited plan) as reserve(s) for Drainage and Recreation and/or Community Purposes and vested in the Crown under Section 152 of the *Planning and Development Act 2005*, such land to be ceded free of cost and without any payment of compensation by the Crown. (Local Government)

25. The proposed Community Purpose reserves being connected to reticulated power, water and sewerage service. (Local Government)

26. Arrangements being made for the proposed public open space to be developed by the landowner/applicant to a minimum standard and maintained for two summers through the implementation of an approved landscape plan providing for the development and maintenance of the proposed public open space in accordance with the requirements of Liveable Neighbourhoods and to the specifications of the local government. (Local Government)

27. Arrangements being made with the Shire of Capel to the satisfaction of the Western Australian Planning Commission, for the landowner/applicant to contribute towards the costs of providing community and/or common infrastructure as established through Amendment No.65 (when gazetted) to the Shire of Capel Town Planning Scheme No.7. (Local Government)

28. The landowner/applicant entering into a Deed of Agreement with Main Roads regarding the timing, funding and upgrading of the Bussell Highway / Harewoods Road intersection, prior to the first stage of subdivision clearance, to the satisfaction of the WAPC. The terms of the Deed of Agreement is to generally reflect the "Dalyellup South - Strategy for Implementation of the Strategic Road Network - Rev 3", dated 14 December 2017 (as amended). (Main Roads WA)

29. Engineering drawings and specifications are to be submitted, approved, and subdivisional works undertaken in accordance with the approved plan of subdivision, engineering drawings and specifications, to ensure that those lots not fronting an existing road are provided with frontage to a constructed road(s) connected by a constructed road(s) to the local road system and such road(s) are constructed and drained at the landowner/applicant's cost.

As an alternative, and subject to the agreement of the Local Government the Western Australian Planning Commission (WAPC) is prepared to accept the landowner/applicant paying to the local government the cost of such road works as estimated by the local government and the local government providing formal assurance to the WAPC confirming that the works will be completed within a reasonable period as agreed by the WAPC. (Local Government)

30. Engineering drawings and specifications are to be submitted and approved, and subdivisional works undertaken in accordance with the approved plan of subdivision, engineering drawings and specifications to ensure that:

a) street lighting is installed on all new subdivisional roads to the standards of the relevant licensed service provider; and

b) roads that have been designed to connect with existing or proposed roads abutting the subject land are coordinated so the road reserve location and width connect seamlessly; and

c) temporary turning areas are provided to those subdivisional roads that are subject to future extension; and

d) embayment parking is provided abutting Public Open Space and the proposed medium density lots affected by access restrictions imposed by condition 37;

to the satisfaction of the Western Australian Planning Commission. (Local Government)

31. Engineering drawings and specifications are to be submitted, approved, and subdivisional works undertaken in accordance with the approved plan of subdivision, engineering drawings and specifications, for the provision of shared paths through and connecting to the application area in accordance with the Dalyellup South - Strategy for the Implementation of the Strategic Road Network. The approved shared paths are to be constructed by the landowner/applicant. (Local Government)

32. Arrangements being made for the preparation and implementation of the Dalyellup South - Strategy for the Implementation of the Strategic Road Network to the satisfaction of the local government, in consultation with Main Roads WA. (Local Government)

33. Harewoods Road being widened to 22 metres where it abuts the application area in accordance with the approved plan of subdivision by the landowner transferring the land required to the Crown free of cost for the purpose of widening. (Local Government)

34. The section of Harewoods Road widened in accordance with this approval, is to be constructed and drained at the full cost of the landowner/applicant. (Local Government)

35. All local streets within the subdivision being truncated in accordance with the Western Australian Planning Commission's *Liveable Neighbourhoods* policy.(Local Government)

36. Pursuant to Section 150 of the *Planning and Development Act 2005* and Division 3 of the *Planning and Development Regulations 2009* a covenant preventing vehicular access onto Harewoods Roads being lodged on the certificate(s) of title of proposed lots 1, 18, 34, 35, 93, 94, 124, 583 at the full expense of the landowner/applicant. The covenant is to prevent access, to the benefit of the Shire of Capel, in accordance with the plan dated 2 August 2017 (attached) and the covenant is to specify:

    "*No vehicular access is permitted to and from (as applicable) Harewoods Road*" (Local Government)

37. Pursuant to Section 150 of the *Planning and Development Act 2005* and Division 3 of the *Planning and Development Regulations 2009* a covenant preventing vehicular access onto the primary street frontage being lodged on the certificate(s) of title of proposed lots 130-146, 171-207, 230-237, 262-269, 275, 367-374, 380, 499-505, 526-532 and 553-559 (inclusive) at the full expense of the landowner/applicant. The covenant is to prevent access, to the benefit of the Shire of Capel, in accordance with the plan dated 2 August 2017 (attached) and the covenant is to specify:

    "*No vehicular* access *is permitted to and from (as applicable) the primary street frontage*." (Local Government)

38. Local Development Plan(s) being prepared and approved for lots 8-11, 19-22, 26-29, 57-60, 73-76, 83-86, 100-103, 110-113, 117-120, 130-138, 139-146, 157-160, 171-211, 218-237, 248-251, 262-279, 291-294, 306-327, 328-331, 337-381, 394-397, 409-412, 421-425, 433-435, 449-452, 481-484, 499-505, 514-517, 526-532, 541-544, 553-559 and 568-571 that addresses the following:

a) Vehicular access points;

b) Driveways, garages and setbacks; and

c) Uniform fencing.

to the satisfaction of the Western Australian Planning Commission. (Local Government)

39. Uniform fencing being constructed along the boundaries of all of the proposed lots abutting public open space. (Local Government)

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e-mail: info@dplh.wa.gov.au; web address: http://www.dplh.wa.gov.au
ABN 35 482 341 493

40. Uniform fencing being constructed along the primary street frontage of lots 130-146, 171-207, 230-237, 262-268, 367-380, 499-505, 526-532 and 553-559. (Local Government)

41. The landowner/applicant shall make arrangements to ensure that prospective purchasers are advised in writing that:

a) lots the subject of a Local Development Plan that Local Development Plan provisions apply;

b) the Shire of Capel will impose a specified area rate within the Precinct for the purposes of assisting with the maintenance of public open space and infrastructure in the locality; and

c) portions of public open space will be subject to occasional inundation as part of the functioning of the local stormwater drainage system and action that should be taken to minimise the release of nutrients to the local environment from their premises.(Local Government)

42. The street block containing Lots 306-326 (inclusive) being redesigned such that proposed Lots 306, 307, 325 and 326 achieve a minimum lot size of 260m² per lot. (Western Australian Planning Commission)

ADVICE:

i. In regard to Condition 6, the management plan is to cover the application area and Lot 317 to the south.

ii. In regard to Condition 11, the landowner/applicant is advised that if evidence is provided that the sand and limestone extraction have ceased operating after conditional approval is granted then Condition 11 will no longer need to be satisfied.

iii. In regard to Condition 13, Western Power provides only one underground point of electricity supply per freehold lot.

iii. Condition 16 has been imposed in accordance with Better Urban Water Management Guidelines (WAPC 2008). Further guidance on the contents of urban water management plans is provided in 'Urban Water Management Plans: Guidelines for preparing and complying with subdivision conditions' (Published by the then Department of Water 2008).

iv. In regard to Condition 24, separate reserves are to be created for the Community Purpose sites, in consultation with the Shire of Capel.

v. With regard to Condition 24, the development is to include full earthworks, basic reticulation, grassing of key areas, and pathways that form part of the overall pedestrian and/or cycle network.

vi. With regard to Condition 26, the development is to include full earthworks, basic reticulation, grassing of key areas, and pathways that form part of the overall pedestrian and/or cycle network.

vii. Condition 27 is in acknowledgement of proposed Amendment No.65 that is viewed by the Western Australian Planning Commission to be a seriously entertained planning proposal, which will provide for developer contributions for community infrastructure.

viii. In regard to Condition 34, the applicant may come to agreement with other landowners for shared contributions to the upgrade, at their agreement.

ix. The landowner/applicant and the local government are advised to refer to the Institute of Public Works Engineering Australia Local Government Guidelines for Subdivisional Development (current edition). The guidelines set out the minimum best practice requirements recommended for subdivision construction and granting clearance of engineering conditions imposed.

Kerrine Blenkinsop
Secretary
Western Australian Planning Commission
8 February 2018

Enquiries : Scott Penfold (Ph 9791 0588)

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ABN 35 482 341 493

LOT YIELD TABLE					
LOT YIELD			LOT AREA		
Size	No. Lots	% Total Lots	Average Size	% of Total Area	Area
180m² - 234m²	43	7.43%	225m²	4.17%	9675m²
235m² - 319m²	89	15.37%	268m²	10.30%	23870m²
320m² - 449m²	172	29.71%	373m²	27.71%	64232m²
450m² - 499m²	207	35.75%	472m²	42.17%	97758m²
500m² - 549m²	54	9.33%	520m²	12.13%	28114m²
550m² - 599m²	11	1.90%	571m²	2.71%	6287m²
600m² - 699m²	3	0.52%	624m²	0.81%	1872m²
Total Number of Lots	579				
SCHOOL SITE	1				3.51ha
LOCAL CENTRE	1				5131m²
BALANCE LOT	1				12.04ha

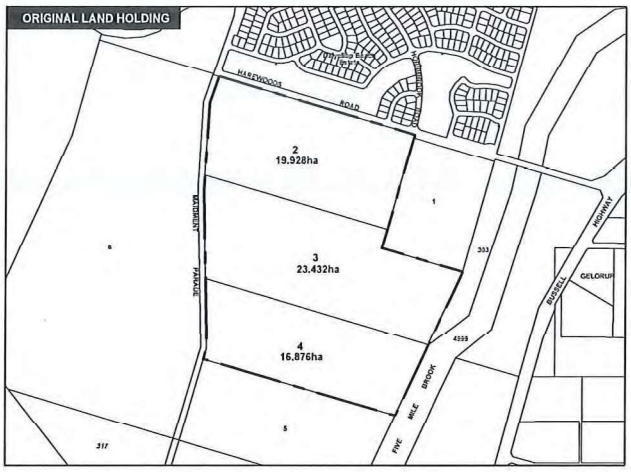
Residential Lots: Minimum Lot Size 225m² Average Lot Size 400m²
Maximum Lot Size 654m² Total Lot Area 231816m²

POS TABLE	
POS A	1.53ha
POS B	3384m²
POS C	6002m²
POS D	1.54ha
POS E	3.85ha
POS TOTAL	8.30ha

DEPARTMENT OF PLANNING, LANDS AND HERITAGE

DATE 02-Aug-2017 FILE 155519

ORIGINAL LAND HOLDING



A	16/3/2017	FIRST ISSUE
Revision	Date	Item

NOTES
Base data supplied by Landgate / MNG
Areas and dimensions shown are subject to final survey calculations.
All contaminants are shown for illustrative purposes only and are subject to detailed engineering design.
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LEGEND
- APPLICATION BOUNDARY
- PROPOSED BOUNDARY
- EXISTING BOUNDARY TO BE REMOVED
- EXISTING VEGETATION

PHOENIX RISE DEVELOPMENTS PTY LTD
CLIENT : DEVELOPMENTS PTY LTD
SCALE : 1:2,000@A1
DATE : 26 July 2017
PLAN No : DS-3-002.dgn
REVISION : B
PLANNER : SLB
DRAWN : BL

PROPOSED PLAN OF SUBDIVISION
Lots 2, 3 & 4 Maldment Parade, DALYELLUP

LB PLANNING
TOWN PLANNING | URBAN DESIGN | LAND DEVELOPMENT CONSULTING

Appendix B

Soil Logs

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**1C**
EASTING:	370872
NORTHING:	6302189
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.5
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.2	Dark grey sand		
0.2 - 0.4	Pale grey sand		
0.4 - 0.6	Dark grey sand		
0.6 - 1.1	Dark yellow-brown sand		
1.1 - 1.5	Brownish yellow sand; seepage at about 1.4m		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**1C.5**
EASTING:	370860
NORTHING:	6302189
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.5
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.4	Dark grey sand		
0.4 - 1.5	Brownish-grey sand with very slight mottling; seepage at 1.15m		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**1D**
EASTING:	370850
NORTHING:	6302186
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.8
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.25	Dark grey sand		
0.25 - 0.6	Peaty sand		
0.6 - 0.7	Dark grey sand		
0.7 - 1.4	Grey sand, slight H_2S smell		
1.4 - 1.75	Pale grey sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**1E**
EASTING:	370830
NORTHING:	6302184
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.7
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.2	Dark grey sand		
0.25 - 0.45	Dark grey slightly peaty sand; seepage at 0.45m		
0.45 - 1.55	Dark grey sand		
1.55 - 1.7	Grey-brown silty sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**2C.5**
EASTING:	370881
NORTHING:	6301772
METHOD:	Excavator
TOTAL DEPTH (mbgl):	
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.15	Dark grey sand		
0.15 - 0.7	Brownish-grey sand		
0.7 - 1.1	Grey sand		
1.1 - 1.5	Yellow-brown sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**2D**
EASTING:	370870
NORTHING:	6301774
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.5
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.3	Dark grey sand		
0.3 - 0.75	Dark grey slightly peaty sand		
0.45 - 1.1	Dark grey sand		
1.1 - 1.4	Pale grey-brown sand		
1.4 - 1.5	Yellow sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**2D.5**
EASTING:	370860
NORTHING:	6301778
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.7
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.1	Dark grey sand		
0.1 - 0.45	Brownish-grey sand		
0.45 - 1.5	Dark brown peaty sand		
1.5 - 1.7	Pale grey-brown sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**2E**
EASTING:	370949
NORTHING:	6301776
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.9
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.25	Dark grey sand		
0.25 - 0.35	Grey-brown sand		
0.35 - 1.7	Dark grey peaty sand		
1.7 - 1.9	Brownish grey clayey sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**2F**
EASTING:	370829
NORTHING:	6301777
METHOD:	Excavator
TOTAL DEPTH (mbgl):	2.1
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.1	Dark grey silty sand		
0.1 - 0.5	Pale silty sand with marly clay nodules		
0.5 - 2.1	Dark brownish grey peaty sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**3C**
EASTING:	370807
NORTHING:	6301349
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.5
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.25	Dark grey sand		
0.25 - 0.8	Grey sand		
0.8 - 1.5	Pale grey-brown sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**3C.5**
EASTING:	370708
NORTHING:	6301349
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.7
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.1	Dark grey sand		
0.1 - 0.4	Paler grey clayey sand		
0.4 - 1.0	Dark brown peaty sand		
1.0 - 1.65	Brown sand		
1.65 - 1.7	Pale grey sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**3D**
EASTING:	370785
NORTHING:	6301350
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.9
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.15	Dark grey loamy sand		
0.15 - 0.45	Pale brownish-grey clayey sand		
0.45 - 1.2	Dark brown peaty sand		
1.2 - 1.9	Brownish-grey sand; seepage from 1.6m		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**3E**
EASTING:	370766
NORTHING:	6301351
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.8
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.15	Grey clayey sand		
0.15 - 0.45	Pale brown clayey sand		
0.45 - 1.3	Dark brown peaty sand		
1.3 - 1.75	Brownish-grey silty sand; H_2S smell		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**3F**
EASTING:	370745
NORTHING:	6301350
METHOD:	Excavator
TOTAL DEPTH (mbgl):	2.4
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.2	Dark brown sand		
0.2 - 0.25	Pale grey-brown clayey sand		
0.25 - 2.4	Dark brown peaty sand		

SOIL PROFILE LOG

PROJECT NUMBER:	J07013
SITE ID:	**3G**
EASTING:	370725
NORTHING:	6301350
METHOD:	Excavator
TOTAL DEPTH (mbgl):	1.5
REFUSAL (Y/N):	N
DATE:	25/05/2008
DEPTH TO WATER (mbgl)	

SOIL PROFILE		**SAMPLE DATA**	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0 - 0.2	Dark grey clayey sand		
0.2 - 1.0	Orange iron-enriched soft pan; copious seepage from 0.4m		
1.0 - 1.5	Dark grey peaty sand		

Appendix C

Botanical Report

VEGETATION SURVEYS AND RARE FLORA SEARCHES
Pts LOTS 313 TO 317 HAREWOODS ROAD
West of Minninup Road Reserve

GELORUP

Shire of Capel

Prepared by

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24 MARCH 2009

SUMMARY

This report describes methods and presents results of vegetation surveys, condition assessments and searches for rare flora in the western, Vasse and, possibly, Quindalup parts of Lots 313-317 Harewoods Road, Gelorup. The principal objectives of this project are to search the property for Declared Rare and Priority Flora, and to describe and map vegetation units and to assess their condition.

Fieldwork for the project was done by botanist Dr Arthur Weston and assistants in, mainly, spring and summer 2007-2008.

VEGETATION UNITS

Nine vegetation units with native, not-planted plants in them were distinguished on the basis of height, density and dominant species. These vegetation units, and six others with few or no natives in them, and the symbols used for them in the Figure 1, Vegetation Units and Relevé Locations, are:

Upland Associations (4 units)

- Peppermint (*Agonis flexuosa*) Open to Closed Low Forest **Pf**
- Peppermint (*Agonis flexuosa*) Woodland **Pw**
- Tuart (*Eucalyptus gomphocephala*) Open Forest to Woodland **Tfw**
- Tuart (*Eucalyptus gomphocephala*) Woodland **Tw**

Wetland and Transitional Associations (5 units)

- *Baumea articulata (*Jointed Rush) Closed Tall Sedgeland **B**
- *Lepidosperma gladiatum* (Coast Sword-sedge) Open Sedgeland **G**
- *Melaleuca rhaphiophylla* (Swamp Paperbark) Open to Closed Low Forest **M**
- Bulrush (*Typha orientalis*) - *Baumea articulata* Closed Tall Rushland **RB**
- Wattle (*Acacia saligna*) - Peppermint Closed Low Forest **WP**

Vegetation with few, if any, Native Plants (6 units)

- Aliens: mixed grasses and other herbaceous plants **AH**
- Bulrush (*Typha orientalis*) Tall Rushland, mainly Closed **R**
- Bulrush (*Typha orientalis*) Tall Rushland &/over mixed low herbs **RH**
- Bulrush (*Typha orientalis*) Tall Rushland &/over *Isolepis prolifera* Clubrush **RI**
- *Cirsium vulgare* - *Centella asiatica* Closed mixed, mostly alien, Herbland **C**
- Sumpland: open water in spring; herbland in summer **So**

Approximately one-third of the bushland in the project area is of upland units, which intergrade and vary widely in density and relative proportions of dominant trees. Tuart and Peppermint trees are in all of the upland vegetation units with native vegetation in them. Except for a few small areas, the understorey comprises various mixtures of pasture grasses and established alien species (weeds) of grasses and herbaceous plants.

Approximately two-thirds of the bushland in the project area is of wetland units, most of which are dominated by one or more of several established alien species, especially Bulrush (*Typha orientalis*) and Clubrush (*Isolepis prolifera*). However, four native species are dominants of relatively small stands of native wetland and transitional vegetation in Good to Very Good to Excellent condition. These species are *Agonis flexuosa, Acacia saligna, Melaleuca rhaphiophylla* and *Baumea articulata*.

VEGETATION CONDITION

The condition of the bushland vegetation is shown in Figure 2, Vegetation Condition. It is assessed as generally Degraded to Completely Degraded, and even Totally Cleared, largely due to replacement of native shrubs and herbaceous plants in the understorey by aliens. It ranges, on the six-point Keighery-Trudgen scale, from Completely Degraded (CD) to Good (G) and, in a few relatively small areas Very Good to Excellent (VG-E). There are also areas totally cleared of native species (TC).

VEGETATION COMPLEXES

All of the project area, or at least the wetland part of it, is in the Vasse Vegetation Complex, which typically consists of closed scrub of *Melaleuca* species fringing woodlands of *Eucalyptus rudis – Melaleuca* spp. and open forest of *Eucalyptus gomphocephala – E marginata – Corymbia calophylla.*

FLORISTIC COMMUNITY TYPES

It would be impossible to assign most, if not all, of the vegetation of the Gelorup project area to any floristic community type on the basis of detailed floristic analysis because there is so little native understorey or ground layer vegetation and so few native species left in it.

The location of the lots, the presence of *Agonis flexuosa* and Tuart in most of the upland vegetation, which is on Quindalup South Soil-Landscape Units, and the presence of *Melaleuca rhaphiophylla*, *Gahnia trifida, Acacia saligna, Baumea articulata* and *Centella asiatica* in the wetlands suggest that the floristic groups most likely to be represented in the project area are degraded Floristic Community Types (FCTs) 12, 17 or 30b, or combinations of them, and possibly FCT 15 (Gibson *et al* 1994).

None of these floristic community types is on the Threatened Ecological Community (TEC) database.

FLORA

Approximately 80 taxa (species, subspecies and varieties) of vascular plants were recorded and identified, at least to genus, during the study. Approximately 45 of the taxa are native, and 36 aliens (weeds). It is estimated that these numbers comprise around 60-70% of the flora of the project area.

No Declared Rare Flora or Priority Flora species was found during the fieldwork, nor were likely habitats for any identified.

TABLE OF CONTENTS

VEGETATION SURVEYS AND RARE FLORA SEARCHES
Pts LOTS 313 TO 317 HAREWOODS ROAD
(West of Minninup Road Reserve)
GELORUP, CITY of BUNBURY

1.0 INTRODUCTION

This report describes methods and presents results of vegetation surveys, condition assessments and searches for rare flora in the western, Vasse and Quindalup parts of Lots 313-317 Harewoods Road, Gelorup. These parts are referred to in this report as 'the project area'.

1.1 LOCATION

The project area is the parts of Lots 313, 314, 315, 316 and 317 Harewoods Road, Gelorup, that are south-west of the western end of Harewoods Road and on the western side of the Minninup Road reserve. Each of the five lots is divided approximately in half by the Minninup Road reserve. There is no road separating the lot parts from each other, but a fence on the eastern edge of the road reserve does that.

The total size of the five lots is 188ha. The size of the western parts, the project area, is 73ha.

1.2 OBJECTIVES

The principal objectives of this project were to:

- describe and map project area vegetation units and condition based upon field work and interpretation of high resolution aerial photography,
- set up and sample between 5 and 10 (depending upon nature and condition of vegetation) floristic quadrats (or relevés) in the project area,
- infer Floristic Community Types from analyses of the quadrat (or relevé) samples,
- search the project area for significant flora, mainly the species of Declared Rare Flora (DRF) and Priority Flora (P) listed in results of Department of Environment and Conservation (DEC) searches of DEC flora databases,
- prepare a report, including descriptions of vegetation and condition and the locations of any rare, or otherwise significant, flora found.

The EPA's *Guidance No. 51* (Environmental Protection Authority 2004) was used in the preparation of this report. As the anticipated scale and nature of the proposed project's impact on native vegetation and flora in the project area would be low, a Level 1 Reconnaissance Survey, as described on Page 39 of *Guidance No. 51*, was undertaken. Also, relevés of stands of native vegetation in the project area in best condition were sampled.

A Level 1 survey consists of the following two stages:

- Background research or 'desktop' study, and
- Reconnaissance survey.

1.3 REGIONAL SETTING

1.3.1 Landforms and Soils

Churchward and McArthur (1978) show two of their landforms-soils units as occurring in the project area. These are the Quindalup (Q) unit, "coastal dunes and beach ridges composed of calcareous sand", and the Vasse (V) unit, "poorly drained plains with variable undifferentiated estuarine and marine deposits". The Churchward and McArthur 1:250 000 scale maps show the Quindalup unit as extending more or less continuously along the coast from the south-western edge of their mapping, at Peppermint Grove Beach, to the northern end, north of Lancelin. They show the Vasse unit as having a patchy occurrence on the western side of the Swan Coastal Plain from the south-western edge of their mapping, at Peppermint Grove Beach, to Mandurah, with small outliers along the Swan River in Perth, South Perth and Nedlands. The northern end of the most southern Vasse occurrence they show is in the vicinity of Harewoods Road, and the next occurrence is in Bunbury.

Mapping by the Department of Agriculture WA, as depicted in Figure 3 of BES (2009), shows the soil-landscape unit of the eastern, wetland side of the project area as Spearwood S3a, and the units of the western, upland side of the project area as Quindalup South Qd and Qp3.

1.3.2 Wetlands

The DEC's Geomorphic Wetlands Database maps about 35ha of the project area as a wetland. The wetland type is shown as Basin Sumpland and the management category as Conservation. The mapped wetland extends from the base of the Quindalup dunes in the west of the project area to just west of the Minninup Road reserve.

The wetland within the project area is part of a much larger (258ha) sumpland that extends uninterrupted for about 8.5km south from Dalyellup. Various parts of this sumpland have been classified as Conservation, Resource Enhancement and Multiple Use categories by the DEC, apparently on the basis of vegetation condition and land tenure.

1.3.3 Vegetation

Heddle *et al.* (1978) and Smith (1974) have mapped the vegetation of Gelorup and the Bunbury and Collie areas at a scale of 1:250 000. The Heddle *et al.* mapping is, like the Churchward and McArthur (1978) mapping, broad-scale (1:250 000), and it often follows the landform-soil boundaries mapped by Churchward and McArthur. Vegetation complexes are mapped as they are presumed to have been in pre-European times, prior to any clearing.

Smith (1974) mapped vegetation at the same scale as Heddle *et al.* (1978) -1:250 000 - but as it was at the time he mapped it, in 1973 and 1974. The units he mapped are Formations, which are defined by plant height, form and cover (or density), and Plant Associations, which are defined floristically, by which species are dominant. The Smith vegetation maps distinguish between formations by the colours of their polygons and use letter symbols to indicate plant associations.

Vegetation Complexes (Heddle *et al.* 1978)

Heddle *et al.* (1978) show two of their vegetation complexes – groupings of plant communities defined in relation to site-vegetation types, landform-soil units and rainfall - as occurring in the project area.

The two vegetation complexes in the project area are the Quindalup Vegetation Complex (55) and the Vasse Vegetation Complex (57); they are more or less coincident with the Quindalup (Q) and Vasse (V) landform-soil units and occur on them. The Quindalup Complex extends more or less continuously along the coast from the south-western edge of the Heddle *et al.* mapping, at Peppermint Grove Beach, to the northern end, north of Lancelin, but the Quindalup Vegetation Complex is narrower at its northern end than the Quindalup landform-soils unit. The Vasse Complex has a patchy occurrence on the western side of the Swan Coastal Plain from the south-western edge of their mapping, at Peppermint Grove Beach, to Mandurah, with small outliers along the Swan River in Perth, South Perth and Nedlands. The northern end of the most southerly Vasse Complex occurrence they show is in the vicinity of Harewoods Road, and the next occurrence is in Bunbury.

The Vasse Vegetation Complex typically consists of closed scrub of species of *Melaleuca*, fringing woodlands of *Eucalyptus rudis – Melaleuca* spp. and open forest of *Eucalyptus gomphocephala – E marginata – Corymbia calophylla*. Twenty nine percent of the Vasse Complex remains on the southern Swan Coastal Plain. This percentage is slightly under the 30% level set by the Environmental Protection Authority (2000) and Environment Australia (2001) below which there should be no more clearing.

Twenty three percent of the Vasse Complex remains in the Greater Bunbury Region, of which 22% is within secure tenure. Within a 15 kilometre radius of the project area, approximately 3761 hectares is vegetated with the Vasse Complex. About 81ha of the Vasse Complex is in either System Six areas or National Parks within 15km of the project area.

Formations and Plant Associations (Smith 1974)

Smith shows the project area as being Peppermint (*Agonis flexuosa*) Low Shrubland (under 2 m high) flanked by Tuart Woodland, in the Spearwood Vegetation System. The southern end of the Peppermint Low Shrubland is on the western side of the Stratham Golf Course, where it is flanked on the west by coastal Open Heath and on the east by Tuart Woodland and Banksia Low Open Forest. The Smith map shows no clearing nor paperbark or other distinctively wetland vegetation in Lots 316 to 317.

The narrow strip of Peppermint Low Shrubland between Harewoods Road and the Stratham Golf Course is the only occurrence of this vegetation unit shown on the Smith map. Part of it has been cleared and developed since Smith mapped it.

2.0 METHODS

The vegetation survey and rare flora search comprised the following three overlapping and interrelated stages:

- preparation for fieldwork, particularly preparation of Table A1 (see Appendix A), familiarization with the appearance of the flora to be searched for, and examination of relevant reports, maps and other information;

- fieldwork to determine units, distribution and condition of vegetation and rare flora habitats and presence or absence of any rare flora listed in Table A1 and any other significant flora, and

- office and herbarium work done following the fieldwork (1) to check identifications of plant specimens collected during fieldwork and (2) to prepare this report.

2.1 PREPARATION FOR FIELD WORK

Preparation for field work entailed provisional description, listing and mapping of vegetation units of the project area and preparing a table of rare flora to be searched for during field work. Methods for field work were chosen during the preparation stage.

2.1.1 Vegetation

Provisional description, mapping and understanding of vegetation of the project area were based upon prior field work in the general area, examining digital aerial photography and reading various publications and maps. Vegetation unit boundaries were checked by examination of digital aerial photography provided by Bayley Environmental Services.

2.1.2 Floristic Community Types

The most accurate way to determine which floristic community types (FCTs) are in a Swan Coastal Plain study area is to select, sample and analyse Gibson-type, 10m by 10m quadrats (plots) using the techniques described by Gibson *et al.* (1994) and Keighery (1994). An essential component of these techniques is the compilation of a complete list of species for each quadrat based upon correctly identified plant specimens. This often requires sampling the quadrat more than once.

It should be possible, however, according to Gibson (pers. comm.) and *Bush Forever* (Government of Western Australia 2000, Volume 2, p. 487), to infer, at least tentatively, which floristic community types, at least of the original 43 described by Gibson et al. (1994), occur in a study area. Inferences of which FCTs occur in particular Bush Forever sites have been made from "information on the floristics of the area and the area's geographic location" (Government of Western Australia 2000, Volume 2, p. 487).

More specifically, inferences can be made by comparing comprehensive lists of species, key species, aerial photography and other information from an area with:

1. the 'Thirty Group Classification' descriptions of floristic community types in Gibson *et al.* (1994, pp. 29-30, 37, 39-45),

2. the sorted two-way Table 12 in Gibson *et al.* (1994, pp. 31-36), which shows species

frequency by community type in Species Groups A through S,

3. the descriptions of community types and maps of locations of their sampling quadrats in Appendix 1 of Gibson *et al.* (1994, pp. 74-159),

4. geomorphological and land system information about the study area and its vicinity (e.g. Agriculture WA 1991 mapping; and, to a lesser extent, the Churchward and McArthur 1978 smaller scale maps),

5. lists of floristic community types, bushland areas and locations of sampling quadrats given in appendices of Gibson *et al.* (1994) and in relevant surveys and reports by consultants and others, and

6. Bushland Plant Survey Recording Sheets for sampled quadrats in similar areas of bushland as near the study area as possible (Department of Environmental Protection 1996).

Looking at sampling quadrat sites of floristic community types recorded nearest the study area and comparing them with plant communities in the study area might also be helpful.

This study used some of these methods as adjuncts to sampling six temporary relevés. The locations of these relevés is shown in Figure 1, and brief descriptions of them are given in Appendix C, along with the coordinates of their locations.

2.1.3 Rare Flora

The first phase of the rare flora search was preparation of a table of taxa of Declared Rare and Priority Flora with distributions and locations that may include the broader area. This table was compiled from the results of searches of three databases carried out by the Wildlife Branch of Department of Environment and Conservation (DEC). These three DEC databases are *Threatened (Declared Rare) Flora* (Summary of Threatened Flora Data), *Declared Rare and Priority Flora List* and *Western Australian Herbarium Specimen* (WAHERB). The searches were for Declared Rare and Priority Flora taxa recorded in the general vicinity of the project area and up to 10 km or more from it.

Table A1 in Appendix A lists the taxa in the results of the DEC rare flora database searches. The table also lists conservation codes, distributions, localities, growth forms, habitats and flowering times.

2.1.4 Significant Vegetation

Guidance No. 10 (Environmental Protection Authority 2003, pp. 54-56) provides information about conservation and reservation status of vegetation complexes of the southern Swan Coastal Plain.

There are no publications that provide information about conservation and reservation status of vegetation units in the general area, but Gibson *et al.* (1994), English and Blyth (1997) and WA Threatened Species &Communities Unit do so for floristic community types and threatened ecological communities.

Table A2 in Appendix A lists Threatened Ecological Communities recorded in the general vicinity of the project area. The table was compiled from the results of a DEC Wildlife

Branch search of its *Threatened Ecological Community* database for Threatened Ecological Communities recorded up to 10 km or more from the project area.

2.2 FIELD WORK

The field work component of the study was undertaken by botanist Dr. Arthur Weston, colleagues and assistants on 4 August, 30 September, 1 and 29 October and 15 November 2007 and 23 January 2008. Observations on structure and floristic composition of vegetation were recorded, condition of the vegetation was assessed and rare flora were searched for. More detailed descriptions of vegetation structure and floristics were made at relevé sites and other waypoints. Locations of waypoints are shown in Figure 1, and coordinates of the relevé waypoints are listed in Appendix C.

The classification system used for describing vegetation and the six-point scale used for assessing vegetation condition are based upon Keighery (1994), Muir (1977) and Government of Western Australia (2000, Vol. 2, p. 493), and from Keighery (1994), Trudgen (1991) and Government of Western Australia (2000, Vol. 2, pp. 493-494), respectively.

The part of the system for descriptions of vegetation used in this report is:

Canopy cover /Form, height	100% - 70%	70% - 30%	30% - 10%	10% - 2%
Trees 10-30m Trees < 10m	Closed Forest Closed Low Forest	Open Forest Open Low Forest	Woodland Low Woodland	Open Woodland Open Low Woodland
Shrubs > 2m Shrubs 1-2m Shrubs < 1m	Closed Tall Scrub Closed Heath Closed Low Heath	Open Tall Scrub Open Heath Open Low Heath	Tall Shrubland Shrubland Low Shrubland	Open Tall Shrubland Open Shrubland Open Low Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Also Sedges: Sedgelands. Rushes: Rushlands. etc.				

The six-point condition scale is, basically:

P	Pristine	No obvious signs of disturbance,
E	Excellent	Vegetation structure intact, disturbance affecting individual species (plants?), weeds are non-aggressive species,
VG	Very Good	Vegetation structure altered, obvious signs of disturbance,
G	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance; basic vegetation structure or ability to regenerate it is retained,
D	Degraded	Basic vegetation structure severely impacted by disturbance; scope for regeneration but not to a state approaching good condition without intensive management, and
CD	Completely Degraded	Vegetation structure not intact; the area completely or almost completely without native species ('parkland cleared').
TC		Vegetation structure destroyed and native species absent

The 'TC' is an additional condition point which is used for areas that were completely cleared of native vegetation, often with a grader or bulldozed or ploughed.

Flora and vegetation units and condition were recorded at waypoints, in relevés and elsewhere, and provisional vegetation descriptions and map boundaries were confirmed and revised.

Specimens of dominant and characteristic plants not readily identifiable in the field, or with help from keys and descriptions in Wheeler *et al.*(2002), Marchant *et al.* (1987), Hussey *et al.* (1987, 2007), other floras and articles were collected for subsequent identification. Voucher specimens of uncommon and possibly significant plants were also collected and pressed.

2.3 AFTER FIELD WORK

After returning from field work, pressing of plant specimens collected during the field work was completed, and the pressed specimens were dried. The specimens were identified by checking them against FloraBase (2008), a variety of keys and descriptions in floras and taxonomic works, only some of which are referred to in this report, by consulting other botanists, and, after fumigation, by comparing them with specimens in collections in the Western Australian Herbarium in South Perth.

During the process of identification and following it, the names of the plants identified were checked against the tables in Appendix A and other lists of significant flora, including Atkins 2006, 2008b)

The provisional vegetation descriptions and boundaries were revised, refined and finalised, and the significance of vegetation units, vegetation complexes and floristic community types in the project area was assessed in terms of conservation significance and reservation status.

Maps were drawn to show boundaries and condition of vegetation units in the project area, and locations of significant flora recorded.

3.0 RESULTS AND DISCUSSION

3.1 VEGETATION

3.1.1 Vegetation Units

Nine vegetation units with native, not-planted plants in them were distinguished on the basis of height, density and dominant species. These vegetation units, and six others with few or no natives in them, and the symbols used for them in the Figure 1, Vegetation Units and Relevé Locations, are listed below. Photographs of them are in Figure 3 and Appendix C.

Upland Vegetation Units (4 mapped units)

- Peppermint (*Agonis flexuosa*) Open to Closed Low Forest **Pf**
- Peppermint (*Agonis flexuosa*) Woodland **Pw**
- Tuart (*Eucalyptus gomphocephala*) Open Forest to Woodland **Tfw**
- Tuart (*Eucalyptus gomphocephala*) Woodland **Tw**

Wetland and Transitional Vegetation Units (5 mapped units)

- *Baumea articulata* (Jointed Rush) Closed Tall Sedgeland **B**
- *Lepidosperma gladiatum* (Coast Sword-sedge) Open Sedgeland **G**
- *Melaleuca rhaphiophylla* (Swamp Paperbark) Open to Closed Low Forest **M**
- Bulrush (*Typha orientalis*) - *Baumea articulata* Closed Tall Rushland **RB**
- Wattle (*Acacia saligna*) - Peppermint Closed Low Forest **WP**

Vegetation with few, if any, Native Plants (6 mapped units)

- Aliens: mixed grasses and other herbaceous plants **AH**
- Bulrush (*Typha orientalis*) Tall Rushland, mainly Closed **R**
- Bulrush (*Typha orientalis*) Tall Rushland &/over mixed low herbs **RH**
- Bulrush (*Typha orientalis*) Tall Rushland &/over *Isolepis prolifera* Clubrush **RI**
- *Cirsium vulgare - Centella asiatica* Closed mixed, mostly alien, Herbland **C**
- Sumpland: open water in spring; herbland in summer **So**

Upland Vegetation

Approximately one-third of the bushland in the project area is a mosaic of upland units, which intergrade and vary in density and relative proportions of the two dominant trees. Tuart and Peppermint trees are in all of the upland vegetation units with native vegetation in them. Except for a few small areas, the understorey comprises various mixtures of pasture grasses and other established alien species (weeds) of grasses and herbaceous plants. The most common or conspicuous native understorey species include the shrubs *Rhagodia baccata, Diplolaena dampieri, Myoporum caprarioides, Templetonia retusa, Leucopogon parviflorus* and *Spyridium globulosum,* the lianes *Hardenbergia comptoniana* and *Clematis linearifolia,* the herbaceous species *Acanthocarpus preissii* and the sedge *Lepidosperma gladiatum.*

A small area of upland vegetation assessed as being in best condition, due to paucity of weeds in it, is Relevé 6. The species recorded in this relevé, and in the other five relevés, are listed in Appendix B, the relevés are illustrated and briefly described in Appendix C, and their locations are shown in Figure 1.

Wetland Vegetation

Approximately two-thirds of the bushland in the project area is of wetland units, most of which are dominated by one or few of several established alien species, especially Bulrush (*Typha orientalis*) and Clubrush (*Isolepis prolifera*). However, four native species are dominants of relatively small stands of native wetland and transitional vegetation in Good to Very Good to Excellent condition. These species are *Agonis flexuosa, Acacia saligna, Melaleuca rhaphiophylla* and *Baumea articulata.*

The stands of wetland vegetation dominated by native species are the *Acacia saligna* - Peppermint Closed Low Forest (**WP**) in the north-east corner of the project area, and the *Melaleuca rhaphiophylla* (Swamp Paperbark) Open to Closed Low Forests (**M**) and *Baumea articulata* (Jointed Rush) Closed Tall Sedgelands (**B**) in western parts of the wetlands. Aliens are prominent in the understoreys of Swamp Paperbark Forests, but there are few understorey plants, either native or alien, in the *Baumea articulata* Sedgelands.

The *Lepidosperma gladiatum* (Coast Sword-sedge) Open Sedgeland in the south-eastern part of the project area has a native dominant and dense understorey, but the understorey has very few, if any, native plants.

3.1.2 Vegetation Condition

The condition of the bushland vegetation is shown in Figure 2. It is assessed as generally Degraded to Completely Degraded, and even Totally Cleared, largely due to replacement of native shrubs and herbaceous plants in the understorey by aliens. It ranges, on the six-point Keighery-Trudgen scale, from Completely Degraded (CD) to Good (G) and, in a few relatively small areas, Very Good to Excellent (VG-E). There are also areas totally cleared of native species (TC).

The native understorey in the upland bushland is generally sparse and is largely replaced with weeds. A few small understoreys of dense *Diplolaena dampieri* shrubs or *Lepidosperma gladiatum* sedges are exceptions.

Most of the herbaceous layer in the wetland also comprises alien species, and most of the wetland has no overstorey. The exceptions are the *Acacia saligna* - Peppermint Closed Low Forest (**WP**) in the north-east corner of the project area, and the *Melaleuca rhaphiophylla* (Swamp Paperbark) Open to Closed Low Forests (**M**) and *Baumea articulata* (Jointed Rush) Closed Tall Sedgelands (**B**) in western parts of the wetlands.

3.1.3 Floristic Community Types and Threatened Ecological Communities

It would be impossible to assign most, if not all, of the vegetation of the Gelorup project area to any floristic community type on the basis of detailed floristic analysis because there is so little native understorey or ground layer vegetation and so few native species left in it.

The location of the lots, the presence of *Agonis flexuosa* and Tuart in most of the upland vegetation, which is on Quindalup South Soil-Landscape Units, and the presence of *Melaleuca rhaphiophylla*, *Gahnia trifida, Acacia saligna, Baumea articulata* and *Centella asiatica* in the wetlands suggest that the floristic groups most likely to be represented in the project area are degraded Floristic Community Types (FCTs) 12, 17 or 30b, or combinations

of them, and possibly FCT 15 (Gibson *et al* 1994).

The name, reservation status and conservation status given by Gibson *et al.* (1994) for each of these Floristic Community Types are, respectively:

• FCT 12	*Melaleuca teretifolia* and / or *Astartea* aff. *fascicularis* shrublands	Well reserved	Low risk
• FCT 15	Forests and woodlands of deep seasonal wetlands	Well reserved	Vulnerable
• FCT 17	*Melaleuca rhaphiophylla – Gahnia trifida* seasonal wetlands	Well reserved	Low risk
• FCT 30b	Quindalup *Eucalyptus gomphocephala* and/or *Agonis flexuosa* woodlands	Well reserved	Susceptible

None of these floristic community types is on the Threatened Ecological Community (TEC) database, but FCT 25, Southern *Eucalyptus gomphocephala - Agonis flexuosa* woodlands, might have been represented immediately east of the project area prior to its degradation. FCT 25 is listed in Gibson *et al* (1994) as Poorly reserved and Susceptible and has been proposed for listing on the Threatened Ecological Communities database.

3.2 FLORA

The approximately 80 taxa (species, subspecies and varieties) of vascular plants recorded and identified, at least to genus, during the field trips are listed in Appendix B. The list includes 45 native taxa and 36 aliens (weeds). It is estimated that these numbers comprise around 60-70% of the flora of the project area.

No Declared Rare Flora or Priority Flora species was found during the fieldwork, nor were likely habitats for any identified.

3.3 LIMITATIONS

No attempt was made to record all of the taxa in the project area, and it is probable that some were not seen. Some species may occur in the project area but be identifiable only rarely; e.g. only during the first spring or two after a fire.

The vegetation categories described and mapped here are sometimes broad and cover ranges of variation which cannot, for various reasons, be satisfactorily delimited either on the ground or on high resolution aerial photography. And condition ratings are often given as ranges and percentages because they also, like vegetation units, cover mosaics and continua.

4.0 ACKNOWLEDGEMENTS

Panairama printouts, aerial photographs and other information and assistance were provided by Phil Bayley. Clem Love, Indrani Weston and Elisha Mueller assisted with fieldwork.

Assistance by Mike Hislop and staff of the Western Australian Herbarium and other botanists in identifying plant specimens and access to the Western Australian Herbarium collections, which was essential for carrying out the project, are greatly appreciated.

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FIGURES

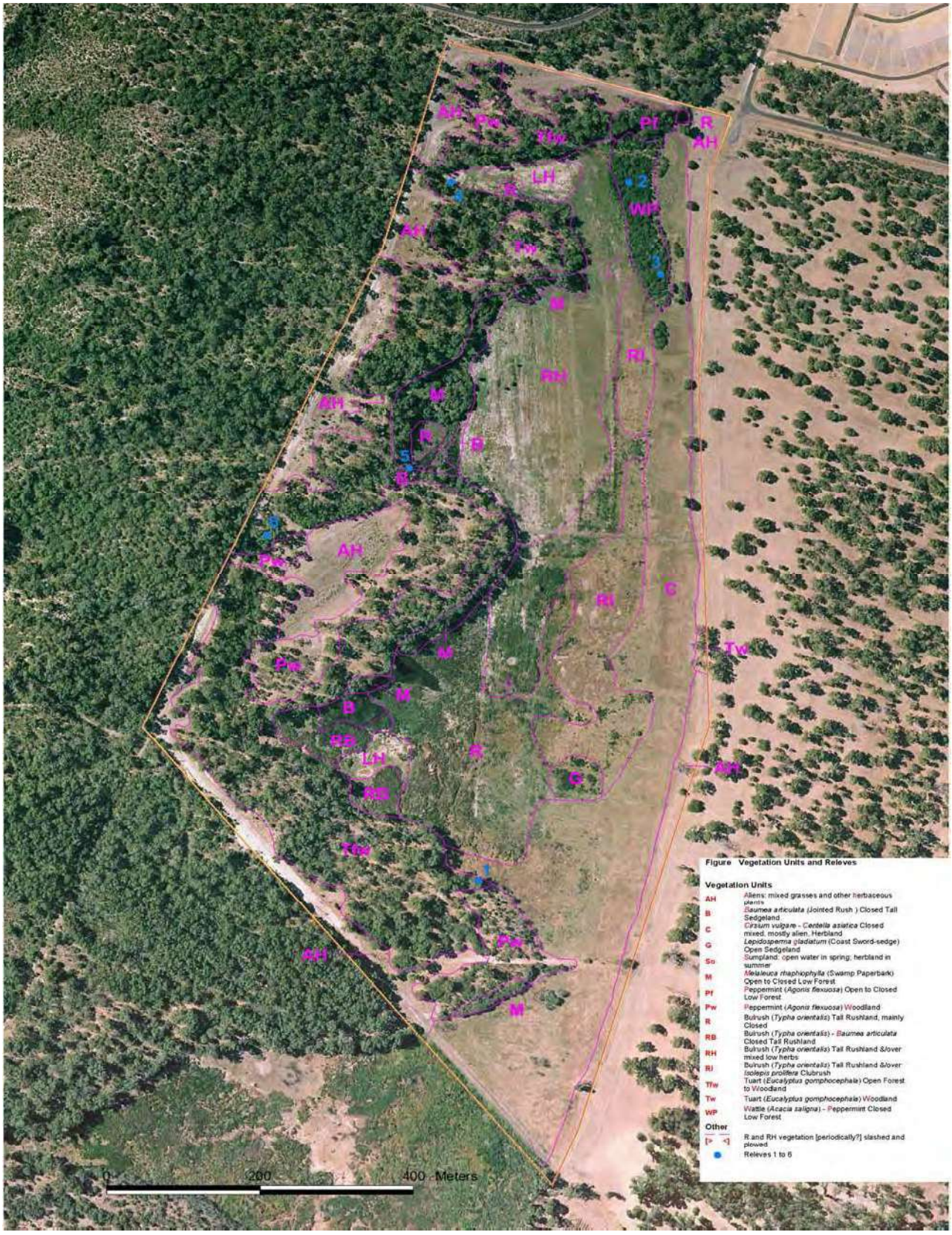

FIGURE 1 Vegetation Photographs Units and Relevé Locations

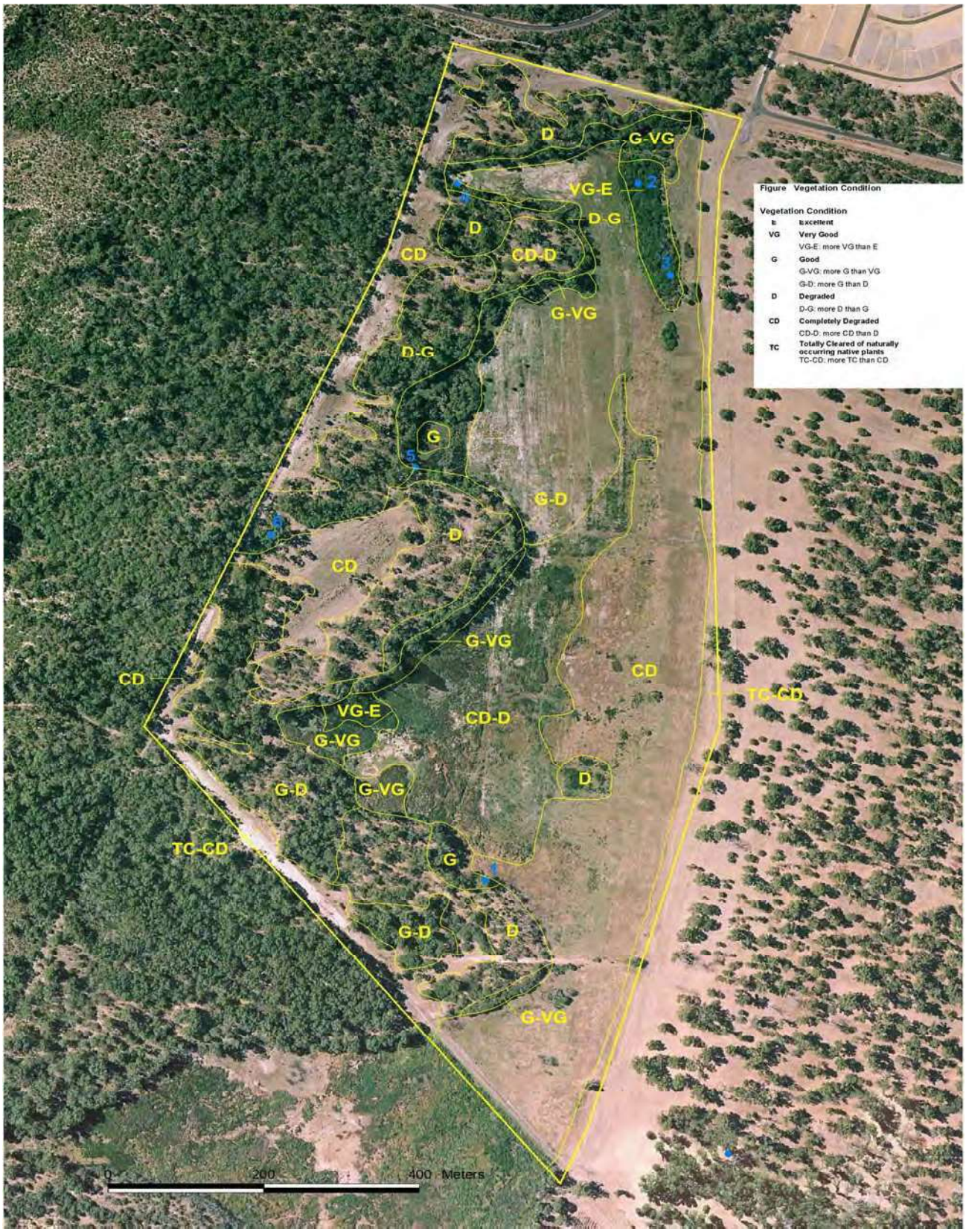

FIGURE 2 Vegetation Condition [and Relevé Locations]

A. Veg. unit AH (foreground) **-** **Trachyandra divaricata* (brown), exotic grasses and forbs and, on left, Peppermint tree.
Veg. unit WP (central line of 'shrubs') **–** Orange Wattle **-** Peppermint Closed Low Forest.
Veg. unit C (between **AH** and **WP**) **-** **Cirsium vulgare* - *Centella asiatica* Closed mixed, mostly alien, Herbland.
Veg. unit Tfw (background) **-** Tuart Open Forest to Woodland.
Veg. unit M (right of Peppermint and on right edge; both are between **WP** and **Tfw**) **-**Swamp Paperbark Open to Closed Low Forest.

(Photograph ASW.07.VIII.1-15 **–** looking SW from S of NE corner of project area)

B. Veg. unit So (foreground) **-** Sumpland: open water in spring; herbland in summer.
Veg. unit WP (central line of 'shrubs') **–** Orange Wattle **-** Peppermint Closed Low Forest.
Veg. unit RH (between **So** and **WP**) **-** Bulrush Tall Rushland (slashed) with mixed low herbs.
Veg unit Pf or Pw (in centre beyond **WP**; there is more left [N] of it) **-** Peppermint Open to Closed Low Forest or Woodland
Veg. unit AH (on right behind Peppermint trees) **-** Aliens: mixed grasses and other herbs
In background (in Gelorup East project area and beyond) **–**Unit AH, Banksia, Peppermints, Tuarts.

(Photograph ASW.07.VIII.1-23 **–** looking E towards Photopoint **B** from near Relevè 4; R4 is behind Peppermint on right)

C. Veg. unit R (foreground) **-** Bulrush (*Typha orientalis*) Tall Rushland, mainly Closed.
Veg. unit B (dark, in left centre beyond **R**) **-** *Baumea articulata (*Jointed Rush) Closed Tall Sedgeland.
Veg. unit RH (in centre and right centre) **-** Bulrush Tall Rushland (ploughed and slashed) with and over mixed low herbs.
Veg. unit M (in far centre beyond **B** and **RH**) **-** Swamp Paperbark Open to Closed Low Forest.
Veg. units Tfw and **Tw** (background) **-** Tuart Open Forest to Woodland, and Tuart Woodland

(Photograph ASW.07.VIII.1-18 **–** looking E towards Photopoint **B** from near Relevè 4; R4 is behind Peppermint on right)

FIGURE 3 Vegetation Photographs

APPENDIX A

DECLARED RARE AND PRIORITY FLORA WITH DISTRIBUTIONS AND HABITATS WHICH MAY INCLUDE LOTS 313 TO 317 HAREWOODS ROAD GELORUP

Contents

Appendix A

Declared Rare and Priority Flora and Threatened Ecological Communities with Distributions and Habitats which may include Lots 313 to 317 Harewoods Road Gelorup

Introduction

Table A1 lists the 35 taxa (species, subspecies and varieties) of Declared Rare (R) and Priority (P) Flora Table A2 lists 5 Threatened Ecological Communities (TECs) that are listed in Department of Environment and Conservation databases as having been recorded in the broader vicinity of the Lots 313 to 317 project area. The list was compiled from the results of searches of four databases carried out by the Database Officers of the Species and Communities Branch, Department of Environment and Conservation (DEC), in August 2007. These four DEC databases, and the symbols for three of them in Table A1, are *Threatened (Declared Rare) Flora* (Summary of Threatened Flora Data) [**ThrFlor**], *Declared Rare and Priority Flora List* [**D-P List**], *Western Australian Herbarium Specimen* (WAHERB) [**WA Herb**] and *Threatened Ecological Community*.

The DEC database searches were for Declared Rare and Priority Flora taxa recorded within 10km of information about conservation codes, distributions, locality records, growth forms, habitats and flowering times. The parameters requested for the searches were:

- the *Declared Rare and Priority Flora List* database for the locations: Bunbury, Capel, Dalyellup, Minninup, Peppermint Grove,

- the *Western Australian Herbarium Specimen* database for records in the rectangle defined by the coordinates 33^0 20' - 33^0 30' S and 115^0 30' - 115^0 38' E,

- the *Threatened (Declared Rare) Flora* database for records in the rectangle defined by the coordinates 33^0 20' - 33^0 30' S and 115^0 30' - 115^0 38' E and

- the *Threatened Ecological Community* database for records in the rectangle defined by the coordinates 33^0 20' - 33^0 30' S and 115^0 30' - 115^0 38' E.

The printouts also provided some information about conservation codes, localities and distributions, and flowering times. Most of the additional information in Table A1 about conservation codes, distributions, locality records, growth forms, habitats and flowering times was obtained from Atkins (2006, 2008), FloraBase (2007, 2008), Hoffman and Brown (1998) and Paczkowska and Chapman (2000). The information about distributions, localities, growth forms, habitats and flowering times is not always comprehensive. Information about growth form and habitat is at least indicative and should be useful in assessing how likely rare flora is to occur in a given area.

Five of the taxa listed in Table A1 are R: Declared Rare Flora, but only two of them - *Caladenia huegelii* and *Eleocharis keigheryi* - were in the results of the database searches as having been recorded within 10 km of the Gelorup property. One plant of *Caladenia huegelii* was recorded south to south-east of there, and *Eleocharis keigheryi* plants were recorded in a clay pan 9 km from Boyanup along the railway line from there to Capel. None of the habitats in the project area is believed to be suitable for either species.

The 35 taxa of rare flora listed in Table A1 are the principal taxa, but not the only ones, searched for in Lots 313 to 317 in spring 2007 and summer 2008. The cover letter with the printouts from the sets of the database search results emphasizes that "the information supplied should be regarded as an indication only of rare flora that may be present". There may well be rare, or otherwise significant, flora in the area other than the taxa listed in the

printouts. Item 7 in the Attachment provided with DEC database search results states that:

> "It should be noted that the supplied data do not necessarily represent a comprehensive listing of the rare flora of the area in question. Its comprehensiveness is dependant on the amount of survey carried out within the specified area."

Four of the 20 taxa McCutcheon searched for in 2001 and 2002 in the parts of Lots 313-317 that are east of the Minninup Road reserve (Bayley Environmental Services 2009) are no longer Priority listed, and four others are no longer mapped, in FloraBase, as occurring south of Mandurah, Yalgorup or Pinjarra. These latter four are *Jacksonia sericea, Pithocarpa corymbulosa, Platysace ramosissima* and *Stylidium striatum*. Four others –McCutcheon's 'Less Likely' Taxa *Chordifex gracilior, Synaphea odocoileops, Synaphea petiolaris* subsp. *simplex* and *Verticordia densiflora* var. *pedunculata* – are not listed in the results of the 2007 database searches.

DEC Flora Conservation Codes

The following copy of the second page of Atkins (2008b) lists the conservation code symbols used by the DEC for Declared Rare and Priority Flora, and it gives their definitions. Table A1 uses 'DRF' instead of 'R' and 'P1' etc instead of '1' etc.

R: Declared Rare Flora - Extant Taxa

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

X: Declared Rare Flora - Presumed Extinct Taxa

Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.

1: Priority One - Poorly known Taxa

Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

2: Priority Two - Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

3: Priority Three - Poorly Known Taxa

Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

4: Priority Four - Rare Taxa

Taxa which are considered to have been adequately surveyed and which, whilst

being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

Note, the need for further survey of poorly known taxa is prioritised into the three categories depending on the perceived urgency for determining the conservation status of those taxa, as indicated by the apparent degree of threat to the taxa based on the current information.

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Table A1
Declared Rare and Priority Flora Recorded in Gelorup and up to 10 km from Lots 313-317 Harewoods Road, Gelorup
(as of August 2007)

D-P List	Thr Flor	WA Herb	SPECIES / TAXON	FAM CODE	CONS CODE	DISTRIBUTION / LOCALITIES	Flowers	Form / Habitats
D	-	-	Acacia flagelliformis	163	4	Harvey, Eaton, Bunbury, Capel, Busselton, Donnybrook	(May-) Jul-Sep	Rush-like, erect or sprawling shrub, 0.3–0.75(–1.6) m high; fl. yellow. Sandy soils. Winter-wet areas.
-	-	2	Acacia semitrullata	163	3	Yallingup, Donnybrook, Harvey, Yarloop, Collie	(May-) Jun-Aug (Oct)	Low shrub with slender, erect stems and pungent phyllodes, (0.1–)0.2–0.7(–1.5) m high; fl. cream, white. White/grey sand, sometimes over laterite, clay. Sandplains, swampy areas.
D	-	-	Amperea micrantha	185	2	Mokine, Yoongarillup, Capel, Whicher Range, Ruabon NR	Sep-Oct (Nov)	Low, spreading, thin and weak-stemmed, bushy perennial herb, 0.1–0.3 m high; fl. brown, Sandy soils.
-	-	1	Anthotium junciforme	341	4	Wattle Grove, Midland, Bayswater, Serpentine, Upper Swan, Kenwick, Busselton, Scott River Plain, Albany	(Nov-) Dec-Mar	Open, erect to prostrate, grass-like, tufted, perennial herb, 0.05–0.4 m high; leaves linear to terete, 0.5-1 mm wide; fl. blue, violet, purple (rarely white or pink), terminal on stalks longer than leaves, 12-40 cm long. Sandy clay, clay. Winter-wet depressions, drainage lines. Low in landscape in eucalypt woodlands or winter-wet flats, depressions, drainage lines.
D	-	-	Aponogeton hexatepalus	025	4	Perth, Pinjarra, Capel, Bunbury, Boyanup, Nannup	(Jul-) Aug-Sep (Oct-)	Rhizomatous or cormous, aquatic perennial herb; leaves straplike, the floating part of which is broader than the submerged part; fl. green, white. Mud. Shallow freshwater: ponds winter pools on clayey soils, rivers, claypans.
D	-	-	Boronia humifusa	175	1	Capel, Tutunup, Kalamunda	Jun/Sep	Low-growing, wiry perennial herb, 0.1–0.2 m high fl. pink, red. Gravelly clay loam over laterite. Jarrah-marri open forest.
D	-	-	Boronia tetragona	175	3	Capel, Busselton, Whicher Range, Cowaramup	Oct-Dec	Perennial herb, 0.3–0.7 m high; leaves sessile, entire, with papillate margins; branches quadrangular; sepals ciliate; fl. pink, red. Black/white sand, laterite, brown sandy loam. Winter-wet flats, swamps, open woodland.
D	-	-	Caladenia busselliana	066	R	Marybrook, Capel	(Sep-) Oct	Tuberous, perennial herb, 0.2–0.3 m high; fl. green, yellow, cream. Sandy loam. Winter-wet swamps.
D	1	-	Caladenia huegelii	066	R	Perth - Capel	Aug-Oct	Large, few-flowered spider orchid w. large labellum that is dark red (& white) and has long fringing hairs that are usually white and often divided at tip; leaves & stem w. long thin spreading hairs at base. Grey or brown sandy (possibly also clay loam) soils in banksia and eucalypt woodlands and open forests which are, usually, low in the landscape and, at least

								near Perth, usually have *Dasypogon bromeliifolius* and *Phlebocarya ciliata*.
D	1	9	Caladenia speciosa	066	4	Myalup, Eaton, Yarloop, Ludlow, Gingin, Capel	Sep-Oct	Spider orchid; fl. mainly white (to pink); labellum fringe hairs long and red to, distally, shorter and white. White, grey or black sand; generally in *Banksia* and jarrah woodland, especially after summer fires.
D	-	1	Chamaescilla gibsonii	054F	3	Muchea, Ellen Brook, Yule Brook, Drakesbrook, Capel	Jun/Sep	Clumped tuberous herb. fl. blue. Clay to sandy clay. Winter-wet flats, shallow water-filled claypans.
D	-	-	Chamelaucium roycei ms	273	R	Capel, Tutunup	(Aug-) Oct-Dec	Bushy shrub, 0.3–1.5 m high; leaves -/+ terete, pungent; fl. white, pink. Sandy clay, clay, lateritic soils. Winter-wet flats, swamps, stream banks.
-	1	-	Conostylis pauciflora subsp. pauciflora	055	4	Yarloop, Dawesville, Yalgorup NP	(Jun-) Aug-Oct	Stoloniferous, yellow-flowered herb. Eucalypt, peppermint, banksia woodlands on grey sand, deep or shallow over limestone, on lower and middle slopes of stabilised dunes.
D	-	-	Dryandra squarrosa subsp. argillacea (now *Banksia s.* subsp.*a.*)	090	R	Ruabon, Tutunup, Whicher Range, Upper Capel	(Jun-) Jul-Aug (-Nov)	Erect, open, non-lignotuberous shrub, 1.2–4 m high; fl. yellow. White/grey sand, gravelly clay or loam. Winter-wet flats, clay flats.
-	-	1	Eleocharis keighery	032	R	'Kenwick, Lesueur, Cataby, Wannamal, Ellenbrook, Boyanup, Waterloo, Julimar, Lesueur	Aug–Nov	Rhizomatous, clumped, perennial, grass-like sedge, to 0.4 m high; fls. terminal, green. Clay, sandy loam. Emergent in freshwater: creeks, claypans.
D	-	-	Eryngium ferox ms	281	3	Collie, Pinjarra, Capel, Kulunilup NR	Oct, Nov	Erect, open, tuberous herb, 0.1–0.3 m high; fl. green. Grey to brown loamy to sandy clay, brown cracking clay. Winter-wet flats, swamps, dried claypans, ridges.
D	-	-	Eryngium pinnatifidum subsp. palustre ms	281	3	Arrowsmith-Capel Serpentine, Kenwick, Forrestdale, Bullsbrook	Oct-Nov	Herb; *Melaleuca* shrublands and low open vegetation on winter-wet sandy-clay flats; (MET: swales in Quindalup dunes). vegetation on winter-wet sandy-clay flats.
D	-	-	Franklandia triaristata	090	4	Capel, Tutunup, Jarrahwood, Argyle	Aug-Oct	Erect, lignotuberous shrub, 0.2–1 m high; fl. 4-lobed, white (& cream, yellow, brown, purple). White or grey sand.
-	1	-	Hibbertia spicata subsp. leptotheca	226	3	'Yalgorup, Lancelin, Burns Beach	Sep-Nov (Jul-Dec)	Mound or semi-prostrate small shrub. Mainly limestone heath.
D	-	-	Isopogon formosus subsp. dasylepis	090	3	Capel. Ludlow, Busselton, Ruabon, Scott R, Yoongarillup	Jun-Dec	Low, bushy or slender, upright, non-lignotuberous shrub, 0.2–2 m high; fl. pink, purple, red. Sand, sandy clay, gravelly sandy soils over laterite. Often swampy areas.
D	4	3	Lasiopetalum membranaceum	223	3	Capel, Dwellingup, Yandup, Australind, Dawesville, Yanchep	Sep-Dec	Small shrub with cordate leaves; Sand, mainly over limestone and in tuart woodland.
D	-	-	Logania wendyae	302	1	Capel, Dardanup	Oct	Decumbent dwarf shrub, to 0.17 m high; fl. white, blue. Brown clay to sandy clay, laterite gravel.
D	-	-	Mitreola minima	302	3	Woolbernup Hill, Walpole, Capel	(Oct-) Nov-Jan	Slender, erect annual herb, 0.025–0.04 m high; fl. white. Grey sand. Peaty swampy areas.
-	1	-	Platysace ramosissima	281	3	Yalgorup, Lancelin, Boonanarring, Gingin, Bullsbrook NR	Oct-Nov	Perennial herb with ribbed or angular stems. Heath on Spearwood sand or limestone.

D	-	-	Pultenaea skinneri	165	4	Collie, Binningup, Boyanup, Whicher Rng, Bunbury, Nannup	Jul-Jan	Slender shrub, 1–2 m high; fl. yellow, orange, red. Sandy or clayey soils. Winter-wet depressions.
D	-	-	Rhodanthe pyrethrum	345	3	Bullsbrook-Waterloo-Denmark, Capel, Kenwick, Forrestdale	Sep-Oct (-Dec)	Erect, slender annual, herb, 0.05–0.2 m high; fl. white, yellow. Clay, sandy clay. Winter-wet depressions, clay pans, swamps.
-	1	1	Schoenus benthamii	032	3	Mogumber, Kenwick, Busselton, Manypeaks	Oct–Nov	Tufted, perennial sedge, 0.15–0.45 m high; fl. brown. White, grey sand, sandy clay. Winter-wet flats, swamps.
D	-	-	Stylidium leeuwinense	343	3	Capel, Scott River, Milyeannup, Shannon River, Walpole-Nornalup NP	Feb-May	Erect perennial herb, 0.15–0.6 m high, Leaves adpressed to stem, lanceolate, 0.2-0.5 cm long, 0.6-1 mm wide, apex acute, margin hyaline or margin hyaline and fimbriate, glabrous; inflorescence racemose; fl. pink. Grey to black peaty sand. Winter-wet habitats and depressions. Shrubland, heath, sedgeland or low woodland.
D	-	-	Stylidium longitubum	343	3	Midland, Busselton, Arthur River, Jandakot	Nov (Oct–Dec)	Very small, erect annual (ephemeral) herb, 0.05–0.12 m high; fl. pink, with distinct red line across near throat. Grey sandy clay over clay; winter wet flats; *Melaleuca viminea* shrubland.
-	1	-	Stylidium maritimum	343	3	Yalgorup - Breton Bay, Cervantes, Nilgen, Bold Park, Drovers Cave NP	Sep-Dec	Tufted, linear-leaved triggerplant; Sand dunes and depressions in limestone.
D	-	-	Stylidium striatum	343	4	Gooseberry Hill, Armadale, Flynn Block, Beverley, Capel, Boyanup	Oct-Nov	Rosetted perennial herb, 0.15–0.55 m high; leaves erect, oblanceolate to spathulate, 1.5-4 cm long, 1.5-6 mm wide, apex acute to acuminate, margin entire, glabrous, striate; scape sparingly glandular on inflorescence axis, glabrous below; inflorescence racemose; fl. yellow. Brown clay loam over laterite. Hillslopes. Jarrah/Marri forest, Wandoo woodland.
D	-	-	Synaphea hians	090	3	Busselton, Collie, Ludlow, Capel, Crooked Brook	Sep-Oct (Jul–Nov)	Prostrate or decumbent shrub, 0.15–0.6 m high, to 1 m wide; leaves lobed, fan-like; fl. yellow. Sandy soils. Rises.
D	-	-	Tetratheca parvifolia	182	3	Capel, East of Donnybrook, Collie	Oct	Small shrub, 0.2–0.3 m high; leaves small; fl. pink.
D	-	-	Verticordia attenuata	273	3	Ruabon – Tutunup (Busselton), Bunbury, Capel	Jan (Dec–May)	Shrub, 0.4–1 m high; fl. pink. White or grey sand. Winter-wet depressions.
-	-	1	Villarsia submersa	303A	4	Gunapin, Boyanup, Lake Muir, Denmark, Forrestdale, Kenwick, Frankland River, Lane Poole	Sep-Oct (Aug–Nov)	Rooted aquatic, extremely slender, perennial herb; leaf blades elliptic, floating; fl. white, floating. In freshwater 0.05-0.6 m deep. Pools, lakes, swamps, winter-wet clay depressions, claypans.

Table A2
Results of DEC Database Search for Threatened Ecological Communities
in the Broader Vicinity of Gelorup
(as of September 2007)

TEC No.	FCT/ SCP No.	TEC/SCP Name/Description	Conserv. category	Plot	Distance from site
14	SCP18	Shrublands on calcareous silts of the Swan Coastal Plain (SCP)	Vulnerable	HAY05	5.5km NNE
14	SCP18	Shrublands on calcareous silts of the SCP	Vulnerable	myHAY03	5.7km NNE
22	SCP1b	*Eucalyptus calophylla* woodlands on heavy soils of the southern SCP	Vulnerable	R116703	9km E
32	SCP07	Herb-rich saline shrublands in clay pans	Vulnerable	mySwamp01	6km NE
32	SCP07	Herb-rich saline shrublands in clay pans	Vulnerable	Swamp02	6km NE
33	SCP08	Herb-rich shrublands in clay pans	Vulnerable	HAY01	6.3km NNE
33	SCP08	Herb-rich shrublands in clay pans	Vulnerable	myHAY01	6.3km NNE
33	SCP08	Herb-rich shrublands in clay pans	Vulnerable	myHAY02	6km NNE
34	SCP09	Dense shrublands on clay flats	Vulnerable	MANEA01	7km NE

APPENDIX B

Vascular Flora Recorded in the Gelorup West Project Area

Contents

APPENDIX B

Vascular Flora Recorded in the Gelorup West Project Area

Introduction

The approximately 80 taxa (species, subspecies and varieties) recorded and identified in the Gelorup West project area in spring 2007 and summer 2008 are listed in Table B1.

The Table B1 list includes 45 native taxa and 36 aliens (weeds). No Declared Rare Flora was found during the field work, nor were likely habitats for any identified.

The table lists families alphabetically and species alphabetically within families. The names used for taxa follow the curent Max 3.1.2.215 database. An asterisk (*) preceding the taxon name indicates that the species is alien, a weed.

Table B1
Vascular Flora Recorded in the Gelorup West Project Area
during 2007 and 2008

Family Code	Family and Taxon Names	Id	R1	R2	R3	R4	R5	R6	Notes
011C	**Dennstaedtiaceae**								
	Pteridium esculentum	11	X					X	
20	**Typhaceae**								
	*Typha orientalis	8				X	X		
31	**Poaceae**								
	Austrostipa ?compressa	40						X	
	*Bromus diandrus	24	X						
	*Cynodon dactylon	81							
	*Ehrharta longiflora	17	X					X	
	*Holcus lanatus	22	X	X	X				
	*Paspalum distichum	68				X			
32	**Cyperaceae**								
	Baumea articulata	33					X		
	Baumea juncea	84		X					
	Baumea rubiginosa	67				X			
	*Carex ?divisa (or appressa)	70		X					
	Ficinia nodosa	59							
	Gahnia trifida	6			X				
	*Isolepis prolifera	1							
	Lepidosperma angustatum	28	X						
	Lepidosperma gladiatum	5	X	X	X			X	
	Tetraria capillaris	39						X	
35	**Araceae**								
	*Zantedeschia aethiopica	20	X						
054C	**Dasypogonaceae**								
	Acanthocarpus preissii								
054F	**Anthericaceae**								
	Caesia ?micrantha	58							
	Thysanotus ?manglesianus	41						X	
	Tricoryne elatior	56							

Family Code	Family and Taxon Names	Id	R1	R2	R3	R4	R5	R6	Notes
054G	**Asphodelaceae**								
	*Trachyandra divaricata	43						X	
60	**Iridaceae**								
	*Romulea rosea	46						X	
66	**Orchidaceae**								
	Caladenia latifolia	19	X					X	
87	**Moraceae**								
	*Ficus carica	65		X					
88	**Urticaceae**								
	Parietaria debilis	53							
103	**Polygonaceae**								
	*Acetosella vulgaris	75					X		
105	**Chenopodiaceae**								
	Rhagodia baccata subsp. baccata	7	X	X	X			X	
113	**Caryophyllaceae**								
	*Cerastium glomeratum	47						X	
	*Petrorhagia dubia	35							
	*Stellaria ?media	45						X	
119	**Ranunculaceae**								
	Clematis linearifolia	62							
131	**Lauraceae**								
	Cassytha ?racemosa	69				X			
138	**Brassicaceae**								
	*Heliophila pusilla	54							
163	**Mimosaceae**								
	Acacia rostellifera	85		X					
	Acacia saligna	2		X	X			X	
165	**Papilionaceae**								
	*Dipogon lignosus	63							
	Hardenbergia comptoniana	23	X					X	
	Isotropis cuneifolia	60							
	*Medicago ?polymorpha	32	X						
	*Melilotus indicus	36						X	
	Templetonia retusa								
167	**Geraniaceae**								
	*Geranium sp.	16	X					X	
	Pelargonium ?littorale	14	X						
168	**Oxalidaceae**								
	Oxalis ?perennans	44						X	
175	**Rutaceae**								
	Diplolaena dampieri	37						X	
185	**Euphorbiaceae**								
	*Euphorbia sp.	21	X					X	
215	**Rhamnaceae**								
	Spyridium globulosum	42		X				X	
226	**Dilleniaceae**								
	Hibbertia cuneiformis	13	X	X	X			X	
273	**Myrtaceae**								
	Agonis flexuosa	4	X	X	X			X	
	Eucalyptus gomphocephala	10	X					X	
	Melaleuca rhaphiophylla	9							
275	**Onagraceae**								

Family Code	Family and Taxon Names	Id	R1	R2	R3	R4	R5	R6	Notes
	Epilobium ?billardiereanum	82							
276	**Haloragaceae**								
	Haloragis ?brownii	77							
281	**Apiaceae**								
	Apium prostratum	78							
	Centella asiatica	64		X					
	Daucus glochidiatus	50						X	
	Trachymene pilosa	57							
293	**Primulaceae**								
	*Anagallis arvensis	30	X					x	
302	**Loganiaceae**								
	Logania vaginalis	61							
303	**Gentianaceae**								
	*Centaurium ?erythraea	83							
303A	**Menyanthaceae**								
	Villarsia violifolia	74					X		
305	**Asclepiadaceae**								
	*Gomphocarpus fruticosus	31	X						
307	**Convolvulaceae**								
	Dichondra repens	12	X						
313	**Lamiaceae**								
	*Mentha pulegium	76							
315	**Solanaceae**								
	*Solanum ?laciniatum								
	*Solanum linnaeanum	25	X						
	*Solanum nigrum	15	X						
316	**Scrophulariaceae**								
	*Verbascum virgatum	52							
326	**Myoporaceae**								
	Myoporum caprarioides	66		X	X				
331	**Rubiaceae**								
	*Galium ?murale	49						X	
	Opercularia ?hispidula	55							
	*Sherardia arvensis	48						X	
340	**Lobeliaceae**								
	Lobelia anceps	79							
345	**Asteraceae**								
	*Arctotheca calendula	27	X						
	*Carduus pycnocephalus	26	X					X	
	*Cirsium vulgare	29	X		X				
	*Cotula coronopifolia	34							
	Olearia axillaris	38						X	
	*Sonchus oleraceus	18	X						

APPENDIX C

Relevés

(the area in each relevé is under to much under 10m from centre post)

Relevé	Way-point	Position: easting mE northing mN	Alt. m	First Date	Photo in Fig. C1 ASW.	Vegetation Description and Condition and notes
R1	385	50 H 370576 6301375	4.45	1 Oct 2007	07.VII.1-15	Tuart Woodland over Peppermint Open Low Forest over Bracken Herbland , Sword-sedge Sedgeland , Kidney Weed Herbland and Grassland of pasture grasses. **Condition**: G-D. No other G vegetation nearby.
R2	434	50 H 370780 6302388	1.09	15 Nov 2007	07.XI.1-05	Orange Wattle (- Peppermint) Open (to Closed) Low Forest or Tall Scrub over Berry Saltbush Heaths (to Tall Scrubs) over Sword-sedge Sedgeland to Open Sedgeland, Kidney Weed Herbland to Open Herbland and Grassland of pasture grasses. **Condition**: G-VG.
R3	435	50 H 370832 6302255	23.7	15 Nov 2007	07.XI.1-04	Peppermint Low Woodland over Orange Wattle Closed Low Forest or Tall Scrub over Berry Saltbush Open Heath over Saw-sedge Sedgeland **Condition**: locally E, including slender, tangled *Myoporum caprarioides* Closed Heath to west.
R4	436	50 H 370537 6302379	2.77	15 Nov 2007	07.XI.1-03	Bulrush (- *Baumea rubiginosa*) Closed Rushland over ?Water Couch Grassland. **Condition**: G
R5	446	50 H 370494 6301962	?	23 Jan 2008	07.XII.1-04A	Tuart Open Forest over (1) Jointed Rush Closed Rushland, (2) Bulrush Closed Rushland and (3) Mixed alien (-*Villarsia violifolia*) Closed Herbland. **Condition**: (1) VG-E, (2) and (3) CD
R6	103	50 H 370315 6301868	7	1 Oct 2007	07.VII.1-22	Tuart Woodland to Open Forest over Peppermint Open Low Forest over Diplolaena Closed Tall Scrub over Sword-sedge Closed Sedgeland. **Condition**: E-G. The best condition in the area.

Names and Abbreviations

(names are from FloraBase 2009)

Common	Scientific	Common	Scientific
Berry Saltbush	*Rhagodia baccata*	Kidney Weed	*Dichondra repens*
Bracken	*Pteridium esculaentum*	Peppermint	*Agonis flexuosa*
Bulrush	*Typha orientalis*	Saw-sedge	*Gahnia trifida*
Diplolaena	*Diplolaena dampieri*	Sword-sedge	*Lepidosperma gladiatum*
Jointed Rush (a sedge)	*Baumea articulata*	Tuart	*Eucalyptus gomphocephala*
( )	less common	Water Couch	*Paspalum distichum*
E - Excellent	VG - Good	G – Good	D – Degraded	CD - Completely Degraded

Relevé 1. (Photograph ASW.07.VIII.1-15)

Relevé 2. (Photograph ASW.07.XI.1-05)

Relevé 4. (Photograph ASW.07.XI.1-03)

Relevé 3. (Photograph ASW.07.XI.1-04)

Relevé 5. (Photograph ASW.07.XII.1-04A)

Relevé 6. (Photograph ASW.07.VIII.1-22)

Figure C1

Photographs of Relevés

Appendix D

Planting Plan

1.0 PLANTING PLAN

1.1 Implementation

The planting will be undertaken by a professional rehabilitation specialist engaged by Piacentini Developments Pty Ltd. The rehabilitation contractor will be accredited with the Revegetation Industry Association of Western Australia or equivalent.

The planting will begin with a series of trials to test different weed control and ground preparation techniques (herbicides, scalping, burning, hoeing), planting methods (tube stock vs direct seeding) and seedling protection measures (e.g fencing vs tree guards, fence height etc.). Details of the trials are given in Section 1.8.

1.2 Site Preparation

The focus of site preparation will be to remove weeds and ground compaction from the planting site so as to give the seedlings the best possible chance of survival.

1.2.1 Weed Control

Herbicide Treatment

- A knockdown herbicide (usually glyphosate-based) will be used to kill all weeds in the planting area.
- Less weed-infested areas may require only a single treatment one month before planting.
- Heavily weed-infested sites (especially with grasses) may require repeated treatments over twelve months.
- In and close to the wetland, a herbicide approved for aquatic use such as Roundup Biactive® will be required. Residual herbicides will not be used in or near the wetland.
- Herbicide may be applied broadacre (e.g. by boom spray) or by spot-application (targeting individual planting sites). Broadacre application is likely to be used in the east of the site and in the wetland, while spot application may be used for infill plantings in the west.

Scalping

- In areas with very heavy grass growth, machinery may be used after herbicide treatment to remove the top 20cm or so of soil, thereby removing much of the weed seed store and surviving rhizomes.
- This has the advantage of delaying weed re-emergence.
- The main disadvantage is loss of the most fertile part of the soil profile.
- The effectiveness of scalping will depend on the depth of rhizomes and roots.

Burning

- After herbicide treatment, fire may be used (depending on the density of grass growth and the results of trials) to remove the dead plant material and kill surviving parts of plants and seeds.
- This may delay the re-emergence of weeds.
- Burning also creates an ash bed into which seeds or seedlings can be planted.
- Woody debris from the clearing in the development area may also be burned in the revegetation areas to create an ash bed for seedlings.
- The effectiveness of burning depends on the intensity of the fire. Sufficient heat to kill seeds and rhizomes typically penetrates only a few centimetres into the soil, while grass rhizomes may penetrate to 0.5m and roots to over 3m.

1.2.2 Ground Preparation

Ripping

Ripping to a depth of 0.5m helps to break up ground compaction (caused by vehicles and/or cattle) and aids root penetration. Shallower ripping to 0.2-0.3m may be used in areas where existing tree roots need to be protected. Ripping will not be employed within the "drip line" of existing trees.

Mounding

Mounding with a disc plough or similar may be used to create mounds into which tube stock are planted.

Mulching

Mulched debris from the clearing may be applied to a depth of about 5cm and ploughed into the topsoil to help maintain soil aeration, increase organic content and reduce moisture loss.

1.3 Species Selection and Source

Tuart, Jarrah, Banksias, Peppermint and paperbarks will be the primary tree species used in the planting, with a particular emphasis on Peppermint (the main food source for possums) and Banksias (the main food source for black cockatoos). Understorey species will also be planted to maximise the sustainability and habitat value of the vegetation. These will be a mixture of species drawn from the local species listed in Table 2.1.

Most planting will be carried out using nursery tube stock sourced from local nurseries, grown from seed collected on or within 5km of the planting site. The exact understorey species grown will depend upon the species in fruit at the time of the seed collection.

Depending on the results of trials, some understorey species may be direct-seeded.

1.4 Planting Density

Tube stock planting density will vary depending on the location, as detailed below.

Wetland

- Planted area approx. 8.83ha.
- Planted with trees, shrubs, sedges and herbs.
- Density:

Trees	50/ha (15m spacing)
Shrubs	400/ha (5m spacing)
Sedges & herbs	10,000/ha in patches (overall 2,500/ha).

Wetland Buffer

- Planted area approx. 3.84ha.
- Planted with sedges, herbs, low shrubs (<2m) and scattered trees (<10% cover).
- Density:

Trees	50/ha (15m spacing)
Shrubs	400/ha (5m spacing)
Sedges & herbs	10,000/ha in patches (overall 2,500/ha).

Swales

- Planted area approx. 1.85ha.
- Planted with sedges, herbs, low shrubs (<2m) and scattered trees (<10% cover).
- Density:

Trees	50/ha (15m spacing)
Shrubs	400/ha (5m spacing)
Sedges & herbs	10,000/ha (1m spacing).

Possum/Cockatoo Habitat

- Planted area 28ha.
- Planted with overstorey & understorey trees, shrubs, sedges & herbs.
- Density:

Trees	400/ha (5m spacing)
Shrubs	400/ha (5m spacing)
Sedges & herbs	400/ha (5m spacing).

If direct seeding is employed, the seed will be applied at a rate of approximately 4 kg/ha, depending upon the particular species being seeded. The seed will be prepared by scarifying, soaking and/or smoking before planting, as appropriate to the species.

In areas where a mid-storey and/or understorey already exists, planting will be carried out at sufficient density to raise the overall density to 400/ha in each of the mid-storey and understorey.

The planting density is designed to allow for 20% attrition over the first few years of growth.

1.5 Timing of Planting

Tube stock planting will be undertaken nominally in June after the first significant winter rains. The timing may be varied depending on the arrival of significant rainfall.

Direct seeding will be undertaken approximately one to two months earlier than tube stock planting, before the start of winter rains.

1.6 Planting Method

Tube Stock
A hand planter ("Pottiputki" or similar) will be used to drill a hole approximately 175mm deep and 55mm wide for each seedling. Each seedling will be planted with a slow-release native plant fertiliser pill.

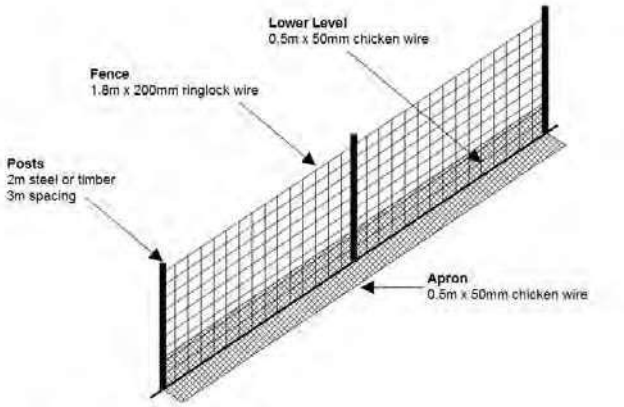
Direct Seeding
Direct seeding has the ability to create high-density seedling growth of certain species at significantly less effort and cost than tube stock planting. Because the seedlings germinate *in-situ*, direct seeding also tends to produce more robust plants and a more diverse, naturally-structured vegetation form (M. Blunt, Tranen, pers. comm.).

Mr Piacentini's company is well equipped and experienced in direct seeding through its extensive rehabilitation work for mining companies. If direct seeding is used, it will be carried out with equipment designed for native seed, with the seeding depth and configuration set for the particular species being seeded.

1.7 Protection of Seedlings

The seedlings will be protected from grazing by kangaroos and rabbits by fencing or tree guards. Fencing is likely to be used in the larger planting areas, while tree guards may be used in smaller infill planting areas.

The fences will constructed of 1.8m high ringlock wire on posts with a 0.5m chicken wire lower layer and a 0.5m apron to prevent kangaroos and rabbits from digging or pushing under the fence. The diagram below shows an example of the type of fencing proposed.



Indicative Fence Design

The fencing and/or tree guards will be kept in place and maintained for at least two years, after which the new growth is expected to be large enough to withstand grazing. After two years, the tree guards will be inspected and progressively removed once the plants reach a height of 1m for trees and 0.5m for shrubs (based on advice from Tranen Revegetation Systems Pty Ltd). The fences will be left in place for five years. After this time, provided the completion criteria have been met, they will be either removed or left in place, depending on the wishes of the WAPC and the DBCA.

1.8 Pre-Planting Trials

In order to optimise the site preparation, planting and protection techniques for the site, a series of trials will be carried out before the full-scale planting begins. The trials will be conducted in three 2.5ha-3.75ha plots on upland, wetland and wetland buffer locations and will test:

- Site preparation
  - Duration of pre-planting weed control (1 month vs 12 months)
  - Burning
  - Scalping (wetland and buffer only)
  - Ripping
- Planting method
  - Tube stock vs direct seeding (understorey species)
- Protection
  - Fencing vs tree guards
  - Mulching

The trials will begin in autumn immediately following the start of clearing (Year 1), with the commencement of 12-month weed control in the wetland and buffer. The plantings will be undertaken in April - June of the following year. Each set of plots will include a control plot, which will be planted with no pre-planting weed control, ground preparation or protection (fencing or tree guards). The plots (except the control plot) will be surrounded by a 10m weed-free buffer to minimise weed encroachment from untreated areas.

The trial plots will be monitored for twelve months after planting and the success of the different strategies (including seedling survival, growth rates and need for follow-up weed control) assessed. The most successful and practical methods will be used for the major planting works to be completed in the year following the trial plantings (Year 3).

Figure 1 shows the locations of the trial plots.

2.0 POST-PLANTING MAINTENANCE

2.1 Weed Control

Follow-up weed treatments using an appropriate herbicide applied by hand sprayer or wand will be undertaken in spring in the year of planting and the year following. For the subsequent three years (i.e. 3-5 years after planting), annual quantitative weed monitoring will be carried out in spring and visual weed inspections will be carried out quarterly. Weed control will be undertaken as and where necessary, based on the results of the quarterly inspections and annual monitoring. This may include additional weed control treatments in other seasons.

The necessity for weed control will be assessed not on fixed criteria but on the judgement of the contractor as to whether the height and density of weeds is likely to impede the growth of the planted vegetation. The point at which weed control becomes necessary will vary with the area and the stage of growth of the plantings.

2.2 Monitoring

2.2.1 Objectives of Monitoring

The primary objective of post-planting monitoring is to confirm that the planted vegetation is thriving and creating viable habitat. These habitat values are expected to develop gradually over a period of up to twenty years. Within the five-year intensive management period, the development of habitat values will be visible as an increase in vegetation cover, particularly in the critical Peppermint, Flooded Gum and Banksias.

Within this overall framework, specific objectives of the monitoring include demonstrating that:

- the new plantings are achieving, or progressing towards achieving, the completion criteria of species richness, vegetation cover and health;
- the regrowth is not being significantly impaired by grazing, weed growth, drought or vandalism;
- fences and other protective measures are in good repair and functioning effectively;
- fires, disease and other catastrophic events are avoided.

2.2.2 Monitoring Programme

Hardware and Structures
The condition of tree guards and fences will be monitored quarterly for the first three years after planting. Any guards that become displaced or damaged will be repositioned or replaced. Fences will be monitored for integrity and security on the same schedule and repaired as necessary.

Vegetation
The success of the plantings will be monitored annually for five years after the completion of the planting programme. For the first two years this will be undertaken by the planting contractor; thereafter it may be done by the planting contractor or by a botanist contracted by Piacentini Developments Pty Ltd.

Quantitative monitoring of regrowth will be undertaken by a combination of high-resolution aerial photography and fixed 100m^2 quadrats selected and set out during the planting works. Approximately four quadrats will be established within the 8.8ha planting area within the wetland.

The identity, height, width and condition of all plants within each quadrat will be recorded to give data on species composition, cover, structure and health. Photographs will be taken at fixed points in each quadrat. Comparison between monitoring dates will provide data on survival rates. Opportunistic observations of fauna (especially black cockatoo and Western Ringtail Possum) presence in the revegetation area will be recorded.

After five years have passed, the transect monitoring will cease but monitoring by aerial imagery will continue. As well as the annual quantitative monitoring, qualitative visual monitoring (consisting of foot traverses of the quadrats and photography) will be undertaken quarterly. The objectives of the qualitative monitoring will be to detect damage to tree guards and fences, detect disease (including dieback and Agonis canker) and assess weed growth.

Fauna
Observations of black cockatoo and Western Ringtail Possum presence in the revegetation area will be recorded during the annual and quarterly monitoring visits. Indications of presence will include:

- Black cockatoos – birds seen or heard feeding, roosting or overflying the area, chewed nuts or banksia cones, dropped leaves and twigs beneath trees.
- Western Ringtail Possum – direct sightings, dreys, signs of browsing on Peppermints, droppings beneath trees.

At the end of the five-year intensive management period, at the request of DBCA a detailed fauna survey will be carried out by a fauna specialist to assess the habitat value

of the revegetation area for Western Ringtail Possums and black cockatoos and to search for the presence of each species within the site.

Reporting
The results of each round of monitoring will be reported to the DEE and published on Mr Piacentini's website.

2.3 Completion and Success Criteria

The planting density is designed to allow for 20% attrition of seedlings. Success of the planting will therefore be defined as a density of at least 80% of the planted density in good health after five years. Further indications of success will be:

- an increase in the assessed habitat value of the vegetation for black cockatoos and Western Ringtail Possums; and
- observed direct or indirect evidence of black cockatoo or Western Ringtail Possum presence in the revegetation area.

2.4 Contingency Response

If, at any time within five years after planting, monitoring shows that the survival rate of any planted structural element (overstorey, mid-storey or lower storey) or any area is approaching or below 80%, infill planting of the same structural element will be undertaken. If a particular species appears to be suffering high mortality then an alternative local species with similar habitat value may be used for the infill planting for the remainder of the five-year maintenance period.

If aerial imagery monitoring shows that the total canopy cover after twenty years is less than 80%, infill planting of appropriate canopy species (Peppermint in upland, Paperbark in wetland) will be undertaken. In practice, aerial imagery monitoring in previous years will provide an indication of whether the 80% target is likely to be achieved, thus allowing pre-emptive infill planting to be undertaken if necessary.

2.5 Reporting

Mr Piacentini will report regularly on the progress of the pre-planting trials, the planting programme and post-planting monitoring. The reports will be forwarded to the relevant agencies and published on Mr Piacentini's website. A preliminary reporting schedule is shown below.

Item	*Expected timing of report*
Start of trials	May following start of clearing (Year 1)
Completion of trial plantings	July Year 2

Results of trials	June Year 3
Start of major site preparation	June Year 3
Completion of full-scale plantings	July Year 3 – Year 4
Annual monitoring results	December Year 3 – Year 8
Adverse events (eg fire, vandalism)	With annual compliance report
Report success after 5 years	December Year 7 – Year 8

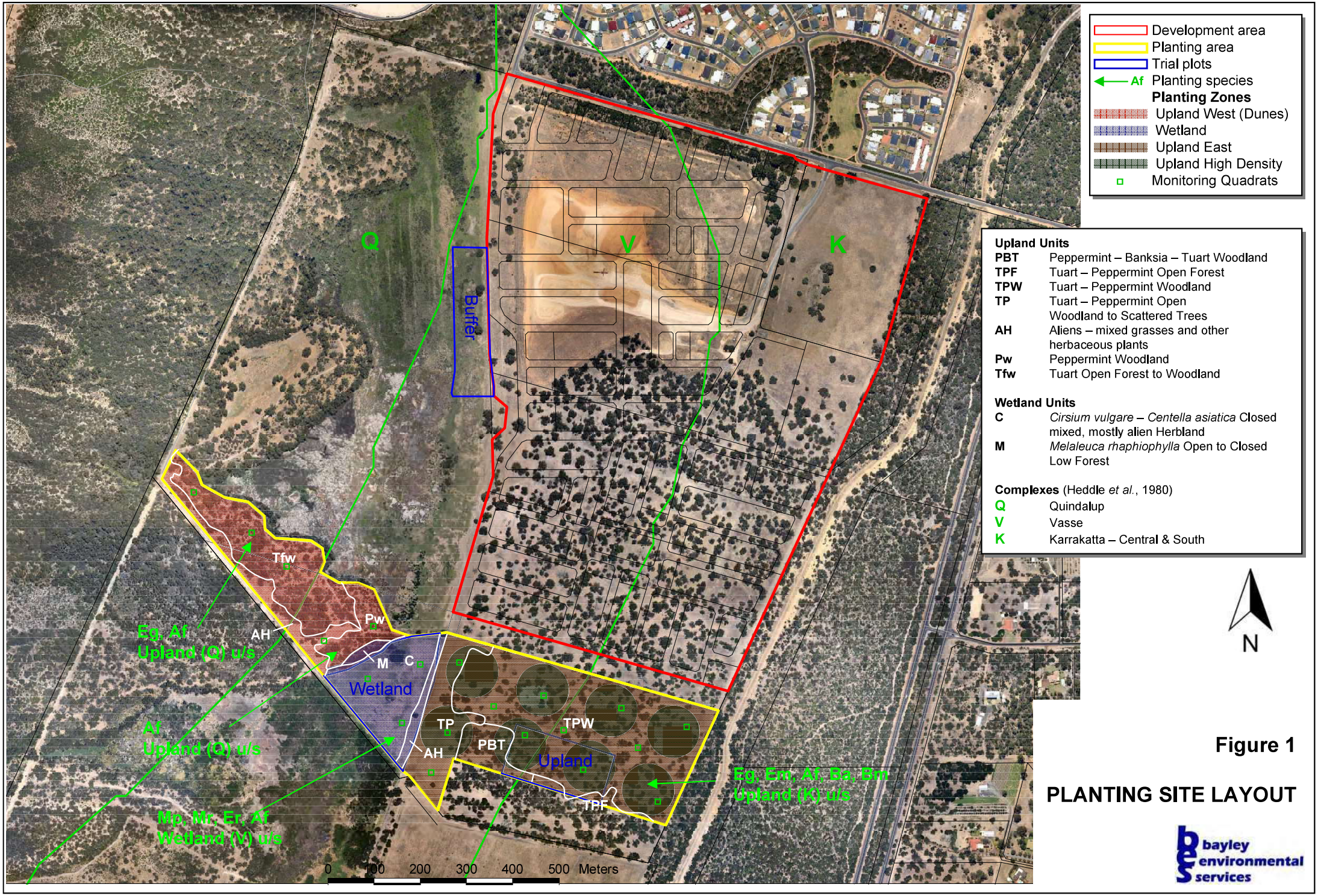


Figure 1

PLANTING SITE LAYOUT

bayley environmental services