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1. Introduction

1.1 Background

Baigup Wetland Reserve is a local government reserve along the foreshore of the Swan River in the City of Bayswater. This Reserve is one of the few remaining bushland areas on the Swan Estuary and is recognised as a regionally significant bushland reserve as Bush Forever site no. 313 (Government of Western Australia 2000). Baigup Wetland Reserve has been identified by the Swan River Trust as Priority 1 vegetation (Swan River Trust 2008) and is ranked eleventh on the prioritised 14/15 Proactive list as requiring attention.

The Reserve contains high value fauna habitat and is part of a regionally significant ecological linkage. The Reserve is used by the community for passive recreation. This Reserve has been subject to a number of disturbance factors that have led to environmental issues at the site, including acid sulphate soils and ponding water.

The Reserve has been the subject of a number of studies over the years. A management plan for the Reserve was first written in 1994 and was updated in 2004 (Regeneration Technology 1994; 2004). A previous report on the area by Seimon et al. (1991) was not sighted for this report.

In 2006 Department of Water was allocated funding to develop an action plan for remedial works at Baigup Wetland Reserve which included the preparation of an environmental management and remediation plan (Randall and Storer 2010).

1.2 Purpose of this report

The City of Bayswater (COB) commissioned GHD Pty Ltd (GHD) to provide a review of historical information and develop a management plan for Baigup Wetland Reserve within the COB, Western Australia.

This management plan is an update of the previous management plans (Regeneration Technology 1994, 2004; Randall and Storer 2010). These earlier documents provide strategies for management, and details on the principles of management (i.e. weed control) which are not repeated in this document. This management plan provides details on the current environment present at the Reserve, the current threats to the environmental values of the Reserve and an implementation plan with specific management recommendations.

This management plan includes a 10-year weed control and revegetation plan with the first three years of proposed actions outlined on a monthly basis.

1.3 Resourcing availability

The management plan will set out what activities can be implemented over the following decade within council's existing resources. Although it is understood that resourcing will be reviewed annually it is expected that, as a minimum, the following resources will be allocated to the restoration of Baigup Wetland Reserve each year:

- \$40,000 for works,
- \$5,000 for water quality/soil assessments,
- Environmental officer time for managing works and community liaison 1 day per month (approx.).

It is expected that the COB will work with State and federal agencies to use this management plan to seek additional funding and grants to bring forward elements of these works.

The City's desire is to review the proposed actions with the Bayswater Wetland Interest Group (BWIG) to determine which activities they wish to implement or bring forward with additional grant funding and resourcing they can provide.

1.4 Study area

The Reserve is located on the Swan River floodplain in Bayswater. This Reserve extends approximately 1 kilometre west of Garrett Road Bridge and is bound by the Swan River to the south (Figure 1). The site has an area of approximately 20 hectares.

The western part of the Reserve is a crown reserve and the majority of the rest of the area is freehold land owned by the Department of Planning. It has been proposed that the freehold land be transferred to the State of Western Australia with the aim to establish a Crown reserve vested in the COB (Regeneration Technology 2004), but this has not yet occurred. The Reserve is currently managed by the COB.

1.5 Acknowledgement

GHD acknowledges the considerable assistance of Jeremy Maher, Environmental Co-ordinator, City of Bayswater and Dr Penny Lee, Co-ordinator, Baigup Reserve Interest Group, in reviewing the document and providing background, management history and suggestions for future management of the Reserve.

1.6 Scope and limitations

This report: has been prepared by GHD for City of Bayswater and may only be used and relied on by City of Bayswater for the purpose agreed between GHD and the City of Bayswater as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than City of Bayswater arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by City of Bayswater and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Methodology

2.1 Literature review

GHD conducted a desktop and rehabilitation assessment which focused on a review of acid sulfate soil, water balance and decline in *Melaleuca raphiophylla* (GHD 2015). The reports utilised for this review, and referenced in this management plan include:

- Ecoscape (Australia) Pty Ltd (2008), *Baigup Reserve Macro invertebrate Survey*. Unpublished report prepared on behalf of Government of Western Australia, Department of Water. May 2008.
- URS Australia Pty Ltd (2008), *Baigup Reserve Hydrogeological Survey - Soil and Water Quality Sampling and Hydrogeological Conceptual Modelling*. Unpublished report prepared on behalf of Government of Western Australia, Department of Water. December 2008.
- CSIRO; Douglas, Patterson, Davis, Wendling, Coleman and Furness (2008), *Assessment of Acid Sulfate Soils and Surface Water and Groundwater Quality at Baigup Reserve, WA*. August 2008.
- URS Australia Pty Ltd (2009), *Final Report- Baigup Hydrogeological Survey and Acid Sulphate Soil Mapping*. Unpublished report prepared on behalf of Government of Western Australia, Department of Water. December 2009.
- Douglas, Patterson, Davis, Adeney and Furness (2007), *Baigup Field Assessment*. June 2007.
- Randall, N and Storer, T (2010). *Baigup Reserve remediation and management plan, final report*. Prepared by Ecoscape (Australia) Pty Ltd for the Department of Water, Western Australia.
- Regeneration Technology (1994), *Baigup Wetland Reserve Management Plan 1994-1999*. Unpublished report prepared on behalf of City of Bayswater. January 2004.
- Regeneration Technology (2004), *Baigup Wetland Reserve Management Plan 2004-2014*. Unpublished report prepared on behalf of City of Bayswater. January 2004.

In addition to these reports a number of technical references accessed on line and available information sources were used to identify environmental features at Baigup Reserve (Table 1). The datasets used are listed below.

Table 1 Information sources for the desktop investigation

Aspect	Information Source
Land zoning	Western Australian Planning Commission's mapping of: <ul style="list-style-type: none"> • Metropolitan Region Scheme reservation • Local Town Planning Scheme reservation and zoning
Bush Forever	Bush Forever sites spatial dataset. Information on Bush Forever sites provided by Government of Western Australia (2000)
Vegetation	Vegetation in the Project Area as shown in: <ul style="list-style-type: none"> • Beard (1979) vegetation mapping • Heddle et al. (1980) vegetation mapping
Threatened and Priority Ecological Communities	Ecological communities listed in the following databases as being within the Project Area: <ul style="list-style-type: none"> • DPaW Threatened Ecological Community (TEC) and Priority Ecological

Aspect	Information Source
	Community (PEC) spatial datasets; <ul style="list-style-type: none"> • DPaW Priority Ecological Communities List; and • Threatened Ecological Communities Endorsed by the Minister for Environment.
Habitat linkages	Perth Metropolitan Regional Linkages as listed in Government of Western Australia (2000) and in the Local Government Biodiversity Planning Guidelines (Del Marco et al. 2004)
Waterways and wetlands	Assessment of the surface and groundwater features based on: Department of Water (DoW) Geographic Data Atlas, including: <ul style="list-style-type: none"> • Swan Coastal Plain geomorphic wetlands
Heritage	Identification of Indigenous and Non-Indigenous heritage sites using: <ul style="list-style-type: none"> • Department of Aboriginal Affairs (DAA): Aboriginal Heritage Inquiry System; • DotE: Australian Heritage Database; • Government of Western Australia Inherit Database

2.2 Field assessment

A half day reconnaissance field assessment was undertaken by a GHD Ecologist on the 10th of March 2015. This was not a full field assessment but included ground-truthing of the previous vegetation community mapping, an assessment of changes in vegetation communities, an assessment of vegetation condition and opportunistic records of flora species present at the time of the survey. The survey was undertaken at the end of summer which means that a number of annual species were not present and a number of species were not identifiable due to lack of flowering or fruiting material.

Vegetation communities

The mapping of the vegetation communities that had been previously described within the Reserve (Regeneration Technology 1994; 2004; Randall and Storer 2010) was updated using field observations and aerial photography interpretation. The vegetation communities mapped previously were not directly comparable to one another as different methods were used to map the communities. This assessment endeavoured to utilise the previous methods as far as possible to enable direct comparison of vegetation types to ensure that changes in vegetation over time can be quantified. For this purpose the vegetation units were assigned a broad community type, using the methods used by Regeneration Technology (1994; 2004), (determined by overstorey and understorey native flora composition) as well as a detailed description based on the methods used by Randall and Storer (2010) which followed the methodology used by Keighery (1994, adapted from Muir 1977 & Aplin 1979, as cited in Randall and Storer 2010). However, where the vegetation communities can no longer be considered as an intact community (ie. where they are predominantly cleared, highly modified or contain planted/weedy species) they were not defined using the methods of Randall and Storer (2010).

Vegetation condition

The vegetation condition of the Reserve was assessed using the vegetation condition rating scale developed by Keighery (1994). This rating scale recognises the intactness of vegetation, which is defined by the following:

- Completeness of structural levels
- Extent of weed invasion
- Historical disturbance from tracks and other clearing or dumping

- The potential for natural or assisted regeneration

The scale consists of six (6) rating levels as outlined below in Table 2.

Table 2 Vegetation condition rating scale (Keighery 1994)

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

2.3 Stakeholder workshops

A workshop was held by the Environment Coordinator of the COB with members of the local community group, BWIG in December 2014. This workshop included 20 members of the community, most of whom live within two kilometres of Baigup Wetland. The objective was to agree and articulate a vision for the Reserve achievable within the next 10 years. The outcomes of the workshop indicated that the community's requirements for the management and enhancement of the Reserve (in general order of preference) were to:

- restore native vegetation and retain and improve natural systems
- improve and develop infrastructure to optimize community use and enjoyment (including the development of boardwalks, track/cycleway improvements)
- refine and develop entry point statements, lookouts (including the development of an interpretive centre with eco-café)
- increase natural water flow and nutrient trapping at the landward side of the Reserve
- develop improved interpretation, school liaison and community education processes.

It was understood that a number of these requirements would be subject to funding availability.

3. Existing Environment

3.1 Land use

The Reserve was used historically by the Nyungar people who would have likely used the marshy river flats and camped on higher ground. After European settlement sections were used by market gardeners and for grazing of animals. In the 1970s the land was acquired as a road Reserve and for parks and recreation. Subsequently the road reserve was removed and the whole area is now reserved as Parks and Recreation in the Metropolitan Regional Scheme (Regeneration Technology 2004).

In 1986 the Dampier to Perth gas pipeline was laid through the Reserve and the raised track used during construction of the pipeline was subsequently paved as a footpath and cycleway. In the 1990s another track was created along the northern boundary of the Reserve to allow the laying of Water Corporation pipework. The Reserve had also been used as a receiving point for drainage, including road and property runoff.

Currently, the main purpose of the Reserve is conservation; however it is also used for passive recreation, including walking/jogging, cycling and canoeing. The foreshore of the Reserve is also used by people fishing in the river. Road and property runoff is still collected on the Reserve via a number of drains.

The Reserves recreational facilities are currently limited to:

- A paved dual-use walking and cycling path that runs the length of the Reserve, west-east
- A limestone path in the centre of the Reserve that runs northwest-southeast from private properties down to the river.
- A boardwalk at the eastern end of the Reserve that offers a scenic viewpoint.

Occasional, informal tracks occur in sections of the Reserve and are used by people accessing the river to fish. Recreational facilities, including bathrooms, picnic areas and barbeques are located east of the Garratt Street Bridge in the A.P. Hinds Reserve.

The Reserve is part of Bush Forever site 313 'Swan River Saltmarshes'.



Plate 1 Boardwalk at eastern end of Baigup Wetland Reserve

3.1.1 Community groups

Baigup Wetland Interest Group was established in early 2012. This group produces quarterly newsletters (which started in early 2013) and undertake a number of on-ground works, including

weeding, revegetation and community engagement/education programs. Previous community groups (of which a number of members are now part of BWIG) included the Friends of Baigup Wetland (FoBW) in the early 2000s and the Bayswater Integrated Catchment Management (BICM) in the 1990s.

3.2 Aboriginal heritage

The Swan River is a registered 'Mythological' heritage site (ID #3536). No other 'registered sites' and no 'other heritage places' have been recorded within or directly adjacent to Baigup Wetland Reserve.

3.3 Non-indigenous heritage

The Garratt Road Bridge, at the eastern end of the Reserve, is listed on the state heritage register. The bridge comprises two adjacent bridges, one built in 1935 and one in 1972. The bridge is a significant element of the adjacent recreation areas and a landmark on the Swan River. The bridge area is used for recreational pursuits and is the finishing point for the Avon Descent (Heritage Council of WA 2015).

3.4 Landforms, topography and soils

The previous management plan (Randall and Storer 2010) states that Reserve sits within the landform of the Bassendean Dunes. However, while the Reserve sits within the general Bassendean landform the majority of the soils associated with the river are the soils associated with the Pinjarra Plain which is an alluvial plain that generally occurs on the eastern side of the Perth area, and which originates from river systems flowing down from the plateau (Government of Western Australia 2000).

The majority of the Reserve occurs within a low-lying floodplain adjacent to the river. At the western and eastern ends of the Reserve the site slopes up to higher ground along the northern boundary.

3.4.1 Soils

Most soil types within the site are alluvial in origin due to the low-lying location of the Reserve. The undisturbed superficial deposits comprise sand/loamy sand profile, mud and silty sandy estuarine/lagoonal deposits. The porous, grey sands occur in the most landward and elevated sections of the Reserve. Peat is found closest to the river's foreshore and in the swamps. Silty clay of low plasticity is found at locations at the eastern portion of the site and clay is generally found along the northern boundary of the Reserve.

Acid Sulfate Soils

The Reserve is extensively underlain by acid sulfate soils with high concentrations of pyritic materials that have accumulated in the wetland sediments/soils fed by sulfate and iron enriched waters. In the context of ideal conditions for pyrite formation, sulfate is readily available from the river and previous land-use activities, while iron is freely available from terrestrial sources and an abundance of organic matter within the Reserve. There are potential acidity stores and metals within the wetland that can be released when the subsoils are subject to soil disturbance, oxidation and acidification. The Reserve has progressively acidified since the alteration of the local hydrology following the construction of an access causeway in 1986.

3.5 Hydrology and hydrogeology

The Reserve was originally fed by groundwater expression with numerous freshwater springs, local stormwater systems and was periodically inundated by tidal flood from the Swan River.

The construction of the Dampier to Perth high pressure gas pipeline and an access causeway through the centre of the site in 1986 altered the natural hydrology within the Reserve. The causeway (now a dual-use path) was constructed with compacted limestone materials which created a hydraulic barrier within a natural flushing system. Although at least ten drainage culverts were installed to alleviate local flooding and facilitate stormwater discharge to the river, the subsidence of some sections of the culverts has reduced their effectiveness for tidal exchange. In addition a saline groundwater wedge from the Swan River has been identified within the Reserve that may act as a hydraulic barrier for groundwater seepages to the river. These processes not only significantly changed the local hydrology, they have also affected the soils and water quality of the Reserve.

The northern portion on the landward side of the path, now retains significant freshwater from numerous springs and stormwater outlets has become a woodland swamp. The southern portion on the river side of the dual-use path is still influenced by tidal flood from the Swan River and contributions from the stormwater overflows from the wetland, thus creating a brackish wetland system. Two artificial lakes were constructed between 1990 to early 2000 to enhance the aesthetic value of the Reserve while providing a permanent water habitat for fauna and flora. Spoils from the lake construction were dumped over the degraded wetland areas.

The hydrological and hydrogeological assessments that have been undertaken at the Reserve indicate that both surface waters and groundwater are saline in areas close to the river (south of the path) and fresh to brackish in areas away from the river (north of the path) (URS 2008). A CSIRO (2008) assessment also indicated that there was ingress of saline waters during high tides, which was largely restricted to the river side (south of the path) by the position of the path.

Based on the observations and information reviewed, upwards groundwater discharge into the lakes through the clayey profile does not appear as a major contributor to the surface water balance (GHD 2015). The majority of surface water within the Reserve is likely to be derived from springs located on the northern boundary of the Reserve (groundwater outcrop), which is directed to the wetlands through surface drainage where present - possibly through the shallow sandy fill material.

3.5.1 Wetlands

The majority of the Reserve has been mapped as a Conservation Category wetland 'Two Lakes Swamp'. The rest of the Reserve has been mapped as Multiple Use Swamp with the classification 'Estuary-Peripheral'.

Two artificial lakes were constructed within Baigup Wetland Reserve; the first in 2000 (Primary Lake) and the second in 2001 (Secondary Lake). The aim of the lake construction was:

- To improve the quality of water entering the riverside vegetation communities and the Swan River
- To enhance the Reserve's aesthetic value
- To establish open water habitats for endemic fauna (particularly birds) and flora
- To reduce fire risk by decreasing the fuel load

(Randall and Storer 2010)

The constructed wetlands are fringed by both native and weed species and offer excellent habitat, particularly for waterbirds.



Plate 2 Channel next to Secondary Lake, Baigup Wetland Reserve

3.6 Vegetation and flora

3.6.1 Vegetation communities

Regional vegetation has been mapped by Heddle et al. (1980) based on major geomorphic units on the Swan Coastal Plain. Heddle et al. (1980) mapping indicates that the vegetation complex 'Swan complex' occurs across the Reserve. The Swan Complex is generally associated with the Pinjarra Plain and is described as 'a fringing woodland of *Eucalyptus rudis*-*Melaleuca raphiophylla* with localised occurrence of low open forest of *Casuarina* spp.¹ and *M. cuticularis*.

Prior to European settlement the vegetation at the Reserve would likely have supported sedgeland in the low-lying floodplain with the more permanently wet areas supporting a *Melaleuca raphiophylla* woodland with an understorey of sedges. A community of *Eucalyptus rudis* would likely have occurred close to the river at either end of the Reserve where the floodplain narrows (Regeneration Technology 2004). In the upland areas of the Reserve there would likely have been a Marri-*Banksia* woodland.

Changes to vegetation since 1994

The vegetation within Baigup Wetland Reserve has undergone a number of changes within the last 20-30 years, related to the changes to hydrology (including the creation of the artificial lakes) fire events and the rehabilitation works within the Reserve. The vegetation was mapped in 1994 (Regeneration Technology 1994), 2002 (Regeneration Technology 2004) and 2009 (Randall and Storer 2010). This vegetation mapping has been used to assess the change in vegetation over time; however, there are some difficulties with this as there are some discrepancies within the mapping (ie. between the text described and the mapped areas) and the vegetation classification system used in 2009 was different to that used in 1994 and 2002. It is recommended that future mapping should ensure vegetation classification is aligned with that previously used so the mapping is comparable.

The changes to vegetation within the Reserve, based on previous mapping and the 2015 field assessment, are detailed in Table B.1 Appendix B.



¹ There is the potential that at least some or all of the *Casuarina* trees present at the reserve are the weedy species *C. glauca* which is very similar to the native *C. obesa*. *Casuarina glauca* has been planted throughout the Perth region and may have been planted in Baigup Reserve in the past. However, during the brief 2015 survey it was not possible to confirm which species occurs at the site, due to lack of diagnostic material. It is likely that both species are present throughout the reserve.





2015 Vegetation communities





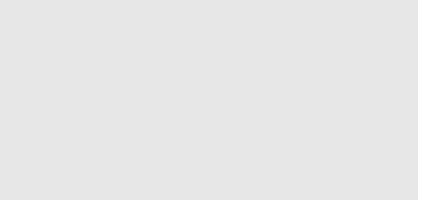
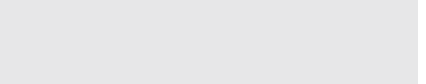
The vegetation within the Reserve includes sedgelands; woodlands of *Melaleuca raphiophylla* and *Casuarina* spp. over sedgelands and patches of *Eucalyptus* woodlands in the west and east of the Reserve. There are also sections of highly modified areas that are either cleared or dominated by weedy species.

The vegetation types currently present within the Reserve are described in Table 3 and mapped in Figure 2, Appendix A.

Table 3 Vegetation communities mapped within Baigup Wetland Reserve

Vegetation communities 2015 (modified from Regeneration Technology, 2004; Randall and Storer 2010)	Location and Extent (2015)	Example Photo
<p>CoMrW <i>Casuarina</i> -<i>Melaleuca</i> woodland</p> <p><i>Casuarina obesa</i>/<i>Melaleuca raphiophylla</i> Woodland over <i>Bolboschoenus caldwellii</i>/<i>Juncus krausii</i> Closed Sedgeland</p>	<p>Occurs on the river side of the path in the centre of the Reserve, and along the path in this area</p> <p>1.52 ha</p>	
<p>ErMrW <i>Eucalyptus</i> -<i>Melaleuca</i> open woodland</p> <p><i>Eucalyptus rudis</i> Open Woodland over an Open Shrubland of <i>Melaleuca raphiophylla</i> over a <i>Typha orientalis</i>/<i>Baumea articulata</i> Sedgeland</p>	<p>A small patch occurs along the river at the western end of the Reserve</p> <p>0.16 ha</p>	<p>-</p>
<p>ErMrCoW <i>Eucalyptus</i> -<i>Melaleuca</i> - <i>Casuarina</i> Woodland</p> <p><i>Melaleuca raphiophylla</i>/<i>Eucalyptus rudis</i> /<i>Casuarina</i> spp. Closed Forest over a Very Open Herbland of <i>Centella asiatica</i> and a <i>Bolboschoenus caldwellii</i> /<i>Carex divisa</i> Closed Sedgeland</p> <p>South of the path this vegetation has a relatively intact mixed sedgeland understorey.</p> <p>North of the path the understorey is dominated by weedy species (mapped as WErMrCoW)</p>	<p>Occurs at the eastern end of the Reserve</p> <p>0.57 ha</p>	

Vegetation communities 2015 (modified from Regeneration Technology, 2004; Randall and Storer 2010)	Location and Extent (2015)	Example Photo
<p>MrW <i>Melaleuca raphiophylla</i> Scrub</p> <p><i>Melaleuca raphiophylla</i> Tall open Scrub over a <i>Bolboschoenus caldwellii</i> / <i>Juncus kraussii</i> Sedgeland</p>	<p>One of the dominant vegetation types, occurs on the north and south side of the path across much of the Reserve</p> <p>4.45 ha</p>	
<p>JkS <i>Juncus kraussii</i> closed sedgeland:</p> <p>Closed Sedgeland of <i>J. kraussii</i> with an Open Shrubland of <i>Sarcocornia quinqueflora</i> and scattered <i>Melaleuca raphiophylla</i></p> <p>Large areas of this vegetation are still in good condition, with limited disturbances.</p>	<p>Occurs mainly in the eastern part of the Reserve, on the south side of the path, with a small patch north of the path and another small patch south of the path in the centre of the Reserve.</p> <p>2.04 ha</p>	
<p>ErWicV <i>Eucalyptus rudis</i> woodland over <i>Ipomoea carica</i> vineland</p> <p><i>Eucalyptus rudis</i> and <i>Eucalyptus</i> spp. Woodland over <i>Ipomoea carica</i> and *<i>Dipogon lignosus</i> Vineland and mixed exotic Closed Grassland</p>	<p>A small patch occurs below the path, next to the river at the western end of the Reserve.</p> <p>0.55 ha</p>	
<p>MS Mixed <i>Typha/Baumea/Schoenoplectus</i> sedgeland.</p> <p><i>Typha orientalis</i>, <i>Baumea articulata</i>, <i>Schoenoplectus vallidus</i> Sedgeland over a Very Open Herbland of <i>Cotula coronopifolia</i> with scattered <i>M. raphiophylla</i></p> <p>This area has been revegetated in the years 2012-13, since removal of <i>Juncus kraussii</i></p>	<p>Occurs on the north side of the path, at the western end of the Reserve, around and within Secondary Lake.</p> <p>1.28 ha</p>	

Vegetation communities 2015 (modified from Regeneration Technology, 2004; Randall and Storer 2010)	Location and Extent (2015)	Example Photo
<p>HM/C Highly modified community/Cleared</p> <p>Includes areas of revegetation, regrowth <i>Casuarina</i> and weed communities</p>	<p>Includes the path, the limestone track along the northern boundary and cleared/degraded areas on the north side of the path.</p> <p>2.02 ha</p>	
<p>HM/I Highly modified community/Introduced species</p> <p>Includes areas dominated by Bracken (<i>Pteridium esculentum</i>), introduced Eucalypts, Poplars, <i>Typha</i> and other weedy species with some scattered native species, including planted <i>Banksia littoralis</i> and Marri (<i>Corymbia calophylla</i>)</p>	<p>Occurs in the north-east of the Reserve</p> <p>1.76 ha</p>	
<p>MGS Mixed grassland and sedgeland (dominated by weed species) with scattered <i>Melaleuca raphiophylla</i></p>	<p>Small patch at the eastern end of the Reserve, south side of the path</p> <p>0.25 ha</p>	
<p>PI - Plantings: There is a new section of revegetation in the upland area adjacent to the entrance of the Reserve. This area also includes some established upland plants such as <i>Macrozamia fraseri</i></p>	<p>Two patches of revegetation in upland areas, at the north end of the Reserve and on a patch of higher ground near Secondary Lake</p> <p>0.45 ha</p>	
<p>ErW <i>Eucalyptus rudis</i> open woodland</p> <p><i>E. rudis</i> Open Woodland over a Very Open Herbland of <i>*Rumex</i> sp. and <i>T. orientalis</i> ver Open Sedgeland of a mixed exotic Closed Grassland</p>	<p>Small patch along the northern boundary, just east of the central track</p> <p>0.14 ha</p>	
<p>EBW Planted <i>Eucalyptus</i> species and <i>Banksia</i> woodland</p>	<p>Small patch in the east of the Reserve</p>	

Vegetation communities 2015 (modified from Regeneration Technology, 2004; Randall and Storer 2010)	Location and Extent (2015)	Example Photo
Woodland that includes planted <i>Eucalyptus</i> species and <i>Banksia littoralis</i> over weedy grasses and planted shrubs	0.16 ha	

3.6.2 Conservation significant communities

The Department of Parks and Wildlife (DPaW)- listed Priority Ecological Community (PEC) 'Coastal Saltmarsh' is also listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) Act as a Threatened Ecological Community (TEC) 'Subtropical and Temperate Coastal Saltmarsh' (August 2013). Subtropical and Temperate Coastal Saltmarsh occurs within a relatively narrow margin of the Australian coastline within the subtropical and temperate climate zones. The physical environment for this community is coastal areas under regular or intermittent tidal influence. Saltmarsh is the main vegetation type in the intertidal zone and commonly occurs in association with estuaries. It typically is restricted to the upper intertidal environment. The Coastal Saltmarsh ecological community consists mainly of salt-tolerant vegetation, generally dominated by succulent herbs, shrubs and grasses but also with sedges and rushes (DotE 2014a).

This TEC was likely once present throughout much of the Swan River Estuary; however, it has probably declined in the area by over 50 % (Keighery 2013). The vegetation community that occurs at the Reserve that is likely to be equivalent to the TEC/PEC Coastal Saltmarsh is the *Juncus kraussii* sedgeland that occur along the foreshore

The key diagnostic characteristics of the Coastal Saltmarsh ecological community and their presence within Baigup Wetland Reserve are described in Table 4.

Table 4 Key diagnostic characteristics of Coastal Saltmarsh ecological community and their presence within Baigup Wetland Reserve

Key Diagnostic Characteristics	Baigup Wetland Reserve
Occurs within the range of community	Yes, within range
Occurs on the coastal margin, along estuaries and coastal embayment and on low wave energy coasts	Yes, the foreshore is along the Swan River which in this area can be considered estuarine
Occurs on places with at least some tidal connection	Yes - microtidal
Consists of dense to patchy areas of characteristic saltmarsh plant species	Yes within sedgeland areas adjacent to river, <i>Juncus kraussii</i> , <i>Tecticornia</i> sp.
Proportional cover by tree canopy is not greater than 50 % nor is proportional ground cover by seagrass greater than 50 %	Yes (in sedgeland areas)

The coastal saltmarsh is considered an important vegetation community and should be protected, and its values enhanced, wherever possible.

3.6.3 Vegetation condition

The vegetation condition of the Reserve has been mapped previously (Regeneration Technology 1994, 2004; Randall and Storer 2010) and was re-assessed and mapped during the March 2015 field visit (Figure 3, Appendix A).

The vegetation at Baigup Wetland Reserve has been modified and impacted which has affected both the structure and floristics (introduction of weeds/non-local natives) of the area. One of the

dominant overstorey species in the native vegetation, *Melaleuca raphiophylla*, is in poor condition in a number of areas. Anecdotal evidence indicates that *Melaleuca raphiophylla* have been dying in certain areas within the Reserve since 2002/3 (P Lee, BWIG, 2015 pers comm., 15 Feb.).

In general, the vegetation on the south (river) side of the dual-use path is in better condition than that on the north side. The vegetation condition on the south side of the path has, however, been partly altered by low-level weed invasion, trampling of vegetation, deaths of native vegetation (specifically *Melaleuca raphiophylla*) and traversing by an all-terrain vehicle (ATV) used for mosquito control in 2014/2015. The vegetation at the western end of the Reserve, on the south side of the path is generally in poor condition and is dominated by weedy species, with large areas smothered by *Ipomoea* sp. (Morning Glory) and *Dipogon lignosus* (Dolichos Pea).

Large areas of the north side of the path have been previously cleared, used for market gardening and are highly modified. There are areas of native vegetation (*Melaleuca* woodlands/sedgeland) on this side of the path, particularly around the central area of the Reserve; however these areas have been impacted by acid scalds, and potentially waterlogging, which are likely to have detrimentally affected the health of the vegetation. Currently there are dead or dying *M. raphiophylla* throughout the Reserve but particularly around the scald area east of Primary Lake and in the wetland area in the central part of the Reserve. In this section the trees that are on higher ground appeared healthy compared to some in more low-lying areas.

The north-east area of the Reserve (adjacent to the private houses along Garratt Rd and the eastern end of Stone Street) is dominated by introduced and planted species. The vegetation structure in this area has been highly altered and there is little remnant native vegetation.

The section around Secondary Lake is dominated by introduced *Typha orientalis*; however there has been revegetation undertaken in this area, including planting of native sedge species and weed control. The condition of this area would be expected to improve within the next few years, with ongoing care and maintenance of the revegetation and continued weed control.

3.6.4 Flora

A total of 140 flora taxa (including subspecies and varieties) have been previously recorded within the Reserve. This total comprises 54 (39 %) native taxa and 86 (61 %) introduced taxa. The full flora list of species previously recorded at the Reserve is presented in Table B.2, Appendix B.

These records come from the previous surveys (Regeneration Technology 1994, 2004; Randall and Storer 2010) as well as incidental records from the brief site visit in 2015. A full flora survey has not been conducted recently and it is recommended that recording of all flora species at the site be undertaken as part of any monitoring/weed surveys at the Reserve in order to update the existing species list.

3.7 Fauna

3.7.1 Fauna species

130 fauna species have been previously recorded with Baigup Wetland Reserve (Appendix C). This includes 115 birds, including waterbird species and some species listed and protected under international agreements (the Japan-Australia Migratory Bird Agreement and the China-Australia Migratory Bird Agreement). Some of these records may be old and no longer current; however, in the last three years 78 birds, three mammals, three reptiles and five frogs have been recorded by BWIG or Birdlife Western Australia within the Reserve (see Appendix C).

Forest Red-tailed Black Cockatoo, Carnaby's Black Cockatoo and Baudin's Back Cockatoo have been previously recorded in the Reserve, all of which are threatened in Western Australia and listed Vulnerable, Endangered and Endangered respectively under the federal EPBC Act.

Six frog species and one native mammal species, the Water Rat (*Hydromys chyrogiaster*) have previously been recorded at the Reserve. The Water rat is listed as Priority 4 by DPaW. Five introduced mammals have been recorded at the Reserve, including the Fox (*Vulpes vulpes*), the Cat (*Felis catis*), the Brown rat (*Rattus norvegicus*), the Black rat (*Rattus rattus*) and the House mouse (*Mus musculus*). Eight native reptile species have been previously recorded at the Reserve. One introduced turtle species, the Red-eared slider (*Trachemys scripta elegans*), has been sighted at Baigup previously but it is believed that this species has been eradicated from the Reserve.

Previous surveys in the Paperbark wetlands at the site reported a high diversity of invertebrates and at the majority of sampling sites this diversity was considered to represent a 'healthy wetland' (Regeneration Technology 1994). This sampling was undertaken prior to the construction of the two wetlands. Additional sampling of aquatic invertebrates in the main stormwater drain was undertaken in 1994 and 2007 which found that this drain was virtually absent of aquatic invertebrates (Regeneration Technology 1994; Ecoscape 2008).

The majority of the fauna records have come from three BirdLife surveys that have been undertaken at the Reserve which focused on bird species and from a fauna survey undertaken by Siemon in 1991 (Regeneration Technology 1994). No targeted surveys for other faunal groups have been undertaken recently at the Reserve. However, a number of fauna records have been reported anecdotally through community members using the Reserve and during conservation works. The information on the mammals, reptiles and amphibians present at the Reserve come from surveys conducted prior to 1994. As such this data is out of date and further surveys are required to determine the current complement of fauna species at the Reserve.



Plate 3 Waterbird species in situ at Baigup Wetland Reserve

3.7.2 Habitat

Baigup Wetland Reserve has a diversity of habitat types, including sedgeland areas, woodland areas and open water bodies. The Reserve includes saline and freshwater zones with wading areas, dense sedge and herb coverage and woodlands for perching habitat. The Reserve has high value as fauna habitat, particularly for bird species.

3.7.3 Habitat linkages

Baigup Wetland Reserve is part of a regional ecological linkage identified as part of the Perth Biodiversity Project. This regional linkage includes the Swan River and its foreshores which connects the Swan Coastal Plain to the eastern hills (EMRC 2008). Baigup Wetland Reserve is also part of local linkage 2, recognised in the Collective Local Biodiversity Strategy (EMRC 2008). This local linkage is a series of stepping stones of natural areas, including small parks and reserves north from Baigup Wetland Reserve.

4. Threats

4.1 Acid Sulphate Soils

The Reserve is extensively underlain by acid sulfate soils with high concentrations of pyritic materials that have accumulated in the wetland sediments/soils fed by sulfate and iron enriched waters and the Reserve has progressively acidified since the alteration of the local hydrology in 1986. There is evidence of extensive acid scalds, dying vegetation, low pH and high acidity in the surface sediments and subsoils. The soils in the Reserve have accumulated a large pool of acidity (actual and retained acidity) that could potentially be mobilised in runoff during the first significant rainfall event and discharged to the river via surface drainage.

In response to the potential risk to the river, the City of Bayswater, Swan River Trust and the former Department of Environment modified the existing drainage culverts along the dual-use path to prevent acid metal-rich waters from the Reserve impacting the Swan River. The drainage modification also reduced extensive soil oxidation and acidification. The success of this drainage modification was evident from subsequent site investigations that revealed little evidence of actual acid sulfate soils occurring at the Reserve, however, potential acidity is still widespread throughout most soil profiles.

Studies have demonstrated that the majority of the pH measurements of surface and ground water quality are circumneutral (pH 6 – 8) with isolated occurrence of pH between 5 and 6, which suggests there is little evidence that active export of acidity is occurring from the Reserve (GHD 2015). It is also evident that the elevated iron concentrations in surface and groundwater promote other secondary minerals precipitation that could affect water quality on a seasonal and intermittent basis. Studies have shown that significant iron precipitate accumulations in coastal acid sulfate landscape similar to the Reserve have become stores of acidity that could affect water quality in relation to the amount of titratable actual acidity. The relationship between water quality and the type of iron precipitated minerals formed would determine the amount of acidity accumulations in the soils and pore water.

An additional factor to consider is a range of salinity levels in surface water and groundwater that could potentially be harmful because it relates to sulfate salts of aluminium and iron. In the root zone, groundwater chloride salinity contributes to osmotic stress, and acidic sulfate salinity can cause metal toxicity and nutrient deficiencies including osmotic stress.

4.2 Climate change

According to the Swan River Trust (Government of Western Australia 2007) report 'Potential Impacts of Climate Change on the Swan and Canning Rivers', the impacts of climate change will affect the Swan and Canning Rivers at an ecological, infrastructural, human health, social and economic level. The Swan River Trust report states that many of the effects of climate change will unfortunately not have the opportunity for active management and for factors that can be controlled decisions will need to be made between developing foreshore protection measures or allowing processes to continue without interference. The predicted scenarios investigated by the Swan River Trust indicate:

- accelerated atmosphere and ocean warming
- decrease in total winter stream flows
- accelerated sea and tidal estuary level rise
- decreased winter rainfall
- increased frequency of droughts

- increase in extreme tidal estuary levels
- increase in frequency of warm spells and heat waves.

Because of the diverse nature of the Swan and Canning river foreshore and ecological system, the potential impacts from climate change are numerous and difficult to predict definitively. Climate change will inevitably effect: sediment composition and nutrient loads; dissolved oxygen levels; nutrient cycling; fringing vegetation; community structure (including trophic dynamics with a particular focus on birds and fish); mudflats; sea grass and macro-algae; biodiversity; acidification; and geomorphology. Climate change already is, and has the potential to, cause changes in riverside vegetation within Baigup Wetland Reserve.

The Swan River Trust report indicates that there is increasing seasonal salinity in the Swan River, particularly the upper reaches of the estuary, where water has historically been brackish (Government of Western Australia 2007). The effects of reduced rainfall and catchment runoff for the Swan River, and therefore reduced flushing of salts from the system, create an increasing salt water wedge, which infiltrates previously fresh watertables at the river edges. This change in seasonal salinity may be detrimentally affecting *Melaleuca raphiophylla* on the riverside and landward areas of the dual-use path within Baigup Wetland Reserve.

Additionally, rising river levels and water temperatures have the potential to increase mosquito breeding and change the type of species breeding in the area. For practical purposes (for the ten year plan) this will not require a different treatment/assessment approach however needs to be considered as part of ongoing mosquito management review.

4.3 Foreshore erosion

The Swan River foreshore is a dynamic boundary that changes form in response to natural processes and human impacts (Swan River Trust 2009). The foreshore of the Reserve is susceptible to a variety of mechanisms that can lead to instability of the banks and erosion, including wave action, river flow and boat wakes.

The 2004 management plan (Regeneration Technology 2004) noted that erosion is a major problem along the river foreshore, especially in the eastern end of the Reserve. Wave wash from boats has impacted on the sandy shoreline. The river in this area is relatively shallow and this, combined with the low height of the Garratt Road bridge means the boating traffic travels on the northern side of the river and Baigup foreshore gets substantial wave wash. A Swan River Trust, foreshore assessment of the area that included Baigup Wetland Reserve considered that there was moderate evidence of erosion (Swan River Trust 2008). Bank instability, including fallen trees, was noted during the 2015 field visit (Plate 4) and movement of the foreshore bank is likely to be an ongoing and dynamic process. In recent years, further erosion at the western end has brought high tides up to the path on numerous occasions (P Lee, BWIG, 2015 pers comm. 10 May)

A number of erosion control techniques have been used in the past along the Baigup foreshore including bollard river bank protection at the eastern end of the Reserve. However, there do not appear to be any ongoing control techniques in place. The natural migration of the foreshore over time is an acceptable method of 'managed retreat' (Swan River Trust 2008). However, ongoing monitoring of the infrastructure through engineering assessments is required to ensure that erosion does not start to impact on infrastructure and thus create a safety risk, such as on the boardwalk at the eastern end. COB will work in partnership with the Swan River Trust to assess the erosion along Baigup Reserve and develop a management plan.



Plate 4 Fallen trees along Baigup Wetland Reserve banks (eastern end of Reserve)

4.4 Hydrological issues

4.4.1 Salinity

Increased salinity levels in the river and the likely presence of a salt water wedge under the Reserve have led to increased salinity levels in the Reserve. The increased salinity has the potential to cause changes to the wetlands and associated vegetation within the Reserve.

A number of studies (Gibson 2001; Froend et al. 2006) have found that wetland *Melaleuca* species are not tolerant of high salinities, particularly when combined with long term inundation. The Gibson (2001) study on hydrological changes in the Peel Harvey Estuary has suggested that increased salinity due to additional sea-water ingress in the estuary was the likely cause of decline in vegetation health.

4.4.2 Waterlogging

The hydrological changes that were caused by the infrastructure works in 1986 have led to waterlogging of soils north of the dual-use path. Waterlogging occurs when there is too much water in the plant's root zone which means that the roots cannot access enough oxygen for respiration which can lead to decline and death (DAFWA 2015).

A study has been conducted on a lake in Western Australia's south-west that has been subject to changes in waterlogging and salinity (Froend et al. 2006). This study concluded that the lack of natural drying periods due to additional water ingress into a lake caused vegetation decline, specifically on the species *Casuarina* spp., *Eucalyptus rudis* and *Melaleuca raphiophylla*.

4.5 Weeds

Invasive species (including weeds) represent the biggest threat to biodiversity after habitat loss (DotE 2014b). Weeds are plants that grow in areas where they are not wanted and where they may have an environmental or economic impact. Weeds can impact on natural values by:

- Out-competing native species for nutrients, water, space and sunlight
- Reducing the natural diversity by smothering native plants or preventing them from growing back

- Reducing habitat for native animals
- Altering fire regimes (DPaW 2014).

The Reserve has significant weed infestations due to its historical use and there are large areas of the Reserve that are dominated by introduced species. In general the area to the north of the path has higher weed coverage than the areas on the river side of the path; however there are patches of high weed coverage in the west of Reserve, adjacent to the river.

A list of the weed species at the site has been prepared from information presented in the previous management plans and the brief site visit, which indicate that 85 weed species have been recorded within the Reserve (Appendix B). However, besides a brief site visit in March 2015, which included opportunistic recording of species, no recent weed mapping has been conducted at the site. It would be beneficial to prepare updated weed maps, which can be revisited every few years and which can assist in targeting control works and providing baseline information to monitor the success of the control works.

The weeds present at the Reserve have the potential to spread into the areas of the Reserve that retain native vegetation and that are in relatively good condition. In addition, there are a number of vectors that may lead to the introduction of new weeds and the further spread of additional weeds in the Reserve including:

- Dumping of rubbish
- Escape of garden plants: particularly in areas where gardens border the Reserve
- Human and animal transport

These vectors need to be taken into consideration when planning weed control as while it may be possible to control weeds within the Reserve there will always be a source of seed in private gardens which will make eradication of the weeds within the Reserve very difficult.

4.5.1 Priority weeds

The previous management plans (Regeneration Technology 1994, 2004; Randall and Storer 2010) ranked the weeds present at the Reserve and prioritised those that were considered a threat to the ecology of the reserve. The original plan (Regeneration Technology 1994) listed five key weed species, while the 2004 plan (Regeneration Technology 2004) ranked the weeds using the distribution, invasiveness and impacts of the weeds within the reserve as well as the rating given to the weed by the Environmental Weed Strategy for WA (CALM 1999). The Randall and Storer (2010) ranking process used a scoring system and calculated rankings that took into account:



- The weeds rating in the Environmental Weed Strategy for WA (CALM 1999)
- The rating in Dixon and Keighery's 'Recommended methods to control specific weed species (as cited in Randall and Storer 2010)
- Whether the weed was listed on the *Agricultural and Related Resources Protection Act 1976* (now the *Biosecurity and Agriculture Management Act, 2007*)
- Whether the weeds was listed as a Weed of National Significance (WoNS)
- Its local significance to natural areas

All the weeds that were previously considered as 'key weed species' and 'high or moderate weed species' have been detailed in Table 5. In addition this table includes species identified during the March 2015 site visit as having isolated occurrences in the Reserve, for which eradication may be possible. It also includes any species that have been identified as species of concern for the community (P Lee, BWIG, 2015 pers comm., 15 Feb.).


During the 2015 brief site survey of the Reserve, a new record of a Weed of National Significance was made. This species, Madeira Vine (*Anredera cordifolia*), is a high priority for removal as it was only recorded as present in one location in 2015 and can spread rapidly and smother vegetation, including trees.


It is recommended that updated weed mapping should be undertaken at the reserve and this should include re-assessment and prioritisation of the weeds present at site.

Table 5 Priority weed species within Baigup Wetland Reserve




Weed species ²	Location in Reserve	Historical or existing control measures	Prioritisation
<p>Typha (<i>Typha orientalis</i>)</p> 	<p>Previously extensive stands of Typha have been brought under control.</p> <p>Existing infestations are mainly isolated plants or clumps on the river side of the path, with some sizeable clumps on landward side, particularly at Secondary Lake. Typha is spreading in Secondary Lake from a small clump in the middle of the lake and from the west end.</p>	<p>BICM/FOBW historically conducted control days using herbicide and slashing.</p> <p>This weed considered a priority by BWIG.</p> <p>Access issues (boat required) associated with Typha in Secondary Lake.</p> <p>Typha provides habitat, especially for wetland birds and weed control needs to consider potential impacts.</p>	<p>Key weed species (Regeneration Technology 1994)</p> <p>Highly ranked weed (Regeneration Technology 2004)</p>
<p>Madeira Vine (<i>Anredera cordifolia</i>)</p> 	<p>A single occurrence was noted on the northern side of the reserve, west of the central track, adjacent to private properties (likely a garden escape/planted)</p>	<p>Not previously recorded.</p> <p>Requires control through physical removal and herbicide control of regrowth.</p>	<p>Weed of National Significance</p> <p>Requires removal as soon as possible</p>
<p><i>Conyza</i> species</p>	<p>Along edges of bushland, at eastern end</p>	<p>Slashed and sprayed annually in recent years at the western end of the reserve.</p>	<p>Highly ranked weed</p>

² Note – *Salvinia molesta* was recorded as a highly ranked weed in Regeneration Technology (2004); however, an intensive program to remove this weed was undertaken from approximately 2002-2010 and this species has not been recorded since. . Future weed mapping should monitor for this weed to ensure this species does not become re-established at Baigup Reserve.

Weed species ²	Location in Reserve	Historical or existing control measures	Prioritisation
	of Reserve and in degraded areas	Control improved in 2014/15; preferable to spray before seeding	(Regeneration Technology 2004) High and moderate priority weeds (Randall and Storer 2010)
Arum Lily <i>(Zantedeschia aethiopica)</i>	 Scattered occurrences throughout the vegetation north of the path, at the eastern end of the Reserve, mostly north of the rear limestone path and also in the vegetation communities HM/I and ErMrCoW.	Well controlled in the western end. Infestation in the eastern end.	Highly ranked weed (Regeneration Technology 2004) High and moderate priority weeds (Randall and Storer 2010)
Rhizomatous/stoloniferous (creeping) grasses: Kikuyu (<i>Cenchrus clandestinus</i>)/Buffalo (<i>Stenotaphrum secundatum</i>)/Couch (<i>Cynodon dactylon</i>)	Along edges of bushland and at eastern end of Reserve	Historical and ongoing spraying	Key weed species (Regeneration Technology 1994) Highly ranked weed (Regeneration Technology 2004) High and moderate priority weeds (Randall and Storer 2010)
Tussock forming grasses: Paspalum (<i>Paspalum dilatatum</i>)/ Water Couch (<i>Paspalum distichum</i>)/ Perennial Veldt Grass (<i>Ehrharta calycina</i>)/ Hares Tail Grass (<i>Lagurus ovatus</i>) / Wild Oat (<i>Avena fatua</i>), Annual Beardgrass (<i>Polypogon monspeliensis</i>)	Annual Beardgrass is extensive throughout the northern part of MrW in the eastern end of the reserve and on the north side of path below Kelvin St in 2014.	Historical and ongoing spraying/slashing	Highly ranked weed (Regeneration Technology 2004) High and moderate priority weeds (Randall and Storer 2010)
Pampas Grass (<i>Cortaderia selloana</i>)	Isolated outbreaks occasionally propagate in the Reserve.	All the large infestations have been controlled and the outbreaks are being eradicated, however, seed sources are	Key weed species (Regeneration Technology 1994) Highly ranked weed

Weed species ²	Location in Reserve	Historical or existing control measures	Prioritisation
		present in adjacent properties.	(Regeneration Technology 2004) High and moderate priority weeds (Randall and Storer 2010)
Water Cress (<i>Rorippa nasturtium-aquaticum</i>)	Scattered throughout the degraded areas of the Reserve, in damp areas and waterways	Drainage channels at Kelvin St (west) end are hand pulled yearly to keep water running as a mosquito control measure. BWIG prefers it not to be sprayed.	Highly ranked weed (Regeneration Technology 2004) High and moderate priority weeds (Randall and Storer 2010)
Geraldton Carnation Weed (<i>Euphorbia terracina</i>)	Both sides of path, especially eastern end.	Sprayed annually and currently under good control.	High and moderate priority weeds (Randall and Storer 2010)
Blackberry (<i>Rubus</i> sp.) 	Well controlled in the western end. Infestation in the eastern end.	Has been subject to past and ongoing control works. Control is difficult at the western end of the Reserve due to thickets on Stone St properties bordering the degraded area. There has been minimal control at the eastern end of the Reserve within the last ten years.	Key weed species (Regeneration Technology 1994) Highly ranked weed (Regeneration Technology 2004) High and moderate priority weeds (Randall and Storer 2010)

Weed species ²	Location in Reserve	Historical or existing control measures	Prioritisation
<p>Poplars</p> 	<p>A number of established Poplar trees (estimated at 35 plants in 2014) occur along the north-eastern side of the Reserve, at the eastern end of the limestone track that runs along the north side of the Reserve. This species is spreading aggressively through suckering.</p>	<p>Three largest trees removed in 2014.</p>	<p>Site visit/community concerns</p>
<p>Japanese Pepper (<i>Schinus terebinthifolius</i>)</p>	<p>Larger trees occur on the bund between Secondary Lake and the sealed path.</p> <p>Seedlings can be found across the Reserve</p>	<p>Seedlings controlled by COB.</p>	<p>High and moderate priority weeds (Randall and Storer 2010)</p>
<p>Cape Lilac (<i>Melia azedarach</i>)</p>	<p>Occasionally sprouting in mulched area</p>	<p>Controlled by COB and volunteers</p>	<p>Site visit/community concerns</p>
<p><i>Washingtonia filifera</i></p> 	<p>Occasionally sprouting in mulched area and one growing in ErWlcV below Kelvin Street.</p>	<p>Controlled by COB and volunteers</p>	<p>Site visit/community concerns</p>

Weed species ²	Location in Reserve	Historical or existing control measures	Prioritisation
<p>Castor Oil Plant (<i>Ricinus communis</i>)</p> 	<p>In the slightly higher ground along the northern edge of the Reserve, adjacent to private properties.</p>	<p>There appears to have been substantial efforts to control this species where it would have occurred in a large patch in the area north-west of Primary Lake. Seedlings are continuing to emerge.</p>	<p>High and moderate priority weeds (Randall and Storer 2010)</p>
<p>Willow (<i>Salix</i> sp.)</p> 	<p>A number of established Willow trees occur along the north-eastern side of the Reserve, adjacent to the private properties along Stone St.</p>	<p>There does not appear to have been any control works undertaken to date. Some young Willows occur and should be culled annually as they emerge. BWIG and COB determined that old plants have some heritage value (market gardens).</p>	<p>Site visit</p>
<p>Morning Glory/Coast Morning Glory (<i>Ipomoea cairica</i>/<i>I. indica</i>.)</p> 	<p>From the brief site visit it appears that there are two species of weedy <i>Ipomoea</i> within the Reserve. Both of these species can be managed using the same methods and can be controlled concurrently (they will be referred to as <i>Ipomoea</i> sp.)</p> <p>Small infestations of this vine occur throughout the areas of <i>Typha</i> around Secondary Lake, and scattered on the north side of the path. There is a large infestation of these vines within the</p>	<p>Some control of this vine appears to have been undertaken in the area around Secondary Lake, concurrently with the other weed control undertaken in this area.</p>	<p>Highly ranked weed (Regeneration Technology 2004)</p> <p>High and moderate priority weeds (Randall and Storer 2010)</p>

Weed species ²	Location in Reserve	Historical or existing control measures	Prioritisation
	western edge of the Reserve, below the path that leads from Kelvin Street.		
Dolichos Pea (<i>Dipogon lignosus</i>)	Reported to be smothering <i>Melaleucas</i> on the eastern edge of vegetation ErWICV	-	
<i>Pelargonium capitatum</i>	Unknown – not sighted during brief site visit. Very little likely to occur, may still be in parts of ErMrCoW at the eastern end of the Reserve.	Unknown	High and moderate priority weeds (Randall and Storer 2010)

4.6 Trampling of vegetation

Loss of vegetation can be caused by trampling through uncontrolled access, such as the use of undefined tracks through reserves. Trampling can damage vegetation, change plant composition, reduce plant cover and may result in the spread of weeds. Trampling and loss of vegetation can also lead to soil erosion. Trampling impacts can depend on the type and density of vegetation.

Trampling does not appear to be a significant threat for the majority of the Reserve as the majority of Reserve users utilise the dual-use path. However, unofficial tracks do occur along the foreshore in the eastern section of the Reserve, originating at the boardwalk. It is likely that these paths are used by fishermen. Tracks left by an ATV in this section of the reserve have also damaged vegetation.

4.1 Vandalism and dumping of rubbish

Vandalism can include destruction of property and facilities as well as damage to native vegetation, such as tree poisoning and illegal clearing. Dumping of large amounts of rubbish in the Reserve is uncommon as access is generally well regulated; however littering is a low level threat associated with public use of the Reserve. Significant areas of litter were noted during the field visit, and predominantly occurred along the foreshore along the unofficial tracks discussed in Section 4.6 (Plate 5). This litter included plastics, bottles and other packaging materials which, due to the proximity to the river have the potential to enter the river system and be a threat to fauna species.

COB has assessed the Reserve for rubbish bin placement and an additional bin has been placed on the east side of Garratt Road Bridge with a fishing line bin at the river edge. Other strategies to discourage littering in this area of the Reserve should be considered in consultation with the local community and may include measures such as:

- Erection of signs at the Garratt Road entrance of the Reserve outlining the environmental significance of the Reserve and reminding people to remove their rubbish
- Undertake a community clean-up day to ensure rubbish doesn't accumulate.



Plate 5 Litter along the foreshore at Baigup Wetland Reserve

4.2 Introduced fauna

There are a number of introduced fauna species that have the potential to occur within the Reserve and these animals can have potential impacts on native species including:

- Predation on native fauna species and grazing of native plants
- Competition with native fauna for food and shelter
- Destroying habitat
- Spreading diseases
- Land degradation including soil erosion and destruction of vegetation (DotE 2014c)

Introduced fauna species that may be a threat to the vegetation of the Reserve include:

- European red fox (*Vulpes vulpes*): preys on native fauna species, competes with native fauna
- Feral cat (*Felis catus*): preys on native fauna species, competes with native fauna

The rabbit, fox and feral cat are listed under the EPBC Act as key threatening process.

4.3 Diseases and pathogens

Disease and pathogens of plants have the potential to cause death and decline of plant species within the Reserve. There are a number of diseases and pathogens, including rusts, cankers and Mundulla Yellows that may potentially occur within the Reserve and affect vegetation health.

Phytophthora cinnamomi dieback is found throughout the southern extent of Western Australia in areas with susceptible plant species that receive rainfall in excess of 400 mm/year (Dieback Working Group 2010). *P. cinnamomi* causes root rot in susceptible plants, thereby limiting or stopping the uptake of water and nutrients (Dieback Working Group 2014). Dieback (*Phytophthora cinnamomi*) is spread by the movement of infected soil, plant material or water. The disease spreads naturally in sloping areas where surface water movements may result in contamination of areas downslope of an infected area. Dieback is also commonly spread via human activities, such as earth moving, vehicle movement and heavy foot traffic in susceptible soils. The expression of the disease is determined by a combination of the pathogen, vegetation and environmental conditions and is affected by soil type and climate.

The majority of species within the Reserve are resistant to *Phytophthora* dieback; however some scattered individuals of species that occur in the upland areas of the Reserve are susceptible to dieback, including *Xanthorrhoea preissii*. This disease is unlikely to be an issue in the majority of the Reserve. However, standard hygiene methods should be used to prevent potential introduction or spread of plant pests and diseases during works at the Reserve. In addition, due to previous disturbance it is highly likely that much of the Reserve is already infested with *Phytophthora*, and the design of new plantings, particularly in the higher areas of sandy/loam slopes, should consider the proposed species in relation to this risk.

4.4 Fire

Historically there has been high frequency of fire within Baigup Wetland Reserve; which were often extensive and purposely lit to reduce weed seeds. However, in the last ten years fires have been infrequent and reasonably small. Fire can destroy property and be a safety hazard. Fire also impacts on native vegetation in a variety of ways, depending on the scale of the fire and the vegetation. The impacts of fire on vegetation can be very complex with some effects positive and some negative. Management of fire in the Reserve requires detailed consideration

of all the ecological, social and resourcing factors associated with this issue. The small and fragmented nature of Baigup and the close proximity of neighbours mean that any fire within the Reserve is a high risk.

Should any fires occur within the Reserve a number of management measures will have to be implemented post-fire to address safety and environmental issues. In particular, resources should be directed to weed control as weed cover can increase after a fire, and post-fire management can be an effective method of weed control and potentially eradication.

5. Previous management measures

The previous management plan (Regeneration Technology 2004) and the remediation and management plan (Randall and Storer 2010) detailed a number of strategies and recommendations for the management of the Reserve. Some of the strategies were overarching strategies that will require ongoing implementation while others were recommendations for specific works.

When the acid sulphate situation came to the attention of Department of Environment and Conservation (DEC now DPaW) around 2004 normal implementation of the management plan was at least partly suspended and the former friends group, FOBW, ceased volunteer work in the Reserve around the end of 2003, partly due to the breakdown of the group (P Lee, BWIG, 2015 pers comm., 15 Feb.). Hence, some of the recommended works were not implemented. During 2012 a new group, 'BWIG' formed, with some early members who were also previously members of FOBW. BWIG members have undertaken volunteer works in the Reserve, particularly in regard to weed control and revegetation.

Table D.1, Appendix D, details the recommendations of the previous management plans and whether these recommendations have been implemented or were effective. Most of the general recommendations and recommendations regarding revegetation and weed control have either been implemented, or partly implemented and are ongoing; however, the recommendations regarding baseline studies and monitoring of the Reserve do not appear to have been undertaken. Additionally, there has been little work undertaken on the recommendations relating to hydrology and the Acid Sulphate Soils issues as further work to determine the best management is still required.

6. Implementation Plan

6.1 Management strategy

The management strategies for Baigup Wetland Reserve have been formed around the objective for the Reserve to be a self-sustaining, healthy environment that supports a natural ecosystem with a high biological diversity. The use of the Reserve for education and recreation should be encouraged, if it is compatible with the natural values of the site.

6.2 Roles and responsibilities

This management plan provides guidance on potential management measures. The majority of the on-ground works will be undertaken by the COB and their contractors. There is a strong community interest in the Reserve and currently some management works, such as weed control activities are undertaken by BWIG. This implementation plan includes works that could be undertaken as a partnership between the BWIG and COB.

6.3 Potential approvals required for works

Some of the works recommended in this plan will require consultation with other stakeholders and application for approvals. This includes consultation/potential approvals from:

- Swan River Trust
- ATCO Gas
- Department of Aboriginal Affairs
- Department of Parks and Wildlife (licence to collect flora if relevant)
- Department of Environment Regulation

6.4 Key recommendations

The key recommendations to provide ongoing management and improvement of the environment at the Reserve are to:

1. Identify the extent of iron rich scalds within the Reserve that require urgent rehabilitation.
2. Identify the surface soil and subsoil salinity within the scalded areas caused by the greater rates of capillary rise and evaporation.
3. Undertake acidity mitigation, where the investigations outlined above have indicated that it is required, through soil amendments such as the addition of lime and mulching.
4. Undertake a trial rehabilitation of selected scalded areas for a field demonstration site, including a comprehensive monitoring program.
5. Undertake weed mapping throughout the Reserve that includes total weed coverage and mapping of high priority weeds. This mapping can then be used to target weed control works and to measure the effectiveness of the works.
6. Implement an effective weed control strategy, using hand removal techniques as a preference, and chemical control techniques where necessary. Chemical control must consider the sensitivity of the wetland environment. Weed control should be focused on the degraded areas adjacent to the areas of best condition native vegetation.
7. Revegetation of the Reserve should occur in stages, with works focused on areas adjacent to good quality vegetation and in areas that have existing rehabilitation works, particularly areas that are being controlled for weeds.

8. Undertake a trial planting of *Melaleuca cuticularis*, with a focus on areas in which *Melaleuca raphiophylla* is in poor condition, with ongoing monitoring, to determine the success of the planting.
9. Establish monitoring sites and implement a community-led, annual vegetation monitoring project, to monitor changes in vegetation communities and condition within the Reserve. This should also include monitoring of *Melaleuca* health in order to gather data and clarify likely causes of the *Melaleuca* deaths throughout the Reserve.
10. BWIG and SRT to finalise and manage a Virtual Trail and to develop further initiatives over time in line with Marli Riverpark framework for Swan/Canning Rivers, Signage should include educative material for the fishers using the Reserve to encourage them to reduce the trampling of vegetation and disposal of rubbish within the Reserve.
11. Educate adjacent landowners about potential threats to the Reserve, particularly the presence of Pampas grass and other weeds in private properties that are a source of seed for the Reserve.
12. Undertake a detailed fauna survey, focusing on mammals, reptiles, amphibians and invertebrates, to provide baseline data on the faunal complement of the Reserve for future monitoring comparison.
13. Consider opportunities for developing the limestone access track at the rear of the Reserve as a walking/cycling track linked to the existing paths.
14. Consider the options for providing separation of cyclists and pedestrians on the shared path through line marking.
15. Consider funding and development opportunities for the construction of new boardwalks, including an extension of the existing boardwalk near Garratt Road Bridge, and entry statements and lookouts.
16. Consider funding and development opportunities for the establishment of an interpretive centre and eco-café near the carpark at A.P. Hinds Reserve. This could also function as a focus for school liaison and communities education projects. This would need further consideration by the council as part of COB's Community Strategic Plan and assessment in terms of the long-term financial plan.
17. Develop a management policy specific to mosquito management in Zone 3. This will include using alternative methods (than ATV) to spread larvacide in this area.
18. Confirm the taxonomy of the species of *Casuarina* present at the Reserve.

6.5 Implementation and review

The implementation of this management plan will commence immediately and will be reviewed within 10 years. An implementation plan has been prepared which outlines management measures recommended per month for the first three years and then ongoing management measures for the next seven years. Management measures are prioritised as 'high', 'medium' or 'low', based on the natural values of the area, the extent of the threat and the resources required to undertake the management works (ie. works with high resource requirements have occasionally been prioritised as 'low' or 'medium' as funding opportunities may need to be pursued in order to implement these works).

The Reserve has been differentiated into 'management zones' which group areas that have similar ecological management issues and proposed responses. These management zones are detailed in Table 6 and mapped at Figure 4.

Table 6 Ecological management zones within Baigup Wetland Reserve

Management Zone		Description	Major issues/management requirements
Zone 1		This area includes a mix of native, weedy and planted species. Substantial weed infestations occur.	Ongoing weed control is required. Will require assisted revegetation in the future. This is not a priority area for the first 3 years of the plan but more substantial weed control and infill planting is proposed for years 4-7. Priority weeds such as Blackberry and Arum Lily should be tackled in years 1-3.
Zone 2		This area contains vegetation in relatively good condition, as well as a boardwalk and viewpoint.	Ongoing weed control and maintenance of infrastructure is required.
Zone 3	Zone 3 South (S)	This is the area of native vegetation that occurs on the river-side of the path and which is in the best condition, including <i>Melaleuca</i> scrub and sedgelands	This zone contains the vegetation which is in the best condition within the Reserve. Disturbance to this area should be minimised. Required management measures include managing access to this area and controlling weeds along the edge of this zone. The sinkhole near the outlet of culverts 10 and 11 may require stabilisation.
	Zone 3 North (N)	This section of the sedgeland area occurs on the north side of the path and occurs in the scald area which is also associated with Zone 5S	This zone contains iron rich scalds which are likely to require significant works to rehabilitate. However, further investigations, and a trial rehabilitation site is required before large scale works can occur.
Zone 4	Zone 4 West (W)	<i>Melaleuca</i> woodland within a low-lying, often inundated area. Some <i>Melaleuca</i> deaths.	The decline in health of the <i>Melaleucas</i> in this area requires monitoring and assessment to determine potential management measures
	Zone 4 East (E)	<i>Melaleuca</i> woodland within a low-lying, inundated area. Some <i>Melaleuca</i> deaths.	The decline in health of the <i>Melaleucas</i> in this area requires monitoring and assessment to determine potential management measures
Zone 5	Zone 5 West (W)	This zone contains the Primary Lake, with vegetation in better condition adjacent to the acid scald, and alongside the north-east side of the lake.	This vegetation may be vulnerable to changes in water quality and issues associated with salinity and acidity of the Primary Lake. This area requires monitoring so that any changes to vegetation health can be identified early.

Management Zone		Description	Major issues/management requirements
	Zone 5 North (N)	This zone contains vegetation in better condition adjacent to the degraded acid scald.	This area requires monitoring to assess whether the health of vegetation is deteriorating and to determine whether impacts from the acid scald are spreading. Monitoring should allow any changes to vegetation health to be identified early.
	Zone 5 South (S)	This area contains <i>Melaleuca</i> scrub that is in poor condition due to a large patch of acid scald. There are many dead and dying <i>Melaleucas</i> throughout this zone.	This zone contains iron rich scalds which are likely to require significant works to rehabilitate. However, further investigations, and a trial rehabilitation site is required before large scale works can occur.
Zone 6	Zone 6 West (W)	This zone includes the previously cleared area around Secondary Lake. Weed control and revegetation works have been undertaken in this area.	Ongoing weed control and revegetation. Zone 6 is the first priority area for revegetation as some works have already been undertaken in this area. For the first 3 years of this plan resources should be concentrated in this zone to assist in the success of the existing revegetation efforts, and to bring this area as close as possible to a functional, self-sustaining system.
	Zone 6 East (E)	This zone includes Secondary Lake and associated sedgelands. Substantial <i>Typha</i> populations	
Zone 7		This zone encompasses the largely cleared areas at the north of Baigup, which includes the limestone firebreak and service access road. Small patches of native vegetation, including some <i>Eucalyptus rudis</i> are scattered in this area but this area is primarily weedy.	Control of significant weeds, such as Castor Oil Plant and <i>Washingtonia</i> Palm should be continued through this area. Any revegetation works in this area should be focused along the edges of this zone, adjacent to areas of better quality vegetation. Once the revegetation in Zone 6 has been established and is self-supporting then the areas of this zone adjacent to Zone 6 should be the next priority for revegetation. Revegetation in areas adjacent to Zone 6 may occur in Years 1-3, with continued bands of revegetation proposed for years 4-7
Zone 8		This zone is a highly modified area that consists of large sections of introduced species and which contains little intact native vegetation other than large areas of Bracken (<i>Pteridium esculentum</i>)	Control of significant weeds, such as Blackberry, should be continued through this area. This area will require significant resources for large-scale weed removal and revegetation with native species. It is proposed that this zone be a low priority

Management Zone		Description	Major issues/management requirements
			<p>until other zones have become self-sustaining and until significant resources are available.</p> <p>Large-scale weed control and revegetation is proposed for years 4-7.</p>
Zone 9	Zone 9 West (W)	Low-lying zone that consists of planted <i>Eucalyptus</i> and thick infestations of <i>Ipomoea</i> species and Dolichos Pea.	Major infestation of <i>Ipomoea</i> spp. that will require significant effort to eradicate. Proposed for years 7-10.
	Zone 9 East (E)	Open area, substantial weed infestations	<p>Adjacent to area of relatively good condition native vegetation, control of weeds important to prevent further spread.</p> <p>Weed control of creeper weeds on <i>Melaleuca</i> trees on the margin of this area and Zone 3, proposed for years 1-3</p> <p>Revegetation with native species, following weed control, proposed for years 7-10</p>
Zone 10		Covers the dry upland area directly adjacent to the path entrance from Kelvin St which has been recently replanted	<p>Continue weed control in revegetated area.</p> <p>Infill planting of revegetation for the first 3 years of plan, with the aim of creating a self-sustaining system within 3 years.</p>

The implementation plan is detailed in Table 7. Works should be undertaken utilising the detailed revegetation and weed control methodologies described in the previous management plans (Revegetation Technology 1994, 2004 and Randall and Storer 2010) or new 'best practice' as identified.

Table 7 10 Year Implementation Plan for Baigup Wetland Reserve

Year	Month	Actions	Priority	Current COB resourcing	Additional resources required	BWIG to undertake or bring forward	Indicative costs to undertake work
Year 1 (2015-16)	All months	Opportunistic weed control, particularly in revegetation areas: Zone 10 and Zone 6	Medium	√			Bush care team
	All months	Monthly monitoring of shallow monitoring wells (see below)	High		√		\$14, 950 (bi-annually over 3 years, includes \$2,700 sample analysis costs)
	July	Undertake investigations to identify the iron rich scalds along the north eastern section of the dual-use path in particular Zone 3N and Zone 5S which have been in transient phases of oxidation and potential acid generation	High		√		\$7,200
		Establish 3 transects of shallow monitoring wells in Zone 4W, 4E and 5S to measure pH, TTA, TALK and EC in order to identify the surface soil and subsoil salinity within the scalded areas caused by the greater rates of capillary rise and evaporation (through Masters student).	High		√		\$5,000
	July-August	Weed control works ³ : <ul style="list-style-type: none"> • Pampas Grass (chemical treatment for young plants, remove flower heads, slash clumps, spray regrowth) • Target small infestation of Madeira Vine (<i>Anredera cordifolia</i>) (chemical, spray may be possible in isolated occurrence, otherwise scrape and paint) • Arum Lily (chemical treatment) • Typha in small areas in Zone 6 (physical) and any isolated clumps in Zone 3 	High	√			Bush care team
		Seek funding for community training in vegetation / invertebrate monitoring protocols	Medium		√		\$3, 970

³ Weed control references include: Brown and Bettink (2009) and Brown and Brooks (2002)

Year	Month	Actions	Priority	Current COB resourcing	Additional resources required	BWIG to undertake or bring forward	Indicative costs to undertake work
	September	Establish vegetation monitoring transects and undertake 1 st round of vegetation monitoring (see Appendix D for example methodology). This should include collection of specimens of the <i>Casuarina</i> sp. to send to the Western Australian Herbarium for confirmation. Align vegetation transects with the hydrological/hydrogeological transects being undertaken by the Masters student, as this will allow comparison of results from both assessments.	Medium	√			\$5,960
	September - October	Undertake weed mapping for entire Reserve to determine extent of weed populations and priorities for weed control	High		√		\$8,740
	September-October	Continue revegetation works in sedgeland and wet areas at Secondary Lake (Zone 6E)	High	√			Bush care team
	October-November	Fill-in planting of sedges in revegetation areas around Secondary Lake (Zone 6E and creekline/low-lying areas in Zone 6W). This should include replacing dead seedlings and infilling of areas where revegetation has not been successful	High	√			Bush care team
		Assess results of Masters groundwater/surface water study, which should provide a better understanding of water balance and processes within the wetland areas and focus future works	High		√		\$2,000
	December	Weed control works, including: <ul style="list-style-type: none"> Follow-up weed control for any late-growth plants (especially Arum Lily, Pampas grass) not controlled during the early spring weed control works. Hand-pulling of weed seedlings (ensuring removal of all root material), including: Pepper Tree, Cape Lilac, Castor Oil Plant Typha (physical control) 	High	√			Bush care team
	November -	Slash grassy weeds (post flower head emergent, prior to	High	√			Bush care team

Year	Month	Actions	Priority	Current COB resourcing	Additional resources required	BWIG to undertake or bring forward	Indicative costs to undertake work
	December	seeding)					
	January-February	Weed control works, including: <ul style="list-style-type: none"> • Typha (chemical) • Blackberry (cut and paint or slash) • Pepper Tree (chemical- injection) • Cape Lilac (chemical- injection) • Castor Oil Plant (chemical) • Taro (cut and paint) • Madeira Vine (chemical, follow-up on new seedlings or ground runners) 	High	√			Bush care team
	February	Establish relationships with local schools for educational opportunities/ planting / weeding days	Low		√		Cost of contact hours
	February – March	Dependent on the results of the site investigations, undertake acidity mitigation through soil amendments such as the addition of lime and mulching	High		√		\$20,000
	March	Establish two field demonstration sites (one in Zone 3N and one in Zone 5S) for rehabilitation of scalded areas – approval required from stakeholders (eg. Swan River Trust, ATCO Gas and Department of Aboriginal Affairs)	High		√		(included in cost for investigations above - \$7200)
	March	Map <i>Melaleuca raphiophylla</i> health across reserve	High	√	√		\$5,000
	March-April	Consider options for improving signage and education of Reserve users and estimate/request funds required. Request budget /source funding for 2017	Medium			√	BWIG
	April-May	Control Typha on island in Secondary Lake (Zone 6E) Revegetate with native in species areas in which Typha have been controlled in Zone 6	High	√	√		\$9,000
	May-June	Replace any dead seedlings within the new revegetation in Zone 10 and the upland areas of Zone 6W	Medium	√			Bush care team
TOTAL:	Unfunded						\$81,820

Year	Month	Actions	Priority	Current COB resourcing	Additional resources required	Work BWIG to undertake or bring forward	Indicative costs to undertake works	
Year 2 (2016-17)	All months	Opportunistic weed control, particularly in revegetation areas: Zone 10 and Zone 6	Medium	√			Bush care team	
	Anytime	Construct new educational signage if funds available and continue to build and maintain virtual trail.	Medium		√			
	Anytime	Undertake a review to identify planning considerations for high density development along Stone Street and specifically its impact on the fresh water seeps.	High	√			\$6,000	
	July		Develop options for control of access to the shoreline, as determined by community consultation, and implement	Medium	√		√	
			Provide opportunity/forum for educating adjacent landowners on weed issues	Low	√			\$3,000
	July-August	Weed control: <ul style="list-style-type: none"> Pampas Grass (chemical treatment for young plants, remove flower heads, slash clumps, spray regrowth) Target small infestation of Madiera Vine (chemical, spray may be possible in isolated occurrences, otherwise scrape and paint) Arum Lily (chemical treatment) Typha in small areas in Zone 6 (physical) and any isolated clumps in Zone 3 Remove creeper weeds (<i>Ipomoea</i> spp. and <i>Dolichos</i> Pea) from Melaleucas at the boundary of Zone 9E and Zone 3 (physical/chemical).	High	√			Bush care team	
	August	Commence water balance modelling investigations, focused on	High			√		\$48,500

Year	Month	Actions	Priority	Current COB resourcing	Additional resources required	Work BWIG to undertake or bring forward	Indicative costs to undertake works
		levels in scald areas.					
	September	Undertake 2 nd round of vegetation monitoring	Medium	√			Bush care team/BWIG
	September – October	Commence trial of <i>Melaleuca cuticularis</i> plantings (possibly west end of Zone 3, or one of the areas where river is closest to path): ensure seedlings have been raised in areas with similar salinity to that of the planting area. Will require monitoring to determine success of trial.	Low	√			Bush care team
	September – October	Fill-in planting of sedges in revegetation areas (Zone 6E and low-lying areas of Zone 6W)	High	√			Bush care team
	November - December	Follow-up weed control for any late-growth plants not controlled during the early spring weed control works. Hand-pulling of weed seedlings (ensuring removal of all root material), including: Pepper Tree, Cape Lilac, Castor Oil Plant	High	√			Bush care team
	January-February	Weed control works, including: <ul style="list-style-type: none"> Typha (chemical) Blackberry (cut and paint or slash) Pepper Tree (chemical- injection) Cape Lilac (chemical- injection) Castor Oil Plant (chemical) Taro (cut and paint) Madeira Vine (chemical, follow-up on new seedlings or ground runners)	High	√			Bush care team
	February	<ul style="list-style-type: none"> Follow-up control Typha on island in Secondary Lake (Zone 6E) 	High	√			Bush care team
	February-March	Undertake soil and water monitoring in wells and scald areas, dependent on outcomes of previous study	High		√		\$5,000
	March	Map <i>Melaleuca raphiophylla</i> health	High	√			\$5,000
	March-April	Investigate options for improving rear limestone path for	Medium	√			

Year	Month	Actions	Priority	Current COB resourcing	Additional resources required	Work BWIG to undertake or bring forward	Indicative costs to undertake works
		cyclists/pedestrians and linking it to the existing paths. Request budget for 2017-18.					
	April-May	Infill planting within the new revegetation in Zone 10 and the upland areas of Zone 6W	High	√			Bush care team
TOTAL	Unfunded						\$67,500

Year	Month	Actions	Priority	Current COB resourcing	Additional resources required	Work BWIG to undertake or bring forward	Indicative costs to undertake works
Year 3 (2017-18)	All months	Opportunistic weed control, particularly in revegetation areas: Zone 10 and Zone 6	Medium	√			Bush care team
	Anytime	Commence works on new path connections if funds available	Medium	√			Bush care team
	July-August	Weed control works: <ul style="list-style-type: none"> Pampas grass (chemical treatment for young plants, remove flower heads, slash clumps, spray regrowth) Arum Lily (chemical treatment) Madeira Vine (targeted new seedlings or ground runners) Typha in small areas in Zone 6 (physical) and any isolated clumps in Zone 3 	High	√			Bush care team
	September	Undertake 3 rd round of vegetation monitoring	Medium	√			Bush care team/BWIG
	September - October	Fill-in planting of sedges in revegetation areas (Zone 6E and low-lying areas of Zone 6W)	High	√			Bush care team
		Revegetation works in sedgeland and wet areas, Zone 6	High	√			Bush care team

	October-November	Monitor <i>Melaleuca cuticularis</i> plantings	Low	√			Bush care team
	November	Undertake detailed fauna survey (subject to funding)	Medium		√		\$25,000
	December	Weed control works: <ul style="list-style-type: none"> Follow-up weed control for any late-growth plants not controlled during the early spring weed control works. Hand-pulling of weed seedlings (ensuring removal of all root material), including: Pepper Tree, Cape Lilac, Castor Oil Plant 	High	√			Bush care team
	January-February	Weed control works, including: <ul style="list-style-type: none"> Typha (chemical) Blackberry (cut and paint or slash) Pepper Tree (chemical- injection) Cape Lilac (chemical- injection) Castor Oil Plant (chemical) Taro (cut and paint) 	High	√			Bush care team
	February	Follow-up control Typha on island in Secondary Lake	High	√			Bush care team
	February-March	Undertake soil and water monitoring as determined by outcomes of previous results	High		√		\$5,000
	March	Map <i>Melaleuca raphiophylla</i> health	Medium	√			\$5,000
	March-April	Develop options/design for extension of boardwalk, bird hide and other facilities and request/source funding for 2018-19.	Medium	√			\$5,000
	April-May	Infill planting within revegetation in Zone 10 and the upland areas of Zone 6W	High	√			Bush care team
		Cost works for upcoming years 4-7 of management plan	High	√			
TOTAL	Unfunded						\$40,000

Year	Month	Actions	COB resourcing	Additional resources required	Work BWIG to undertake or bring forward	Indicative costs to undertake work
Year 4 (2018-19)		Erect additional boardwalk, bird hide etc. if funds available	Medium		√	
		Continue ongoing weed control	High	√		
		Commence systematic weed control and revegetation of Zones 1, 7 and 8 (ongoing for at least the next 3 years). Commence revegetation along edges of better quality vegetation and work along bands.	High	√		
		Assess the success of limiting public access along the river and identify any areas of trampling/erosion that have not established naturally and that require assisted revegetation	Low	√		
		Consider funding options for design or construction of works for Reserve facilities, entry statements, additional community education, the eco-café.	Medium		√	
Year 5 (2019-20)		Undertake weed mapping to determine success of control works and priorities for weed control	High	√		
		Continue ongoing weed control	High	√		
		Infill planting in previous revegetation areas in Zones 1, 7 and 8	Medium	√		
		Expand revegetation works within Zones 1, 7 and 8.	Medium	√		
		Ideally weed control in years 1-4 should have controlled the early priority species and weed control of other priority species can progress including: <ul style="list-style-type: none"> Extend control of <i>Ipomoea</i> species (Chemical: scrape and paint stem) and Dolichos Pea (physical and chemical), will require ongoing monitoring and control of populations in subsequent years Any Giant Reed in Reserve (<i>Arundo donax</i>) (physical if small infestation or chemical in late summer/autumn) Lantana (chemical) 	Medium	√		

Year	Month	Actions	COB resourcing	Additional resources required	Work BWIG to undertake or bring forward	Indicative costs to undertake work
		Undertake any development of facilities, based on funding outcomes and/or seek funding	Medium	√		
		Consider funding requirements for invertebrate survey and seek funds	Medium	√		
		Undertake community/stakeholder consultation regarding the outcomes/success of this plan and amend/develop requirements for next five years, as necessary	High	√		
Year 6 (2020-21)		Remove Typha once native revegetation established – in flooded areas cut plant below water level during in late summer/autumn	High	√		
		Continue ongoing weed control	High	√		
		Infill planting in previous revegetation areas in Zones 1, 7 and 8	Medium	√		
		Expand revegetation works within Zones 1, 7 and 8.	Medium	√		
		Undertake detailed invertebrate fauna if funds available	Medium		√	
	Develop cost estimates for works in years 7 to 10					
Year 7 (2021-22)		Continue ongoing weed control	High	√		
		Commence systematic weed control and revegetation of Zone 9 (ongoing for at least the next 3 years). Commence revegetation along edges of better quality vegetation and work along bands.	Medium	√		
Year 8 (2022-23)		Pursue funding opportunities for repeat fauna survey	Medium		√	
		Continue ongoing weed control	High	√		
		Infill planting in previous revegetation areas in Zone 9	Medium	√		
Year 9 (2023-24)		Continue ongoing weed control	High	√		
		Infill planting in previous revegetation areas in Zone 9	Medium	√		
		Consider ongoing requirements for Reserve and request budget for new 10-year management plan, if required	Medium	√		

Year	Month	Actions	COB resourcing	Additional resources required	Work BWIG to undertake or bring forward	Indicative costs to undertake work
Year 10 (2024-25)		Undertake weed mapping to determine success of control works and priorities for weed control	High	√		
		Continue ongoing weed control	High	√		
		Develop new 10 year management plan, if required	Medium	√		

7. References

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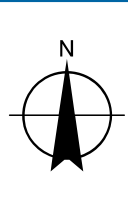
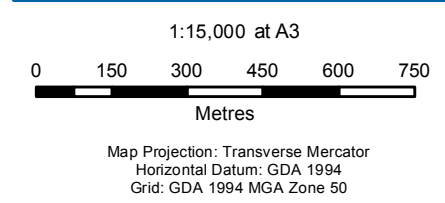
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Appendices

Appendix A - Figures

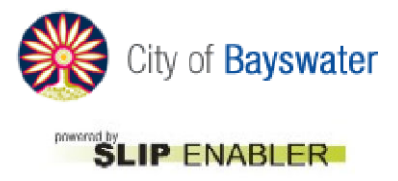
- Figure 1 Locality map
- Figure 2 Vegetation communities
- Figure 3 Vegetation condition
- Figure 4 Management zones



LEGEND

Study Area

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



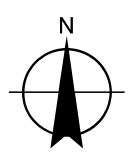
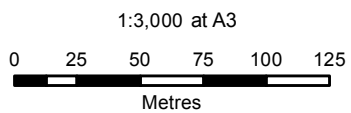
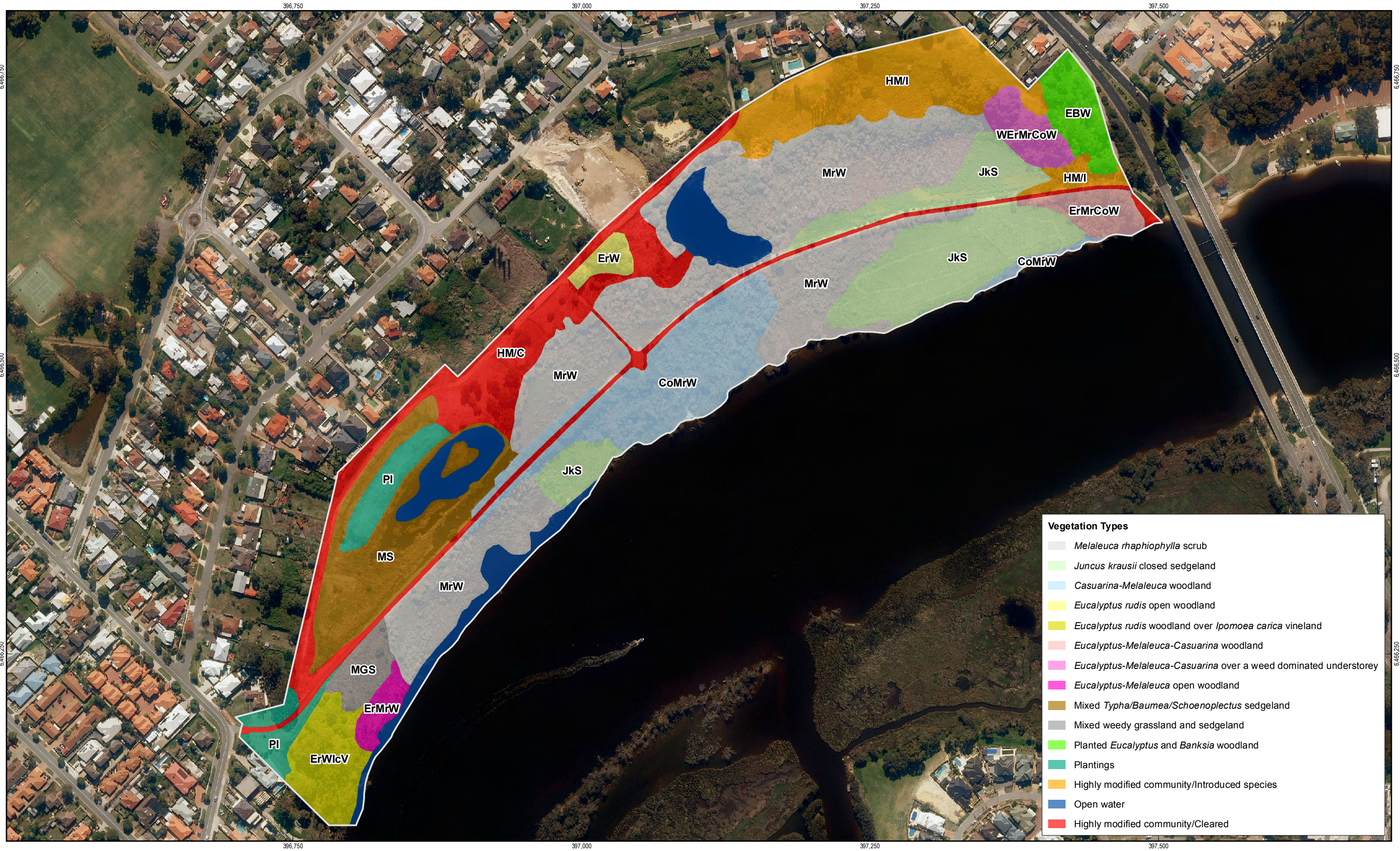
City of Bayswater
Management Plan
Baigup Reserve, Bayswater

Job Number | 61-3138010
Revision | 1
Date | 17 Mar 2015

Site locality

Figure 1

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Data source: Landgate: Street Smart 2011 Mosaic; GHD: Study Area - 20150128. Created by: jmontaignes



LEGEND
Study Area

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



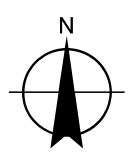
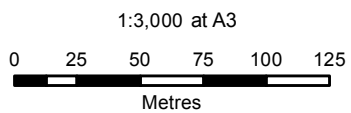
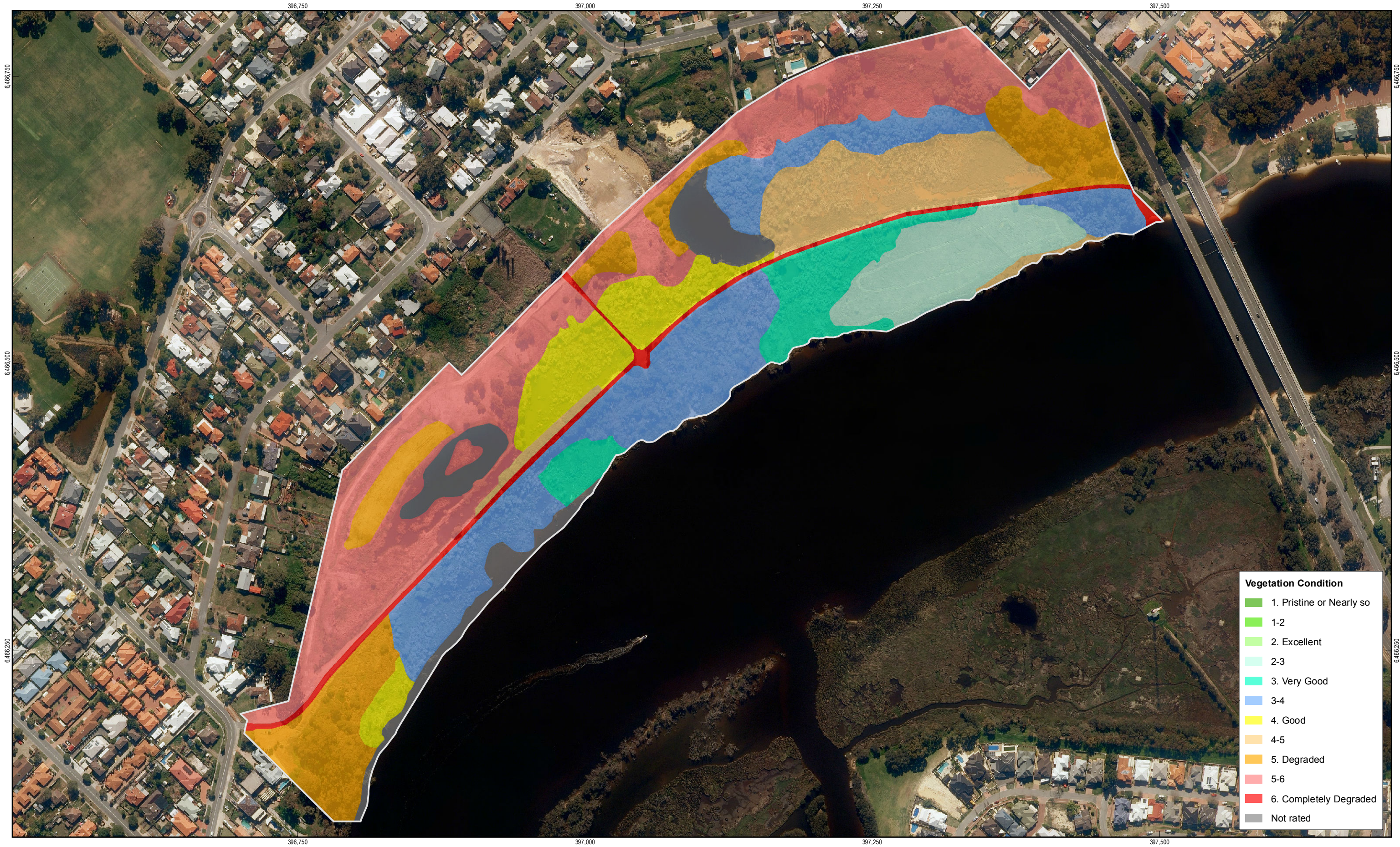
City of Bayswater
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Baigup Reserve, Bayswater

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Date | 09 Jun 2015

Vegetation types

Figure 2

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Data source: Landgate: Virtual Mosaic 2015; GHD: Study Area - 20150128, Vegetation Types - 20150313. Created by: jmonteignies



LEGEND
Study Area

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



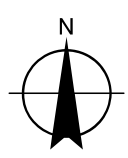
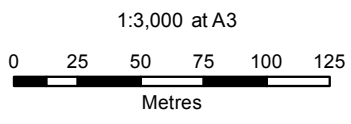
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Management Plan
Baigup Reserve, Bayswater

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Date | 09 Jun 2015

Vegetation condition

Figure 3

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Data source: Landgate: Virtual Mosaic 2015; GHD: Study Area - 20150128, Vegetation Condition - 20150313. Created by: jmonteignies



LEGEND		Timeframe		Work Locations:	
	Management Zones		Year 1		Years 2-3
	Study Area		Years 4-6		Years 1-2
	Proposed Monitoring Transect Locations		Years 1-3		Years 7-10
					WR - Revegetation
					W - Weed Control
					E - Engineering works
					M - Monitoring



City of Bayswater
Management Plan
Baigup Reserve, Bayswater

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Date | 23 Jun 2015

Management zones

Figure 4

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Data source: Landgate: Virtual Mosaic 2015; GHD: Study Area - 20150128, Work Locations - 20150603, Management Zones - 20150401, Proposed Monitoring Transect Locations - 20150609, Timeframe - 20150623. Created by: jmonteignies

Appendix B - Baigup Wetland Reserve Flora List

Comparison of mapped vegetation communities from the various assessments conducted within Baigup Wetland Reserve

Flora species list for Baigup Wetland Reserve

Table B.1 Comparison of mapped vegetation communities from the various assessments conducted within Baigup Wetland Reserve

Vegetation types (Regeneration Technology 1994)	Changes between 1994 – 2002	Vegetation types 2002 (Regeneration Technology 2004)	Changes between 2002-2010	Vegetation types 2010 (Randall and Storer 2010)	Extent (2010)	Comments from 2014 field visit	Vegetation type 2015 (based on Ecoscape 2010)	Extent (2015)
<i>Casuarina</i> – <i>Melaleuca</i> low open woodland	Generally constant; however, areas of planting along the track were mapped separately in 2002	<i>Casuarina</i> – <i>Melaleuca</i> low open woodland <i>Casuarina</i> – <i>Melaleuca</i> with plantings (along edge of track)	A lot less of the Reserve has been mapped as this vegetation type, with more of this vegetation type being placed into the <i>Melaleuca raphiophylla</i> closed swamp vegetation type	8. <i>Casuarina</i> spp./ <i>Melaleuca raphiophylla</i> Woodland over <i>Bolboschoenus caldwellii</i> / <i>Juncus kraussii</i> Closed Sedgeland	0.99 ha	This has been mapped along the path, where it wasn't previously mapped (difference in scale of mapping not actual change in area of vegetation)	CoMrW <i>Casuarina</i> -<i>Melaleuca</i> woodland <i>Casuarina</i> spp./ <i>Melaleuca raphiophylla</i> Woodland over <i>Bolboschoenus caldwellii</i> / <i>Juncus kraussii</i> Closed Sedgeland	1.52 ha
<i>Eucalyptus</i> - <i>Melaleuca</i> low open forest	Generally constant; however, areas of planting were mapped separately in 2002	2. <i>Eucalyptus</i> - <i>Melaleuca</i> low open forest	Relatively constant	10. <i>Eucalyptus rudis</i> Open Woodland over an Open Shrubland of <i>Melaleuca raphiophylla</i> over a <i>Typha orientalis</i> / <i>Baumea articulata</i> / <i>Schoenoplectus validus</i> Sedgeland	0.76 ha	Small section mapped along the river edge – not accessed during survey. Previous calculations likely to be incorrect as extent has not differed significantly	ErMrW <i>Eucalyptus</i> -<i>Melaleuca</i> open woodland <i>Eucalyptus rudis</i> Open Woodland over an Open Shrubland of <i>Melaleuca raphiophylla</i> over a <i>Typha orientalis</i> / <i>Baumea articulata</i> Sedgeland	0.16 ha
		<i>Eucalyptus rudis</i> - <i>Melaleuca raphiophylla</i> community with plantings	The mapped extent of this vegetation type has increased since 2002 with two patches occurring at the eastern end of the Reserve.	6. <i>Melaleuca raphiophylla</i> / <i>Eucalyptus rudis</i> Closed Forest over a Very Open Herbland of <i>Centella asiatica</i> and a <i>Bolboschoenus caldwellii</i> /* <i>Carex divisa</i> Closed Sedgeland	0.62 ha	Split into two vegetation communities north of the path and south of the path, as the section north of the path has many more weeds	ErMrCoW <i>Eucalyptus</i> -<i>Melaleuca</i> -<i>Casuarina</i> Woodland Has a relatively intact mixed sedgeland understorey. <i>Melaleuca raphiophylla</i> / <i>Eucalyptus rudis</i> / <i>Casuarina</i> spp. Closed Forest over a Very Open Herbland of <i>Centella asiatica</i> and a <i>Bolboschoenus caldwellii</i> /* <i>Carex divisa</i> Closed Sedgeland WErMrCoW <i>Eucalyptus</i> -<i>Melaleuca</i> -<i>Casuarina</i> Woodland over a weed dominated understorey Has a weedy understorey. <i>Melaleuca raphiophylla</i> / <i>Eucalyptus rudis</i> / <i>Casuarina</i> spp. Closed Forest over a mixed shrubland and vineland of weedy species	0.57 ha
3. <i>Melaleuca raphiophylla</i> closed swamp	Relatively constant, major change being construction of lake through this vegetation.	3. <i>Melaleuca raphiophylla</i> closed swamp	Health of one section to the immediate west of the midway access track appears in decline in 2003. In 2010 this vegetation type has also been mapped across part of the area originally mapped as <i>Casuarina</i> -	2. <i>Melaleuca raphiophylla</i> Tall open Scrub over a <i>Bolboschoenus caldwellii</i> / <i>Junus kraussii</i> Sedgeland	4.28 ha	Includes large areas of dead <i>Melaleucas</i> and some areas of this vegetation type are transitioning to sedgeland	MrW <i>Melaleuca raphiophylla</i> Scrub <i>Melaleuca raphiophylla</i> Tall open Scrub over a <i>Bolboschoenus caldwellii</i> / <i>Junus kraussii</i> Sedgeland	4.45 ha

			<i>Melaleuca</i> woodland, as well in some of the areas previously mapped as 'weed community'					
4. <i>Juncus kraussii</i> closed sedgeland	No change	4. <i>Juncus kraussii</i> closed sedgeland	Increased in area – now also occurs north of the trail (densely planted following weed control works in 2002)	7. <i>M. raphiophylla</i> Open Sedgeland (sic. assumed this should be woodland) over a Very Open Shrubland of <i>Sarcocornia quinqueflora</i> and a Closed Sedgeland of <i>J. kraussii</i>	2.3 ha		JkS <i>Juncus kraussii</i> closed sedgeland: Closed Sedgeland of <i>J. kraussii</i> with an Open Shrubland of <i>Sarcocornia quinqueflora</i> and scattered <i>Melaleuca raphiophylla</i>	2.04 ha
5. <i>Schoenoplectus validus</i> closed sedgeland	Some change associated with the creation of the lakes	5. <i>Schoenoplectus validus</i> closed sedgeland	No longer mapped as separate community – within larger communities					
	During the creation of the lake a sedgeland of <i>Schoenoplectus validus</i> / <i>Baumea articulata</i> was formed around Primary Lake	<i>Schoenoplectus validus</i> / <i>Baumea articulata</i> community with plantings						
		<i>Schoenoplectus validus</i> community with plantings						
6. <i>Typha</i> closed sedgeland	Decreased substantially – no longer mapped	The former <i>Typha</i> areas are mapped in 2002 as either 'weed community' or 'cleared area' (see below)						
7. <i>Carex divisa</i> subcommunity	No longer mapped, now mapped as <i>Casuarina-Melaleuca</i> woodland							
8. <i>Bulboschoenus caldwellii</i> subcommunity	No longer mapped, now mapped as <i>Casuarina-Melaleuca</i> woodland							
9. <i>Eucalyptus rudis</i> – <i>Corymbia calophylla</i> open woodland	Generally constant; however, areas of planting within the <i>Eucalyptus rudis</i> were mapped separately in 2002	6. <i>Eucalyptus rudis</i> – <i>Corymbia calophylla</i> open woodland <i>Eucalyptus rudis</i> with plantings	Generally constant, though more of this area has been mapped as a degraded vegetation in 2010 (though this may be an artefact of mapping rather than change in vegetation)	11. <i>Eucalyptus rudis</i> Open Woodland over mixed exotic Closed Grassland	0.27 ha		ErWicV <i>Eucalyptus rudis</i> woodland over <i>Ipomoea carica</i> vineland <i>Eucalyptus rudis</i> and <i>Eucalyptus</i> spp. Woodland over <i>Ipomoea carica</i> and * <i>Dipogon lignosus</i> Vineland	0.55 ha
10. Weed community	Some areas increased, some	Weed community	Decreased substantially, including as a result of	1. <i>T. orientalis</i> / <i>Baumea articulata</i> / <i>Schoenoplectus</i>	2.07 ha	Areas of sedgeland occur around the lake	MS Mixed <i>Typha</i>/<i>Baumea</i>/<i>Schoenoplectus</i> sedgeland.	1.28 ha

decreased		construction of the lakes	<i>vallidus</i> Sedgeland over a Very Open Herbland of <i>Cotula coronopifolia</i> with scattered <i>M. raphiophylla</i>		and along drainage lines, and includes areas of revegetation	<i>Typha orientalis</i> , <i>Baumea articulata</i> , <i>Schoenoplectus vallidus</i> Sedgeland over a Very Open Herbland of <i>Cotula coronopifolia</i> with scattered <i>M. raphiophylla</i>		
					Areas covered by woodchips and upland areas surrounding the sedgeland	HM/C Highly modified community/Cleared Includes areas of rehabilitation, regrowth <i>Casuarina</i> and weed communities	2.02 ha	
			4.. <i>M. raphiophylla</i> Open Woodland over a Very Open Herbland of * <i>Cotula coronopifolia</i> and a <i>T. orientalis/Baumea articulata/Schoenoplectus vallidus</i> Sedgeland	0.22 ha	No longer mapped separately, mapped as part of Highly Modified community and 'EBW'			
				5. <i>Pteridium esculentum</i> community over a <i>Cynodon dactylon</i> /* <i>Pennisetum clandestinum</i> Closed Grassland	1.5 ha	This classification covers a highly modified area that no longer can be considered an intact vegetation community	HM/I Highly modified community/Introduced species Includes areas dominated by Bracken (<i>Pteridium esculentum</i>), introduced Eucalypts, Poplars, <i>Typha</i> and other weedy species with some scattered native species, including planted <i>Banksia littoralis</i> and Marri (<i>Corymbia calophylla</i>)	1.76 ha
	Weed community with plantings	Generally constant	9. Mixed exotic Closed Grassland with scattered <i>M. raphiophylla</i>	0.76 ha	Some sections now mapped as "Plantings" (recent revegetation) and some as part of <i>Eucalyptus</i> – <i>Melaleuca</i> open woodland	MGS Mixed grassland and sedgeland (dominated by weed species) with scattered <i>Melaleuca raphiophylla</i>	0.25 ha	
					Not previously mapped, recent revegetation in this area	PI - Plantings: New section of revegetation in the upland area adjacent to the entrance of the Reserve. This area also includes some established upland plants such as <i>Macrozamia fraseri</i>	0.45 ha	
	Not previously mapped – included within weed community	Cleared area		3. <i>E. rudis</i> Open Woodland over an Open Shrubland of * <i>Lathyrus tingitanus</i> , over a Very Open Herbland of * <i>Rumex</i> sp. and <i>T. orientalis</i> ver Open Sedgeland of a mixed exotic Closed Grassland	0.47 ha		ErW <i>Eucalyptus rudis</i> open woodland <i>E. rudis</i> and <i>Eucalyptus</i> sp. Open Woodland, over a Very Open Herbland of * <i>Rumex</i> sp. of a mixed exotic Closed Grassland	0.4 ha

Table B.2 Flora species recorded at Baigup Reserve since 1994

Family	Taxon	Common Name	Status	Source		
				Regeneration Technology 1994	Flora list recorded in Randall and Storer (2010)	2015 site visit
Amaranthaceae	<i>Amaranthus powellii</i>	Powell's Amaranth	*			x
Anacardiaceae	<i>Schinus terebinthifolius</i>	Japanese pepper	*	x	x	x
Apiaceae	<i>Apium prostratum</i>	Sea Celery		x		x
Apiaceae	<i>Centella asiatica</i>			x	x	
Apiaceae	<i>Foeniculum vulgare</i>	Fennel	*	x		
Apocynaceae	<i>Gomphocarpus fruticosus</i>	Narrowleaf Cottonbush	* DP	x		x
Apocynaceae	<i>Nerium oleander</i>	Oleander	*			x
Araceae	<i>Colocasia esculenta</i>	Taro	*	x		x
Araceae	<i>Lemna disperma</i>	Duckweed		x		x
Araceae	<i>Zantedeschia aethiopica</i>	Arum lily	*DP		x	x
Arecaceae	<i>Washingtonia filifera</i>	Cotton Palm	*			x
Asteraceae	? <i>Cirsium vulgare</i>	Spear Thistle	*			x
Asteraceae	<i>Arctotheca calendula</i>	Cape Weed	*	x		
Asteraceae	<i>Conyza bonariensis</i>	Flaxleaf fleabane	*	x	x	x
Asteraceae	<i>Conyza sumatrensis</i>		*	x		
Asteraceae	<i>Cotula coronopifolia</i>	Water buttons	*	x	x	x
Asteraceae	<i>Hypochaeris glabra</i>	Flatweed	*		x	
Asteraceae	<i>Lactuca serriola</i>	Prickly Lettuce	*			x
Asteraceae	<i>Solidago canadensis</i>		*			x
Asteraceae	<i>Sonchus oleraceus</i>	Common Sowthistle	*	x		x
Asteraceae	<i>Symphotrichum squamatum</i>	Bushy Starwort	*	x		x
Asteraceae	<i>Taraxacum officinale</i>	Dandelion	*	x		
Asteraceae	<i>Verbesina encelioides</i>	Golden Crownbeard	*			x
Basellaceae	<i>Anredera cordifolia</i>	Madeira Vine	* WONS			x
Bignoniaceae	<i>Campsis radicans</i>	Orange Trumpet Flower	*			x
Bignoniaceae	<i>Jacaranda sp.</i>	Jacaranda	*	x		
Brassicaceae	<i>Brassica rapa</i>	Wild radish	*	x		
Brassicaceae	<i>Raphanus raphanistrum</i>	Wild radish	*		x	
Brassicaceae	<i>Rorippa nasturtium aquaticum</i>	Water cress	*	x	x	
Campanulaceae	<i>Lobelia anceps</i>	Angled Lobelia		x		
Cannaceae	<i>Canna spp.</i>	spp.				
Casuarinaceae	<i>Casuarina obesa</i>	Swamp sheoak		x	x	x
Casuarinaceae	<i>Casuarina glauca</i>		*			

Family	Taxon	Common Name	Status	Source		
				Regeneration Technology 1994	Flora list recorded in Randall and Storer (2010)	2015 site visit
Chenopodiaceae	<i>Atriplex prostrata</i>	Hastate Orache	*	x		
Chenopodiaceae	<i>Chenopodium album</i>	White				
Chenopodiaceae	<i>Sarcocornia quinqueflora</i>	Beaded samphire		x	x	
Chenopodiaceae	<i>Suaeda australis</i>	Seablite		x		x
Chenopodiaceae	<i>Tecticornia halocnemoides</i>			x		
Chenopodiaceae	<i>Threlkeldia diffusa</i>	Coast Bonefruit		x		
Convolvulaceae	<i>Ipomoea cairica</i>	Morning glory	*		x	x
Convolvulaceae	<i>Ipomoea indica</i>	Coast Morning Glory				x
Cyperaceae	<i>Baumea arthropphylla</i>			x	x	
Cyperaceae	<i>Baumea articulata</i>	Jointed rush		x	x	x
Cyperaceae	<i>Baumea juncea</i>	Bare twigrush		x	x	
Cyperaceae	<i>Baumea preissii</i>			x	x	
Cyperaceae	<i>Baumea vaginalis</i>					
Cyperaceae	<i>Bolboschoenus caldwellii</i>	Marsh club-rush		x	x	x
Cyperaceae	<i>Carex appressa</i>	Tall sedge		x	x	
Cyperaceae	<i>Carex divisa</i>		*	x	x	
Cyperaceae	<i>Carex fascicularis</i>	Tassel sedge		x	x	
Cyperaceae	<i>Carex inversa</i>	Knob sedge		x	x	
Cyperaceae	<i>Cyperus involucratus</i>		*		x	x
Cyperaceae	<i>Cyperus rotundus</i>	Nut Grass	*	x		x
Cyperaceae	<i>Ficinia nodosa</i>	Knotted club-rush		x	x	
Cyperaceae	<i>Lepidosperma longitudinale</i>	Pithy sword sedge		x	x	
Cyperaceae	<i>Lepidosperma tetraquetrum</i>			x	x	
Cyperaceae	<i>Schoenoplectus validus</i>	Lake club-rush		x	x	x
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken		x		x
Euphorbiaceae	<i>Euphorbia maculata</i>		*			x
Euphorbiaceae	<i>Euphorbia terracina</i>	Geraldton carnation weed	* DP		x	
Euphorbiaceae	<i>Ricinus communis</i>	Castor oil	*	x	x	x
Fabaceae	<i>Acacia pulchella</i>		planted			x
Fabaceae	<i>Acacia saligna</i>	Orange wattle		x	x	x
Fabaceae	<i>Dipogon lignosus</i>	Dolichos Pea	*			⁴
Fabaceae	<i>Hardenbergia comptoniana</i>		planted			x
Fabaceae	<i>Kennedia prostrata</i>	Scarlet Runner	planted			x
Fabaceae	<i>Lathyrus tingitanus</i>	Tangier pea	*	x	x	x

⁴ Record supplied by Baigup Wetland Interest Group (P Lee, BWIG, 2015 pers comm., 10 May).

Family	Taxon	Common Name	Status	Source		
				Regeneration Technology 1994	Flora list recorded in Randall and Storer (2010)	2015 site visit
Fabaceae	<i>Lotus uliginosus</i>		*	x		x
Fabaceae	<i>Lupinus angustifolius</i>	Narrowleaf Lupin	*	x		
Fabaceae	<i>Lupinus cosentinii</i>		*	x		x
Fabaceae	<i>Medicago polymorpha</i>	Burr Medic	*			x
Fabaceae	<i>Melilotus indicus</i>		*	x		
Fabaceae	<i>Paraserianthes lophantha</i>	Albizia		x		
Fabaceae	<i>Trifolium sp.</i>	Clover	*	x		
Fabaceae	<i>Viminaria juncea</i>	Swishbush		x	x	
Geraniaceae	<i>Geranium molle</i>	Dove's Foot Cranesbill	*	x		
Geraniaceae	<i>Pelargonium capitatum</i>	Rose pelargonium	*		x	x
Goodeniaceae	<i>Scaevola crassifolia</i>		planted			x
Haemodoraceae	<i>Anigozanthos manglesii</i>	Mangles Kangaroo Paw				
Iridaceae	<i>Freesia sp.</i>		*	x		
Iridaceae	<i>Gladiolus angustus</i>	Long Tubed Painted Lady	*	x		
Iridaceae	<i>Gladiolus caryophyllaceus</i>	Wild Gladiolus	*	x		
Iridaceae	<i>Moraea flaccida</i>	One-leaf Cape Tulip	*DP	x		
Iridaceae	<i>Patersonia occidentalis</i>	Purple Flag				x
Juncaceae	<i>Juncus kraussii</i>	Sea rush		x	x	x
Juncaceae	<i>Juncus microcephalus</i>		*		x	x
Juncaceae	<i>Juncus pallidus</i>	Pale rush		x	x	x
Juncaceae	<i>Juncus planifolius</i>	Broadleaf rush		x	x	
Lamiaceae	<i>Mentha spicata</i>	Spearmint	*	x		
Lamiaceae	<i>Metha x piperita</i>		*	x		
Lauraceae	<i>Cassytha glabella</i>	Dodder		x		
Loranthaceae	<i>Amyema preissii</i>					x
Loranthaceae	<i>Amyema spp.</i>	Mistletoe		x		
Malvaceae	<i>Malva parviflora</i>		*			x
Moraceae	<i>Ficus sp.</i>	Fig	*	x		
Musaceae	<i>Musa x paradisiaca</i>		*	x		x
Myrtaceae	<i>Eucalyptus botryoides</i>		*			x
Myrtaceae	<i>Eucalyptus citriodora</i>	Lemon-scented Gum	planted			x
Myrtaceae	<i>Eucalyptus rudis</i>	Flooded gum		x	x	x
Myrtaceae	<i>Melaleuca raphiophylla</i>	Swamp paperbark		x	x	x
Nyctaginaceae	<i>Bougainvillea sp.</i>	Bougainvillea	*	x		x

Family	Taxon	Common Name	Status	Source		
				Regeneration Technology 1994	Flora list recorded in Randall and Storer (2010)	2015 site visit
Onagraceae	<i>Oenothera laciniata</i>		*			x
Oxalidaceae	<i>Oxalis pes-caprae</i>	Soursob	*	x		
Papaveraceae	<i>Fumaria capreolata</i>	Whiteflower Fumitory	*	x		
Plantaginaceae	<i>Bacopa monnieri</i>		*			x
Plantaginaceae	<i>Plantago major</i>		*			x
Poaceae	<i>Arundo donax</i>	Giant reed	*	x	x	x
Poaceae	<i>Avena fatua</i>	Wild oat	*	x	x	
Poaceae	<i>Briza maxima</i>	Blowfly Grass	*	x		
Poaceae	<i>Cortaderia selloana</i>	Pampas grass	*	x	x	x
Poaceae	<i>Cynodon dactylon</i>	Couch	*	x	x	
Poaceae	<i>Echinochloa ? crus-galli/telmatophila</i>	Barnyard Grass	*			x
Poaceae	<i>Ehrharta calycina</i>	Perennial veldt grass	*		x	x
Poaceae	<i>Lagurus ovatus</i>	Hares tail grass	*		x	
Poaceae	<i>Lolium rigidum</i>	Ryegrass	*		x	
Poaceae	<i>Paspalum dilatatum</i>	Paspalum	*	x	x	
Poaceae	<i>Paspalum distichum</i>	Water couch	*	x	x	x
Poaceae	<i>Pennisetum clandestinum</i>	Kikuyu	*	x	x	
Poaceae	<i>Polypogon monspeliensis</i>	Annual Beardgrass	*			x
Poaceae	<i>Stenotaphrum secundatum</i>	Buffalo Grass	*	x		
Polygonaceae	<i>Persicaria decipiens</i>					x
Polygonaceae	<i>Persicaria sp.</i>				x	
Polygonaceae	<i>Rumex brownii</i>	Swamp Dock	*	x		
Polygonaceae	<i>Rumex crispus</i>	Curled Dock	*	x		x
Portulacaceae	<i>Portulaca oleracea</i>		*			x
Primulaceae	<i>Lysimachia arvensis</i>		*			x
Primulaceae	<i>Samolus repens</i>	Creeping brookweed			x	
Proteaceae	<i>Adenanthos cygnorum</i>	Common Woollybush	planted			x
Proteaceae	<i>Banksia littoralis</i>					x
Proteaceae	<i>Grevillea crithmifolia</i>		planted			x
Rosaceae	<i>Rubus sp.</i>	Blackberry	*	x	x	
Salicaceae	<i>Populus alba</i>	Poplar	*			x
Salicaceae	<i>Salix babylonica</i>	Weeping willow	*	x	x	x
Salviniaceae	<i>Azolla rubra</i>					x
Scrophulariaceae	<i>Myoporum sp.</i>			x		
Solanaceae	<i>Solanum nigrum</i>	Black Berry Nightshade	*			x

Family	Taxon	Common Name	Status	Source		
				Regeneration Technology 1994	Flora list recorded in Randall and Storer (2010)	2015 site visit
Tropaeolaceae	<i>Tropaeolum majus</i>	Garden Nasturtium	*	x		x
Typhaceae	<i>Typha orientalis</i>	Bulrush	*	x	x	x
Verbenaceae	<i>Lantana sp.</i>		*	x		x
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>	Grass Tree				x
Zamiaceae	<i>Macrozamia fraseri</i>	Zamia				x

* Introduced or weed species

DP Declared Pest under the Biosecurity and Agriculture Management Act

WONS Weed of National Significance

Appendix C – Baigup Wetland Reserve Fauna List

Table C.1 Fauna species listed recorded at Baigup Reserve (various sources)

Group	Family	Taxon	Common name	Status	Source			
					Birds Australia (as cited in Randall and Storer 2010)	Seimon 1991 (as cited in Regeneration Technology 1994)	Anecdotal (BWIG and comments/number of sightings)	
Amphibians	Hylidae	<i>Litoria adelaidensis</i>	Slender Tree Frog			x	x	Small population
Amphibians	Hylidae	<i>Litoria moorei</i>	Motorbike Frog			X	x	Dispersed, small population
Amphibians	Limnodynastidae	<i>Heleioporus eyrei</i>	Moaning frog			x		Not heard
Amphibians	Limnodynastidae	<i>Limnodynastes dorsalis</i>	Pobblebonk/Western Banjo Frog			x	x	Dispersed, small population
Amphibians	Myobatrachidae	<i>Crinia georgiana</i>	Quacking Frog			x	x	Strong population
Amphibians	Myobatrachidae	<i>Crinia glauteri</i>	Clicking Frog			x	x	Dispersed, large population
Birds	Acanthizidae	<i>Acanthiza apicalis</i>	Inland Thornbill			x	BLWA	1
Birds	Acanthizidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill			x	BLWA	1
Birds	Acanthizidae	<i>Acanthiza inornata</i>	Western Thornbill			x	-	
Birds	Acanthizidae	<i>Smicrornis brevirostris</i>	Weebill				BLWA	3
BLWA	Acanthizidae	<i>Gerygone fusca</i>	Western Gerygone		x	x	BLWA	1
Birds	Accipitridae	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk		x	x	BLWA	1
Birds	Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk		x		BLWA	1
Birds	Accipitridae	<i>Circus approximans</i>	Swamp Harrier				BLWA	2

Group	Family	Taxon	Common name	Status	Source			
					Birds Australia (as cited in Randall and Storer 2010)	Seimon 1991 (as cited in Regeneration Technology 1994)	Anecdotal (BWIG and comments/number of sightings)	
Birds	Accipitridae	<i>Circus assimilis</i>	Spotted Harrier			x	-	
Birds	Accipitridae	<i>Elanus caeruleus</i>	Black-shouldered kite		x	x	BLWA	1 - regular
Birds	Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite			x	BLWA	2 - regular
Birds	Anatidae	<i>Anas castanea</i>	Chestnut Teal				BLWA	1
Birds	Anatidae	<i>Anas gracilis</i>	Grey teal		x		BLWA	8 – breeding /always
Birds	Anatidae	<i>Anas rhynchotis</i>	Australasian shoveler		x		BLWA	1 - regular
Birds	Anatidae	<i>Anas superciliosa</i>	Pacific Black Duck		x	x	BLWA	8 – breeding /always
Birds	Anatidae	<i>Aythya australis</i>	Hardhead		x		BLWA	2 - regular
Birds	Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck				BLWA	1 – breeding /regular
Birds	Anatidae	<i>Cygnus atratus</i>	Black Swan		x	x	BLWA	3 – breeding /regular
Birds	Anatidae	<i>Malacorhynchus membranaceus</i>	Pink-eared Duck				BLWA	Breeding
Birds	Anatidae	<i>Oxyura australis</i>	Blue-billed Duck				-	
Birds	Anatidae	<i>Tadorna tasdornoides</i>	Australian Shelduck		x	x	BLWA	6, regular
Birds	Anhingidae	<i>Anhinga melanogaster</i>	Darter		x	x	BLWA	7, frequent
Birds	Ardeidae	<i>Ardea garzetta</i>	Little Egret			x	-	
Birds	Ardeidae	<i>Ardea modesta</i>	Eastern Great Egret	S3, Mi	x		BLWA	6, regular
Birds	Ardeidae	<i>Ardea novaehollandiae</i>	White-faced Heron		x	x	BLWA	7, frequent
Birds	Ardeidae	<i>Ardea pacifica</i>	White-necked Heron			x	x	

Group	Family	Taxon	Common name	Status	Source			
					Birds Australia (as cited in Randall and Storer 2010)	Seimon 1991 (as cited in Regeneration Technology 1994)	Anecdotal (BWIG and comments/number of sightings)	
Birds	Ardeidae	<i>Ardea sacra</i>	Eastern Reef Heron	S3, Mi		x		
Birds	Ardeidae	<i>Nycticorax caledonicus</i>	Rufous Night Heron (Nankeen Night heron)			x	x	4, frequent
Birds	Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	*		x	-	
Birds	Cacatuidae	<i>Cacatua roseicapilla</i>	Galah			x	BLWA	4
Birds	Cacatuidae	<i>Cacatua sanguinea</i>	Little Corella			x	BLWA	4
Birds	Cacatuidae	<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	T, Vu		x	BLWA	2
Birds	Cacatuidae	<i>Calyptorhynchus baudinii</i>	Baudin's Black Cockatoo	T, Vu		x	-	
Birds	Cacatuidae	<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	T, En			BLWA	2
Birds	Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		x	x	BLWA	6
Birds	Campephagidae	<i>Lalage tricolor</i>	White-winged triller		x		-	
Birds	Charadriidae	<i>Charadrius melanops</i>	Black-fronted dotterel		x		BLWA	5
Birds	Charadriidae	<i>Erythronyx cinctus</i>	Red-kneed dotterel		x		-	
Birds	Columbidae	<i>Columba livia</i>	Feral Pigeon	*			BLWA	5
Birds	Columbidae	<i>Streptopelia chinensis</i>	Spotted turtle-dove	*	x	x	BLWA	7
Birds	Columbidae	<i>Streptopelia senegalensis</i>	Laughing turtle-dove	*	x	x	BLWA	7
Birds	Corvidae	<i>Corvus bennetti</i>	Little Crow			x	-	
Birds	Corvidae	<i>Corvus coronoides</i>	Australian raven		x	x	BLWA	7, frequent
Birds	Cracticidae	<i>Cracticus tibicen</i>	Australian magpie		x	x	BLWA	6

Group	Family	Taxon	Common name	Status	Source			Anecdotal (BWIG and comments/number of sightings)
					Birds Australia (as cited in Randall and Storer 2010)	Seimon 1991 (as cited in Regeneration Technology 1994)		
Birds	Cracticidae	<i>Cracticus torquatus</i>	Grey Butcherbird			x	BLWA	2
Birds	Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo		x	x	-	
Birds	Dicaeidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird		x	x	BLWA	6
Birds	Estrildidae	<i>Lonchura castaneothorax</i>	Chestnut-breasted Mannikin	*		x	-	
Birds	Falconidae	<i>Falco berigora</i>	Brown Falcon			x	-	
Birds	Falconidae	<i>Falco cenchroides</i>	Australian kestrel			x	-	
Birds	Falconidae	<i>Falco longipennis</i>	Australian Hobby			x	BLWA	7
Birds	Falconidae	<i>Falco subniger</i>	Black Falcon			x	-	
Birds	Fringillidae	<i>Carduelis carduelis</i>	European goldfinch	*	x		-	
Birds	Halcyonidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	*	x	x	BLWA	2
Birds	Halcyonidae	<i>Todiramphus sanctus</i>	Sacred kingfisher			x		1
Birds	Hirundinidae	<i>Hirundo neoxena</i>	Welcome swallow		x	x	BLWA	2
Birds	Hirundinidae	<i>Hirundo nigricans</i>	Tree martin		x		BLWA	2
Birds	Laridae	<i>Larus novaehollandiae</i>	Silver gull		x	x	BLWA	6
Birds	Laridae	<i>Sterna bergii</i>	Crested tern		x	x	BLWA	5
Birds	Laridae	<i>Sterna caspia</i>	Caspian tern	S3, Mi		x	BLWA	6
Birds	Locustellidae	<i>Megalurus gramineus</i>	Little grassbird				BLWA	5
Birds	Maluridae	<i>Malurus lamberti</i>	Variegated Fairy-wren				BLWA	2
Birds	Maluridae	<i>Malurus splendens</i>	Splendid Fairy-wren			x	-	
Birds	Meliphagidae	<i>Acanthorhynchus</i>	Western Spinebill			x	-	

Group	Family	Taxon	Common name	Status	Source			
					Birds Australia (as cited in Randall and Storer 2010)	Seimon 1991 (as cited in Regeneration Technology 1994)	Anecdotal (BWIG and comments/number of sightings)	
		<i>superciliosus</i>						
Birds	Meliphagidae	<i>Anthochaera carunculata</i>	Red wattlebird		x	x	BLWA	7
Birds	Meliphagidae	<i>Anthochaera lunulata</i>	Little wattlebird		x	x	-	
Birds	Meliphagidae	<i>Gavicalis virescens</i>	Singing honeyeater		x	x	BLWA	8
Birds	Meliphagidae	<i>Lichmera indistincta</i>	Brown honeyeater		x	x	BLWA	8
Birds	Meliphagidae	<i>Melithreptus lunatus chloropsis</i>	Western White-naped Honeyeater			x	-	
Birds	Meliphagidae	<i>Phylidonyris nigra</i>	White-cheeked honeyeater		x		BLWA	4
Birds	Meliphagidae	<i>Phylidonyris novaehollandiae</i>	New Holland honeyeater		x		BLWA	5
Birds	Meropidae	<i>Merops ornatus</i>	Rainbow bee-eater	S3, Mi	x	x	BLWA	4, every year – seasonal
Birds	Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark		x	x	BLWA	6
Birds	Motacillidae	<i>Anthus australis</i>	Australian Pipit			x	-	
Birds	Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush				BLWA	1
Birds	Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler			x	-	
Birds	Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous whistler		x	x	BLWA	5
Birds	Pandionidae	<i>Pandion cristatus</i>	Eastern Osprey				BLWA	2
Birds	Pardalotidae	<i>Pardalotus striatus</i>	Striated pardalote			x	BLWA	4
Birds	Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian pelican		x	x	BLWA	7
Birds	Petroicidae	<i>Petroica multicolor</i>	Scarlet Robin			x	-	

Group	Family	Taxon	Common name	Status	Source		
					Birds Australia (as cited in Randall and Storer 2010)	Seimon 1991 (as cited in Regeneration Technology 1994)	Anecdotal (BWIG and comments/number of sightings)
Birds	Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great cormorant		x	x	BLWA 3
Birds	Phalacrocoracidae	<i>Phalacrocorax melanoleucos</i>	Little pied cormorant		x	x	BLWA 8, frequent
Birds	Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little black cormorant		x	x	BLWA 8
Birds	Podicipedidae	<i>Poliiocephalus poliocephalus</i>	Hoary-headed grebe		x		-
Birds	Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian grebe		x (breeding)		BLWA 8
Birds	Psittacidae	<i>Platycercus zonarius</i>	Australian ringneck		x	x	BLWA 2
Birds	Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow lorikeet	*	x		BLWA 7
Birds	Rallidae	<i>Fulica atra</i>	Eurasian coot		x	x	BLWA 8
Birds	Rallidae	<i>Gallinula tenebrosa</i>	Dusky moorhen		x	x	BLWA 8
Birds	Rallidae	<i>Gallirallus philippensis</i>	Buff-banded rail (breeding)		x	x	BLWA 1
Birds	Rallidae	<i>Porphyrio porphyrio</i>	Purple swamphen		x	x	BLWA 8, always
Birds	Rallidae	<i>Porzana pusilla</i>	Baillon's crake		x	x	-
Birds	Rallidae	<i>Porzana tabuensis</i>	Spotless crake		x	x	BLWA 1
Birds	Rallidae	<i>Tribonyx ventralis</i>	Black-tailed Native-hen			x	-
Birds	Recurvirostridae	<i>Himantopus himantopus</i>	Black-winged stilt		x		-
Birds	Recurvirostridae	<i>Cladorhynchus leucocephalus</i>	Banded stilt				BLWA 1
Birds	Rhipiduridae	<i>Rhipidura fuliginosa</i>	Grey fantail		x	x	BLWA 3

Group	Family	Taxon	Common name	Status	Source			
					Birds Australia (as cited in Randall and Storer 2010)	Seimon 1991 (as cited in Regeneration Technology 1994)	Anecdotal (BWIG and comments/number of sightings)	
Birds	Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail		x	x	BLWA	8
Birds	Scolopacidae	<i>Tringa hypoleucos</i>	Common sandpiper	S3, Mi	x		-	
Birds	Stercorariidae	<i>Stercorarius parasiticus</i>	Arctic Jaeger/Arctic Skua				BLWA	7
Birds	Strigidae	<i>Ninox novaeseelandiae</i>	Boobook Owl			x	-	
Birds	Sylviidae	<i>Acrocephalus australis</i>	Australian Reed Warbler (Clamorous reed-warbler)		x	x	BLWA	8
Birds	Sylviidae	<i>Megalurus gramineus</i>	Little Grassbird		x	x	BLWA	5
Birds	Threskiornithidae	<i>Platalea flavipes</i>	Yellow-billed spoonbill		x	x	BLWA	7
Birds	Threskiornithidae	<i>Threskiornis molucca</i>	Australian white ibis		x	x	BLWA	8
Birds	Threskiornithidae	<i>Threskiornis spinicollis</i>	Straw-necked Ibis			x	BLWA	2
Birds	Tytonidae	<i>Tyto alba</i>	Barn Owl			x	-	
Birds	Zosteropidae	<i>Zosterops lateralis</i>	Grey-breasted White-eye (Silvereye)		x	x	BLWA	5
Mammals	Canidae	<i>Vulpes vulpes</i>	Fox	*		x	X	
Mammals	Felidae	<i>Felis catis</i>	Feral Cat				x	
Mammals	Muridae	<i>Hydromys chrysogaster</i>	Water rat	P4		x	x	
Mammals	Muridae	<i>Mus musculus</i>	House mouse	*		x		
Mammals	Muridae	<i>Rattus norvegicus</i>	Brown rat	*		x		
Mammals	Muridae	<i>Rattus rattus</i>	Black rat	*		x		
Reptiles	Cheluidae	<i>Chelodina colliei</i>	Oblong Turtle				x	
Reptiles	Egerniidae	<i>Egernia kingii</i>	King's skink			x		

Group	Family	Taxon	Common name	Status	Source			
					Birds Australia (as cited in Randall and Storer 2010)	Seimon 1991 (as cited in Regeneration Technology 1994)	Anecdotal (BWIG and comments/number of sightings)	
Reptiles	Egerniidae	<i>Lissolepis luctuosa</i>	Western Glossy Swamp Skink			x	x	
Reptiles	Elapidae	<i>Notechis scutatus</i>	Western tiger snake			x		
Reptiles	Elapidae	<i>Pseudonaja affinis</i>	Dugite			x	x	
Reptiles	Emydidae	<i>Trachemys scripta elegans</i>	Red-eared slider	*			x	Removed from site
Reptiles	Eugongylidae	<i>Acritoscincus trilineatum</i>	Western Three-lined Skink			x		
Reptiles	Eugongylidae	<i>Morethia obscura</i>	Shrubland Snake-eyed Skink			x		
Reptiles	Sphenomorphidae	<i>Ctenotus labillardieri</i>	Red Legged Skink			x		

BLWA Bird Life Western Australia surveys 2012-15

Appendix D – Previous management measures

Table D.1 Previous strategies and recommendations for Baigup Wetland Reserve, and the outcomes of these recommendations

Aspect	Strategies (Regeneration Technology 2004)	Recommendation (Randall and Storer 2010)	Outcome
Management Directions	1. Manage the Reserve for conservation and allow recreation and other uses of the Reserve to occur to the extent they do not impair the values of the park		Ongoing
	2. Apply the policies from relevant wetland biodiversity policies that relate to conservation and research and monitoring to the Reserve		Ongoing
	3. Prepare a local government policy statement for implementation by COB that reflects the principles outlined in the plan		Not prepared as yet
	4. Prepare a policy statement for Water Corporation and Alinta Gas that reflects the intent of the Management Plan		Not prepared as yet
	5. Establish and collate existing baseline information to initiate the process of monitoring the Key Performance Indicators at regular intervals through implementation plans such as weed management and rehabilitation plans		Not undertaken - the implementation of the previous management plans was partly suspended due to the acid sulphate situation
	6. Develop an integrated program of survey research and monitoring within the Reserve focusing on the key performance indicators		Not undertaken
	7. Audit and measure the overall effectiveness of Reserve management based on the key performance indicators		Not undertaken
Erosion	8. Investigate the placement of large woody debris into the river including methods for securing it to ensure it stays in place. Densely plant large clumps of <i>Schoenoplectus validus</i> into the river to ensure rapid establishment.		A community workshop was held on seed collection and some sedge seeds collected but no plantings appear to have occurred.
	9. Investigate all methods to protect and rehabilitate the shore		Ongoing. COB has been working with Swan River Trust on this issue across the entire Bayswater foreshore.
Acid Sulfate		Surface water and groundwater should be	Ongoing. Some monitoring was undertaken in 2014

Aspect	Strategies (Regeneration Technology 2004)	Recommendation (Randall and Storer 2010)	Outcome
Soils		monitored following any site disturbance, e.g. weed control, rehabilitation, installation of infrastructure	following an algal bloom in the central part of the reserve in the summer of 2012/13. DER has been involved in monitoring building suites in Stone Street.
		Disturbance should be conducted in a staged approach to minimise and better manage the outcomes	Has occurred – large scale clearing of Typha in 2012 was slowed to preserve habitat for waterbirds and to allow a staged approach to revegetation.
		Conduct a disturbance test site to determine the possible extent of impacts before large disturbance works	COB and DER investigated water prior to proposed further digging of ditches for mosquito control in western end of Reserve in 2013.
		Retain pooling of water within the lakes to reduce exposure of acid sulfate soils to the atmosphere	Both lakes have retained water in every year since construction
		Install several large box culverts allowing for increased exchange between the two sides of the path	Funds unavailable
		Depending on the level of access required by Alinta Gas to maintain the pipeline, investigate replacing sections of the bike path with a raised walkway to enable exchange between the two sides of the path	Needed extensive prior investigation, funds not available.
Weed Control	16. Implement the Weed Control and Rehabilitation Plan (Regeneration Technology 2003)		Work started, some halted at the time of ASS investigation. Some work (such as Typha control) continued by COB and community group.
	17. Educate Reserve visitors and neighbours about: <ul style="list-style-type: none"> The effects of dumping rubbish and garden refuse in the Reserve Invasive plants that pose a threat to the biodiversity of the park (eg. Salvinia) 		Education of residents conducted in 1991 during the Seimon et al university study (1991), there now appears to be little dumping of garden waste.
	18. Form a partnership with property owners who back onto the Reserve to control		This work has been discussed by COB and BWIG and it is

Aspect	Strategies (Regeneration Technology 2004)	Recommendation (Randall and Storer 2010)	Outcome
	garden plants and weeds escaping into the Reserve		recommended that this be taken further.
	19. Encourage volunteer community groups to become involved with weed control in the Reserve		Since 2013 the BWIG has been participating in weed control
	20. Co-ordinate community involvement in weed control works within the Reserve		Since 2013 the BWIG has been participating in weed control. Since 2014 one member of the BWIG committee has been taking increasing responsibility for liaising with COB staff about weed control days and management of volunteers.
		Conduct a comprehensive weed survey to prioritise weeds for control	As yet, not undertaken
		Use Table 5 to undertake immediate removal of the six identified High Priority weeds at Baigup Reserve.	Ongoing – see Table 5
		Ensure application of any herbicides is in accordance with the material safety data sheets and Department of Water (2000) water catchment restrictions	Ongoing
	21. Monitor the extent of highly ranked weed species (Weed Control and Rehabilitation Plan 2003) distribution and abundance, bushland condition and changes to vegetation communities. Compare with previous studies to monitor changes.	Implement monitoring program to assess changes in weed species and distribution in the study area and adapt weed strategies accordingly	As yet, not undertaken. Particular weed species could be 'adopted' by a volunteer. GHD has provided 'baseline' vegetation communities and condition mapping for future comparisons (this report).
		High disturbance weed control (e.g. removal of Typha) should be conducted in a staged approach in potential acid sulfate soil areas to minimise and better manage the outcomes	There has been a staged approach to removal of Typha around Secondary Lake with initial large scale clearing halted during 2012. Planting of sedges and other plantings in 2013/4 is replacing Typha. Typha eradication during 2014 extended towards west and being well maintained by COB staff. This is ongoing.
Rehabilitation and	11. Investigate wilful damage of vegetation in the Reserve and where appropriate		No further incidents have been observed since a possible tree poisoning

Aspect	Strategies (Regeneration Technology 2004)	Recommendation (Randall and Storer 2010)	Outcome
revegetation	offenders should be prosecuted		around 2003.
	12. Provide interpretative material for local residents encouraging them to plant local species in areas surrounding the Reserve		City of Bayswater has prepared Local Native Plants Guide, and provided information online for the community
	13. & 27. Implement the Weed Control and Rehabilitation Plan.		Some has been undertaken, including planting in ErMrCoW and EBW near Garratt Road.
	28. Co-ordinate works with contractors, COB and community groups		Work days have been undertaken with the collaboration of BWIG and COB
	29. Co-ordinate rehabilitation with weed control.		Some has occurred
	30. Inform local residents neighbouring the Reserve when proposing to undertake significant rehabilitation works in the Reserve.		Residents were advised of works relating to excavation of lakes around 1999/2000. This should be ongoing; it would be good to provide residents with an update of ongoing works.
		Maintain the Good to Excellent condition bushland through assisted natural regeneration in zones 2, 3 and 4	No assisted natural regeneration as occurred in these three zones since 2010.
		Focus reconstruction efforts within Zone 6	Underway – Typha removal has occurred 2011/12 and revegetation works 2013-15.
		Develop an annual monitoring program to assess vegetation condition through the success or failure of weed control and rehabilitation	As yet, not undertaken
	10. Ensure local species are used for landscape and amenity planting in the Reserve 31. Use locally collected seed for propagating plants	Use only local provenance plants for rehabilitation	This should be an ongoing objective, where possible. Locally suitable plants have been used in revegetation but may not be local provenance. Attempts were made to collect seed from this area in 2003.
		Maintain the Good to Excellent condition bushland through assisted natural regeneration in zones 2, 3 and 4	This should be an ongoing objective
32. Encourage members of the		FOBW had regular Typha	

Aspect	Strategies (Regeneration Technology 2004)	Recommendation (Randall and Storer 2010)	Outcome
	local community and schools to participate in undertaking rehabilitation works and seek external funding to achieve these works where possible		control days to around 2003. Since 2013 the BWIG has been participating in rehabilitation works
Fire	22. Prepare and implement a fire response plan	Develop fire-response plan to assist the fire-fighting response	In 2014 COB developed a fire plan for the Reserve, which included input from BWIG
	23. Co-ordinate weed control and rehabilitation works with fire prevention requirements		This should be ongoing, with input from the Department of Fire and Emergency Services (DFES) on requirements for a fire access track.
		Educate the community to increase awareness of the damaging effects of fire, particularly through school education programs	This may not be required, and effort may be better placed in appreciating the speedy response of neighbours in dealing with arson events, and encouraging further assistance from residents in case of future events.
		Regularly maintain fire breaks and keep tracks clear of weeds	Tracks are in good condition, except that there is no access between the Water Corporation track and the Garratt Road/Stone Street Junction.
		Reduce fuel loads through control of weeds such as perennial veldt grass and bulrush	No longer considered so important as weedy grasses and Typha being controlled. Continue to clean up sprayed weeds.
Fauna	24. Monitor for mosquitoes at relevant times of the year and undertake appropriate control practices		Mosquito control has been a major initiative through the COB Environmental Health section since 2013. Ongoing.
	25. Use signs and interpretative information to inform the community about the adverse effects of pets on native fauna	Use signs and interpretative information to inform the community about the adverse effects of pets on native fauna	Sign regarding introduced (pet) turtle species is present at the Reserve but could be removed.
	26. Ensure dogs are on a lead and under effective control at all times	Ensure dogs are on a lead and under effective control at all times	Most dogs are currently kept on lead and almost all droppings picked up. Additional humorous signs could be erected.
		Provide more plastic bags and bins around the Reserve for dog owners to dispose of waste responsibly	Dog bin at Kelvin St entrance needs to be emptied more frequently and there is no dog bin or doggy bags at the Garratt Road entrance.

Aspect	Strategies (Regeneration Technology 2004)	Recommendation (Randall and Storer 2010)	Outcome
		Trap and remove the European fox and discourage adjacent landowners from dumping garden refuse in the wetland to help reduce rat and mouse populations	Little done, and foxes are still an issue. This requires cooperation with the City of Belmont and Bassendean.
		Investigate the implementation of a cat curfew within a certain buffer of the Reserve to minimise predation on the native fauna by domestic cats	No undertaken, but microchipping of cats has started.
		Encourage landowners to restrict the free movement of pet cats and dogs in the Reserve to reduce negative effects on native birds and mammals	Not attempted since 1991.
	14. Prepare and undertake a monitoring program of the avian, amphibian, reptile and invertebrate communities	Undertake an initial fauna survey of amphibians, reptiles, mammals and invertebrates to gather baseline information of the species present	Avian surveys have been done by BirdLife Australia (1-2 bird walks for the community each year); ongoing. A visual survey of other fauna species was provided by Regeneration Technology (1994) however no surveys of amphibians, reptiles or mammals have been undertaken
		Undertake routine sampling of fauna to determine changes in diversity and population size	Not undertaken.
	15. Provide interpretive and educational material which: <ul style="list-style-type: none"> • Promote the Reserve's fauna, particularly water birds and frogs • Discourage the feeding of birds and fish in the lakes • Educate local residents about the effects of dumping exotic animals and fish into the wetland • Informs the public about the adverse impact of feral animals and domestic pets on native fauna in the Reserve 		BWIG is working with Swan River Trust in creating a virtual trail through the Reserve. Online material is under development and this should be fully developed by the end of 2015. Does not include feral and domestic predator information.

Aspect	Strategies (Regeneration Technology 2004)	Recommendation (Randall and Storer 2010)	Outcome
Access, recreation and infrastructure	36. Restrict access to the limestone access track at the rear of Stone Street properties	Restrict access to the limestone access track at the rear of Stone Street properties	Has not occurred. Limestone track is used by dog walkers, bird watchers etc. May not be required.
	37. Consider the installation of a boardwalk and fishing platforms to allow for access to sections of the foreshore		Has not yet occurred, recommended.
	38. Allow access for emergency response vehicles	Allow access for emergency response vehicles	Good access everywhere except north-west corner of the reserve.
	39. Ensure all new boardwalks and platforms are designed to Australian design standards to allow access for all	Ensure all new boardwalks and platforms are designed to Australian design standards to allow access for all	Ongoing
	34. Prepare and plan for suitable and safe facilities guided by Australian standards	Prepare and plan for suitable and safe facilities guided by Australian standards	Ongoing
	35. Develop facilities and structures in a manner that is sympathetic with the surrounding landscape	Develop facilities and structures in a manner that is sympathetic with the surrounding landscape	Ongoing
	42. Prepare a safety audit program for the Reserve		May be undertaken by COB?
	43. Provide information to visitors that identifies potential hazards and hazardous activities	Provide information to visitors that identifies potential hazards and hazardous activities	Alinta gas sign erected that warns of water toxicity around scalds.
Cultural heritage, interpretation and education/Signs	40. Develop and implement a sign system and plan for the Reserve	Develop an interpretation plan for the Reserve to facilitate a coordinated plan for interpretation and education	Underway and ongoing – virtual trail, additional signs for fishing areas.
		Establish interpretive signage along the walk trail	No undertaken and Marli Riverpark Interpretive Plan now advocates minimal conventional signage. Other approaches possible, such as entrance statements
	41. Liaise with other authorities (eg. Alinta Gas and Bikewest) to ensure consistency of signs (or sign placement) within the Reserve	Develop a signage standard/scheme such that all signs are consistent in materials, dimensions, colours etc.	Must fit in with overall Swan/Canning Marli Riverpark interpretive scheme.
Research and monitoring	44. Set up an integrated program of research and monitoring based on (but not limited to) the Key Performance Indicators		As yet, not implemented
	45. Support and where		Ongoing – BWIG has

Aspect	Strategies (Regeneration Technology 2004)	Recommendation (Randall and Storer 2010)	Outcome
	possible seek grant applications for research and monitoring in the Reserve		applied for grants for works
	46. Encourage the participation of volunteers, school groups and other educational institutions in research in the Reserve		Ongoing, through activities of BWIG, BirdLife etc
Performance assessment	47. Review the implementation of the management plan annually to identify strategies that have been achieved.		This assessment
	48. Undertake an audit of the Management Plan mid-term (after 5 years, say 2008) and end of term		2010 Plan prepared. This assessment.

Appendix E - Example transect monitoring methodology



Example methodology for vegetation transect monitoring at Baigup Wetland Reserve

Purpose of the vegetation monitoring

A vegetation monitoring program is proposed for Baigup Wetland Reserve. The main objective of a vegetation monitoring program is to provide baseline data and ongoing comparable information to assess changes in the vegetation condition and type.

For this reason, it is suggested that monitoring by transect is most suitable as this will provide information across a range of vegetation types and will enable the assessment of changes in the vegetation boundaries. Data on species composition, percent cover of plant species and vegetation condition will be collected in order to assess changes in vegetation over time.

The below methodology is an example methodology that can be used to measure a variety of vegetation parameters. However, prior to the monitoring project specialists will need to determine specifically what will be measured by the monitoring program, including parameters that will be measured and the analysis that will be undertaken on the resulting data.

Notes

- If transects are being surveyed only once per year it is best that this occur in Spring, being the optimal growth season in south-west Western Australia.
- It is preferable to have the same observers monitoring the site to allow for continuity in data collection.
- Only people with a 'Licence to take flora for scientific or other prescribed purposes (issued by Department of Parks and Wildlife) should collect specimens of native species.
- Useful resources that provides background information include:
 - *Bushland Plant Survey: A guide to plant community survey for the community. By Bronwen Keighery. A Wildflower Society of WA Publication.*
 - Perth Biodiversity Project Resources, including: Natural Area Initial Assessment Templates, available at:
<http://pbp.walga.asn.au/Tools/NaturalAreaInitialAssessmentTemplates.aspx>
- Monitoring of the transects could be undertaken by point intersect method or by sampling the entire transect (1 m either side of the transect) – the second option, which is simpler and more easily repeatable, has been outlined below.

Equipment required for monitoring

- General location map (including aerial photograph)
- GPS and batteries
- Compass
- 100 m tape measure on reel



- Site marker (star picket/fence dropper or similar) and hammer/post-driver
- Camera
- Clip-board, recording sheets, pencil
- Print-out of photos looking down transect (for second and subsequent monitoring events this will assist in locating transect/laying out tape)
- If collecting specimens: flora licence, plastic bags/paper bags/watch maker tags (for storing and labelling specimens), plant press
- Personal Protective Equipment: eg. Boots/gumboots/gaiters/long pants and shirt/hat/sunscreen

Establishing the transects

1. Determine the most appropriate transect locations.
It would be preferable to have transects that pass through a number of vegetation types and through vegetation in a range of conditions (ie. both on the north and south side of the path).
2. Mark the start of the transect with a star picket/fence dropper (making sure it is in a location where it will not be a safety hazard or will not interfere with the works of the City of Bayswater). This will be Point A. Record the location of Point A using a GPS and also make notes of location based on environmental features (eg. 1m north-west of the base of large *Melaleuca raphiophylla*) in case marker is vandalised or removed
3. Measure out transect using tape measure and mark end of transect with star picket/fence dropper (Point B – mark as per Point A). Measure compass bearing of transect (from Point A).
4. Record site variables (first page of “recording form”).
5. Begin transect monitoring methodology (From dot point “4” below). The transect should include 1 m on either side of the tape measure.

Monitoring the transects

1. Find the Transect Point A, and attach the tape measure (zero end) to the star picket/post.
2. Second observer locates Point B (using print-outs of previous photos and compass bearing) and guides first observer to run out the measuring tape to Point B.
3. Both observers ensure tape is taut.
4. Take photos:
 - a single photo straight down the transect from Point A to Point B



- a single photo straight down the transect from Point B to Point A.
 - Take one set of panorama photos from Point A
5. Use the vegetation recording form (see below) to record data including:
- Date: Always record the data of survey. Where possible, the annual surveys should be done at the same time every year
 - Transect #: Each transect should be labelled with a code or number that can easily identify it
 - Observers: Record all people involved in the survey
 - Latitude/Longitude or Easting/Northing: Record the location of Point A and Point B (first survey only).
 - Photos: take a photo with the camera on top of the stake looking down the transect (in subsequent surveys it can help to have a print-out of the previous photos to enable replication of position)
Record the numbers of any additional photos taken along the transect, and where the photographs were taken.
 - Vegetation condition: record vegetation condition at Point A (remembering that this may change across the transect) using the methodology of Keighery (1994)
 - Slope and aspect/soil/drainage: circle appropriate response
 - Record the start/finish (by measuring off the tape) of each vegetation type present along the transect.
 - Observers should walk on each side of the transect, recording all the plants that occur within each vegetation type (remembering the transect includes 1 m either side of the measuring tape).
 - At the end of each vegetation type estimate the cover of each of the species that have been recorded within the vegetation type (use a defined method of estimating cover, such as that outlined in Keighery 1994). Include an estimate of cover for: bare ground, litter and open water.
 - Count the number of juvenile *Melaleuca raphiophylla* seedlings/saplings along the transect (under 1m).



- Record the vegetation condition across the transect using the scale of Keighery 1994 (see below). If the vegetation condition changes across the transect record the measurement (on the tape) where the condition changes.
- For any *Melaleuca raphiophylla* trees within the transect record the health of the tree by recording the amount of canopy that is alive ie:
 - i. Condition 'Good': > 70% of original canopy alive, tree shows little evidence of stress
 - ii. Condition 'Poor': 30-70 % of original canopy alive, some evidence of stress, and death of large sections of the tree
 - iii. Condition 'Very Poor': <30% of original canopy alive, tree very stressed, majority of tree is in decline
- Every 5 m along transect record presence of water (dry, waterlogged or wet (if wet record depth of water))

Vegetation condition rating

The vegetation condition rating scale of Keighery (1994) is defined by the following:

- Completeness of structural levels
- Extent of weed invasion
- Historical disturbance from tracks and other clearing or dumping
- The potential for natural or assisted regeneration

The scale consists of six (6) rating levels as outlined below in Table 1.

Table 1 Vegetation condition rating scale (Keighery 1994)

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



References

Keighery, B, 1994 *Bushland Plant Survey: a guide to plant community survey for the community*, Wildflower Society of WA, Perth, Western Australia.



Baigup Reserve Example Vegetation Transect Monitoring Sheet									
Date:					Transect #				
					Location:				
Observers:									
Point A	Latitude/ Easting:				Longitude/ Northing:			Photo #	
Point B	Latitude/ Easting:				Longitude/ Northing:			Photo #	
Panorama photos from Point A									
Photographers name/camera									
Vegetation Condition (circle)		<i>Pristine (1) Excellent (2) Very Good (3) Good (4) Degraded (5) Completely Degraded (6)</i>							
Vegetation condition (comments)									
Slope (circle)	Flat	Gentle	Steep	Aspect (circle)		N NE E SE S SW W NW NA			
Landform	Upland	Lowland		Drainage		Well	Moderate	Poor	
Soil	Sand	Loamy sand	Sandy loam	Loam	Clay				
Comments/ observations									
Tree seedling counts									
Water (dry/ waterlogged/ wet)	0m		5m		10m		15m		
	20m		25m		30m		35m		
	40m		45m		50m				

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