LAKE GWELUP RESERVE MANAGEMENT PLAN 2015

Prepared for the City of Stirling by

ecoscape

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Rev.	Author	Approved	Date
Draft Rev 0	MM	BT	May 2014
Draft Rev 1	MM	BT	June 2014
Draft Rev2	MM	BT	July 2014
Draft Rev 3	MM	BT	September 2014
Draft Rev4	MM	BT	November 2014
Draft Rev 5	MM	BT	January 2015
Draft Final	MM	BT	March 2015
Final	MM	BT	April 2015
Final Rev1	LA	LA	April 2015

ACKNOWLEDGEMENTS

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SUMMARY

Lake Gwelup Reserve (the Reserve) is a 75 hectare multi-purpose reserve consisting of wetland, bushland and recreation parkland. The previous 2005 Environmental Management Plan for Lake Gwelup Reserve has been revised and updated to align it with current local and regional issues. The aim of the revised EMP is to provide a five year framework that identifies and conserves ecologically sensitive areas and manages compatible recreational activities in parklands adjacent to the natural areas.

Physical Environment

Lake Gwelup Reserve is part of a north-south trending interdunal depression (or swale) that runs virtually parallel to the coast, in the Spearwood dune system. The peat soil type surrounding and within Lake Gwelup and in the freeway drain is rated High to Moderate Risk in Potential Acid Sulphate Soils.

The study area is characterised by a mild Mediterranean type climate with hot dry summers and mild wet winters. Climate patterns have recently slightly differed from the long term averages. In general, winter months have become slightly drier and summer months slightly wetter and mean temperatures have been around 0.5^{o} C higher.

Lake Gwelup has dried three times between 1921 and 2001, however since then has dried each year, except for the summer of 2013-14. This lake level decline has been consistent with declining rainfall and increased use of groundwater. Lakes need to remain saturated (i.e. at a minimum of 0.5m below the bed surface level) to maintain sediment processes and reduce risk of lake acidification (Froend *et al*. 2004). There are currently no Ministerial conditions in regards to maintaining the water levels in Lake Gwelup.

Groundwater level monitoring near Lake Gwelup has indicated a general decline since the 1970s. Data from Yesertener (2008) infers that groundwater abstraction, not reduced rainfall, is the main factor of the groundwater level decline at Lake Gwelup. It should be noted that the Lake was historically ephemeral and only became permanent as a result of urbanisation.

The water is currently neutral and fresh to brackish, however may be trending to be more saline and acidic. There is also a risk of increasing levels of aluminium, arsenic and iron and other pollutants. Possible sources for these include the Bushfield drain and the Kwinana freeway, nearby urban works and the Reserve's historical land for horticultural purposes.

DEC (2011) stated that the Reserve contains three wetlands, two Conservation Category and one Multiple Use. One of the Conservation Category wetlands is likely to be an error in aerial interpretation as it is located on a sporting field and needs to have its status revised. The wetlands also have regional significance as they are part of the few remaining areas in the metropolitan region containing a significant area of remnant native wetland vegetation.

Biological Environment

A total of three Heddle et al (1980) vegetation complexes are known to occur in the Reserve – Herdsmen, Cottesloe Central and South and Karrakatta Central and South. Six local vegetation communities were mapped and described, their composition and distributions are largely the result of topography and hydrology forming wetland, transition and dryland areas.

The Reserve is listed as a Bush Forever site and is considered to be regionally significant, particularly as it supports an array of local and migratory wildlife species. The majority of the existing native vegetation is in a degraded condition, as a result of previous and current land uses, frequent fires, weed invasion and recreational activities.

A total of 112 native flora species have been recorded in the Reserve, this list is not exhaustive. Spring surveys are required to expand this inventory to identify fully the flora diversity. There were no State or Commonwealth listed threatened flora species known to occur in the area. A total of three State priority listed flora may occur in the Reserve, however only *Jacksonia sericea* has been confirmed. The City's (2013b) Flora database lists eight flora species that are regionally significant, seven of which are orchids. *Eucalyptus gomphocephala* (Tuart) and *Schoenoplectus validus* (Lake Club-rush) are also generally regarded as important in the Perth area as they provide valuable native fauna habitat but their distributions are in decline.

A total of 70 weed species have been recorded as being present in Reserve, including three non-indigenous native tree species. A total of 28 weed species were determined to be high priority to control, based on State and Federal listings, environmental ratings and local significance. The City has been mapping the populations of several of these species. Populations of Perennial Veldt Grass have been reported to be resistant to grass specific herbicides, making their management more difficult.

There was a total of 100 native bird species identified as likely to occur in the local area of the study area. Six of these species have some level of conservation significance, including Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*). Only one native mammal, the Western Grey Kangaroo (*Macropus fuliginosus*) has been officially recorded in Lake Gwelup Reserve in the last two decades. . It is also partly due to the loss of habitat due to weed invasion, fires and inappropriate land use and recreational activities. Locals have reported Dugites (*Pseudonaja affinis*) and Tiger Snakes (*Notechis scutatus*) as being common (Dames and Moore 1984). The site is likely to contain a suite of common reptiles such as skinks and dragon lizards. Oblong Turtle *(Chelodina colliei*, previously known as *C. oblonga*) is the only turtle species recorded in the local area. A total of 14 frog species are highly likely to occur within the Reserve. Appropriate survey techniques are required to confirm their presence. A total of 18 Scheduled or Priority Fauna species are known or likely to be present or visit the Reserve.

Several feral fauna species have been identified or historically recorded in Lake Gwelup, including European Red Fox (*Vulpes vulpes*), Rabbit (*Oryctolagus cuniculus*), rodents, feral birds and European Honeybees (*Apis mellifera*). Some native species have greatly increased in population size as a result of European settlement and have become overabundant, including the Australian Raven (*Corvus coronoides*). Other species that have not previously been recorded in Lake Gwelup, but are likely to be present in the future are Western Corella (*Cacatua pastinator*) and Rainbow Lorikeet (*Trichoglossus haematodus*). Local midge species breed in the wetlands and occasionally populations increase to become a nuisance to local residence, such as in 2013.

Bougher *et al* (2008) compiled a fungi inventory from surveys of the northern bushland areas and of Lake Gwelup Bush Forever site. A total of 54 species were recorded, mostly from the decomposer genera *Bovisrta, Clitocybe* and *Pluteus*. Many more species are expected to be present, including underground native truffles.

No pathogenic fungi have been identified in the Reserve, other than the weak pathogen *Omphalotus nififormis* (Ghost Fungus) (Bougher et al 2008). The fungus *Coprinopsis* cf. *stangliana* has been introduced in degraded sections of the reserve. There are three main fungi diseases that, if introduced, threaten the natural values of Lake Gwelup – Dieback (*Phytophthora cinnamomi*), Honey Fungus (*Armillaria luteobubalbina*) and Aerial Canker. All of the City's Natural Areas staff have completed environmental specific training which includes identifying the differing forms of dieback. All staff and contractors follow hygiene procedures via the City's disease management process flowchart (Process ID IPRN13.0).

Lake Gwelup has a history of fires frequently being deliberately lit. A Fire and Emergency Service Authority (2010) *Type 3 Bush Fire Hazard Assessment* determined that approximately 32% of the Reserve was rated

as an Extreme Risk, as a result of dense vegetation structure (fuel load), close proximity to residential housing and general ground slope. Lake Gwelup Reserve is hottest, driest and windiest in summer (Bureau of Meteorology 2010). This time of year is considered high risk for bushfires, as the vegetation and ground litter has dried, increasing ignition risk.

Social Environment

Lake Gwelup Reserve is an important place for the local community. The Reserve's natural environment offers a vital element in defining the identity of Gwelup and has the potential to set a benchmark for the integration of community public open space, nature reserves and recreational facilities within the Perth Metropolitan Area and the Swan Coastal Plain. The Reserve is known to have local Aboriginal history and European significance, although more research is required to learn of the area's unique history. The Reserve is popular for a range of recreational activities. Parts are used actively for sports, such as cricket and football. Other parts are used recreationally, including dog walking, picnicking and bird watching.

Lake Gwelup Reserve contains approximately 5 km of formal paths, boardwalks and bridges. The paths form part of the City of Stirling's 'Bushlinks' Walk Trail (North-Western Zone), an urban walking route linking major bushlands within the City of Stirling that provide a planned and easy access to urban bushlands so that these areas can be better appreciated and valued for their natural attributes. The Reserve is effectively bounded on all sides by a network of designated cycle paths which form part of the Bikewest cycleway system. The Reserve also has 2.8 km of informal paths, which may have resulted from poor wayfinding, more direct route opportunities, poor visual surveillance and a desire by the public to be closer to natural areas.

Car parking at Lake Gwelup is generally informal and located at minor entry points or on the side of the road. There is one main car park located at the Scout Hall on the western edge of the Reserve, to cater for the facilities located in this main node. The car park has limited spaces and poor circulation. The turf areas north of the tennis courts are used for overflow parking during events held at the Reserve.

Lake Gwelup Reserve also has a number of structures and a number of recreational amenities including a Scout hall, playground, boardwalk and viewing deck, rotunda, tennis courts, cricket pitch, cricket nets and a sporting field. All are in various states of access, condition and appearance. The Reserve has a number of bench seats throughout the Reserve, however they are unevenly distributed and often lack shade.

There has been much negative impact on the Reserve by the public, such as deliberately lit fires, allowing dogs to run through the bushland and wetland, graffiti and wilful damage, bike riding through bushlands, picking of wildflowers, rubbish dumping and proliferation of adult cubbies. This has resulted in the degradation of vegetation, death of local native wildlife, introduction of weeds and downgrading natural amenity.

Management Strategy

A three tiered hierarchy of management areas is used as the basis for planning in this management plan. These are (from broadest to most specific):

- **Land Use** - a management framework at a conceptual level on the basis of broadly identifying the Reserve's main functions
- **Zones** - a basis for developing management strategies on the basis of areas defined by relatively uniform management practices
- **Sites** - a basis for detailed planning of areas targeted for specific works.

The Reserve was broadly separated into two Land Uses functions, Conservation and Recreation. The Conservation Land Use was further separated into three Zones based on vegetation type (Wetland, Transition and Bushland). The Recreation Land Use was separated into two Zones based on intensity of

use (Sporting, Recreation). Each of these Zones can be further separated by considering their physical, biological and social environment specific attributes and issues to developed specific and detailed works (e.g. hydrology, high priority weeds, recreational activity). A list of criteria has been provided to assist in determining the issues and attributes in order to separate the Zones into Sites.

The Reserve needs effective management to improve its conservation values, particularly biodiversity and ecological communities. The following Management Plan recommends site management works which include weed management, revegetation, controlling feral animals, improving native fauna habitat, minimising risk of introducing plant diseases and fire management.

A City representative commented that "*Negative changes in society are being reflected in Perth's bushlands*" (Taylor pers comm.). The following Management Plan incorporates strategies to help reverse the impacts of negative social activities and promote the local community's sense of place, such as improving recreational amenities and infrastructure and creating an education and interpretation walk trail.

A total of 73 management recommendations have been made in this report, which are summarised in **Table 1**.

Table 1: Management recommendations for Lake Gwelup Reserve

No.	Management Recommendation	Priority	Responsible Party
1	**Hydrology**		
1.01	Continue to monitor wetland water levels.	High	City
1.02	Revegetate the transition area with appropriate local native species that can tolerate a range of soil moisture levels to account for any future lowering of the water levels	High	City
1.03	Meet with Water Corporation to discuss the implications of their 22 production bores east of the Reserve in the Gwelup Bore Field and the options available for management of the Lake Gwelup.	High	City
1.04	Intensively establish native reeds/ rushes on embankments of Brushfield Way drain and small basin at eastern end and mulch these areas to contain the leaching of acids and iron sulphides into the water	High	City
1.05	Liaise with Water Corporation & DER to remediate the Delawney drain and reduce the acidity and pollutants being released into Lake Gwelup.	High	City
1.06	Investigate whether GPTs, bioretention basins or other water quality improvement device should be installed on drains directly or indirectly discharging into Lake Gwelup	High	City
1.07	Submit an application to DPaW that Wetland UFI 8176 have its CCQ classification changed from Conservation to Multiple Use.	Moderate	City
2.	**Acid Sulphate Soils**		
2.01	Ensure that any future works around and within the wetland do not disturb any potential or actual acid sulphate soils	High	City
2.02	Continue to monitor ground and wetland water levels and determine if it exposes any acid sulphate soils	High	City
3.	**Weed Control**		
3.01	Survey Reserve to determine full weed species inventory and map high priority weed populations to assist with weed strategy	Moderate	City
3.02	Implement site weed control strategy, focusing first on conserving best condition woodland sections, then proceeding into areas of lower bushland condition.	High	City
3.03	Within each section, target high priority weeds first, then proceed to lower priority weed species,	High	City
3.04	Use Lake Gwelup Weed Manager spread sheet to direct site works according to growth form and optimal control times and methods.	High	City
3.05	Consider alternative control methods to control herbicide resistant populations of Perennial Veldt Grass.	High	City
3.06	Rotate control methods for targeting non-herbicide resistant populations of Perennial Veldt Grass to prevent resistance from occurring.	High	City
3.07	Monitor weed populations to determine success of site works and adapt as necessary	Moderate	City
4.	**Revegetation**		
4.01	Use Lake Gwelup Revegetation Species Selector spread sheet to select appropriate local native species that suit local site conditions and land use in revegetation works	High	City
4.02	Revegetate parts of the parkland that are poorly used, are difficult to manage or near public facilities to improve visual amenity and increase native vegetation cover	Moderate	City
4.03	Use pathways to help delineate and buffer Conservation and Recreation Land Uses	Moderate	City
4.04	Investigate damaged or dying trees and determine whether they can be saved or replaced	Moderate	City
4.05	Promote state and City significant flora in revegetation works. Request Kings Park to be involved in replanting of locally significant spider orchids	High	City
5.	**Fauna and Habitat**		
5.01	Undertake conservation works that help protect and promote federal, state and locally significant fauna	High	City
5.02	Conduct site works to promote a wide range of native fauna habitat and improve the Reserve's role as a greenway in Perth's northern suburbs	Moderate	City
5.03	Investigate how to protect areas known to be breeding grounds for turtles from predation and rehabilitate them to be suitable for breeding.	Moderate	City
5.04	Educate the local public how to avoid snakes, not feed wildlife and not disturb vegetation	Moderate	City
5.05	Investigate whether City officers can be more active in Lake Gwelup Reserve in educating the public about the Dog Local Law, Cat Act and Cat Local Law	High	City
5.06	Develop and implement a community awareness programme outlining the impacts of dogs to the bushland and wetland ecosystems and about dog ownership responsibilities to assist in the conservation of these important areas.	High	City
5.07	Encourage dog owners to have their dogs under effective control in the interest of bushland conservation although no declaration will be made of Lake Gwelup Reserve as a 'dogs on leash' area.	High	City
5.08	Undertake a review of the above approach at the end of 2015 to determine its success or otherwise with the view to the adoption of alternate strategies, if required.	High	City
5.09	Develop and implement a community awareness programme about the Reserve's designation as a cat-exclusion zone under the City's Keeping and Control of Cats Local Law 1999 and the requirements under the Cat Act 2011 (WA).	High	City

No.	Management Recommendation	Priority	Responsible Party
6.	**Feral and Overabundant Fauna**		
6.01	Continue mapping or surveying for pests and to continue employing a professional pest controller to control foxes and fumigate fox dens and beehives in all reserves using appropriate control methods	High	City
6.02	Educate the local public in importance of securing bird food from being accessible to rodents	Moderate	City
6.03	Undertake site works aimed improving incoming water quality to include stripping of nutrients to reduce likelihood of midge populations increasing	High	City
6.04	Survey and monitor ringbarked trees and employ a qualified arborist to determine cause and treat appropriately.	High	City
7.	**Plant Disease**		
7.01	Continue to ensure all ground staff and contractors are informed and conduct adequate hygiene measures to minimise risk of introducing plant diseases to the Reserve	High	City
7.02	Educate public on risks of introducing plant disease and how they may assist in minimising the risk	Moderate	City
7.03	Continue to train the City's staff in plant disease identification and the City's dieback procedure flowchart	High	City
7.04	Investigate removal of known dieback infested trees occurring adjacent to Lake Gwelup Reserve.	High	City
8.	**Fire Management**		
8.01	Prevent fire occurrence and impact by reducing ignitable materials and fuel loads, educating the local community and regularly liaising with DFES	High	City
8.02	Ensure that revegetation activities should not increase an area's fire risk hazard rating and should consider fire retardant flora	Moderate	City
8.03	Conduct post fire recovery actions including investigating cause of fire, restricting access to burnt areas, rescuing any injured fauna and conducting appropriate revegetation and weed control activities	High	City, DFES, DPaW
9.	**Heritage**		
9.01	Involve relevant City officers responsible for indigenous, social and cultural heritage in collaborative work with local Aboriginal Groups and elders in the development of interpretative elements including signage, artworks and nature based play elements.	Moderate	City
9.02	Promote local native flora and fauna that have Aboriginal cultural significance as a means of promoting the natural heritage values of the Reserve.	Moderate	City
9.03	Develop and implement a Wayfinding and Interpretation Plan for the foreshore to facilitate a co-ordinated plan for interpretation and education.	High	City
9.04	Review and liaise with local community groups and historians to develop interpretative themes and elements including signage, artworks and nature based play elements.	Moderate	City
10.	**Access and Infrastructure**		
10.01	Prepare a detailed Landscape Master Plan and costing to guide the upgrade of the Reserve's facilities, amenities and fencing on a stage by stage basis.	High	City
10.02	Undertake a review of the existing car parks to ensure they meet standards and safety requirements.	High	City
10.03	Assess access points for equal access and ensure adequate access is achieved at regular locations by all users.	High	City
10.04	Investigate and assess feasibility of access opportunities at key locations to cater for large maintenance/ works vehicles.	High	City
10.05	Conduct an audit of existing facilities, amenities and fencing to assess safety compliance, condition and accessibility.	High	City
10.06	Ensure all amenities are complementary in colour and style and blend in with the natural environment.	Moderate	City
10.07	Investigate feasibility of a mobile kiosk/ café operating within the reserve.	Moderate	City
10.08	Investigate at further date the possibility, type and location of a youth node in or near Lake Gwelup Reserve. Involve public consultation.	High	City
11.	**Education and Interpretation**		
11.01	Conduct an audit of existing directional, informative and interpretive signage assessing style, format, location, safety compliance and condition.	High	City
11.02	Research and develop strong themes for interpretation based on the social, cultural and environmental complexities of the site.	High	City
11.03	Develop and implement a Way-finding and Interpretation Plan for the Reserve to facilitate a co-ordinated plan for interpretation and education. This plan should also address digital methods of communication as well as physical signage.	High	City
11.04	Establish an Eco-news column in the local paper to raise awareness about the environment.	Low	City
11.05	Provide opportunities for the Scouts groups and local primary school to hold educational programs within the Reserve, through science, art and cultural projects.	Low	City
12.	**Community Involvement**		
12.01	Involve the community and local businesses in management of the Reserve where possible. Always reinforce community 'ownership' in this respect.	Moderate	City
12.02	Involve school groups, Scout groups and the local community in educational activities in the natural areas of the site including stencilling projects, signs, media and holiday recreation programs.	Moderate	City
12.03	Continue support for the reformation and involvement of a local friends group to assist the City with environmental monitoring and conservation work.	Moderate	City

No.	Management Recommendation	Priority	Responsible Party
12.04	Provide bushland regeneration courses to interested members of the public who actively commit more than 40 hours per annum to bushland and wetland maintenance.	Low	City
12.05	Review the role, status and use of the scout hall and if appropriate assess opportunities for multiple users.	Moderate	City
13.	**Maintenance**		
13.01	Prepare a detailed Landscape Master Plan and costing to assist in planning for: • sign posting of dog owner control and responsibilities • location of rubbish stations • access restrictions including BMX access • identify maintenance access • hierarchy of all signs • bushland firebreaks • pedestrian access tracks and trails.	High	City
13.02	Review and consolidate turf areas to sporting recreation areas only.	High	City
13.03	Undertake regular inspections of infrastructure and repair or replace where necessary.	High	City
13.04	Investigate the storm drain next to Lagonda St to prevent it depositing sand on the adjacent footpath in future heavy rainfall events.	Moderate	City
13.05	Involve the community in litter collection through the Clean-Up Australia Day.	Moderate	City
13.06	Investigate the feasibility of providing syringe disposal at key locations if the incidence of carelessly discarded needles is high.	High	City
13.07	Prepare and implement a Water Conservation Plan for the Reserve, detailing hydro zoning and eco zoning strategies to assess and monitor the watering requirements for the Reserve.	High	City
13.08	Repair all damaged facilities immediately after any act of vandalism to discourage vandals.	High	City
13.09	Remove graffiti and repair damage to infrastructure as soon as possible after it occurs to discourage graffitists.	Low	City
13.10	Encourage the community to report anti-social and destructive behaviour to the police and council authorities.	Low	City

1.0 INTRODUCTION

1.1 BACKGROUND

Lake Gwelup Reserve (the Reserve) is a 75 hectare area comprising of open water, wetland and bushland. The central feature is a 26 ha wetland. The Bush Forever Reserve has significant native flora, such as *Jacksonia sericea* (Priority 4). It is also home to a wide range of native fauna species, including migratory birds. The Reserve is known to have local Aboriginal and European history, and is used for both sporting and recreational activities.

The City commissioned Ecoscape to develop an Environmental Management Plan (EMP) for the Reserve in 2005, however this is now outdated. The 2015 EMP is an update of the previous 2005 EMP and provides a management framework for the next 5 years.

1.2 STUDY AREA

Lake Gwelup Reserve, is located approximately 11 km north west of the Perth CBD in the suburb of Karrinyup. It is bounded in the south by Segrave Street, to the east by North Beach Road, Lagonda Drive and Wanstead Street, to the north by the Lake Karrinyup Golf Club and to the west partly by Huntriss Road and partly by residences along Finnerty Street that back on to the reserve (**Figure 1**).

The reserve covers 75 hectares, of which 18 hectares is occupied by semi-permanent open water, 35 hectares remains remnant vegetation and 20 hectares is parkland.

1.3 AIMS AND OBJECTIVES

The aim of the revised EMP is to provide a five year framework that identifies and conserves ecologically sensitive areas and manages compatible recreational activities in adjacent parklands.

The objectives are to:

- explore opportunities to enhance education to the public
- retain the area's unique sense of place
- provide an assessment of all attributes and values of the reserve (including biophysical, social, cultural, recreational, educational and heritage)
- ensure the protection, conservation and enhancement of ecologically sensitive areas
- consider how public enjoyment and compatible recreational use can be optimised by improvements/ upgrading without compromising ecologically sensitive areas
- reinforce the reserve's regional significance
- focus on ecological sustainability
- protect, enhance and manage all assets and values, both physical and natural
- incorporate integrated catchment management principles
- balance between conservation and compatible forms of recreation
- engage with the community in conservation planning and site management
- inform/ educate the community on conservation issues to solicit support for management measures taken.

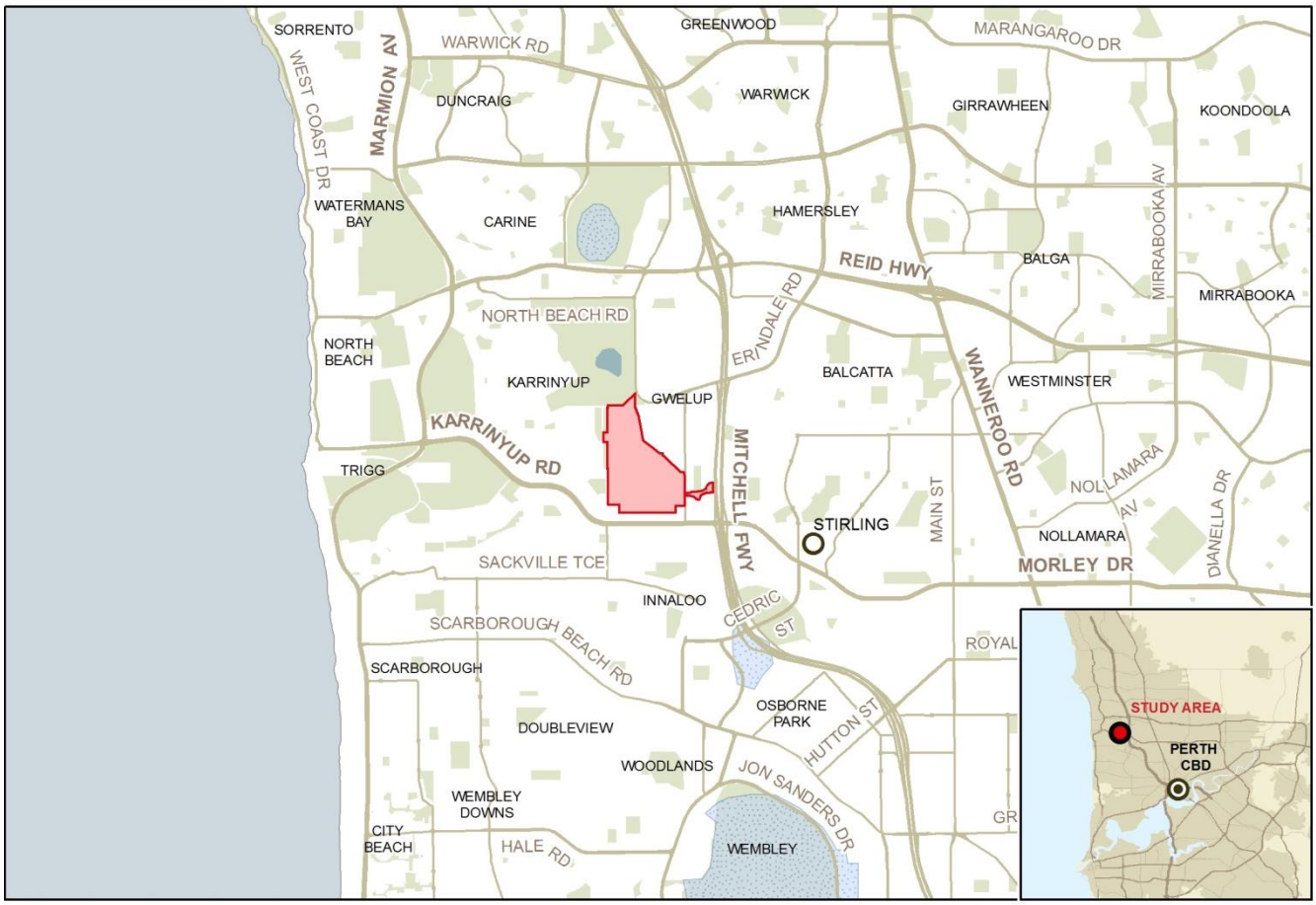

Figure 1: Study area location

2.0 PLANNING AND TENURE

2.1 FEDERAL GOVERNMENT

2.1.1 Policies and Documents

***Weed of National Significance* (WONS) (Weeds Australia 2012)**

This is a joint initiative between the Australian, State and Territory governments to coordinate national efforts against Australia's worst invasive weed species. A list of declared weeds was developed, according to each species invasiveness, impacts, potential for spread and socioeconomic and environmental values.

2.2 STATE GOVERNMENT

2.2.1 Policies and Documents

Department of Agriculture and Food (2013) Biosecurity and Agriculture Management Act (BAM)

The BAM Act lists species of plants not native to Western Australia that are known to be a significant threat to the environment. It replaces the 1974 Agricultural and Related Resources Protection Act (ARRPA). Under the BAM Act 2007, all declared pests are placed in one of three categories:

- C1 Category (Exclusion) – Pests not established in Western Australia. Control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
- C2 Category (Eradication) – Pests present in Western Australia in low enough numbers or sufficiently limited areas that their eradication is still a possibility.
- C3 Category (Management) – Pests established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage.

The Western Australian Environmental Protection Act (1986)

This Act provides authority to the Environmental Protection Authority (EPA) for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing in Western Australia.

The Wildlife Conservation Act (1950)

The Wildlife Conservation Act 1950 is an act of the Western Australian Parliament that provides the statute relating to conservation and legal protection of state native flora and fauna. The Act is supplemented periodically by Notices, which are lists of species subject to protection under the Act. The lists are arranged in Schedules according to level of vulnerability:

- Schedule 1 is "Fauna that is rare or is likely to become extinct" or "Extant [flora] taxa";
- Schedule 2 is "Fauna presumed to be extinct" or [Flora] "Taxa presumed to be extinct".

Department of Conservation and Environment (1983) Conservation Reserves for Western Australia – System 6

The System 6 Conservation Reserve System developed by the Department of Conservation and Environment (1983) was the precursor of the Bush Forever System. The DCE stated that at Lake Gwelup Reserve (Site M39):

The lake is deep and permanent, supporting a good variety of water-birds and is important as a drought refuge and some species are known to breed on the lake. Much of the vegetation around the lake is regenerating and it is important that this process should continue. Important management considerations for the area include: encouraging the growth and regeneration of local indigenous flora; preservation of the landscape; maintaining the habitat for water-birds; except in Reserves C13158 and C33116, allowing only those recreation activities compatible with the conservation of flora and fauna; and the area's location within the Gwelup Public Water Supply Area.

The following recommendation was made for this site:

1. That the Metropolitan Region Planning Authority and the Stirling City Council, in consultation with the Department of Conservation and Environment, prepare a management plan for the area.

This recommendation was implemented.

Environmental Protection Authority Environmental Protection Policy (Environmental Protection Authority 1992)(EPP) for Swan Coastal Plain Lakes (1992)

The wetlands in Lake Gwelup Reserve are identified as an EPP Lake in Miscellaneous Plan No. 1815. As such it is an offence to fill, drain, excavate, pollute or clear any lakes identified without the authorisation of the EPA.

Government of Western Australia Bushfires Act (1954)

The State Act is to make better provision for diminishing the dangers resulting from bush fires, for the prevention, control and extinguishment of bush fires.

Government of Western Australia Aboriginal Heritage Act (1972)

Aboriginal Sites, regardless of whether they are registered or not, are protected under the Aboriginal Heritage Act (1972):

- Section 5 of the Act defines sites as places of importance where objects connected with traditional life have been left, stored or taken from; ceremonies have been conducted; some ethnographic interest
- Section 15 of the Act requires that findings be reported
- Section 17 of the Act makes it an offence to excavate, destroy, damage, conceal or in any way alter any Aboriginal site
- Section 18 of the Act establishes the conditions for certain uses of land affected by the Act.

There are two known registered aboriginal sites recorded within Lake Gwelup Reserve.

Swan Natural Resource Management (2008b) DEC Swan Region – Environmental Weed List: Environmental Weed Census and Prioritisation (EWCP)

The Swan Natural Resource Management (2008) *Environmental Weed Census and Prioritisation* (EWCP) rates weeds species as a threat in Perth bushland conditions. A total of eight ratings are used, according to the risk each species poses to environmental assets in the region, based on invasiveness, ecological impact, current and potential distribution, and thus priority for management

Western Australian Local Government Association (2004) Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region

These guidelines are designed to provide Local Governments and their communities with a clear picture of where the Perth Metropolitan Region is positioned in regards to its biodiversity resource and values. These guidelines provide a four-phase local biodiversity planning process culminating in the preparation and implementation of a Local Biodiversity Strategy to assist Local Governments to:

- determine the protection status of all Locally Significant Natural Areas (LSNAs);
- formalise policies and processes to ensure biodiversity considerations are integrated into their assessment of development proposals and construction activities;
- develop and provide incentives to encourage private land conservation; and
- plan for the management of local reserves and other Local Government lands to conserve biodiversity.

The guidelines and resulting strategies focus on Local Natural Areas and other natural areas that occur within Local Government reserves. Local Natural Areas are natural areas that exist outside of Bush Forever Sites and the Department of Conservation and Land Management (CALM) Managed Estate and Regional Parks. A key focus is to protect the more common natural areas rather than the rare and threatened.

Western Australian Planning Commission (2000a) Bush Forever

Bush Forever replaces the System 6 recommendations as a blueprint for conservation of bushland of regional significance in the Perth Metropolitan Region. Bush Forever was prepared by the Department of Environment Protection, Ministry for Planning, CALM and the Water and Rivers Commission. It was endorsed by Cabinet and supported by the EPA as the principle mechanism to identify and protect regionally significant bushland in the Perth Metropolitan Region. Lake Gwelup Reserve is recorded as being a Bush Forever Site 212 (Lake Gwelup Reserve, Gwelup).

Western Australian Planning Commission (2003) Planning Bulletin 64: Acid Sulphate Soils

Portions of the Reserve are mapped as having a high risk of actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS) at less than 3m from the surface. As such a Preliminary Site Investigation (PSI) is required in accordance with Department of Environment Guidelines if:

- any dewatering works are proposed
- greater than or equal to 100 m3 is proposed to be excavated where the surface level is less than or equal to 5m AHD
- more than or equal to 100 m3 is proposed to be excavated where surface elevation is greater than 5m AHD and the depth of excavation is greater than or equal to 2m.

Western Australian Planning Commission (2004) Biodiversity Planning Guidelines.

These guidelines are designed to provide Local Governments and their communities with a clear picture of where the Perth Metropolitan Region is positioned in regards to its biodiversity resource and values. These guidelines provide a four-phase local biodiversity planning process culminating in the preparation and implementation of a Local Biodiversity Strategy to assist Local Governments to:

- determine the protection status of all Locally Significant Natural Areas (LSNAs)
- formalise policies and processes to ensure biodiversity considerations are integrated into their assessment of development proposals and construction activities
- develop and provide incentives to encourage private land conservation
- plan for the management of local reserves and other Local Government lands to conserve biodiversity.

The guidelines and resulting strategies focus on Local Natural Areas and other natural areas that occur within Local Government reserves. Local Natural Areas are natural areas that exist outside of Bush Forever

Sites and the CALM Managed Estate and Regional Parks. A key focus is to protect the more common natural areas rather than the rare and threatened.

Western Australian Planning Commission (2010) Policy 2.8: Bushland Policy for the Perth Metropolitan region (Draft)

The Reserve is classed as a significant conservation site under the Western Australian Planning Commission (2010) Policy 2.8: Bushland Policy for the Perth Metropolitan region (Draft).

2.3 LOCAL GOVERNMENT

2.3.1 Land Tenure and Vesting

The reserve is totally vested in the City of Stirling for the purpose of conservation, landscape protection and recreation. Prior to 1992 significant portions were managed by the then Metropolitan Regional Planning Authority.

2.3.2 Policies and Documents

Ecoscape (2005) Lake Gwelup Reserve Management Plan

Ecoscape prepared a five year for Lake Gwelup for the City of Stirling in 2005. The plan established a management framework at a conceptual level on the basis of broadly identifying appropriate land uses as well as identifying smaller areas requiring specific management strategies. A large number of issues were taken into account in developing the plan including: EPA restrictions on modifying Lake Gwelup; increasing urbanisation in the vicinity; Aboriginal sites; acid sulphate soils and changes in hydrology. It replaces the previous Halpern Glick Maunsell (1992) *Management Plan for Lake Gwelup*.

City of Stirling (2010) Local Biodiversity Strategy

The Local Biodiversity Strategy is a plan for the protection and management of natural areas within the City of Stirling on public and private lands regardless of land tenure. It adopts a comprehensive approach to the assessment of biodiversity condition in bushlands, wetlands, coastal dunes and other natural areas and develops site specific conservation programmes aimed at improving biodiversity. Quite importantly it advocates strengthened legislative mechanisms to ensure that these areas are protected from future threats and disturbances and loss of biodiversity values.

City of Stirling (2008a) Public Open Space Strategy

The City contains around 50 sports reserves and over 400 parks. The City's public open space strategy (POS) is to develop and manage these areas, including Lake Gwelup Reserve, to satisfy current and future recreational needs in an equitable and sustainable manner

City of Stirling (2002) Green Plan 2

Green Plan 2 is a strategy to conserve regionally as well as locally significant areas of native bushland within the City of Stirling. The strategy aims to ensure the long-term sustainability of these areas by a system of management based on detailed on-site assessment of conservation needs and prescriptions assigned to bushland categories. Under Green Plan 2, Lake Gwelup Reserve is classified as a Group B reserve that is only partially occupied by bushland. These reserves are considered strategic to the ecological linking with Group A reserves. Further planting was recommended wherever possible on developed parkland and bushland areas of Group B reserves such as Lake Gwelup Reserve.

City of Stirling (2008b) Water Smart Parks Strategy

The City has developed a water wise strategy to reduce the impact on groundwater supplies. The strategy involves using appropriate water techniques in its parks and reserves to ensure the recreational areas are fit for purpose with minimal water use. The plan discusses the use of categorising parks and reserves into "hydrozones" and "ecozones" to help direct watering requirements.

City of Stirling (2009) Local Government Property Local Law

The Local Government Property Local Law ensures the protection of local assets by the removal of biohazards through the removal of weeds and overhanging trees/limbs. Additionally, the maintenance of firebreaks ensures property and local areas are protected. Under this local law, the lighting of fires is prohibited unless a permit has been obtained for special purposes (e.g. for a BBQ).

2.4 VESTING AND CADASTRES

The majority of Lake Gwelup is owned by the State of WA (Department of Lands) and management is vested with the City of Stirling for the purposes of Recreation. However, the Reserve is composed of multiple cadastres, some are managed by different agencies and/or for different purposes. The vesting details are summarised in **Table 2**.

Table 2: Vesting and management purposes of Lake Gwelup Reserve

Reserve No.	Lot	Property name	Responsible Agency	Managed/ Vested and Purple
-	6, 7, 8		Water Corporation (Head Office)	
-	42833	Settlers Green Reserve	State of WA (Department of Lands)	COS to purpose, Recreation and Drainage
31538	8694	Lake Gwelup Reserve	State of WA (Department of Lands)	COS to purpose, Recreation
33116	9185	Seagrave Reserve	State of WA (Department of Lands)	COS to purpose, Recreation
33142	9201	Lake Gwelup Reserve	State of WA (Department of Lands)	COS to purpose, Recreation
34266	9507, 9754	Lake Gwelup Reserve	State of WA (Department of Lands)	COS to purpose, Recreation
36776	10094	Lake Gwelup Reserve	State of WA (Department of Lands)	COS to purpose, Recreation
42833	12214	Brushfield Reserve	State of WA (Department of Lands)	COS to purpose, Recreation and Drainage
46329	13988, 9951, 100, 9951	Lake Gwelup Reserve	State of WA (Department of Lands)	COS to purpose, Landscape Protection and Recreation NEC
46359	13998	Lake Gwelup Reserve	State of WA (Department of Lands)	COS to purpose, Recreation
49863	500, 501	Brushfield Reserve	State of WA (Department of Lands)	COS to purpose, Recreation

3.0 PHYSICAL ENVIRONMENT

3.1 CLIMATE

3.1.1 Temperature and Rainfall

The study area is characterised by a mild Mediterranean type climate with hot dry summers and mild wet winters. The climate varies seasonally, with rainfall, temperature and winds following a well-defined annual cycle. The majority of the rainfall occurs in the winter months with 90% falling between April and October.

Historic temperature records from the Perth Metropolitan weather station, located approximately 9 km north-west of the study area, indicate that lowest temperatures are in July with an average daily minimum and maximum temperature of approximately 7.7 °C and 18.4 °C, respectively. The highest temperatures occur in February with an average daily minimum and maximum temperatures of 18.3 °C and 31.6 °C, respectively. The mean annual rainfall is 729.4 mm. Mean summer rainfall is minimal, between 8.5 and 16 mm. The amount of rainfall begins to increase in May and is highest in July with 146.4 mm, before beginning to decline in September (**Figure 2**).

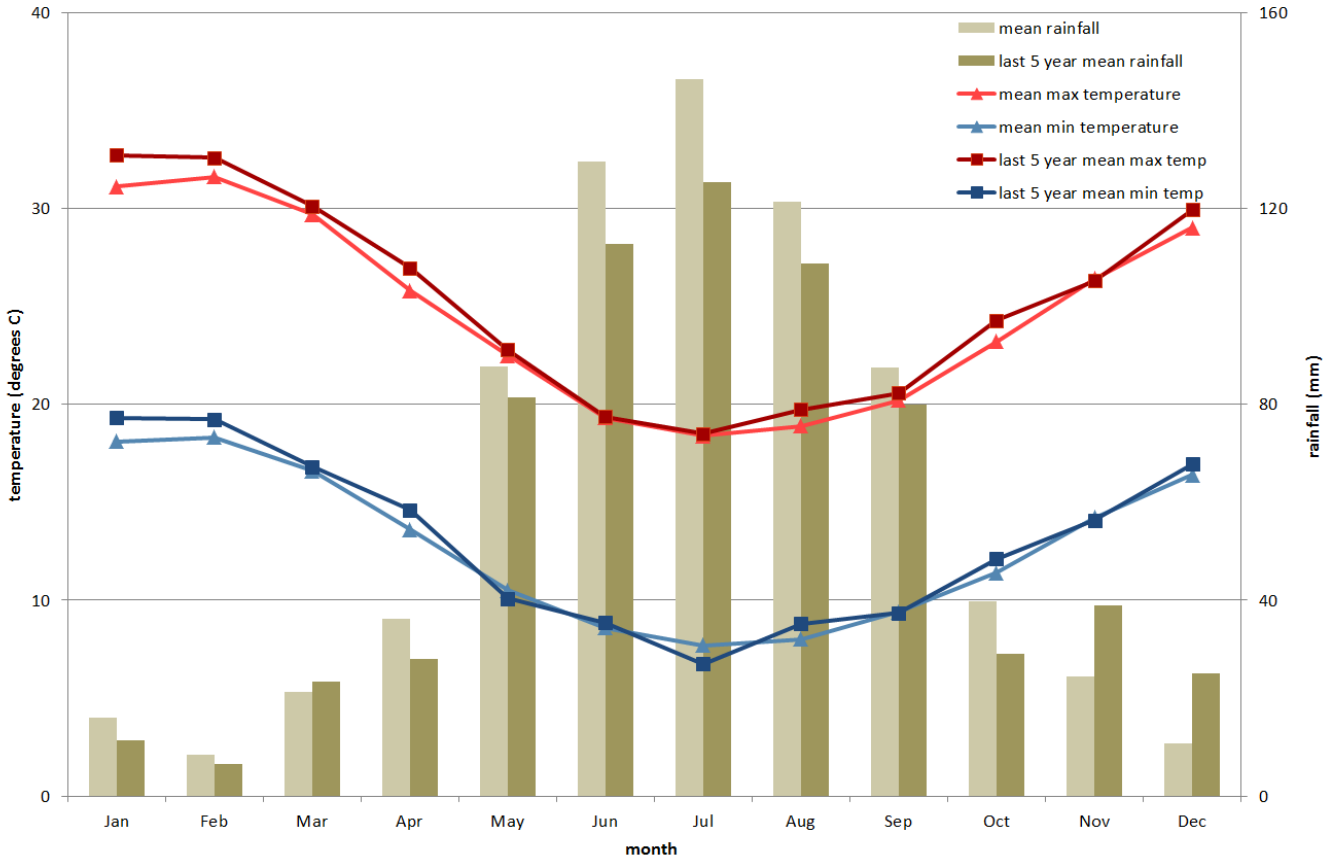

Figure 2: Mean and recent temperature and rainfall for Perth metropolitan area

3.1.2 Climate Change

Climate patterns have recently slightly differed from the long term averages. Over the last five years the mean minimum and maximum temperature have increased by 0.3 °C and 0.6 °C respectively. Mean annual rainfall has decreased by 59.0 mm. In general, winter months have become slightly drier and summer months slightly wetter.

3.2 TOPOGRAPHY

Lake Gwelup Reserve is part of a north-south trending interdunal depression (or swale) that runs virtually parallel to the coast, in the Spearwood dune system. Lake Gwelup occupies the lowest area of the reserve at approximately 4m AHD with the land gently rises outwards to a height of approximately 25m AHD in the north west corner and north east (Gobby 1980). The topography of the reserve in illustrated in **Map 1** in **Appendix One**.

3.3 GEOMORPHOLOGY AND SOILS

3.3.1 Landform and Soil

The entire Reserve comprises of Spearwood soils (McArthur & Bettenay 1960; Seddon 1972). The *Spearwood Dune System* are dunes of variable topography mostly occurring slightly inland from the coast. The surface soils have been leached over time, moving the carbonate below, forming layers of hard, compact limestone which has been exposed in placed by erosion. The sands are yellow-brown and still contain an appreciable level of iron.

The soil sub-system immediately surrounding the lake is 211Sp Cps (peaty clay). A section of the dryland along the north east section is 211Sp LS1 (Limestone). The remainder of the Reserve is 211Sp S7 (Sand). The sol subsystems types are further described in **Table 3** and their distribution presented in **Map 2** in **Appendix One**.

Table 3: Soil landscape Subsystems of Lake Gwelup Reserve

Unit	Description
211Sp Cps	Peaty clay – dark grey and black, soft, variable organic content, some quartz sand in places, of lacustrine origin
211Sp LS1	Limestone - light, yellowish brown, fine to coarse grained, sub-angular to well rounded, quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin. Minor heavy minerals
211Sp S7	Sand – pale and olive yellow, medium to coarse grained, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, of residual origin

3.3.2 Acid Sulphate Soils

Acid sulphate soils (ASS) occur in sulphide soils, and often occur in Perth's wetlands. Active ASS (AASS) soils are generally naturally occurring soils containing sulphides that have reacted with oxygen to produce acids. Potential ASS (PASS) contain sulphides that have not reacted with oxygen, usually due to being permanently waterlogged. They produce acids when exposed to air by excavation, filling, creation of artificial water courses, or groundwater abstraction/dewatering.

The impacts associated with acid sulphate soils can be associated with the increase in acidity and/or the release of heavy metals into the environment. This can result in:

- wetlands degradation
- localised reduction in habitat and biodiversity
- deterioration of surface and groundwater quality
- loss of groundwater for irrigation
- increased health risks associated with arsenic and heavy metals contamination in surface and groundwater, and acid dust
- risk of long-term infrastructure damage through corrosion of sub-surface pipes and foundations by acid water

- invasion by acid tolerant water plants and dominance of acid tolerant plankton species causing loss of biodiversity.

The peat soil type (211Sp Cps) surrounding and within Lake Gwelup and in the freeway drain is rated High to Moderate Risk in Potential Acid Sulphate Soils (PASS). The dryland areas of the Reserve is rated No Known Risk. The distribution of PASS is illustrated in **Map 3** in **Appendix One**.

The City is currently managing acid soil risk within its municipality. Information is presented on the City's website **here**.

3.4 HYDROLOGY

3.4.1 Lake Water Levels

The wetlands receive runoff from local City drains as well as from the wider catchment via Water Corporation constructed drains. The main area of inflow is in the southeast zone of the wetland associated with the Brushfield Drain. Brushfield Drain is an open channel on the eastern edge of the Reserve that feeds runoff from the Delawney Drain, which is adjacent to the Mitchell Freeway. An additional drain from Lake Gwelup feeds into the Karrinyup Golf Course when Lake Gwleup is overfull. The locations of the drains and directions of flow are illustrated on **Map 4** in **Appendix One**.

Lake Gwelup has dried three times between 1921 and 2001, however since then has dried each year, except for the summer of 2013-14 and 2014-15. This lake level decline has been consistent with declining rainfall and increased use of groundwater. Lakes need to remain saturated (i.e. at a minimum of 0.5m below the bed surface level) to maintain sediment processes and reduce risk of lake acidification (Froend *et al*. 2004). There are currently no Ministerial conditions in regards to maintaining the water levels in Lake Gwelup.

3.4.2 Irrigation

The south-west corner of the reserve is the only section that is irrigated for the purpose of maintaining turf for sporting recreation. The location of the irrigated area is illustrated on **Map 4** in **Appendix One**.

3.4.3 Groundwater

Groundwater levels

Groundwater level monitoring near Lake Gwelup has indicated a general decline since the 1970s. This is consistent with:

- the commencement of groundwater abstraction from the Gwelup bore field
- declining trend of annual rainfall
- declining groundwater levels in the Gnangara mound which flows into the Gwelup area
- increase in residential development (DoW 2012).

Yesertener (2008) recorded a decline of 3.75m in groundwater levels within a 6 km radius of the Gwelup bore field. Of this, 3.0 m was attributed to regional groundwater abstraction. This data infers that groundwater abstraction, not reduced rainfall, is the main factor of the groundwater level decline at Lake Gwelup.

Groundwater flow

Groundwater around Lake Gwelup generally flows in an east (inland) to west (coast) direction.

Lake Gwelup Capture Zone and Gwelup Bore Field

The Lake Gwelup Capture Zone is located east and up-gradient of the Reserve, extending into a superficial aquifer. The aquifer extends 32-35 m below the lake. Data suggests that the capture zone extends to the middle of the aquifer, but not to the base. Under isotropic conditions, the capture zone is estimated to be twice the width of the lake (approximately 1 km wide).

The Gwelup bore field occurs east of the Reserve. A total of 22 Water Corporation production bores have been installed in the bore field, with another four bores immediately to the east (DOW 2012). The locations of the bores are presented in Figure 3.

Beenyup Wastewater Treatment Plant

The Water Corporation recently received endorsement from the State Government for a wastewater Managed Aquifer Recharger (MAR) program. An advanced secondary treatment plant is to be built in Beenyup to treat domestic wastewater. The treatment plant will be Australia's first groundwater replenishment trial. The waste water will first be treated using ultrafiltration, reverse osmosis and ultraviolet disinfection. The treated water will then be added to an underground aquifer, where it will be further filtered by natural processes to replenish groundwater (Water Corporation 2014). If successful, it will result in more drinking water being available for Perth's residents and may result in groundwater levels not being lowered further or even raised. However, it may take more than a decade before the trails' impacts are known and the recharge may be minor in the Lake Gwelup region, as the treatment plant is not in the locality.

3.4.4 Water Quality

Salinity

Groundwater salinity underneath Lake Gwelup ranges from fresh to marginally brackish. Total dissolved solids (TDS) were greater near the water table than at depths. Groundwater flowing into Lake Gwelup had greater TDS than water flowing out, suggesting an ongoing accumulation of solids. TDS ranges considerably around the lake, from 170-690 mg/L (GLP_Wc) on the western side to 320-1330 mg/L (GLP_Wc) on the eastern side (DOW 2012).

pH

The pH of the groundwater beneath the lake is generally neutral, ranging between 6.5 and 7.5. However, limited bore monitoring has recorded pH between 6.0 and 6.5, which is outside the preferred pH of freshwater ecosystems. More monitoring is required to determine seasonal groundwater level fluctuations (Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand 2000). Groundwater up-gradient of Lake Gwelup is usually neutral (pH 6.5-7), however Bore GWA7 become highly acidic, with recorded pH levels between 2.66 and 3.60 between 2006 and 2010. Bores GWA1, 3 and 5 also recorded pH levels between 4.2 and 5.99 in March 2006. This suggests a high risk of acid input into the lake system (DOW 2012).

Groundwater pH is particularly important for aquatic ecosystems, as the risk of acidification is magnified by changing the speciation of dissolved inorganic carbon, from bicarbonate ions to carbonic acid.

Metals

DOW (2012) determined that levels of aluminium and arsenic in Lake Gwelup are currently considered to not pose a risk to the wetland ecosystem. However, elevated levels of aluminium and arsenic were recorded up-gradient of Lake Gwelup. If the up-gradient ground water becomes more acidic, higher levels of aluminium may be released. Also, the lowering of the water table may also result in further release of arsenic. Some of the contamination of these two toxic metals may migrate into the wetland in the future.

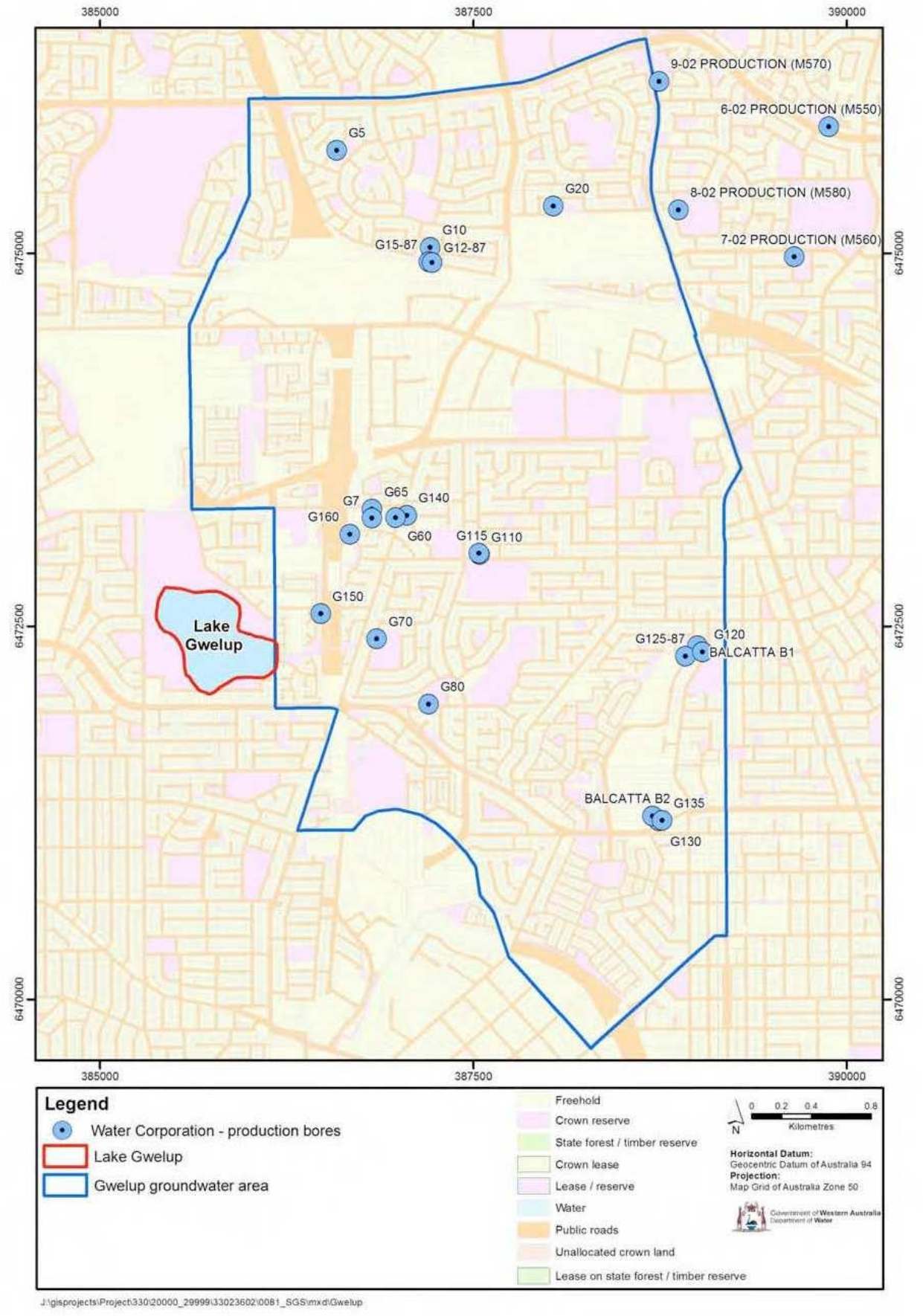

Figure 3: Gwelup Bore Field (borrowed from DOW 2012)

Input contamination

The Delawney drain discharge is highly acidic and contains pollutants from the Kwinana Freeway. In addition to this 11 City local drains deliver inflow either directly into Lake Gwelup or into Brushfield Drain. Of the City drains the majority (seven) are located in the southeast zone, the additional four are to the west and northeast of Lake Gwelup. There are four City drains which indirectly contribute inflow via infiltration through soakwells or sumps. The discharge points of local City drains are summarised below in Table 4. During previous periods where water levels were higher than current levels, water flowed from Lake Gwelup to the north via the Balcatta Drain to Lake Karrinyup and Big Carine Swamp. The locations of the drains and directions of flow are illustrated on **Map 4** in **Appendix One**.

The wetlands also receive runoff from 14 City drains. The run off may be directly into the wetlands, or indirectly via soakwells, sumps or Water Corporation drains, as summarised in Table 4.

Table 4: City drains and discharge points at Lake Gwelup Reserve

Discharge point	Number of Drains
Soakwell	1
Sump	3
Water Corporation Balcatta Branch Drain	1
Water Corporation Delawney Branch Drain	4
Lake Gwelup	7

Several current and historic sources of contamination have been reported formally and anecdotally for the Reserve. Some of the key sources are described below.

1. Water Corporation Drainage

The Water Corporation drains are a significant source of contamination for the Reserve's water. Anecdotal evidence describing some sources of contamination entering via the Brushfield Drain are listed below, these include:

- The body of land bordered by Erindale Road and the Mitchel Freeway has propensity to acidify due to the presence of sulphidic materials. This has led to the acidification of groundwater which flows into Brushfield creek which subsequently discharges into Lake Gwelup. The consequences of this to the Lake environment could be the accumulation of heavy metals and metalloids such as arsenic (Rajah pers comm.)
- There are anecdotal suggestions of a contaminated site near Gwelup Shopping Centre releasing high levels of arsenic into the groundwater which will migrate to the drains. This allegation is currently being investigated and will be further commented up on the final report.

2. City of Stirling Local Drainage

All drains receive water from commercial, residential and roadways, and may contain pollutants from car exhaust, local industry and nutrients from gardens. In the past it was observed that Lake Gwelup used to have occasional occurrences of a large plume of detergent foam entering through the City drainage system. The source was discovered to be originating from the adjacent Gwelup local shopping centre. This situation has recently been resolved through the shopping centre managing their own drainage and mitigating input to the wetland and through on site retention (Woods pers. comm). Of the City local drains two currently have Gross Pollutant Traps (GPTs) installed and two have other water quality traps in place.

3. Groundwater Movement

Urban works in Spoonbill Reserve, located approximately 1.5 km east of Lake Gwelup, have included the excavation of peat, dewatering and construction of an artificial wetland. The activities may not have been managed appropriately and could have resulted in the release of metals including arsenic, aluminium and iron into the groundwater. Some of these metals are may enter Lake Gwelup's water.

4. Sediments

The Reserve has had a long horticultural history, which may have resulted in the wetlands acting as a sink for nutrients. It is possible that the drying of the lake bed from lowering water levels may release sequestered nutrients, resulting in further eutrophication (DOW 2012).

No pesticides or herbicides were detected by DOW (2012). There is no evidence of herbicides or pesticides affecting the quality of the Lake Gwelup groundwater.

3.5 WETLANDS

3.5.1 Existing Wetlands

DEC (2011) states that the Reserve contains three wetlands:

- Lake Gwelup (UFI 8173), approximately 25 ha in size and located in the southern-centre of the Reserve.
- An unnamed dampland (UFI 8176), approximately 3.5 ha in size and located in the southwest corner of the Reserve. It is likely to have been mapped as a wetland in error, as it is situated over a grassy sporting field and has no ecological value.
- An unnamed sumpland (UFI 8171), approximately 1 ha in size and located in along the northern border of the Reserve, overlapping with Lake Karrinyup Golf Club.

The locations of the wetlands are presented in **Map 5** in **Appendix One**.

3.5.2 Wetland Function and Values

Wetlands are one of the most notable features of the Swan Coastal Plain. Apart from channel wetlands (such as rivers and streams), the majority of Swan Coastal Plain wetlands are groundwater dependant in their natural form. These wetlands occur where the ground surface intersects the groundwater table. Due to variations in topography and geomorphology, these wetlands vary from deep, permanent wetlands to shallow seasonal wetlands, through to wetlands with little or no surface water where the water table is at or slightly below the ground surface.

Wetlands perform a number of ecological, hydrological and social functions. Ecologically wetlands provide:

- food webs
- drought refuges for waterbirds
- summer feeding areas for trans-equatorial wading birds
- habitats for plants, animals and communities that are considered to be rare or restricted occurrence or distribution
- limited capacity to assimilate nutrients, pollutants, sediment and litter
- an index of environmental quality (EPA 1993b).

Hydrologically, wetlands also play a flood control function by acting as a compensation or retention basin. The vegetation fringing lakes and wetlands partially act as filters that assimilate nutrients, sediments and pollutants from adjacent land surface runoff (EPA 1993).

Wetlands can play a variety of social functions. There can be historical or archaeological values such as aboriginal sites. There are nature studies, education values and access to wildlife values, such as bird watching. There is also an overall aesthetic consideration to the local community (EPA 1993).

Wetlands in the Swan Coastal Plain have been classified by Hill et al (1996a) as being *Conservation, Resource Enhancement* or *Multiple Use*, according to their functions and attributes. Management priorities for these categories are outlined in **Table 5.**

Table 5: Management categories and objectives and recommendations for change

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

(Hill et al 1996)

UFI 8173 and UFI 8176 are lsited as Conservation Category Wetlands (CCW) . UFI 8171 is listed as an RE wetland.

The recommended separation and management to mitigate potential impacts (threatening processes) for CC W is presented in. These recommended practices are adopted by WAPC (2005) *Draft Guideline for Determination of Wetland Buffer Requirements*. It should be noted that some of the management actions are recommendations and are dependent on local site conditions (e.g. fencing may restrict local fauna).

Table 6: Recommended separation and management for CCWs

Key Threatening Process	Recommended Separation and/or management	Separation area management
Alteration to the water regime	Regulation of groundwater abstraction as catchment management measure	• Area to be vegetated with deep-rooted perennial vegetation • Preferably native plant communities • 6m firebreak minimum, inside of fence • Fence to limit vehicle stock, exotic fauna access • Clear perimeter outside of fence (path, firebreak, road. • Fire control to maintain habitat and species diversity • Minimise track access/clearing, maximise native vegetation • Management for water quality outcomes as required
Habitat modification	• 100 m weed infestation • Up to 100 m for bird habitat dependent on extent of use • 6-50 m firebreak • Fence for controlling exotic fauna access • ≥100 m to minimise edge effects	
Inappropriate recreational use	• ≥50 m to improve aesthetics • ≥50 m for barrier • Fence, paths for controlling access	
Diminished water quality	• Drainage inflows eliminated or managed • Where a proposal may affect wetland water quality, particularly through un-channelised flow, detailed site specific work should be undertaken to determine the specific separation measures required, including management measures	

(WAPC 2005)

3.5.3 Wetland Significance

International Significance

Lake Gwelup Reserve is listed under the *EBPC Act 1999*.

State Significance

The *Geographical Atlas* (DOW 2014) also defines both wetlands UFIs 8173 and 8176 as *Conservation Category* Wetlands (CCW). The conservation status means these wetlands have a high degree of naturalness with a management priority directed towards enhancing the natural features of the wetland (Hill *et al*. 1996b). A 50m buffer from each wetland boundary is recommended for preserving the wetlands from habitat modification unless a site-specific buffer requirement determines the site suitability for a small buffer distance (EPA 2008).

Regional Significance

The site is of regional significance as it is one of the few remaining areas in the metropolitan region containing a significant area of remnant native vegetation.

Land near foreshores is important in the protection of waterways. It acts as a buffer, filtering excess nutrients and pollutants, as well as providing food and habitat to a variety of animal species. Waterways also provide one of the main opportunities for ecological linkages in developed areas, therefore it is desirable to increase the foreshore reserve width to enhance connectivity between remnant vegetation (EPA 2005).

4.0 BIOLOGICAL ENVIRONMENT

4.1 VEGETATION

4.1.1 Vegetation Condition

Vegetation condition is a measure of the degree to which vegetation has been degraded. This measure is based on the proportion of weeds and the degree to which the vegetation structure (i.e. height and density of vegetation layers) has been modified.

The vegetation condition mapping was undertaken by Ecoscape using the standardised Keighery (1994) Vegetation Condition scale shown in **Table 7**. The condition of the vegetation in the Reserve is presented in Map 6 in **Appendix One**.

Table 7: Criteria Used for Vegetation Condition Assessment (Keighery 1994)

Condition	Keighery Criteria
Pristine	No obvious signs of disturbance
Excellent	Vegetation structure intact, disturbance only affecting individual species and weeds are non-aggressive species
Very Good	Vegetation structure altered, obvious signs of disturbance (e.g.: repeated fires, aggressive weeds, dieback, logging and grazing).
Good	Vegetation structure altered, obvious signs of disturbance. Retains basic vegetation structure or ability to regenerate it. The presence of very aggressive weeds at high density, partial clearing, dieback, logging and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Requires intensive management. The presence of very aggressive weeds at high density, partial clearing, dieback, logging and grazing.
Completely Degraded	Vegetation structure is no longer intact and the area is completely or almost completely without native flora.

Almost half of the Reserves contains native vegetation (36.6 ha, 48.5%). None of the native vegetation was rated Excellent or better. Only 9.3% of the vegetation was rated Good. The remaining vegetation was rated Degraded (17.8 ha, 48.5%) or Completely Degraded (20.5 ha, 42.2%). Several small sections were identified as revegetated (1.6 ha, 2.1%). The vegetation condition data is summarised in Table 8.

The main factor impacting the condition was weeds, particularly the grass weed *Ehrharta calycina* (Perennial Veldt Grass) in the bushland and *Typha orientalis* (Bulrush) in the wetland. Some site disturbances were also observed, including unauthorised tracks, ground dug up for bike jumps and litter.

Table 8: Keighery (1994) vegetation condition of Lake Gwelup

Vegetation Condition	Ha	% Reserve	% Vegetation
Pristine	0	0	0
Excellent	0	0	0
Very Good	0	0	0
Good	3.4	4.5	9.3
Degraded	17.8	23.6	48.5
Completely Degraded	15.4	20.5	42.2
Revegetation	1.6	2.1	
Parkland	19.6	26.0	
Open Water	17.7	23.4	
Total Reserve	75.5	100	
Total Vegetation	36.6	48.5	100

4.1.2 Vegetation Complexes

Vegetation types are grouped into vegetation complexes on the basis of patterns in soil and geomorphology (i.e. vegetation types 'are grouped [into complexes] by where they occur rather than by having some characteristic such as the same dominant species in common or a majority of species in common' (Trudgen 1996). Heddle, Loneragan and Havel (1980) mapped and described the vegetation of the Darling System in Western Australia, according to a system of twenty eight complexes, each with shared distinctive characteristics such as flora species composition, soil types and landform.

A total of three of the Heddle et al (1980) vegetation complexes are known to occur in the Reserve:

- **Herdsman Complex** - Sedgelands and fringing woodland of *Eucalyptus rudis - Melaleuca* species
- **Cottesloe Complex - Central and South** - Mosaic of woodland of *Eucalyptus gomphocephala* and open forest of *Eucalyptus gomphocephala - Eucalyptus marginata - Corymbia calophylla*; closed heath on the limestone outcrops.
- **Karrakatta Complex–Central and South** - Predominantly low open forest of *Eucalyptus gomphocephala - Eucalyptus marginata - Corymbia calophylla* and woodland of *Eucalyptus marginata - Banksia* species

An indication of the extents, and examples, of these complexes on the Swan Coastal Plain are given in **Table 9**. The distributions of the vegetation complexes in and around the Reserve are illustrated in **Map 7** in **Appendix One**.

Table 9: Vegetation Complexes recorded in Lake Gwelup Reserve

Vegetation Complex	Typical Vegetation	Area uncleared on Swan Coastal Plain[1]	Area in secure tenure on Swan Coastal Plain[1]	Other Examples[2]
Karrakatta Central & South	• Tuart - Jarrah – Marri low open forest • Jarrah – Banksia woodland	14 729 ha	1 254 ha	Wireless Hill Carine ROS
Cottesloe Central & South	• Tuart woodlands • Tuart - Jarrah – Marri open forest • closed heath on limestone	18 474 ha	3 951 ha	Bold Park
Herdsman	• Sedgelands • Flooded Gum - Melaleuca woodlands fringing lakes	2 875 ha	952 ha	Lake Joondalup Star Swamp Carine ROS

[1] EPA (2003) [2] Powell & Emberson (1996)

It should be noted that the vegetation complex descriptions are general only and as such, some species mentioned in the complex name may be absent in certain locations.

4.1.3 Vegetation Communities

As part of the City's development of the Local Biodiversity Strategy, Ecoscape conducted a *Natural Areas Initial Field Assessment* (NAIA) in the reserve. The six vegetation communities described in the previous report were revised in their structure, common species and distribution within the Reserve. Quadrats (10 m x 10 m) were located in best condition areas of each vegetation community. The quadrat and vegetation community descriptions are presented in Table 10. The distributions of the vegetation communities are presented in **Map 8** in **Appendix One**. The NAIA assessment is presented in **Appendix Two**.

It should be noted that the surveys were done out of season (not Spring) so many understorey species may be present but not identifiable. This would have restricted the list of dominant and common species recorded in each vegetation community.

Table 10: Vegetation Communities of Lake Gwelup Reserve

Quadrat	Quadrat Description	Vegetation Community Name
1	**Typha orientalis, Cyperus vaginatus* Sedgeland over ?*Persicaria decipiens* Very Open Herbland	Bulrush Sedgeland
2	*Melaleuca rhaphiophylla* Woodland over *Acacia saligna* Tall Open Shrubland over *Hypochaeris sp., *Conyza bonariensis* Very Open Herbland and **Cenchrus clandestinus* Very Open Herbland	Freshwater Paperbark Woodland
3	*Eucalyptus rudis, Melaleuca rhaphiophylla* Woodland over **Cenchrus clandestinus*, **Avena barbata* Grassland	Mixed Flooded Gum – Paperbark Woodland
4	Eucalyptus rudis Open Forest over Melaleuca rhaphiophylla Tall Open Shrubland over *Cenchrus clandestinus Open Grassland	Flooded Gum Open Forest
5	*Eucalyptus marginata, Corymbia calophylla* Open Woodland over *Jacksonia sternbergiana, Hakea prostrata* Tall Open Shrubland over *Xanthorrhoea preissii* Shrubland over *Hibbertia hypericoides, Bossiaea eriocarpa* Low Open Shrubland over *Conostylis candicans, Haemodorum paniculatu*m Very Open Herbland and *Desmocladus fasciculatus* Very Open Sedgeland and **Ehrharta calycina* Open Grassland	Jarrah-Marri Woodland
6	*Eucalyptus gomphocephala, Eucalyptus marginata* Open Forest over *Jacksonia furcellata, Jacksonia sternbergiana, Macrozamia riedlei* Tall Open Shrubland over *Xanthorrhoea preissii, Acacia pulchella* Open Shrubland over *Haemodorum paniculatum, *Pelargonium capitatum* Very Open Herbland and *Mesomelaena stygia* Very Open Sedgeland and **Ehrharta calycina* Very Open Grassland	Tuart Open Forest

* indicates weed species

Vegetation communities were largely distributed by the reserve's hydrology and topology. The Bulrush Sedgeland dominated the low wetland region of the reserve, covered 8.2 ha (10.8%) of the reserve. The entire Sedgeland is rated in Completely Degraded condition as it is dominated by Typha and weeds and contains little native flora.

The Freshwater Paperbark and Mixed Flooded Gum-Paperbark Woodlands occupy the damper transitional areas, covering 3.3 ha (8.4%) of the reserve. The Flooded Gum Open Forest occurred in slightly drier regions of the transition area, covering 10.3 ha (13.6%) of the Reserve. All of the transitional vegetation were rated Degraded or lower, because of little native understorey, high weed presence and some disturbances.

The Jarrah-Marri Woodland and Tuart Open Forest occupied the higher dry lands, covering 12.6 ha (16.6%) of the Reserve. Over a third of the dryland vegetation was in Good condition (37%). The Tuart Open forest was overall in better condition, not having any vegetation rated Completed Degraded, compared to the Jarrah-Marri Woodland (1.4 ha, 12.6%). Data for the condition for each vegetation community is presented in **Table 11** and **Table 12**.

Table 11: Size of vegetation communities of Lake Gwelup Reserve

Vegetation Condition	Ha	% Reserve	% Vegetation
Bulrush Sedgeland	8.2	10.8	21.9
Freshwater Paperbark Woodland	4.2	5.6	11.3
Mixed Flooded Gum – Paperbark Woodland	2.1	2.8	5.6
Flooded Gum Open Forest	10.3	13.6	27.6
Jarrah-Marri Woodland	5.9	7.8	15.8
Tuart Open Forest	6.7	8.8	17.9
Total Reserve	75.5		
Total Vegetation	36.6		

Table 12: Condition of vegetation communities of Lake Gwelup Reserve

Vegetation Type		Condition (Ha)			
		Good	Degraded	Completed Degraded	Revegetation
Bulrush Sedgeland	ha	0	0	7.2	0
	%	0	0	100	0
Freshwater Paperbark Woodland	ha	0	1.9	0.2	0
	%	0.0	90.8	9.2	0.0
Mixed Flooded Gum - Paperbark Woodland	ha	0	2.3	3.6	0
	%	0	38.2	61.8	0
Flooded Gum Open Forest	ha	0	2.1	2.1	0
	%	0	49.5	50.5	0
Jarrah-Marri Open Woodland	ha	2.4	6.3	1.4	1.1
	%	21.5	56.1	12.6	9.8
Tuart Open Forest	ha	1.0	5.2	0	0.5
	%	14.5	78.3	0	0

4.1.4 Significant Vegetation

State Significance

1. Bush Forever

WAPC (2000) *Bush Forever Volume 1* states that the Reserve is Bush Forever Site No. 212 (Lake Gwelup, Gwelup). The Implementation Recommendation for this site states:

> *Site with Some Existing Protection; the existing care, control and management intent of the reserve is endorsed. The purpose of the reserve should be amended to include conservation and appropriate mechanisms applied in consultation with the management body.*

The Boundaries of the Bush Forever site are illustrated in **Map 9** in **Appendix One**.

2. Environmental Senstive Area

As the entire Reserve is listed as a Bush Forever site, it is also declared as an ESA under the GWA (2005) *Environmental Protection* (*Environmentally Sensitive Areas*) *Notice*. An ESA defines those areas where priority flora and fauna species, wetlands or TECs are likely to occur and as such are subject to strict land clearing regulations.

The Boundaries of the ESAs in Lake Gwelup are illustrated in **Map 9** in **Appendix One**.

3. Significant Ecological Communities

Threatened Ecological Communities (TECs) are categorised at both State level (Department of Environment and Conservation 2008c) and Commonwealth level (SEWPAC 2011), while Priority Ecological Communities (PECs) are also classed at State level (DEC 2008). The status of the State and Commonwealth ratings are summarised in **Appendix Three**.

WAPC (2000) does not list any PECs or TECs within Lake Gwelup Reserve.

Local and Regional Significance

The amount remaining of Heddle et al (1980) complexes found in Lake Gwelup Reserve are summarised below in Table 13**.**

Table 13: Vegetation Complexes in the Lake Gwelup Reserve (Heddle et al 1980)

Vegetation Complex	Area remaining in Swan Coastal Plain*		Area remaining in Lake Gwelup Reserve#	
	ha	%	ha	%
Karrakatta Complex–Central and South	14,729	29.5	16.8	24.9
Cottesloe Complex – Central and South	18,484	41.1	0.9	14.1
Herdsman Complex	2,875	34.6	2.2	60.9

* SCP vegetation area calculations based from (1993a) EPA Guidance Statement 10

Reserve vegetation area calculations based from DAFWA 2012(2009) Remnant Native Vegetation Extent

EPA (2003) defines several levels to describe the status of a vegetation complex within the metropolitan region and southwest. These are:

- **Threshold level** – 30% of the pre-clearing extent is the level at which species loss appears to accelerate exponentially at an ecosystem level
- **Endangered level –** 10% of the original extent is regarded as being a level representing “endangered”.

The Karrakatta Complex – Central and South has approximately 29.5% of its original area remaining in the Swan Coastal Plain. This complex is above the Endangered level but just below the Threshold level.

The Cottesloe Complex – Central and South has approximately 41.1% of its original area remaining in the Swan Coastal Plain. This complex is above the Threshold level.

The Herdsman Complex has approximately 34.6% of its original area remaining in the Swan Coastal Plain. This complex is just above the Threshold level.

4.2 FLORA

4.2.1 Native Flora

Native Flora Inventory

A total of 112 local native species from 31 plant families have been recorded within Lake Gwelup Reserve which are listed in **Appendix Four**. Of these, 14 species will need to their identified properly confirmed.

Significant Native Flora

1. State and Federal Significance

Flora species require Threatened Flora (TF) or Priority Flora (PF) conservation status where populations are geographically restricted or threatened by local processes. Flora are classified and protected at a federal level through the Australian Government under the *EPBC Act 1999*. There are five categories of protected flora covering the federally listed species, which are described in Appendix Two.

DPaW also enforces regulations under the Western Australian *Wildlife Conservation Act 1950* to conserve TF and protect significant populations. Rare flora species are gazetted under Sub-Section 2 of Section 23F of the *Wildlife Conservation Act 1950*, thereby making it an offence to remove or damage rare flora without Ministerial approval. All Threatened and Priority flora are listed in the DEC (2010) Declared Rare and Priority Flora List. There are six categories of priority flora covering these listed species, which are described in **Appendix Three.**

A review of the previous management plan, DOE Protected Matters Search Tool and WAPC (2000) Bush Forever and DPaW (2014) *Naturemap* indicated that that there were no State or Federally listed threatened flora species known to occur in the area. A total of three state priority listed flora may occur in the Reserve, however only *Jacksonia sericea* has been confirmed (**Table 14**).

Table 14: Significant flora that may occur in Lake Gwelup Reserve

SCIENTIFIC NAME	COMMON NAMES	EPBC	DPAW	CITY
Baeckea sp. Limestone (N. Gibson & N. Lyons 1425)		-	P1	-
Jacksonia sericea	Kapur	-	P4	-
Lepidium pseudohyssopifolium		-	P1	-

2. Local and Regional Significance

The City's (2013b) Flora database lists eight flora species that are regionally significant, seven of which are orchids. Four species are declared to be Locally Rare, having scarce populations, and four are declared Locally Endangered (**Table 15**).

In addition, two species are generally regarded as important in the Perth area. *Eucalyptus gomphocephala* (Tuart) is restricted to the limestone soils along the Swan Coastal Plain. This species is an important source of food and shelter for many local invertebrate and vertebrate fauna species including the Endangered Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*). The distribution of this species is currently in decline (Florabank 2014).

Schoenoplectus validus (Lake Club-rush) is a sedge that occurs in fresh or brackish swamps and lake borders within the Perth region and is an important habitat for water birds. *S. validus* is tolerant of water logging for several months, meaning they occupy different positions in wetland (Florabank 2014).

Table 15: Locally significant flora at Lake Gwelup Reserve

Scientific Name	Common Name	Population Distribution	Status
Erodium cygnorum	Blue Herons Bill	Low	Endangered
Caladenia arenicola	Carousel Spider Orchid	Scarce	Endangered
Caladenia latifolia	Pink Fairy Orchid	Low	Endangered
Caladenia longicauda	White Spider Orchid	Low	Endangered
Caladenia marginata	White Fairy Orchid	Scarce	Rare
Cyanicula sp.	-	Scarce	Rare
Cyanicula deformis	Blue Fairy Orchid	Scarce	Rare
Elythranthera brunonis	Purple Enamel Orchid	Scarce	Rare

4.2.2 Introduced Flora

Weed Inventory

A weed species inventory was compiled by referring to site observations and the following sources:

- Ecoscape (2005) Lake Gwelup Reserve Management Plan
- City of Stirling weed maps (2008-2013)
- Site observations
- Mattiske NAIA template.

A total of 70 weed species have been recorded as being present in Lake Gwelup Reserve. It is possible that that these weed species have been successfully eliminated in the Reserve since the release of the 2005 Management Plan. A detailed site survey is required to confirm whether these weed species are still present.

One native herb species, *Siloxerus humifusus* (Procumbent Siloxerus) is native to WA but not considered to be local to the Perth region. The short lived species has a low threat status as it may continue to regenerate in the transition areas, so is considered to be a weed species.

The full weed species inventory is presented in **Appendix Four**.

Non indigenous WA Native Flora

There are three tree species which are not indigenous to the local area. *Agonis flexuosa* (Peppermint Tree) and *Callitris preissii* both grow in the Perth region, however is considered to not naturally occur in Gwelup. *Corymbia ficifolia* (Red Flowering Gum) is not native to the Perth region. All three species are likely to have been planted as part of previous soft landscaping works. *Corymbia ficifolia* is considered to be a threat to the Reserve as they are unlikely to establish seedlings and compete against native tree species. *Agonis flexuosa* and *Callitris preissii* may spread into the Reserve, so are considered in this report as weed species.

Significant Weeds

1. Methodology

Each weed species was assigned a priority rating according to their deemed threat level:

- *High Priority* - need to have immediate targeted strategies developed and implemented
- *Moderate Priority* - should be targeted to enhance the site condition if there are any resources available after controlling the high priority weed species
- *Low Priority* - should be controlled as part of non-target or site-focused maintenance weed strategies if there are any resources available after controlling the high and moderate priority weed species.

The priority ratings of each weed species were determined after examining:

- the ratings under the
    - *Environmental Weed Census and Prioritisation* (EWCP) by the Swan Natural Resource Management (2008).
    - *Environmental Weed Strategy of Western Australia* (EWSWA) by the Department of Conservation and Land Management (1999)
    - Dixon and Keighery (1995) *Recommended methods to control specific weed species*
- whether it was listed under the
    - DAFWA (2007) *Biosecurity and Agriculture Management Act (BAM Act)*
    - *Weed of National Significance* (WONS) (Weed Australia 2008)
- its local significance to the natural areas.

It should be noted that a weed species may differ in its priority status as a result of its local significance. For example, a weed species may be more invasive and dominant in a wetland community than in a sandy upland community. Therefore this species should be regarded as a higher priority to control in reserves containing wetlands than in reserves containing only upland vegetation.

The full methodology for determining the priority of each weed species and associated calculations are presented in **Appendix Five.**

2. Results

The prioritisation process determined that:

- 28 weed species were considered to be High Priority to control
- 25 weed species were considered to be Moderate Priority to control
- 15 weed species were considered to be Low priority to control.

The High Priority weed species in this reserve are summarised in Table 16. The final priority ratings for all of the weed species are presented in **Appendix Five**.

Table 16: Known High Priority weed species of Lake Gwelup Reserve

COMMON NAME	SCIENTIFIC NAME	WEEDS AUSTRALIA	BAM ACT
African Boxthorn	*Lycium ferocissimum*		
African Cornflag	*Chasmanthe floribunda*		
African Love Grass	*Eragrostis curvula*		
American Nightshade	*Solanum americanum*		
Arum Lily	*Zantedeschia aethiopica*		C3
Bearded Oat	*Avena barbata*		
Black Nightshade	*Solanum nigrum*		
Blackberry	*Rubus fruticosus*	WONS	C3
Blue Lupin	*Lupinus cosentinii*		
Bridal Creeper	*Asparagus asparagoides*	WONS	C3
Buffalo Grass	*Stenotaphrum secundatum*		
Bulrush	*Typha orientalis*		
Couch	*Cynodon dactylon*		
Freesia	*Freesia alba x leichtlinii*		
Gazania	*Gazania linearis*		
Geraldton Carnation Weed	*Euphorbia terracina*		
Great Brome	*Bromus diandrus*		
Hare's Tail Grass	*Lagurus ovatus*		
Kikuyu	*Cenchrus clandestinus*		
One-leaf Cape Tulip	*Moraea flaccida*		C3
Pampas Grass	*Cortaderia selloana*		
Perennial Veldt Grass	*Ehrharta calycina*		
Petty Spurge	*Euphorbia peplus*		
Rose Pelargonium	*Pelargonium capitatum*		
Soursob	*Oxalis pes-caprae*		
Tall Fleabane	*Conyza sumatrensis*		
Water Couch	*Paspalum distichum*		
Vasey Grass	*Paspalum urvillei*		

Weed Mapping and Control Works

The City has been mapping the distribution and conducting targeted control for the following weed species from 2007 to the present:

- Freesia (*Freesia alba x leichtlinii*)
- Blue Lupin (*Lupinus cosentinii*)
- Soursob (*Oxalis pes-caprae*)
- Whiteflower Fumitory (*Fumaria capreolata*)
- Bridal Creeper (*Asparagus asparagoides*)
- Geraldton Carnation Weed (*Euphorbia terracina*)
- African Corn Flag (*Chasmanthe floribunda*)
- Perennial Veldt Grass(*Ehrharta calycina*)

4.3 FAUNA

4.3.1 Native Fauna

Fauna Inventory

An inventory of native fauna known or likely to occur in the Reserve after consulting Ecoscape (2005), NatureMap and DOE (2014) *Protected Matters Search Tool*. The inventory is summarised in **Appendix Four**.

1. Birds

There was a total of 100 native bird species identified as likely to occur in the local area of the study site. Six of these species have some level of conservation significance, including Carnaby's Black-Cockatoo which is listed as Endangered under the *EPBC Act (1999)* and *Wildlife Conservation Act (1950)*.

2. Mammals

Only one native mammal. *Macropus fuliginosus* (Western Grey Kangaroo) has been officially recorded in Lake Gwelup Reserve in the last two decades. This is due in part to a lack of funding and equipment for comprehensive, long term surveys and monitoring. It is also partly due to the loss of habitat due to weed fires and inappropriate land use and recreational activities.

The Chuditch (*Dasyurus geoffroii)* is indicated by DOE as possibly occurring in the area, however it is highly unlikely to be present as:

- the record of this occurrence is from the 1920's and is unreliable in nature and location (NatureMap)
- this species has not been sighted or recorded in the Reserve
- the Reserve's vegetation is degraded
- the Reserve is surrounded by urban development and major roads, reducing the chance of new populations entering the Reserve.
- foxes and domestic pets have preyed upon and eliminated past populations.

The likelihood of native Bat species being present is high as these animals are common across the metropolitan region and lack of appropriate survey techniques would be the reason there have been no records made. The following common species are listed by NatureMap:

- *Chalinolobus gouldii* (Gould's Wattled Bat)
- *Chalinolobus morio* (Chocolate Wattled Bat)
- *Tadarida australis* (White-striped Freetail-bat)
- *Vespadelus regulus* (Southern Forest Bat)

It is highly likely that populations exist of introduced House Mouse (*Mus musculus*) and Black Rat (*Rattus rattus*).

3. Reptiles

No reptiles were observed during the site survey although this was not optimal timing or of sufficient effort to detect most species. Locals have reported Dugites (*Pseudonaja affinis*) and Tiger Snakes (*Notechis scutatus*) as being common (Dames and Moore 1984). The site is likely to contain a suite of common reptiles such as skinks and dragon lizards. The local area has a range of habitats that could support populations of these species and is likely to do so.

Predation by introduced predators such as the European Red Fox and Domestic and Feral Cats may impact heavily on the abundance of individuals and the diversity of species. Predation rates increase due to disturbance and clearing of vegetation and therefore population numbers may be reduced. The surrounding residential areas and major roads also prevent animals from entering the Reserve.

Turtles

Chelodina colliei (Oblong Turtle, formerly *Chelodina oblonga*) is the only turtle species recorded in the local area.

4. Amphibians

A total of 14 frog species were identified as likely to occur within the Reserve through the desktop investigation. These species are common and abundant in the Swan Coastal Plain Region and are highly likely to be present. Appropriate survey techniques are required to confirm their presence. The species recorded in the local area are as follows:

- *Litoria adelaidensis* (Slender Tree Frog)
- *Litoria moorei* (Motorbike Frog)
- *Heleioporus eyrei* (Moaning Frog)
- *Limnodynastes dorsalis* (Western Banjo Frog)
- *Crinia georgiana* (Quacking Frog) - unlikely
- *Crinia glauerti* (Clicking Frog)
- *Crinia insignifera* (Squelching Froglet)
- *Crinia pseudinsignifera* (Bleating Froglet) - unlikely
- *Myobatrachus gouldii* (Turtle Frog)
- *Pseudophryne guentheri* (Crawling Toadlet) - unlikely

Significant Native Fauna

1. State and Federal Significant Fauna

The conservation status of fauna species is assessed the Commonwealth's *EPBC Act 1999* and the State's *Wildlife Conservation Act 1950*. The significance levels for fauna used in the *EPBC Act 1999* are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN).

The *Wildlife Conservation Act 1950* uses a set of Schedules but also classifies species using some of the IUCN categories. These categories provide special protection to listed fauna definitions are shown in **Appendix Three.**

In Western Australia, the DPaW has produced a supplementary list of Priority Fauna, listed using priority codes, which are species that are not considered Threatened under the *Wildlife Conservation Act* but for which DPaW feels there is cause for concern. Some Priority species, however, are also assigned to the IUCN Conservation Dependent category. It is important to recognise that such Priority Lists have no statutory standing, but are used to assist DPaW when considering which fauna are most in need of more surveys or other investigations, in order to establish their status in the wild.

The Priority Fauna List for Western Australia includes taxa organised by priority codes that either:

- have recently been removed from the schedule of threatened fauna
- have a restricted range, are uncommon or are declining in range and/or abundance, but which do not meet the criteria for inclusion on the schedule of threatened fauna
- have been nominated for consideration for the schedule of threatened fauna and for which there is insufficient information for the advisory committee to make an assessment of their status
- are otherwise worthy of inclusion on such a list, as determined by DPaW.

The Priority Fauna List for Western Australia is reviewed by DPaW whenever new information on relevant taxa becomes available. Taxa are removed from the list by DPaW as they cease to meet the requirements identified above.

A review of the Ecoscape (2005) and WAPC (2000) reports indicated that 20 Scheduled or Priority Fauna species have been recorded in the local area of the Reserve (Table 17). Of these, the Chuditch and Western Ringtail Possum are considered not likely to be present.

Table 17: State and Federal significant fauna species that may potentially occur at Lake Gwelup

Scientific name	Common Name	Recorded	EPBC Act	WC Act/DPaW
Bird				
Ardea ibis	Cattle Egret		Migratory	
Ardea modesta	Eastern Great Egret	*	Migratory	
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo		Vulnerable	S1
Calyptorhynchus baudinii	Baudin's Black-Cockatoo		Vulnerable	S1
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	*	Endangered	S1
Falco peregrinus	Peregrine Falcon	*	Threatened	S4
Limosa lapponica	Bar-tailed Godwit	*	Migratory	
Merops ornatus	Rainbow Bee-eater	*	Migratory	
Plegadis falcinellus	Glossy Ibis	*	Migratory	
Rostratula australis	Australian Painted Snipe		Endangered	S1
Sternula nereis nereis	Australian Fairy Tern		Vulnerable	S1
Tringa stagnatilis	Marsh Sandpiper	*	Migratory	
Mammal				
Dasyurus geoffroii	Chudtich, Western Quoll		Vulnerable	S1
Pseudocheirus occidentalis	Western Ringtail Possum		Vulnerable	S1
Isoodon obesulus fusciventer	Quenda			Priority 5
Reptile				
Lerista lineata	Lined Skink			P3
Morelia spilota imbricata	Southwestern Carpet Python			S4
Neelaps calonotos	Black-striped Snake			P3

The Rainbow Bee Eater is known to nest in open areas throughout the reserve. The City encloses known breeding active sites during the breeding seasons (around September to January) to help protect them. The City has educated the public about the fenced nesting sites via site signage, local Stirling scoop newspapers and to encourage them to control their pets and leave the nesting areas alone during the breeding season. Rewrite preceding sentence.

2. Local Significant Fauna

In addition to State and Federal conservation listed species, eight other bird species have been identified at Lake Gwelup that are listed by the City as locally significant (City of Stirling 2013a). The locally significant fauna species are summarised in Table 18.

Table 18: Local Significant fauna species that may potentially occur at Lake Gwelup

Scientific name	Common Name	City
Bird		
Acanthorhynchus superciliosus	Western Spinebill	Priority 1
Ardea pacifica	White Necked Heron	Priority 1
Chrysococcyx lucidus	Shining Bronze Cuckoo	Endangered
Egretta novaehollandiae	White Faced Heron	Endangered
Malurus lamberti	Varigated Fairy Wren	Priority 1
Malurus splendens	Splendid Fairy Wren	Priority 1
Nycticorax caledonicus	Nankeen Night Heron	Endangered
Tyto javanica	Eastern Barn Owl	Priority 1

4.3.2 Feral and Overabundant Fauna

Feral Fauna

Feral Animals are generally regarded as naturalised domestic species such as the turtle dove, or species that were introduced for recreational purposes, like the fox, that have escaped or been released and gone wild. Feral animals are often significant pests to agriculture and the ecological values of the areas that they inhabit. Some feral animals prey on native species, others compete for food and shelter or destroy habitat, and can spread diseases. In Australia, feral animals have few natural predators or fatal diseases and some have high reproductive rates. As a result, their populations are not naturally limited and they can multiply rapidly if conditions are favourable.

Several feral fauna have been identified or historically recorded in DPaW Naturemap database in the Lake Gwelup region. These are listed in Table 19 and discussed below.

Table 19: Feral fauna that are known or may occur at Lake Gwelup Reserve (source: NatureMap)

Scientific name	Common Name
Fish	
Carassius auratus	Goldfish
Gambusia affinis	Mosquitofish
Bird	
Anas platyrhynchos	Mallard
Cacatua tenuirostris	Eastern Long-billed Corella
Carduelis carduelis	European Goldfinch
Columbia livia	Domestic Pigeon
Dacelo novaeguineae	Laughing Kookaburra
Lonchura castaneothorax	Chestnut-breasted Mannikin
Streptopelia chinensis	Spotted Turtle-dove
Streptopelia senegalensis	Laughing Dove
Trichoglossus haematodus	Rainbow Lorikeet
Mammal	
Felis catus	Cat (feral or roaming domestic)
Mus musculus	House Mouse
Oryctolagus cuniculus	Rabbit
Rattus norvegicus	Brown Rat
Rattus rattus	Black Rat
Vulpes vulpes	European Fox
Insects	
Apis mellifera	European Honeybees

1. European Foxes (Vulpes vulpes)

Foxes pose a threat to many native fauna species. Foxes tend to occupy distinct areas, called home ranges, from which they exclude other foxes entering (although home ranges can overlap). Fox numbers are therefore relatively stable, except when animals are removed and there is an influx of new individuals. The size of a home range is determined by food and resources but can typically range from 280 to 1600 ha (Western Australian Department of Agriculture 2004).

2. Rabbits (Oryctolagus cuniculus)

Rabbits are a common problem throughout the coastal areas of the Swan Coastal Plain. They are a serious threat to the natural environment as they graze heavily on vegetation, particularly new seedlings that have been planted or regenerated after fire and can establish large warrens.

3. Rodents (Mus musculus, Rattus norvegicus and Rattus rattus)

The House Mouse (*Mus musculus*), Brown Rat (*Rattus norvegicus*) and Black Rat (*Rattus rattus*) can impact the local vegetation by depleting native seed banks. They can also affect native fauna populations by competing with other animals for food and shelter and transmit diseases to native fauna. Rats are also predatory and may prey on reptiles and birds (Lapidge *et al.* 2004) .

4. Feral Birds

There are several feral bird species recorded in the Reserve, including:

- Mallard (*Anas platyrhynchos*)
- Doves (*Streptopelia chinensis* and *Streptopelia senegalensis*)
- Domestic Pigeon (*Columba livia*)
- Rainbow Lorikeet (*Trichoglossus haematodus*)
- Laughing Kookaburra (*Dacelo novaeguineae*)
- European Goldfinch (*Carduelis carduelis*)
- Chestnut-breasted Mannikin (*Lonchura castaneothorax*)

Feral birds compete with native birds for nesting sites and food; the Rainbow Lorikeet in particular competes for tree-cavity nesting sites with threatened cockatoo species. They can also infect native birds with diseases, mites and ticks. The Mallard is known to hybridise with native Pacific Black Duck (*Anas superciliosus*), and Eastern Long-billed Corella with native western species (*Cacatua sanguinea* and others) impacting the genetic integrity of wild populations. The Goldfinch and Mannikin have naturalised populations localised in the Perth area, founded by aviary escapes, and do not appear to be significantly invasive or deleterious.

5. European Honeybees (Apis mellifera)

The European honeybee was introduced to Australia in 1826 for producing commercial honey and beewax, however colonies often escape and have established throughout Australia. Honeybees can have a negative impact on the environment by:

- competing for nesting places, such as tree hollows and nesting boxes
- competing with native bees and honeyeaters for food
- being less efficient in cross-pollinating native plants, thereby reducing plant reproduction (Burgman & Lindenmayer 1998).

Overabundant Fauna

1. Native Birds

Some native species have greatly increased in population size as a result of European settlement and have become overabundant, putting pressure on the environment and possibly affecting nearby residents. The Australian Raven (*Corvus coronoides*) is overabundant in the Reserve. The species have been observed eating other birds' eggs and hatchlings in several reserves (Taylor pers com).

Species that have not previously been recorded in Lake Gwelup, but are likely to be present in the future are:

- Western Corella (*Cacatua pastinator*), which is considered overabundant in the Perth region
- Rainbow Lorikeet (*Trichoglossus haematodus*), which is exotic to Western Australia and are overabundant in the Perth region.

The City is currently working with the DPaW to control Corella population numbers. This is an ongoing exercise.

2. Midges

Local midge species breed in the wetlands. Occasionally populations increase from high water nutrient levels and become a nuisance to local residence, such as in 2013. The City currently has no infrastructure or strategies in place to control any midge outbreak.

***3. Bullseye Borer* (*Phoracantha acanthocera*)**

Many of the older Marri and Jarrah trees in the western vegetation have observed to be ringbarked, which has resulted in them in being either bare or shedding bark in large sheets (Pike pers comm.). It is suspected that Bullseye Borer grubs are the cause of the ring barking, however this species has not been properly identified.

4.3.3 Pets

Lake Gwelup is frequently used by the public to exercise their pet dogs. Some dog owners do not control the dogs and let them enter native vegetation areas. Also neighbouring residents have pet cats which may enter the Reserve.

It is acknowledged that domestic pets such as dogs and cats are often important companions to people, however these pets can have quite significant impacts on native fauna. Domestic cats may predate native wildlife, such as birds, amphibians and lizards. Dogs can also do damage if they not are not under effective control while being exercised within the Reserve. They can disturb native animals and spoil the native vegetation and habitat, crushing reed beds and disturb hiding and nesting habitat of water birds and aquatic wildlife. Dogs may also chase young birds into lakes.

Dogs

The recreational benefits of dog walking are acknowledged in terms of the dog owners and their pets being able to socially meet in a place like Lake Gwelup reserve which has a mix of recreational parkland, bushland and wetland. However, it is also important to recognise the impacts that dogs can have on the sustainability of bushland areas in particular, when uncontrolled forays occur off designated tracks and trails. These impacts include the following:

- Effects of dog droppings – nutrient loading of soils and altering the growth conditions of most native plants that have evolved generally under nutrient poor conditions thereby resulting in poor recruitment of new seedlings
- Effects of dog droppings on fauna – this could influence the diversity and abundance of invertebrate fauna (based on a 2011 study of dog and non-dog beaches in Scarborough)
- Vegetation damage – from trampling by dogs and their owners which can become significant over time;
- Creation of short-cut trails – through ‘bush-bashing’ by dog owners leading to these trails eventually coalescing to form bare areas as evidenced by several examples on site
- Weed invasion – in areas rendered bare and nutrient enriched by the above processes thus favouring opportunistic colonisation by weeds and ephemerals
- Impacts on wildlife habitation – dogs tend to leave undesirable scents from territorial marking which can discourage wildlife habitation in pre-established niche areas
- Survival of threatened fauna – the sustainability of established habitat niches in bushland understorey could be placed at risk
- Attacks on wildlife – as evidenced by photo documented incidents of reptiles e.g. Bob Tails being mauled;
- Increased fox activity – dog activity in bushland could incite competitive marking of territory by foxes (and other dogs) as evidenced by photo documented incidents.

The cumulative effects of all the above over time could lead to the loss of biodiversity and other natural values of bushland. Quite apart from the above, the dogs themselves are at risk in terms of the following where forays into bush areas occur:

- Snake bite risk – this is likely if dogs make forays into bush areas
- Swooping bird attack – risk of dogs being attacked by swooping magpies or red wattle birds if not under effective control
- Fox trap risk - risk of dogs being caught in fox traps if not under effective control.

Apart from bushland, Lake Gwelup Reserve offers substantial open parkland areas for dogs to be exercised. On that basis, this Management Plan makes no recommendation to have Lake Gwelup Reserve declared a 'dogs on leash' area. Nevertheless, dog owners are encouraged to have their dogs under effective control for the reasons as outlined above. As per the Dog Act 1976 (WA), effective control essentially means that a dog is able to respond when called by the owner/ handler, and being close enough to be placed on leash, as necessary.

Incidents of dogs attacking children, recreational walkers and other dogs make it compelling on dog owners to have their pets under control.

Dog owners are also required to pick up droppings after their dogs. The accumulation of dog droppings particularly in bushland areas fringing walk tracks and trails has reached a state where it is becoming difficult and unhygienic for bushland conservation staff and volunteers to work in.

In regard to wetland areas of Lake Gwelup Reserve however, the City's Dogs Local Law 2008 stipulates that dogs are prohibited anywhere within the high water mark of the lake area. This is important to prevent the following in the lake and wetland areas of the reserve:

- disturbance to turtle nesting sites
- disturbance to new plantings of native reeds and rushes
- disturbance to waterbird habitat
- harassment and mauling of waterbirds.

It is recommended that a community awareness programme be developed and implemented outlining the impacts of dogs to the bushland and wetland ecosystems and about dog ownership responsibilities to assist in the conservation of these important areas. The programme should employ effective mechanisms to inform the public such as via the City's website, Stirling Scoop, appropriate signs on site, public awareness days involving the City's Rangers and conservation staff at Lake Gwelup Reserve and/or the Henderson Environment Centre, North Beach.

Pending the implementation of the community awareness programme, it is recommended that a review be undertaken at the end of 2015 to determine the success or otherwise of the above approach with the view to the adoption of alternate strategies, if needed.

Cats

Under the Cat Act 2011 (WA), owners of cats (over the age of six months) must ensure that their pets are:

- micro-chipped, wearing a collar and registration tags (for identification purposes if the animal is lost, injured or caught in a feral animal trap)
- sterilised (unless being used for breeding purposes by a Council approved breeder)
- registered with the Local Government.

Additionally, the City's Keeping and Control of Cats Local Law 1999 indicates that Trigg Bushland Reserve is one of 11 conservation reserves where cats are prohibited in the interests of wildlife protection.

More information on the responsibilities of cat owners under the City's Cats Local Law 1999 and the Cat Act 2011 (WA) may be found on the City's website.

4.4 FUNGI

4.4.1 Native Fungi

Bougher *et al* (2008) compiled a fungi inventory from surveys of the northern bushland areas and of Lake Gwelup Bush Forever site. A total of 54 species were recorded, mostly from the decomposer genera *Bovisrta, Clitocybe* and *Pluteus*, however many more species are expected to be present, including underground native truffles.

Species of note include *Phallus hadriani, Megalocystidium* (voucher E9216), *Mycena clarkeana.* A total of six beneficial mychorrhizal fungi were observed from the genera *Amanita, Clavulina, Dermocbye* and *Laccaria*.

An inventory of known fungi in Lake Gwelup Reserve is presented in **Appendix Four**.

4.4.2 Plant Diseases

Disease Status

No pathogenic fungi have been identified in the Reserve, other than the weak pathogen *Omphalotus nififormis* (Ghost Fungus) (Bougher et al 2008). The fungus *Coprinopsis* cf. *stangliana* has been introduced in degraded sections of the reserve. This species has been observed to be spreading in many of Perth's bushlands (Bougher 2006). It is not currently known whether this fungus poses a threat to the local vegetation.

To date a few reserves within the City have been identified or suspected of having dieback. There has only been one recorded case of honey fungus in the City, which has been removed. There have been no known infestations of aerial canker within the City (Woods pers comm.).

There are three main diseases that threaten the natural values of Lake Gwelup, which are outlined below.

Dieback *(Phytophthora cinnamomi)*

There are 15 *Phytophthora* species in Western Australia. These are soil-borne water moulds that kill a wide selection of plant species of the south west of Western Australia. As *Phytophthora* is a parasite, it requires a living host on which to feed and extracts its food by a mass of thread-like mycelium, which forms the body of the organism. *Phytophthora* is a water mould that kills its host by girdling the base of the stem, destroying the roots and depriving the plant access to nutrients and water. The most significant *Phytophthora* species is *Phytophthora cinnamomi*. The life cycle of this *Phytophthora* requires moist, non-alkaline conditions that favour survival, sporulation and dispersal (Murray 1997).

The City has identified three street trees adjacent to Lake Gwelup that are known to be infected with dieback:

- 12 March Street, Gwelup
- 17 Lagonda Drive, Gwelup
- 70 Finnerty Street, Gwelup.

Honey Fungus *(Armillaria luteobubalbina)*

Armillaria luteobubalbina (Honey Fungus) is a toadstool-producing parasitic fungus that lives off both live and dead hosts and is native to Western Australia. Although this species has not been recorded in the study area, it is known to commonly occur in the south-west of the state and may be present.

Unlike *Phytophthora cinnamomi* is not restricted by soil or landform types. It occurs in woodlands, forests, scrublands and parks on a wide variety of eucalypts and other plants such as *Acacia, Agonis, Banksia, Bossiaea, Grevillea, Hakea, Trymalium* and *Xanthorrhoea*. In some circumstances it can act as a virulent parasite that kills hosts including tuarts (Bougher & Syme 1998), jarrah, marri, wandoo and many understorey species. Deaths may occur as either single plants or as multiple deaths (Bailey 1995). The infection is caused by the aerial dispersion of spores, or through mycelium in root systems. Infection entry points for the spores may be provided by wounds caused by fire, broken limbs and insect damage.

Aerial Canker

Aerial Cankers are diseases caused by a group of largely air-dispersed fungi (including *Cryptodiaporthe melanocraespida* and *Zythiostroma* and *Diplodena* species) that affect the State's flora in the south-west. Occurrence of the disease is dependent on a combination of a susceptible host, infective pathogen, infection site (e.g. pre-existing wounds) and favourable environmental conditions. Under suitable conditions the disease can cause the death of plants within 2 years (Murray 1997). Aerial canker kills twigs in the lower crown and causes lesions called cankers in the bark of the main stem and roots. Severe cankers can cause death in parts of the plants above the canker. The fungus usually enters the plant through an existing wound (insect attack or wind damage). Healthy trees not subject to stress are unlikely to be severely affected (Bailey 1995).

4.4.3 Current City Management Practices

All natural areas staff have completed environmental specific training which includes knowing the differing forms of dieback. Field staff continually monitor all of the City reserves for signs of disease or tree decline. Any identified or suspected disease infection is reported to the Natural Areas Supervisor who then investigates the matter and commissions the City's contract dieback specialist to verify the infection. If a disease is confirmed or still suspected, all City field staff are notified and quarantine measures are applied according to the disease type within that reserve.

Before leaving a reserve known to or suspected of having dieback, the Natural Areas staff inspect and clean all vehicles, footwear and equipment of any soil deposits using dieback cleaning products.

To further minimise risk of disease introduction, the City of Stirling nursery as part of its accreditation status by the Nurseries and Gardening Industry Association of Western Australia adheres to strict hygiene and quality standards. The City has developed a flowchart to direct their disease management processes for their reserves (Process ID IPRN13.0). The process outlines procedures for senior environmental officers, operations supervisors (natural areas) and specialist contractors including, monitoring, identification, sampling, quarantining and supplying treatments. The flowchart is presented in **Appendix Six.**

4.5 FIRE

4.5.1 Fire History

Lake Gwelup has a history of fires being frequently deliberately lit.

4.5.2 Fire Risk Hazard Assessment

A Fire and Emergency Service Authority (FESA 2010) *Type 3 Bush Fire Hazard Assessment* was conducted on the Reserve. This detailed, site specific level of assessment was similar to that required for applications for development approval.

The native vegetation, parkland and additional trees throughout and surrounding the Reserve were all categorised according to their:

- vegetation structure (fuel load)
- proximity to residential housing
- general ground slope.

The categories allow the Reserve to be rated to four levels of bush fire hazard risk as defined by FESA (2010) – Low, Medium, High and Extreme.

Over 20% of the reserve was rated as a Low risk, as a result of open parklands with low fuel loads, gentle slopes and distance from residential housing. Less than 17% was rated as a Moderate Risk, mostly comprised of wetland vegetation with moderate fuel loads and gentle slopes. Approximately 32% of the Reserve was rated as an Extreme Risk, which included the dense bushland in the northern half of the reserve and parkland along the southern border and freeway drain (Table 20). The distributions of the Fire Hazard Risk areas are illustrated in **Map 10** in **Appendix One.**

Table 20: Extent of Fire Risk Hazards in Lake Gwelup Reserve

Fire Risk Hazard	Area (ha)	%
Extreme	24.9	32.2
Moderate	16.8	21.6
Low	17.3	22.3

4.5.3 Seasonality of Fire Risk

Lake Gwelup Reserve is hottest, driest and windiest in summer (Bureau of Meteorology 2010). This time of year is considered high risk for bushfires, as the vegetation and ground litter has dried, increasing ignition risk. The wind speed is higher in the afternoons, which exacerbates the risk as it encourages any fire outbreak to spread faster across the bushland. Conversely, the lowest risk time of the year and day are winter mornings, when there is the most rainfall, coolest temperature and lowest wind speeds.

5.0 SOCIAL ENVIRONMENT

5.1 A SENSE OF PLACE

Lake Gwelup Reserve is an important place for the local community. The Reserve's natural environment offers a vital element in defining the identity of Gwelup and has the potential to set a benchmark for the integration of community public open space, nature reserves and recreational facilities within the Perth Metropolitan Area and the Swan Coastal Plain. Lake Gwelup Reserve not only contributes to the ecological sustainability of the region, it also has the potential to be a key contributor to the aesthetic and physical character of the surrounding suburb, providing identity to the cultural heritage, flora, vegetation and fauna of the area.

Public open space is often appreciated for the recreational opportunities it provides. Lake Gwelup Reserve offers a multitude of sporting recreational opportunities, both organised and individual, through its oval and tennis courts, as well as activities such as walking, jogging and cycling.

Aside from being a visual and recreational asset to the community, Lake Gwelup also has the potential to contribute to broader community objectives such as:

- public health (both physical and psychological)
- youth development (e.g. the various sporting facilities, Scouts Hall)
- education (interpretation and nature play)
- community involvement (community groups and school groups).

5.2 HERITAGE

5.2.1 Aboriginal Heritage

Name of Lake Gwelup

Two possible origins for the name Gwelup have been documented:

- The Department of Land Information (DOLA 2005) suggest that the Aboriginal meaning of the name has been derived from "Gwelgannow" which means to "shift the position" and "step aside" and would therefore probably be "the lake that shifted position" as it changed from a small swamp to a lake with European settlers clearing and filling around the lake.
- Machin (1989) is cited by Halpern Glick Maunsell (1992) as stating that Gwelup is derived from the Aboriginal name Kwilup which is the place of the Kwilim bird or Coot.

Aboriginal Sites

The Department of Indigenous Affairs (DIA 2014) *Aboriginal Heritage Inquiry System* (AHIS) online database indicated the following two heritage sites were located in the study area. None of the registered heritage sites have restricted access. An additional site was listed in the previous MP (Site ID 3393) however this site is no longer registered by DIA. Two further non registered sites were also recorded in the Reserve (Table 21).

Table 21: Indigenous Search results for Lake Gwelup Reserve

ID	No.	Name	Location	Type	Access	Gender Restriction
Registered Sites						
3442	S02752	Lake Gwelup	In central west portion of Reserve	Ceremonial	Open	None
3501	S02569	Lake Gwelup	In south west portion of Reserve	Artefacts/ Scatter	Open	None
Non-Registered Sites						
3206	S00678	Lake Gwelup	In south east portion of Reserve	Artefacts/ scatter	Open	None
3393	S02753	Lake Gwelup	In lake	Camp and hunting ground	Open	None
3500	S02568	Lake Gwelup	In central west portion of Reserve	Artefacts/ scatter	Open	None

5.2.2 European Heritage

Lake Gwelup was long used as a water source for nearby residents and market gardeners, and parts of the Lake Gwelup reserve were previously utilised for market gardening. Remnants of this activity remained after the creation of the current reserve including a fence through centre of the lake (destroyed by vandals in 2009) and there remain water collection points on the north eastern lake shore.

5.3 ACCESS AND INFRASTRUCTURE

5.3.1 Paths

There are approximately 5 km of formal paths, boardwalks and bridges within Lake Gwelup Reserve and 2.8 km of informal paths. The total lengths of the different types of paths are listed in Table 22.

Table 22: Length of Paths in Lake Gwelup Reserve

Type	Surface	Length (m)
Formal	Concrete	3,200
	Consolidated Limestone	1,500
	Wooden Bridge	120
	Timber Boardwalk	200
	Total Formal	**5,020**
Informal	Grass (tracks across lawn areas)	800
	Sand (outside lawn areas)	2,000
	Total Informal	**2,800**
Total		**7,820**

Formal Paths

The majority of the path system consists of 2m width concrete paths. Other types of formal paths include consolidated limestone and timber boardwalks. The concrete path type is the primary path circumnavigating the wetland and connecting to adjacent street path systems. Many of the concrete paths are considered redundant due to the desire lines of pedestrian activity crossing lawn and sand areas on a shorter route.

Consolidated limestone paths require frequent maintenance. They are currently topped up and compacted every 1 to 3 years depending on terrain and usage by the City. The City has begun phasing out consolidated limestone paths in favour of bitumen paths to reduce maintenance requirements.

A timber boardwalk bridge provides a pedestrian connection to Pascoe and Porter Streets at the northern end of the Reserve. A timber boardwalk in the south western end of Lake Gwelup provides access to a timber viewing platform at the edge of the wetland.

The formal path system is popular for recreational walking and jogging by local residents. The Reserve is also accessed by a number of clubs and schools for the site's sporting amenities.

The paths form part of the City of Stirling's 'Bushlinks' Walk Trail (North-Western Zone), an urban walking route linking major bushlands within the City of Stirling that provide a planned and easy access to urban bushlands so that these areas can be better appreciated and valued for their natural attributes. More information on the Bushlinks Walk Trail is located on the City's website **here**.

Lake Gwelup Reserve is effectively bounded on all sides by a network of designated cycle paths which form part of the Bikewest cycleway system. Local Bicycle Route NW 1 runs north-south along the western boundary of the Reserve and meets NW 7, which runs east-west from Trigg beach on the coast and intersects the northern part of the Reserve before connecting with the Principal Shared Path associated with the Mitchell freeway. To the south, cycleway NW 8 adjoins both NW 1and the Mitchell Freeway cycleway.

Informal Paths

Paths identified as Grass (informal tracks across lawn areas) are not paths as such but are commonly used routes across lawns that were distinguishable on aerial photographs by the sparser grass cover.

Paths identified as Sand (informal outside lawn areas) are tracks through Flooded Gum and Freshwater Paperbark communities that have been established by and maintained by pedestrian traffic rather than any maintenance by the City of Stirling.

The identified informal paths may have resulted due to:

- poor wayfinding
- more direct route opportunity
- poor visual surveillance
- a desire to be closer to the wetland edge or in the bushland.

Wayfinding

Wayfinding is difficult throughout the site. In particular the bushland area to the north of the site appears to be have been created in an ad hoc fashion and numerous paths do not appear to have a destination. These paths dissect the bushland and decrease the connectivity of vegetation communities.

5.3.2 Signage

Signage within Lake Gwelup is currently lacking cohesion in terms of functionality and appearance. There are four types of signs erected in reserves, which are discussed below.

Functionality

The existing wayfinding signage lacks clarity, with graphics that are difficult to comprehend and no indication of the visitor's location within the site. Given the scale of the Reserve and potential connections to adjacent reserves or pedestrian and cycle path networks there is a need to establish a unified and coherent signage strategy.

The Reserve has limited interpretation of the natural and cultural aspects of the site and the role of the wetland as part of a larger wetland system. The signage currently provides basic content including diagrammatic references to key elements in the Reserve. Opportunities exist to communicate broader issues relating to the Reserve including climate change affects, maintenance restrictions, natural processes and features as well as cultural knowledge including the ways the site is to be used and why.

Additionally, the function of providing information regarding potential risks (e.g. snakes) and the status of the environment which could affect how a visitor interacts with the Reserve are limited to single small signs in ad hoc locations.

Appearance

Signage varies in size, type and form throughout the Reserve. Signage is typically located at Reserve entry points, however this often includes a cluster of multiple signs of varying materials and graphics which causes visual clutter and limits the effectiveness of communicating information to the user.

Some of the signs within the Reserve have evidence of bore water stains, which also detracts from the appearance and legibility of the graphics.

5.3.3 Car parks

Car parking at Lake Gwelup is generally informal and located at minor entry points or on the side of the road. There is one main car park located at the Scout Hall on the western edge of the Reserve, to cater for the facilities located in this main node. The car park has limited spaces and poor circulation. The turf areas north of the tennis courts are used for overflow parking during events held at the Reserve. The verge area along Segrave Street is also frequently used as an informal parping area by users of the reserve.

5.3.4 Structures

The Reserve has a number of structures in various states of access, condition and appearance. Structures include:

- boardwalk
- viewing deck
- Scout Hall
- rotunda
- shade sails
- play equipment.

The boardwalk and viewing deck were built in 1995. It is well-used and needs repainting, but otherwise appears to be in good condition. The bird hide provides excellent opportunities to view the lake and bird life.

The Scout Hall is in good condition however it is closed off from the public and disassociated with the rest of the main activity area on Huntriss Road.

The shade sails and play equipment are located in the main activity area adjacent to the Scout Hall and surrounded by mature trees. Generally the play equipment is in good condition however it lacks reference to the natural and cultural environment it is set in.

5.3.5 Sporting Amenity

Lake Gwelup Reserve has a number of sporting amenities including:

- tennis courts
- cricket pitch with lights
- cricket nets
- oval.

Generally the sporting amenity is in good condition.

5.3.6 Picnic Amenity

Lake Gwelup Reserve has a number of bench seats throughout the Reserve, however they are unevenly distributed, with many located in the southern half of the Reserve, and very few in the north. Furthermore, the seats are poorly located, with limited shade and often not connected to a path network or positioned to maximise an outlook.

Well-used picnic amenities and play equipment are located in the main activity node on Huntriss Road. The furniture and equipment appears dated and heavily bore stained.

5.3.7 Fencing

The Reserve has a perimeter fence which is currently in the process of being replaced by the City. The eastern side, along North Beach Road was replaced in 2013 and the southern side along Segrave Street is scheduled for replacement in 2015.

5.4 SPORTS AND RECREATION

5.4.1 Sports

Lake Gwelup Reserve has a number of opportunities for sporting pursuits due to the range of amenities available within the Reserve. All of the sporting amenities are located in the southern section of the Reserve, however concrete paths weave throughout the northern section of the Reserve catering to pedestrians and cyclists. The following sporting opportunities currently exist in the Reserve:

- cricket
- tennis
- cycling
- jogging.

5.4.2 Recreation

A number of recreational opportunities are also available within the Reserve, opportunities include:

- walking
- dog walking
- picnicking
- nature interaction (bird watching)
- play.

6.0 MANAGEMENT

6.1 MANAGEMENT MODEL

The objectives of the Management Framework are to:

- reduce or minimise areas where responsibilities, objectives and practices may conflict, particularly in conservation and recreation
- aid in the development of specific management practices appropriate to the different features of the Reserve, which aim to both enhance and converse the biodiversity of Lake Gwelup Reserve.

6.1.1 Issues

Vegetation Degradation and Decline

The vegetation within Lake Gwelup is severely degraded in both condition and biodiversity. Immediate management is required to reverse the decline of the vegetation to restore its local and regional natural values.

Site Complexity

Lake Gwelup is a large site which is diverse in natural and social features and land uses. Therefore it can be difficult to develop strategies and coordinate actions in the Reserve to address issues which will not conflict with other issues. It is also difficult to direct where in the Reserve certain works are to start and stop. A framework is therefore required that can divide the Reserve into specific sections according to their particular site features and management issues. Management actions may then be developed and implemented within particular sections which will not conflict with the features of the other sections.

6.1.2 Strategy

A three tiered hierarchy of management areas is used as the basis for planning in this management plan. These are (from broadest to most specific):

- **Land Use** - a management framework at a conceptual level on the basis of broadly identifying the Reserve's main functions
- **Zones** - a basis for developing management strategies on the basis of areas defined by relatively uniform management practices
- **Sites** - a basis for detailed planning of areas targeted for specific works.

The 2005 Management Plan embraced a similar concept through the inclusion of maps of intended land use activities and characteristics, particularly vegetation types, across the Reserve which equate to land uses. This report aims to align with the previous management plan to maintain continuity.

The interfaces between the different Land Uses, Zones and Sites need to translate into precise, distinct, uncomplicated and easily discernible boundaries. This will aid the City in determining where the management practices are to start and stop. Physical features such as pathways and fences may serve as such boundaries as shown in **Map 11** in **Appendix One** to indicate the recommended Land Use and Zone areas.

Management Framework

Lake Gwelup Reserve was separated according to its primary Land Uses:

- Conservation
- Sporting and Recreation.

Each Land Use was then further partitioned into Zones according to the main attribute, allowing to further direct specific practices into appropriate areas.

The Conservation Land Use was separated according to broad vegetation types :

- Bushland
- Transition
- Wetland.

The Sporting Recreation Land Use was separated by its intensity of social use:

- Sporting
- Recreation.

The City may now further separate each Zone into Sites by considering their physical, biological and social environment specific attributes. Each issue may have one or more issues requiring specific management works. For example, certain areas may require fauna habitat to be installed or monitored for specific weed species

Criteria may be used to determine the specific locations and/ or distribution of each Site issue. Key actions required to assist with identifying the locations of each criteria include, but are not limited to:

- Physical Environment
    - testing acid sulphate soils
    - monitoring water levels
- Biological Environment
    - mapping high priority weed species populations
    - significant fauna habitat
    - nests and shelter sites for feral and pest fauna
- Social Environment
    - locations of Aboriginal and European heritage
    - areas of frequent illegal and unauthorised activities
    - areas of frequent graffiti and wilful damage
    - areas of high natural amenity
    - infrastructure needing updating/ maintenance
    - new recreation infrastructure
    - resting areas lacking shade

Examples of attributes, issues and criteria that should be considered when dividing Zones into Sites are presented in Table 23. The process of separating the Land Uses into Zones and Sites using attributes, issues and criteria is summarised in **Figure 4**.

Table 23: Issues to separate Land Use and Zones into Sites

Land Use	Conservation	Sporting and Recreation Land
Zone	Vegetation Types: • Bushlands • Transition • Wetland	Intensity of Use: • Sporting • Recreational
Attributes	Physical Environment • hydrology • soil type • topography Biological Environment • biodiversity • fauna habitat • significant flora and fauna • vegetation community • vegetation structure Social Environment • education • heritage	Physical Environment • topography Biological Environment • biodiversity Social Environment • education and interpretation • heritage and culture • infrastructure • recreation activity • sense of place • visual amenity
Issues	Physical Environment • acid sulphate soils • groundwater levels • lake water levels • water discharge quality Biological Environment • biodiversity potential • degree of vegetation degradation • fire risk management • integrity of vegetation structure • native & non-native fauna • plant diseases • revegetation • vegetation complexes and floristic communities • type of impact on vegetation • vegetation structure • weed control • pets Social Environment • education opportunities • Aboriginal heritage • European heritage • trampling of vegetation • unauthorised and illegal activities	Physical Environment • irrigation Biological Environment • weed control • native fauna • landscape tree species Social Environment • Aboriginal heritage • access • education opportunities • European heritage • graffiti and wilful damage • recreation activity type and intensity • visual amenity • shade • unauthorised and illegal activities
Criteria to separate Zones into Sites	Physical Environment • PASS boundaries • Water level • Water discharge sites Biological Environment • significant native fauna habitats • other local native fauna habitats • high priority weed species • vegetation communities Social Environment • Aboriginal heritage • European heritage • infrastructure type	Physical Environment • landform Biological Environment • weed populations • significant native fauna habitats • other local native fauna habitats • pests and feral species • landscape tree species Social Environment • infrastructure maintenance • irrigation areas • education opportunities • graffiti and wilful damage types and locations • recreation activity type and intensity • areas of high visual amenity • Areas requiring shade • unauthorised and illegal activities

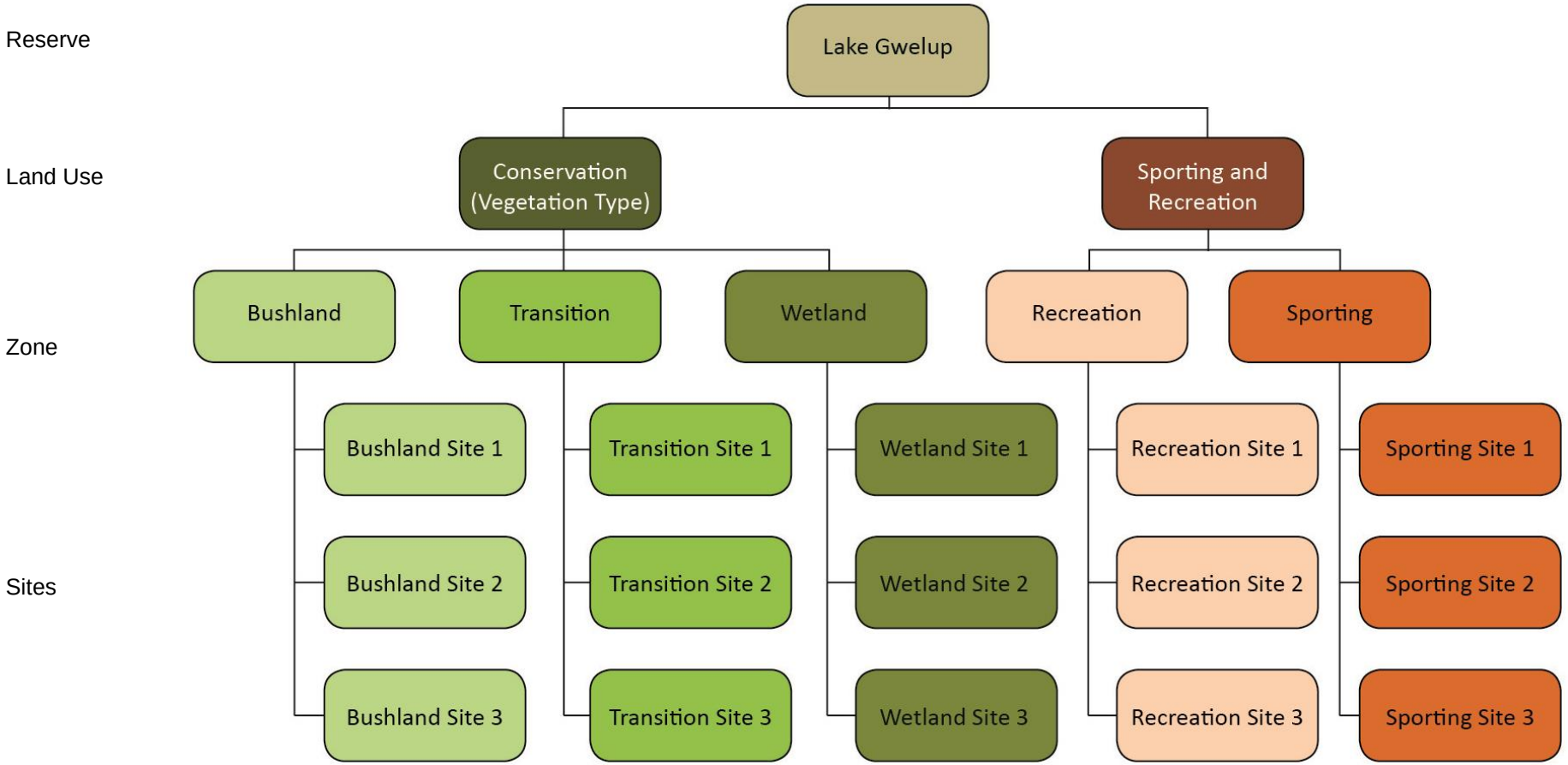

Figure 4: Management Framework for Lake Gwelup Reserve

6.1.3 Performance Measurement

The Management Plan uses the Best Practice management approach, which includes assessing the success of managing all of the identified issues and opportunities. Each issue will have a performance measure for the City to aim for within the five year time frame. It should however be noted that some these measures may not be achieved within this period, as:

- the City is limited in its human resources, field equipment, technology, training and budget
- some factors are outside the City's control (e.g. rainfall, adjacent land managers, water abstraction).

6.2 CONSERVATION MANAGEMENT

6.2.1 Hydrology

Objectives

The objectives of the hydrology strategy are to:

- protect and manage surface and groundwater to maintain biological and social values of the wetlands and Reserve
- conserve the wetland vegetation
- reduce the risk of water quality being degraded.

Applicable Land Uses and Zones

- Conservation (Transition, Wetland)
- Sporting and Recreation (Recreation).

Issues

1. Declining Water Levels

It is likely that the Reserve's declining wetland and groundwater water levels will threaten the biological values of the wetlands and exposure of acid sulphate soils.

2. Water Quality

The water quality in Lake Gwelup is being contaminated by various pollutants from the surrounding catchment known to have high iron sulphate content. A principal entry point of these pollutants is Brushfield Way drain and the small basin at its eastern end. These in turn receive stormwater drainage from the Delawney Street Branch Drain, the Amelia Street Branch Dain and adjacent sections of Mitchell Freeway. Owing to declining groundwater levels resulting in the acidification of soils of the surrounding catchment, Brushfield Way drain receives considerable inflow of acidified water carrying with it the sulphides of iron and other toxic heavy metals and metalloids

3. Classification of Unnamed Dampland UFI 8176

The sporting field near the southwest corner of the Reserve is currently listed within the DEC (2001) Geomorphic Wetlands Swan Coastal Plain Dataset as a Conservation Category Wetland (UFI 8176). Due to the area comprising of a non-vegetated sporting field it is assumed that this classification was given in error.

Strategies

1. Declining Water Levels

The City cannot prevent the seasonal drying out of Lake Gwelup as this is subject to declining groundwater levels due to insufficient rainfall and aquifer recharge. It is also dependent on the rate of groundwater abstraction by other public and private agencies within the Swan Coastal Plain. The popular notion that Lake Gwelup could be deepened to express water is therefore flawed. Besides, such a measure would be environmentally invasive and therefore not advocated. It should be noted that the wetland was historically an ephemeral wetland. The current pattern of seasonally lowered wetland levels does in fact resemble pre-urban landscape conditions.

Future revegetation works in the upper wetland and transition area (i.e. Freshwater Paperbark Woodland to Flooded Gum Open Forest vegetation communities) should ensure that local native species are used that are able to tolerate a range of soil moisture conditions, may survive drying conditions and can maintain healthy vegetation.

The City will meet with the Water Corporation to discuss the implications of their 22 production bores east of the Reserve in the Gwelup Bore Field and the options available for management of Lake Gwelup. The City can also investigate its management of local stormwater discharges, which may slightly increase the groundwater levels.

2. Water Quality

The Brushfield drain should be converted into an effective biofilter to attenuate the discharge of sulphides of iron and other heavy metals as well as acidic groundwater into Lake Gwelup. Embankments of the drain and the small basin should also be intensively established with native reeds and rushes to accumulate nutrients and polluants. Exposed embankments should be mulched with organic mulch (e.g. wood chip) to reduce exposure to oxygen and reduce the acidication processes. The City should also liaise with the Water Corporation and the Department of Environmental Regulation (DER) to remediate the Delawney Street Branch Drain and the Amelia Street Branch Dain to ameliorate these conduits of acidified groundwater flows.

Currently of the 11 City drains that directly enter the wetland only four have some kind of water quality improvement device (GPT or other trap) installed. Following monitoring to determine the characteristics of contaminants entering the wetland from individual drain lines, locations for installing addition GPTs or other water quality management devices may be considered. **Map 4** in **Appendix One** shows existing locations of GPTs and other traps and provides potential location for additional devices to be installed.

Bioretention basins should be considered at all drainage outlets directly entering the wetland. Implementation of either of these strategies would require additional study and specific planning following assessments of the quality of water and the level of contaminants flowing from individual drain locations. Additionally the study would have to consider the feasibility of conducting works in that area. Any earthworks that may disturb areas mapped as PASS should be avoided.

3. Classification of Unnamed Dampland UFI 8176

The City should prepare and submit an application for modification of the Geomorphic Wetlands Swan Coastal Plain Dataset request DPaW to change the CCW classification on UFI 8176 to Multiple Use (MU).

Recommendations

Table 24: Hydrogeology Strategy Recommendations

1	Recommendations	Priority	Responsible Party
1.01	Continue to monitor wetland water levels.	High	City
1.02	Revegetate the transition area with appropriate local native species that can tolerate a range of soil moisture levels to account for any future lowering of the water levels	High	City
1.03	Meet with Water Corporation to discuss the implications of their 22 production bores east of the Reserve in the Gwelup Bore Field and the options available for management of the Lake Gwelup.	High	City
1.04	Intensively establish native reeds/ rushes open embarkments of Brushfield Way drain and small basin at eastern end and mulch these areas to contain leaching of acids and iron sulphides into the water.	High	City
1.05	Liaise with Water Corporation and DER to remediate the Delawney drain and reduce the acidity and pollutants being released into Lake Gwelup.	High	City
1.06	Investigate whether GPTs, bioretention basins or other water quality improvement device should be installed on drains directly or indirectly discharging into Lake Gwelup	High	City
1.07	Submit an application to DPaW that Wetland UFI 8176 have its CCQ classification changed from Conservation to Multiple Use.	Moderate	City

6.2.2 Acid Sulphate Soils

Objectives

The objective of the Acid Sulphate Soils Strategy is to:

- ensure that land containing ASS is managed to minimise potential adverse effects on the natural and built environments.

Applicable Land Uses and Zones

- Conservation (Wetland)

Issues

1. PASS Exposure

WAPC (2000b) states that the Lake Gwelup wetlands are thought likely to contain high risk PASS. If present, the soils in the wetlands are currently inundated by water and therefore inert. However, if the soils are disturbed and exposed to the oxygen in the air, it may trigger sulphuric acid production, increasing the acidity levels of the soil and water. The two likely risks of exposure may come from disturbance of the wetland soils and falling groundwater levels.

Strategies

1. Site Works

The City should ensure that any future works conducted in or immediately surrounding the wetlands should be managed so that they do not disturb any areas containing AASS or PASS, such as.

- maintenance works on boardwalks and bird viewing platform
- upgrading and/or annual cleaning out stormwater drainage outlets.

2. Monitoring

The City cannot prevent any significant decline in ground water levels caused by seasonal and climate change. If the wetlands do contain ASS, the City should continue to monitor both the ground and wetland water levels to detect any such decline and determine whether any actual or potential ASS becomes exposed.

Recommendations

Table 25: Acid Sulphate Soils Strategy Recommendations

2	Recommendations	Priority	Responsible Party
2.01	Ensure that any future works around and within the wetland do not disturb any potential or actual acid sulphate soils	High	City
2.02	Continue to monitor ground and wetland water levels and determine if it exposes any acid sulphate soils	High	City

6.2.3 Weed Control

Objectives

The objectives of the Weed Control Strategy are to:

- identify and control existing populations of high priority weeds species
- prevent introduction of additional weed species
- prevent encroachment of weeds into bushland areas
- improve bushland and wetland condition
- assist revegetation
- improve fauna habitat
- improve natural amenity
- reduce costs of ongoing maintenance
- educate the local community regarding human impacts that contribute to weed invasion.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Sporting, Recreation).

Issues

1. Weed Inventory and Mapping

The weed inventory compiled for some species is incomplete. Some of the weed species may no longer exist in the Reserve, while other unrecorded species may be present. Also, the location and distribution of some weed species are unknown. A detailed assessment of the site is required to determine:

- what species are present
- their location, size and spatial distribution
- their level of threat to the Reserve
- their current population size and spatial distribution.

2. Priority Weed Species

Out of the 63 species recorded or thought to occur in the Reserve, a total of 24 weed species were identified as High Priority to control. The location and distribution of some high priority weed species are currently known.

Populations of one of the high priority weed species, Perennial Veldt Grass (*Ehrharta calycina*) is known to become resistant to grass specific herbicides (e.g. Fusilade) and is becoming more difficult to control and prevent entering the bushland vegetation.

The majority of weed species may have been introduced through “escapees” from:

- residential gardens
- empty building lots and verges that are not maintained
- adjoining parklands
- proliferation of tracks
- domestic pets recreation activities.

A list of potential garden escape weed species present in Lake Gwelup is presented in **Appendix Two**. Photo examples of garden escape weed species are presented in Plates 1-4. A link to the City’s Bushland Weeds pamphlet is presented **here**.

Plate 1:Examples of garden escape geophyte weed species a) Arum Lily and b) African Cornflag

Plate 2: Example of garden escape graminoid weed species a) Giant Reed and b) Couch

Plate 3: Example of garden escape herb weed species a) Black Nightshade and b) Whiteflower Fumitory

Plate 4: Example of garden escape woody weed species – Castor Oil

3. Optimal Control Times

Most weed species have optimal times of the year when they should be controlled. Weed control operations are best conducted targeting many species as possible during their optimal times to reduce the number of site visits required. This would reduce the need for management and minimise the costs and resources.

It is more important to target all high priority weed species during these operations, and only include moderate and low priority weed species if resources allow.

4. Weed Control Methods

Certain weed control methods may harm the public and the environment, in particular certain types of herbicides and surfactants. As such all methods will need to be examined and harmful methods restricted. The preponderance to use herbicides must be revised in favour of integrating with non-chemical methods, such as mechanical slashing and hand pulling.

5. Monitoring Weeds

It should be noted that the weed management issues for Lake Gwelup Reserve may change over time. Some causes for this change are listed below:

1. Optimal times for controlling weeds may change as a result of local changes. For example, early winter rainfall or a fire may trigger weed seed germination, requiring control times to be conducted sooner than anticipated.
2. The removal and/or reduction of some weed species may remove pressure on other weed species, potentially allowing them to invade and become dominant.
3. New weed species may be introduced to the Reserve.
4. The location and distribution of weed species will change as a result of seasonal change, their ability to invade and dominate an area and success of weed control operations
5. Increased impacts of recreational activities such as BMX tracks and ramps, offroad motorbikes, dog walkers, hiking, cubbies, drug and alcohol campsites, Rogaining/ orienteering, Geocaching and Waymarking, as described in Table 26.

Table 26: Definitions of unauthorised bushland activities in the bushland

Unauthorised activity	Description
Rogaining/ Orienteering	A sport of long distance cross-country navigation involving both route planning and navigation between checkpoints using a variety of map types. In city environments, treks commonly use bushland reserves
Geocaching	A recent recreational activity which the participants use a Global positional satellite (GPS) receiver or other navigational techniques to hide and seek containers, called "geocaches" or "caches", anywhere in the world, often in urban and rural bushland areas. A typical cache is a small waterproof container containing a logbook where the geocacher enters the date they found it and signs it with their established code name. After signing the log, the cache must be placed back exactly where the person found it. Containers are often buried in urban bushland reserves.
Waymarking	Posting of signs along a route to help travellers follow a route. One example is the use of chalk dust arrows for Hash House Harriers.
Uncontrolled Dog activity	Dogs which are not under control (i.e. are not close enough to be put on a leash if necessary and not responding to owners commands moving through bushland)
BMX bike riding	The riding of bikes and construction of bike tracks/ jumps in bushland areas
Motorbikes and Quad Bikes	The use of any motorbike off established roads in the Reserve
Camping	The construction of temporary camping areas in bushland with associated vegetation damage, fires, toilet sites and rubbish dumping
Cubbies/Tree houses	The construction of cubbies or tree houses

Strategies

1. Weed Surveys and Mapping

The City should organise a survey of the reserve to:

- determine what weed species are present
- map the location and distribution of weed species.

The ideal time for a weed survey is between August and September, when seedlings and bulbous plants have emerged and grown to a size that makes them identifiable, however this time may vary as result of local weather patterns. Also, it is possible some weed species may not be identifiable during these months. The City's Natural Areas staff should continue to observe weed plants in the Reserve throughout the year during other work operations and include any new observed weed species to the inventory.

Weed species should be mapped according to whether they are distinct individuals (e.g. trees) or populations (e.g. grasses). Distributions of populations should be recorded by either using a GPS handheld unit to trace the perimeter of each population or by marking boundaries on printed aerial photographs of the Reserve.

The densities of each weed population are classed by the percentage weed cover or abundance. A suggested percentage class system is presented in Table 27 using an adaption of the DEC (2011) *Techniques for mapping weed distribution and cover in bushland and wetlands*.

Table 27: Suggested density rating systems for weed densities

DEC 2011		Ecoscape	
Rating	**%**	**Rating**	**%**
Low	Less than 5%	Trace	Less than 5%
Moderate	6-75%	Low	6-25%
		Moderate	26-50%
		High	51-75%
High	76-100%	Very High	76-100%

The City Officers require modern GPS equipment and mapping systems to conduct the weed surveys. The City's Natural Areas section are currently using outdated equipment and methods which are very time consuming and do not accurately capture weed distribution and density. The natural Areas group also lack human resources to carry out the survey works.

2. Site Strategy

Weed control is generally based on one of three types of strategies:

- Site based (targeting weeds within the best condition areas of the study area, then proceeding to target weeds in lower conditions areas)
- Species based (targeting weed species across the entire study area according to their priority)
- Cause based (targeting the cause of weed invasion and spread).

Weed control in Lake Gwelup Reserve should follow a *site based* strategy, in order the first conserve the remnant bushland values, followed by a *species based* strategy. The Reserve should be divided into sections, based on their general condition. Weed control should be focused in the north portion of the Reserve. Once weeds are almost completely eliminated in this area, works should begin to focus into another section, to control weed populations. The northern section should still be monitored and any remnant weed populations controlled.

Within each section, resources should be first focused on controlling High Priority weeds, as these are considered the most invasive and threatening to the Reserve. However, other weed species should not be excluded from control activities if there are enough resources available.

In general:

- High Priority weed species should be targeted first
- Moderate Priority weed species should be controlled opportunistically if resources allow after targeted control of High Priority Weeds
- Low Priority weed species should be controlled opportunistically if resources allow after control of Moderate and High Priority Weeds.

It should also be noted that as weed control of priority species progresses, other weed species which previously may not have been rated as high, may become more important. Therefore, it is important to keep weed control programmes flexible and updated according to monitoring data to ensure that as bushland condition changes and weed species dominance changes, the control activities are adjusted accordingly.

Also, any new weed species identified in the Reserve should be prioritised according to the process outlined in **Appendix Five** and targeted according to their final rating and available resources.

Invasive weed species are also introduced into the bushland via proliferation of tracks from dog walkers, BMX tracks and other recreational activities. Fencing of areas where weed control works are being undertaken are required to control further weed invasion.

3. Optimal Control Times

The optimal control times for targeting the known weed species was determined using the methodology presented in **Appendix Five.** It was determined that the most efficient times to target all of the known high priority weed species are July and November. These months are also suitable for targeting all of the Moderate and Low Priority weed species, except for the Giant Reed (*Arundo donax*) which is optimally targeted in February and March.

It should be noted that the weed survey will result in a different inventory than the one presented it this report, which may affect the recommended activity times. Any new identified weed species will need to have their optimal control times determined using the same methodology. The months may need to be adjusted to accommodate the change in the inventory to aid in targeting the new weed species and removing weed species determined to no longer occur.

4. Targeting Weed Growth Forms

Identified weed species were separated into four growth form groups according to their biology. The growth form groups were then subdivided to group weed species with similar methods of control. The grouping was to aid in understanding what types of weeds were dominating the study area and what main control actions would be needed to reduce their diversity and presence (Figure 5).

It is important to understand the biology of each identified weed species in order to determine the best way to control them. Knowledge should focus on how the plant grows and propagates in order to both remove the existing plants and to prevent future generations. As such, the identified weed species were separated into four types, according to their biology and the type of control methods.

The following section describes the biology of each of the four weed growth forms and notes which of the below control methods are the most effective to control that type.

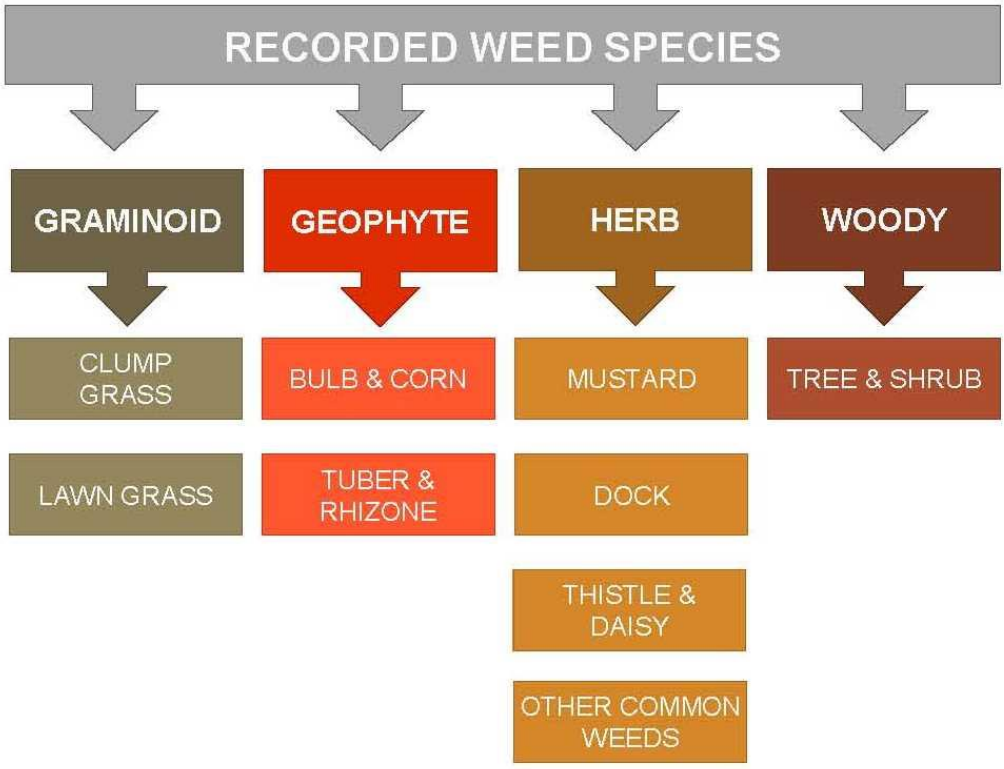

Figure 5: Growth forms of Lake Gwelup weed species

a) Geophytes

Many geophyte weeds are 'garden escapes'; originally planted in people's gardens for aesthetics where seeds have entered adjacent bushland. Most of these species are Irises (family Iridaceae) from the cape region of South Africa. The similar climate and soil types made the Perth metropolitan region and south west highly suitable for these species to proliferate and become major environmental weeds.

Geophyte weeds are plants capable of reproducing though underground propagules such as bulbs, corms and tubers. Normal weed control practices are inefficient, as the parent plant may be killed, but the plants may return from sprouting underground propagules. Weed control therefore requires targeting the propagules as well as the parent plant.

If the populations are small, it may be practical to manually remove the plants. Care must be taken to dig around each plant and ensure that all of the underground propagules are also removed, otherwise new plants will appear in the following year. Caution must also be taken if digging in aboriginal heritage sites, as this method risks damaging burial remains.

Certain herbicides such as chlorsulfuron, metsulfuron and 2, 2 DPA are often used to control geophytes, as they can poison both the parent plant and the underground propagules. Such herbicides are best applied when the plants are flowering to maximise the absorption into the propagules. Application can be carried out by either wicker wiping or spot spraying, depending on the species (e.g. wicker wiping is ineffective on Guildford Grass but is highly effective on Watsonia). Special care must be taken to ensure that adjacent native plants are not exposed to these harmful chemicals. Metsufluron is a common herbicide control treatments that will control most of the recorded geophyte weeds (e.g. Arum Lily, Black Flag, Soursob).

b) Graminoids

Grass, sedge and rush species are all closely related monocots. They have similar physiology which makes them susceptible to certain herbicides that may not be as harmful to broad leaf plants. Using grass selective herbicides such as Fusilade® may assist in controlling monocot weeds while having minimal impact to adjacent broad leaf native plants. Herbicides may be applied through wicker wiping or spot spraying. Many of these species are highly competitive with native plants and can dominate the understorey. Most monocot weeds, particularly annuals, produce high numbers of seeds to ensure seedling recruitment in the following year. It is therefore vital to control infestations before they set seed to prevent further spread of these populations.

Some of these species, in particular lawn grasses, can also spread by rhizomes and stolons. If the grasses cover the ground, effectively forming a lawn, they may in some circumstances be controlled by smothering them in black plastic in summer. If the grasses are invading into bushland areas, they may be controlled by manually gathering the spreading rhizomes/ stolons and removing them off the site.

c) Herbs

Along with grasses, herbs are usually the most common type of weed species in a bushland. Most species do not invade good condition bushland, rather they are opportunists that enter when a site is disturbed. Broad leaf herbs are generally easier to control than geophytes, as they only spread by seed and do not have underground propagules. Such weeds should therefore be controlled before they can set seed, as this is their only method of reproduction. Herbs can be controlled through most general methods. Small populations should be manually removed before they set seed. Care must be taken to remove the crown and taproot, otherwise plants may resprout.

Most species are susceptible to glyphosate when actively growing, although other herbicides may be required on some glyphosate tolerant species. Herbicide application may be through either wicker wiping or spot spraying, depending on the size and nature of the infestation in each reserve.

d) Woody Weeds

Many woody weeds (tree, shrub and climbers) are 'garden escapes' which have invaded adjacent bushlands. Other species, such as the Summer Scented Wattle, are local native species which can be aggressive and dominate in disturbed environments. Most species of this type are generally easy to control. Timing should focus on when they are actively growing and before they set seed.

Mature plants of trees, shrubs and perennial climbers may be cut to ground level and the stump treated with straight glyphosate to prevent the roots from resprouting. Trees and shrubs with prominent stumps may be treated with stem injection or basal bark spraying. Seedlings and annual climbers should be eliminated before they can mature. If numbers are small, it is best to manually remove them. If numbers are high, spot spraying would be more practical.

5. Application of Herbicides

a) Organic Herbicides

The role of organic herbicides was considered for Lake Gwelup Reserve. Organic herbicides use plant based products, including vinegar and plant essential oils (e.g. pine oil, lauric acid, pelargonium oil, citric oil). These products dissolve the out layers of leaves and seeds and cause plants to desiccate. As they target the physical structure of the plant, rather than chemical pathway as synthetic herbicides do, weeds cannot develop a resistance. Also, they are fast acting, and can be seen to work within 15 minutes. Organic herbicides have a short period of activity in the soil and are safe for operators (Marshall 2012).

However, there are several disadvantages to organic herbicides, they:

- are non-selective and can harm native plants
- only work effectively in high temperatures (i.e. above 30^0 C), so are restricted to summer months
- do not affect lignified (woody) plant parts, so are ineffective on mature woody weeds (e.g. trees)
- are not absorbed into the plant, so cannot eradicate bulb and tuber weeds (e.g. Arum Lily, Guildford Grass, Gladiolus)
- are extremely expensive use as the herbicides are expensive and large amounts must be applied (far more expensive than synthetic herbicides requiring smaller amounts), so are cost-prohibitive in large scale weeding works
- require high volumes of water as every entire weed plant must be covered (Marshall 2012).

Organic herbicides are considered to not be appropriate for Lake Gwelup Reserve, as they:

- are too expensive and cost-prohibitive for such a large area
- are restricted to the summer months, missing the spring period when many weed species drop seed
- can only target certain herbaceous and grassy weed species
- can be difficult to apply onto weeds without harming adjacent native plants.

b) Synthetic Herbicides

It is necessary that the application of herbicides be in accordance to labelling requirements or the manufacturers Materials Safety Data Sheet (MSDS) and must be undertaken by qualified personnel trained in the use of herbicide chemicals. The application of any herbicide for purposes not specified on the labelling requires an Off-Label Permit from the National Registration Authority in Canberra. Care must be taken herbicides are not applied on adjacent native vegetation.,

Where possible, a variety of herbicides are recommended for controlling each weed species. It is up to the contractor to decide which herbicide is the most appropriate to use, depending on costs and availability of the herbicides. Specific herbicides (e.g. grass specific herbicides) are preferred over general herbicides (e.g. glyphosate) as they are formulated to kill that weed growth form and have little impact on nearby native plant species. It should be noted that no specific herbicides are harmless to all native plant species, so application of any herbicide should be done with care.

Surfactants should not be used with the herbicide treatments near or in the wetlands. Many common herbicides such as Roundup® contain NPE surfactants which are known to affect the development of amphibian species, which can lead to a decline or even loss of such fauna species (Mann & Biggs 1999). Herbicides not containing NPE surfactants, such as Biactive®, are strongly recommended.

The application of herbicides must also be in accordance with water catchment restrictions. Chemical based weed control strategies, in particular, must recognise potential adverse impacts on water resources such as lakes, wetlands, streams, rivers and dams. Significant control measures must be implemented in Public Drinking Water Sources Areas. The Department of Water's (2000) *Statewide Policy No.2 Pesticides in Public Drinking Water Sources Areas* provides further advice on this matter.

Information relating to the mobility of herbicides in soil, average half life in soil and water, and bioaccumulation can be found within the herbicide's Materials Safety Data Sheet (MSDS). The herbicide's label should also contain a section outlining appropriate measures for the "Protection of Wildlife, Fish, Crustaceans and Environment".

d) Herbicide Techniques

i> Stem Injection

An easy method to kill large trees and shrubs is to drill a hole into the trunk at a 45 degree angle and to immediately fill the hole with herbicide. The hole must be deep enough to penetrate the sapwood to ensure the herbicide is absorbed and circulated within the plant. If the plant has multiple stems, then all stems will need to be treated (Dixon & Keighery 1995).

ii> Cut Stump

Some species may be controlled by cutting down to ground level and treating the stump with straight herbicide. Typical species suitable for such treatment are trees, shrubs and vines (Dixon & Keighery 1995).

iii> Wicker Wiping

Herbaceous weed species may be treated with herbicide by wicker wiping. This involves sponge or rope soaked in a concentrated herbicide solution which is wiped against the leaves of the plant (Dixon & Keighery 1995). Wiping is often more effective in targeting weed plants and not harming adjacent native plants, however this process may be more labour intensive. Weeds most ideal for this treatment are small populations of small shrubs and broadleaf herbs.

iv> Spot Spraying

Spot spraying involves fine spraying a weak solution of herbicide over the foliage of the weeds. Certain tree species may also be treated by spot spraying the base of the trunks with herbicides diluted in diesel. Care must be taken to avoid spraying adjacent native plants. Use of selective herbicides may reduce impact of herbicides on native flora (Dixon & Keighery 1995).

6. Herbicide Resistant Perennial Veldt Grass

Alternative control methods should be considered to target known populations of grass specific herbicide resistant Perennial Veldt Grass. Methods include using alternative non-specific herbicides, such as glyphosate and frequent mowing to prevent seed set. The methods must be carefully considered and applied as they may harm adjacent native vegetation.

The City should also consider rotating its control methods for other populations of Perennial Veldt Grass to prevent further resistance from occurring.

7. Monitoring Weeds

It is recommended that the quadrats be monitored every year and updating of records should occur as often is as practicable to assess the success of weed control programs.

The City's Natural Areas staff should continue monitoring the Reserve throughout the year. The monitoring programme should:

- assess the success of previous weed control efforts
- detect any changes in weed species presence and distributions
- determine whether the control times and methods of weed programmes need to be adjusted
- identify any new weed species.

When monitoring the site, the following strategies should be adopted:

1. Establish monitoring quadrats in areas subject to weed control programs to record the effectiveness of control methods.
2. Monitor any change in distribution of the High Priority species.
3. Monitor for establishment of any new weed species.

In order to determine the effectiveness of any weed control programme, there needs to be a method of determining success and ongoing progress. The following performance criteria could be used or adapted, based on the monitoring data collected:

1. Control/ eradicate at least one third of the High Priority weed species from the site over the next five years.
2. Reduce the area of all High and Moderate priority weed infestations by 50% over five years.
3. Reduce the total number of weed species in the area by at least 50% over five years.

Although not appropriate as performance criteria, other information can be recorded to assist in an overall view of the effectiveness of weed control activities within the site:

1. *The number of new weed species recorded* – it is expected that, initially, new weed species may be recorded as these species may not have been identifiable at the time of the field survey. Over time, it is anticipated that the number of new species recorded should plateau, and then the total number of weed species decrease.
2. *Any new infestations of High Priority species* – this information can be used to determine source areas for new infestations, and, assessed against the number of hours spent on its control, allow an analysis of the success of control of particular species.

Monitoring data is useful not only for determining the success of weed control activities, but also for planning weed control activities from year to year. In order for monitoring data to be useful, it needs to be fed back to the managing agencies. That is, any work undertaken in the field, whether it be actual weeding or monitoring of previous weed control sites, should be fed back into a central management system to ensure efforts are being focussed where they are most needed and to ensure the groups are aware of each other's activities.

8. Lake Gwelup Weed Manager

A separate spread sheet document has been provided with the following information for all weed species recorded of thought to occur in Lake Gwelup Reserve:

- Inventory (full list of weed species and their growth form)
- Priority (state and national ratings and calculated priority rating)
- Control Time (optimal and suboptimal control times)
- Management
- identification, including links to Florabase, Weed Australia, DOE and other information websites.
- manual and herbicide control methods
- Extra Information (taxonomy, reproduction method, threat and impact on native vegetation)
- Herbicides (names, active ingredient, schedules and registrations)
- References.

The Lake Gwelup Weed Manager spreadsheet is a management tool for City officers to determine cost and time effective methods to target weed species, such as determine what species may be optimally controlled at a certain time of year and the most appropriate methods.

Recommendations

Table 28: Weed Control Strategy Recommendations

3	Recommendations	Priority	Responsible Party
3.01	Survey Reserve to determine full weed species inventory and map high priority weed populations to assist with weed strategy	Moderate	City
3.02	Implement site weed control strategy, focusing first on conserving best condition woodland sections, then proceeding into areas of lower bushland condition.	High	City
3.03	Within each section, target first high priority weeds, then proceed to lower priority weed species,	High	City
3.04	Use Lake Gwelup Weed Manager spread sheet to direct site works according to growth form and optimal control times and methods.	High	City
3.05	Consider alternative control methods to control herbicide resistant populations of Perennial Veldt Grass.	High	City
3.06	Rotate control methods for targeting non-herbicide resistant populations of Perennial Veldt Grass to prevent resistance from occurring.	High	City
3.07	Monitor weed populations to determine success of site works and adapt as necessary	Moderate	City

6.2.4 Revegetation

Objectives

The objectives of the Revegetation Strategy are to:

- improve the vegetation condition
- reinstate indigenous flora and vegetation communities where they have been disturbed and/ or depleted
- restore native biodiversity
- improve the resilience and vibrancy of native vegetation
- conserve local provenance
- improve visual amenity.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Sporting, Recreation).

Issues

1. Flora Diversity

The report determined three issues in terms of flora diversity:

1. The vegetation condition in Lake Gwelup Reserve is highly degraded and contains a low biodiversity value.
2. The hydrology and topography within Lake Gwelup is variable across the site. This gradient would result in variation in species and community distribution, resulting in three general conservation zones (wetland, transition, bushland).
3. The importance to preserve provenance (local genetics) of local native plant species when conducting revegetation work.

2. Ecozones

Each of the management zones, whether conservation or recreation, may vary in their revegetation needs. For example, revegetating a parkland zone may require planting dense rows of small aesthetic shrubs and herbs near pathways and installing widely spaced trees further away from the path. Likewise, a wetland

zone may need to be planted with a mosaic of different sedges and rushes to promote different bird habitats. Revegetation efforts require a guide to assist in the selection of appropriate plant species and revegetation design within each zone.

The management framework in **Section 6.1.3** separated Lake Gwelup Reserve into Land Uses and Zones using fences and paths as boundaries (**Map 11**). As a result, some of the areas currently contain lawn are now classified as Conservation areas. These areas should have the lawns removed and restored to the designated Conservation Zone.

Also, several small areas have been identified near public facilities (e.g. car parks, buildings) that may be revegetated with aesthetic local native species. This will both increase the level of native vegetation and decrease watering requirements and lawn maintenance.

3. Land Use Boundaries

There are often no clear boundaries between the vegetation and parkland land uses. This can lead to a parklands areas expanding by "creeping" into the vegetation, through lawn grass invasion or mowing practices. A clear boundary with a buffer is required to help separate the areas and conserve the vegetation.

4. Vegetation Community Mapping

One of the factors that may assist revegetation design of conservation areas is the distribution and composition of existing vegetation communities. Revegetation design within Conservation Land Uses should follow the structure and general distribution of vegetation communities presented in **Map 8** in **Appendix One**.

5. Significant Species

The report identified three native species of state significance and eight species of local significance. Revegetation work should promote these species in appropriate sites to help increase population sizes to help conserve them.

6. Non-indigenous Tree Species

Three non-indigenous tree species were identified in the reserve – *Agonis flexuosa* (Peppermint Tree), *Callitris preissii* (Rottnest Island Pine) and *Corymbia ficifolia* (Red Flowering Gum). *Agonis flexuosa* and *Callitris preissii* are considered weed species as their seeds readily germinate and spread into bushland. Corymbia filifolia is not considered generally considered a weed it is not invasive. All three species were either accidentally or deliberately planted in the Reserve as part of revegetation or soft landscaping works.

7. Dead and Damaged Trees

Local native trees may be damaged or die from events such as storms and diseases. It is important to replace or treat the trees as they provide shade and fauna habitat and are an integral part of vegetation communities.

Strategies

1. Flora Diversity

The City should conduct revegetation works to increase biodiversity values. Revegetation work will need to direct species to appropriate revegetation zones and sites to ensure a higher rate of survival. By identifying which species are appropriate for each Land Use, Zone and Site, it will also encourage plant survival and a higher level of biodiversity.

The non-indigenous tree species *Agonis flexuosa, Callitris preissii* and *Corymbia ficifolia* are considered not to be appropriate and should not be used in future planting works.

It is recognised that the required revegetation works will need a large amount of propagules (e.g. seed, tubestock). It is important that all of the propagules are sourced from local vegetation to preserve the local genetics (provenance). As outlined in the City's *Green Plan 2*, the City has designated the municipality into eight provenance zones according to their soil type and should only use the seed stock sourced from a matching zone in revegetating a reserve. Since Lake Gwelup is designated as party of Zone D (Low Lying - Grey Black Sands), the City should only use seed soured form Zone D to revegetate the Reserve.

More flora surveying should be conducted in the Reserve and adjacent Karrinyup Golf Club's bushlands to confirm the presence of recorded native flora and to determine more understorey species that occur in the vegetation communities. Surveying should be conducted in spring to aid in detecting

2. Ecozones

Areas of parkland may be revegetated to resemble the remnant vegetation. These are where the Conservation Land Use has degraded into lawn areas into adjacent to original vegetation communities. The Sporting and Recreation Land Use areas which are not being actively used by the public and could either be:

- infilled with local native species to improve the visual amenity and reduce lawn cover.
- restored and become part of the Conservation land Use.

Several specific areas that may be revegetated include:

- groups of trees that are difficult to mow around
- open parts of parkland that are not well used.

Each ecozone may need to be subdivided into Sites, according to their unique features, some of which are presented in **Table 22** in **Section 6.1.3**. A revegetation design may then be developed and appropriate plant species used to suit each site's features or proposed use.

3. Land Use Boundaries

It is proposed that the pathways be used as a buffer and boundary line between the conservation and recreation land uses. This will help stop lawn grasses encroach into the native vegetation and provide a clear boundary to direct site works.

4. Infill planting

The City should also consider landscaping small areas near public facilities with aesthetic local native species. This will improve the visual amenity of the area as well as increase the abundance of local native flora.

5. Significant Flora

Eucalyptus gomphocephala (Tuart) should be:

- included in any revegetation work in the Transition or Bushland zones that require overstorey species
- excluded from any works that require the removal of overstorey species.

The remaining significant species are understorey species, which should be promoted in revegetation works.

The orchid species should only be planted in secure fenced areas to deter the public form picking them. The City should contact Kings Park and Botanic Garden (Botanic Parks and Garden Authority) and request their involvement and advice on the replanting of local spider orchid populations, as the latter is well known for its experience in such works.

6. Dead and Damaged Trees

The City will investigate the health or any damaged or dying trees and investigate whether they can be saved or need to be replaced.

7. Lake Gwelup Species Selector

A separate spread sheet document has been provided with the following information for all of the candidate revegetation species for Lake Gwelup Reserve:

- links to Florabase, Florabank and Water Rivers Commission websites
- vegetation structure (growth form and height) and flower (time and colour)
- site characteristic – (soil type, topography)
- end land use (dieback resistance, fire retardant, bird attracting, insect attracting, significant fauna habitat, traditional/ indigenous culture)
- revegetation propagule (cell, tubestock)
- general comments.

The Lake Gwelup Species Selector spread sheet has separate work sheets for each vegetation community, as well as a master worksheet for the Reserve.

The spreadsheet is a management tool for City officers generate a short list of appropriate native species for certain revegetation works. The species list in each work sheet may be shortened by using filters to select the local site's site characteristics and end land use to find a list of appropriate candidate species to consider.

At present, the spread sheet has limited in what flora species are known occur in the vegetation communities. More spring surveys should be conducted in the reserve and adjacent bushlands with similar vegetation in good condition to increase the flora inventory for each community.

Recommendations

Table 29: Revegetation Strategy Recommendations

4	Recommendations	Priority	Responsible Party
4.01	Update and use Lake Gwelup Species Selector spread sheet to select appropriate local native species that suit local site conditions and land use in revegetation works	High	City
4.02	Revegetate parts of the parkland that are poorly used, are difficult to manage or near public facilities to improve visual amenity and increase native vegetation cover	Moderate	City
4.03	Use pathways to help delineate and buffer Conservation and Recreation Land Uses	Moderate	City
4.04	Investigate damaged or dying trees and determine whether they can be saved or replaced	Moderate	City
4.05	Promote state and City significant flora in revegetation works. Request Kings Park to be involved in replanting of locally significant spider orchids	High	City

6.2.5 Fauna and Habitat

Objectives

The objectives of the Fauna and Habitat Strategy are to:

- increase fauna habitat, therefore increase diversity and numbers of native fauna
- improve the connectivity of the Reserve to nearby natural areas
- optimise the use of resources by prioritising areas for rehabilitation
- improve ecological health
- increase diversity through encouraging ecological niches/ habitats.
- conserve locally occurring and significant native fauna by:
    - conserving and maintaining habitat required by local and significant native fauna
    - reducing predation pressure by feral fauna such Cats, Foxes and Honey Bees.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Sporting, Recreation).

Issues

1. Significant Fauna

There are nine state and federally listed conservation significant fauna species known or are thought likely to occur within Lake Gwelup Reserve. A further eight local fauna species are listed as significant to the City. Site works should consider activities to conserve and promote these species, such as promoting fauna habitat and protection against predators.

2. Plant Species

Revegetation should include ensuring there is adequate presence of ideal plant species to provide food and refuge for native animals. This is particularly important for Lake Gwelup, as it serves as a "stepping stone" greenway across Perth's northern suburbs, particularly for listed bird species. Revegetation requires that the correct plant species are chosen to attract and cater for both existing and visiting fauna.

3. Fauna Habitat

Whilst adequate in overstorey cover, the Bushland and Transition areas contain very little understorey shrubs and ground covers, depriving local fauna of shelter and food resources.

The wetland areas have been identified as an important resource for a wide variety of local and international bird species. However the main wetland is currently dominated by the weed Bulrush (*Typha orientalis*) which is limiting the variety of habitats for these bird species.

4. Fauna Predation

Native fauna populations are threatened by feral and introduce fauna through:

- predation (e.g. foxes and cats)
- reduction of habitat and food sources (e.g. rabbits, bees, pigeons).

5. Public Perceptions

The report identified four issues with public actions:

1. Snakes and other local animals may appear "dangerous" by the public and are harmed or killed out of unnecessary 'fear".
2. Members of the public feed birds within the Reserve, especially ducks. This practice may harm birdlife, as:
    - the food offered is not appropriate for a bird's diet, causing health problems

  - it may promote some bird species that do eat food offered by visitors and displace other bird species
  - it may increase the nutrient levels of the waterways, resulting in eutrophication which promotes algal blooms. Such blooms may produce toxins which would pose a health risks to the public and wildlife
  - contributes to aggressive behaviour by bird species
- Dogs to run into the water. Dogs may kill or scare away wetland wildlife. Dogs can also crush the reed beds and disturb hiding and nesting habitat of water birds and aquatic wildlife.
- Cats from nearby residential areas have been observed in the Reserve. These pets can have quite significant impacts on native fauna by hunting birds, reptiles and amphibians.

Strategies

1. Significant Fauna

A review of DPaW's Threatened and Priority Fauna database should determine what other significant fauna may occur in the Reserve. This should be followed by a field assessment, to confirm the presence of the species residing or visiting the Reserve and their habitat requirements. This field assessment should be a Level 2 Fauna Survey, as interpreted from the EPA (2004) *Guidance Statement 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.* Once all significant fauna species have been identified, fauna management and rehabilitation practices should be modified to conserve these species and improve their habitats.

2. Plant Species

The Lake Gwelup Revegetation Species Selector spread sheet includes data on certain local species that provide habitat value for local and significant fauna, such as nesting or a food source. Revegetation efforts should promote species within the vegetation types that have fauna habitat value.

3. Bushland and Transition Areas

The Bushland and Transition areas currently contain adequate overstorey for fauna habitat which provide a variety of refuge niches for many vertebrates and invertebrate species. The City should attempt to retain old mature trees in these areas as they are of high habitat value (e.g. nesting hollows).

Rehabilitation efforts in these zones should promote understorey flora species to provide screening and food sources for native birds and invertebrates.

In addition, additional items may be strategically placed around the Bushland and Transition areas to provide shelter for fauna. This may include:

- logs and timber for invertebrates as well as larger fauna such as snakes and lizards
- nesting boxes for birds.

4. Wetland Areas

Works in the wetlands should focus on reducing the presence of Bulrush and provide a diversity of habitats in the wetlands for native bird species.

The Bulrush should be reduced across this wetland with replaced other reeds and sedge species. This will provide a range of screening/ open habitats to suit different bird species.

It should be noted that while Bulrush is recognised as an aggressive weed species, the species also offers a type of habitat suitable for some bird species, as well as fulfilling a valuable biofiltration function. As such this species should not be eradicated, rather restricted to balanced areas and controlled.

5. Feral Animals

The City's pest control program will include feral cat trapping within the reserve at the start of the 2015/16 financial year.

6. Public Awareness

a) Native Fauna

The City should educate the public:

- to avoid any snakes they encounter
- as to why they should not feed native wildlife, particularly birds
- how to live with magpies.

Possible methods of informing the public include signs, factsheets, City website and Stirling Scoop.

The City will investigate whether the City officers can be on site more often to:

- educate any public member
    - sighted feeding wildlife
    - sighted not controlling their dog responsibly
    - about the Dog Local Law, Cat Act and Local Law.

b) Pet Control

The City should plan and implement a public awareness campaign on the following:

- about the Dog Act and Local Law which outlines the responsibilities of dog owners in public places.
- about the Cat Act and Local Laws regarding owners' responsibilities in controlling their cats.

Dogs are not under effective control if they:

- chase or disturb any person or wildlife
- act in a threatening or aggressive manner
- enter a lake or water channel.

Dogs are under effective control if they:

- respond to owner when called
- be close enough to be leashed if necessary.

Recommendations

Table 30: Fauna Management Strategy Recommendations

5	Recommendations	Priority	Responsible Party
5.01	Undertake conservation works that help protect and promote federal, state and locally significant fauna	High	City
5.02	Conduct site works to promote a wide range of native fauna habitat and improve the Reserve's role as a greenway in Perth's northern suburbs	Moderate	City
5.03	Investigate how to protect areas known to be breeding grounds for turtles from predation and rehabilitate them to be suitable for breeding	Moderate	City
5.04	Educate the local public how to avoid snakes, not feed wildlife and not disturb vegetation	Moderate	City
5.05	Investigate whether City officers can be more active in Lake Gwelup Reserve in educating the public about the Dog Local Law, Cat Act and Cat Local Law	High	City
5.06	Develop and implement a community awareness programme outlining the impacts of dogs to the bushland and wetland ecosystems and about dog ownership responsibilities to assist in the conservation of these important areas.	High	City
5.07	Encourage dog owners to have their dogs under effective control in the interest of bushland conservation although no declaration will be made of Lake Gwelup Reserve as a 'dogs on leash' area.	High	City
5.08	Undertake a review of the above approach at the end of 2015 to determine its success or otherwise with the view to the adoption of alternate strategies, if required.	High	City
5.09	Develop and implement a community awareness programme about the Reserve's designation as a cat-exclusion zone under the City's Keeping and Control of Cats Local Law 1999 and the requirements under the Cat Act 2011 (WA).	High	City

6.2.6 Feral and Overabundant Fauna

Objectives

The objectives of the Feral and Overabundant Fauna Strategy are to:

- reduce risks and impacts from pests and non-local fauna on native fauna and associated habitat
- reduce populations of feral and overabundant fauna.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Recreation).

Issues

1. Feral Fauna

The report identified the following issues regarding feral fauna:

1. Foxes are known to enter the Reserve from surrounding areas. One of the most likely entrances is the adjacent Karrinyup Golf Course
2. Rats and mice may consume native seed and spread diseases.
3. Introduced bird species (e.g. pigeons and turtle doves) may compete with native birds for food and nesting places.
4. A number of bee hives have been observed in around Lake Gwelup over time, occupying tree hollows used by local native birds as nesting sites.

2. Midges

The wetland is known to be a breeding ground for midges. Occasionally the wetland has raised levels of eutrophication, which in turn increases midge populations that are a nuisance for local residence.

3. Ringbarked Trees

Many of the older Marri and Jarrah trees in the western vegetation have become ringbarked. This infestation is stressing the trees and may result in significant number of tree deaths. The ringbarking of the trees may be the result of borer grubs, however this has not been confirmed.

Strategies

1. European Red Fox

The City currently maintains the services of a professional pest control expert who is appropriately licensed by DPaW to reduce fox populations within the City's municipal boundaries. Foxes that intrude on the Reserve are thought to originate from Karrinyup Golf Course (Animal Pest Management Services 2010).

The following points are considered when deciding fox control actions in Lake Gwelup Reserve:

- Poisoned baits are not used.
- Trapping is only conducted:
    - using soft padded foot clamps
    - in areas away from the public
    - traps are inspected daily.
- Any captured foxes should be put down in a humane manner.
- An effective method is for the professional pest control expert to survey all the reserves in the City for den sites and to fumigate them at time of breeding.

The City has maintained a database of fox records since 2006.

An effective method of lowering the impacts of foxes on native fauna is to reduce their foraging efficiency. In environments with dense vegetation or extensive wetlands, prey are less likely to be caught by foxes. Thus providing a continuous canopy and a thick understorey of shrubs reduces the risk of fox predation upon native animals (Environment Australia 1999).

Fox control methods require monitoring as more foxes may invade the Reserve. An effective method of fox monitoring is through using trail (motion sensitive) cameras near "choke points".

2. Rats and Mice

Rodents are normally controlled using trapping and chemical poisoning in domestic situations. However, these methods are time consuming and highly expensive to apply in bushland areas. Also, rodenticides are non-specific toxins and can pose a significant risk to non-target animals, including native fauna (Lapidge *et al*. 2004).

3. Introduced Birds

The City should investigate and implement appropriate control measures for all introduced bird species, if possible.

4. European Honey Bees

The City employs a qualified pest controller to eradicate known European Honey Bee hives. The City's Natural Areas staff will continue to monitor and arrange for the removal of any other non-native bees hives that may form in the future.

5. Midges

The most effective method of controlling midge populations is through prevention. Site works aimed to improve water quality entering the reserve (Section 6.2.1) should also consider stripping nutrients to prevent eutrophication. Midge populations should not increase as there is no increase in nutrients.

6. Feral Birds

An important method of controlling feral populations is prevent any food sources, such as pet food, from being accessible to the feral animals. The City should educate neighbouring residents of the importance of properly securing their pet food in sealed containers and to not overfeed their pets, to prevent uneaten food being left outside.

7. Borer Grubs

The City should survey the Reserve and map areas of ringbarked trees. The health of affected areas should be monitored. A qualified arborist should be consulted to determine cause of the ringbarking, including correct identification of any borer grubs, and apply the most appropriate treatment to minimise further impact on affected trees and to prevent spread to adjacent trees.

Recommendations

Table 31: Non-native Fauna Management Strategy Recommendations

6	Recommendations	Priority	Responsible Party
6.01	Continue mapping or surveying for pests and to continue employing a professional pest controller to control foxes and fumigate fox dens and bee hives in all reserves using appropriate control methods	High	City
6.02	Educate the local public in importance of securing pet food from being accessible to feral animals	Moderate	City
6.03	Undertake site works aimed improving incoming water quality to include stripping of nutrients to reduce likelihood of midge populations increasing	High	City
6.04	Survey and monitor ringbarked trees and employ a qualified arborist to determine cause and treat appropriately.	High	City

6.2.7 Plant Disease

Objectives

The objectives of the Plant Disease Strategy are to:

- reduce the risk of dieback and other diseases being introduced into the Reserve
- prevent further spread of the disease if it becomes established.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Sporting, Recreation).

Issues

1. Prevention

Once introduced, dieback cannot be eliminated from an area. Other diseases may inflect severe damage on the native vegetation before being controlled. Therefore the most important action for disease management is prevention. The Disease Management Strategy should focus on minimising the risk of introducing diseases to the Reserve.

2. Management

Two issues were identified in regard to disease management:

1. The City of Stirling does not currently have a system to routinely carry out dieback assessments of its reserves.
2. Even if an infection is detected and prevention actions are out in place, there is still a risk that diseases may enter Lake Gwelup Reserve. Actions are required to either remove the disease or minimise the risk of it spreading further in the Reserve or into other natural areas.

Strategies

1. Prevention

Human activity is perhaps the biggest factor contributing to the spread of plant diseases. Infected soil can be moved around the Reserve on vehicles or bikes, footwear, animal movements, road construction and earth moving equipment. It should be noted that the City cannot police against the spread of dieback, but can only provide facilities to minimise the spread.

There are two main types of human activity in Lake Gwelup:

- onsite maintenance activities by ground personnel
- recreation and social activities by the general public.

a) Ground Personnel

The City's Natural Areas staff have put into place quarintine measures to prevent diseases from being introduced into the Reserve. The staff continue to inspect and clean all footwear, equipment and vehicles before going to the Reserve. Plant cutting equipment such as secateurs are always cleaned before being used on a plant.

All incoming materials may potentially contain disease. Therefore the City ensures that materials only come from disease free sources, such as certified nurseries and mulch suppliers.

Any contractors who need to access the Reserve should also be made aware of the disease risk and what management measures are required to prevent the introduction and spread of dieback.

b) General Public

The public may unknowingly introduce disease into the Reserve. To minimise this risk, the public should be informed through the use of signs of the threat of these diseases and what they may do to assist in reducing the risk. Suggestions for how they may minimise the risk include:

- not leaving the pathways in the conservation areas
- not allowing pets to enter the conservation areas
- not dumping any material that may contain soil into the Reserve
- not cutting any plants in the Reserve.

2. Management

The City's Natural Areas staff should continue to be trained in:

- monitor for decline for tree health
- identifying any disease outbreak
- knowing how to control the outbreak or minimise its spread
- following the City Dieback procedure flowchart.

Staff should also be able to determine whether the decline in tree health is the result of Bullseye Borer grubs. If any significant infestation is observed, staff are to follow the procedure described in Section 6.2.7, Strategy 7.

Traffic should be minimised in known infected areas to resist spread. Footwear and vehicles should be cleaned before entering and leaving the site (Hussey & Wallace 2003).

The City will investigate the removal of known dieback infested trees that are adjacent to Lake Gwelup Reserve.

Recommendations

Table 32: Disease Management Strategy Recommendations

7	Recommendations	Priority	Responsible Party
7.01	Continue ensure all ground staff and contractors are informed and conduct adequate hygiene measures to minimise risk of introducing plant diseases to the Reserve	High	City
7.02	Educate public on risks of introducing plant disease and how they may assist in minimising the risk	Moderate	City
7.03	Continue to train the City's staff in plant disease identification and the City's dieback procedure flowchart	High	City
7.04	Investigate removal of known dieback infested trees occurring adjacent to Lake Gwelup Reserve.	High	City

6.2.8 Fire Management

Objectives

The objectives of the Fire Strategy are to:

- ensure protection of human life
- ensure protection of property
- ensure protection of ecological integrity and biological values
- help reduce the risks and impacts of fires
- help direct post-fire recovery.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Sporting, Recreation).

Issues

1. Fire Risk

The Reserve has a history of regular fire outbreaks. Potential fire hazards may threaten human life, property, native wildlife and vegetation. An effective fire strategy is required to protect these values. While the 2005 management plan does have a fire strategy, it is outdated and incomplete. A more up to date and comprehensive strategy is needed for this Reserve, which discusses:

- how to prevent or minimise the risk of a fire outbreak
- how to prepare for a fire outbreak
- how to manage the site's recovery after a fire.

Strategies

1. Fire Prevention

The following actions will be required to minimise the risk of a fire outbreak occurring in Lake Gwelup:

- Reduce the amount of ignitable material and fuel loads present in and around the Reserve (including bulrushes).
- Restrict activities that may cause ignition of a fire.

- Educate and involve the local community
- Have annual meetings with DFES to ensure fire breaks comply with safety standards.

a) Revegetation

While the revegetation strategies encourage planting more vegetation into the Reserve, it should be noted that excessive planting of trees and large shrubs may increase the fire risk hazard of an area by increasing the fuel loads. Planting programmes need to be developed for each zone to improve the Reserve's environmental and social values, but not to an extreme that will increase the zone's fire hazard rating.

b) Fire Legislation

Fire restriction legislation and practices are currently in place to minimise fire outbreaks in the Reserve. The City's Thoroughfares and Public Places Local Law does not permit fires to be lit in the Reserve. The Local Government Property Law does not allow any fires unless a permit has been obtained for special purpose. Only gas barbeques are allowed.

c) Community Involvement

The City's Ranger Services and DFES should be actively engaged with the adjoining residential community about the fire management of Lake Gwelup Reserve. It is considered important that local residents are kept informed of:

- the ecological and social value of the Reserve
- the risk of fire to the Reserve
- the need, due to proximity of the built environment to the bushland, to be fire aware and prepared
- the City's plans and activities in relation to protecting the Reserve
- the community's role in reducing the fire threat and risk to the built environment and to the Reserve.

Within the framework of a communication/engagement programme, adjoining residents could be provided available information, including pamphlets provided by DFES, to assist them in their own fire prevention. Relevant pamphlets are available from DFES's Community Development unit's Resource Officer.

The City's Ranger Services should educate the local residents about the ecological and social importance and fire risk of Lake Gwelup so they may become interested in the care and management of the Reserve. Information and action plans may be provided in the form of public meetings, leaflets and fridge magnets. The residents can play a role in fire prevention and preparation by:

- talking to their children
- surveillance of lake Gwelup Reserve and reporting any:
    - suspicious behaviour to the City
    - reporting any smoke or lit fires by ringing 000.

2. Fire Preparation

It should be acknowledged that while fire prevention efforts may greatly reduce the risk of a fire outbreak, it cannot totally eliminate the risk. The following preparation actions are therefore necessary to protect human life and residential properties and minimise the impact on the values of the Reserve:

- Reduce the risk of fire spreading across the Reserve
- Have access and infrastructure items in place to suppress fire
- Have a process to report fire to relevant authorities
- Consider promoting local native species that that are fire retardant within their community types
- Monitor the Reserve for changes in fuel loads and ignition risk
- Educate the local community.

a) Weed Management

The City's Natural Areas staff should continue to conduct weed control, as this will assist to reduce the fire ignition risk (e.g. dry grass and sedge weeds) and fuel loads (e.g. tree and shrub weeds).

b) Fire Retardant Flora

Revegetation of the Reserve should consider promoting plant species that are resistant to fire ignition. A total of three species currently recommended in this report for revegetation are known to be fire retardant (Zanthorrea Nursery 2000). These species should be promoted in revegetation work areas known to be of *High* or *Extreme* fire risk within the Reserve to reduce ignition risk and spread of fire.

The species are listed below:

- *Acacia saligna* (Orange Wattle)
- *Patersonia occidentalis* (Purple Flag)
- *Kennedia prostrata* (Running Postman).

c) Monitoring

It must be noted the fire risk hazards and vegetation communities are expected to change across Lake Gwelup Reserve over time as weed control measures should decrease fire ignition risk and revegetation strategies may increase fuel loads. Annual or biannual site assessments may be required to update the fire risk component of the Fire Strategy.

d) Community Involvement

In addition to their role in the prevention of fire, the residential community within and adjacent to the Reserve, should be provided information regarding the reduction of fire risk to their properties. The City should facilitate the distribution to adjoining resident's appropriate information that is readily available from DFES. Two pamphlets on fire preparation are currently available from DFES.

3. Post fire Recovery

Post-fire recovery actions should be directed towards minimising any threats resulting from a fire outbreak and to assist in the recovery of the Reserve. Actions are outlined below:

- DFES should investigate the cause of the fire.
- DFES and the City should restrict access to the public in burnt areas for safety and recovery reasons.
- DPaW should rescue any injured fauna.
- The City should monitor the site and direct any maintenance, including:
    - conducting weed control to prevent weed invasion into burnt areas
    - consider possible revegetation if burnt area is too damaged to recover.

a) Access and Safety to Public

Any damaged fencing should be replaced or repaired as soon as possible following fire. If substantial areas have been burnt, prominent signage should be erected to explain the damage caused by fire, and the risks associated with trespassing in the burnt areas of the study site.

Any burnt branches that overhang pathways should be removed for safety reasons.

b) Fauna

Following a serious fire and clearance for entry by the local fire brigade, the site should be immediately searched and any injured fauna rescued and treated by qualified carers. DPaW has a 24 hour hotline to wildlife carers (9474 9055). Animals may be released back into the study site once the bushland is deemed to have enough suitable habitat and refuge.

c) Post-Fire Monitoring

It should be remembered that although the fire risk hazard of an area is initially negligible after a fire, this status can quickly increase over the following years as fuel load and ignitable plant materials return. Future monitoring should continue to assess the fire risk hazard of burnt areas and adjust the management actions as appropriate.

Weeds and native vegetation regrowth throughout the burnt areas should be monitored. Monitoring should include the establishment of quadrats in each burnt vegetation community. Each quadrat should be recorded using a GPS. Photos should be taken of each quadrat at the time of monitoring to establish a visual record. Records of native and weed species, their numbers and health and any general observations should also be recorded.

d) Weed Control

Prevention of weed invasion is the most urgent requirement following fire within the bushland. Increased nutrients and light, together with decreased competition from native vegetation, will enhance weed growth. Any increase in the presence of weeds will degrade the condition of the bushland and also increase fire ignition risk. The City should target any weeds that germinate after fire to significantly reduce the weed population of the Reserve.

Weeds should be targeted during regeneration following fire, with options such as spraying or hand weeding to be considered, as appropriate. Any weed control should follow the Weed Control Strategy described in **Section 6.2.3**. Weed control should target the source of the returning weeds – germinating seeds, resprouting plants or both.

Existing weed maps should also be updated on the basis of observations and actions on specific weeds species. These maps should be regularly updated to show changes in weed dynamics over time. This will assist in determining whether the weed control strategies are successful and to identify any new weed populations that may emerge. In addition, GPS readings should be recorded for areas that have been controlled for monitoring purposes.

e) Revegetation

Natural regeneration should be monitored post-fire. Depending on the intensity and/or frequency of fire, or other factors, natural regeneration may be inhibited. An intense fire may sterilise areas through the death of existing vegetation and destruction of the seed bank. In such a case, direct seeding or revegetation with local provenance tubestock should be considered. Any revegetation work should follow the Revegetation recommendations outlined in **Section 6.2.4.**

Recommendations

Table 33: Fire Management Strategy Recommendations

8	Recommendations	Priority	Responsible Party
8.01	Prevent fire occurrence and impact by reducing ignitable materials and fuel loads, educating the local community and regularly liaising with DFES	High	City
8.02	Ensure that revegetation activities should not increase an area's fire risk hazard rating and should consider fire retardant flora	Moderate	City
8.03	Conduct post fire recovery actions including investigating cause of fire, restricting access to burnt areas, rescuing any injured fauna and conducting appropriate revegetation and weed control activities	High	City, DFES, DPaW

6.3 SOCIAL MANAGEMENT

The locations for implementing several of the following recommended management strategies are illustrated in the Concept Plan (Figure 6).

6.3.1 Heritage

Objectives

The objectives of the Heritage Strategy are to:

- promote awareness of local and native flora and fauna that have Aboriginal significance
- identify Aboriginal and European cultural histories
- interpret Aboriginal and European cultural histories with respect.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Sporting, Recreation).

Issues

The Reserve currently provides limited interpretation of Aboriginal and European cultural histories associated with the Reserve. The City has engaged a Heritage Officer to investigate all sites within the City boundaries with regard to Aboriginal cultural complexities.

Strategies

There is ample opportunity to promote local Aboriginal and European culture and heritage within the Reserve. It is recommended that the City should work with local Aboriginal groups and elders to develop ways to promote heritage, including interpretive signage, artworks, and nature based play areas. Relevant species should be promoted in the planting design and integrated with interpretive signage.

The site also has a rich European history (market gardening, vineyard, olive orchard, trotting track, heritage cottage, livestock grazing, the nearby Gwelup Primary School which recently celebrated its 100 anniversary); these histories should also be included in appropriate interpretation.

A Wayfinding and Interpretation Plan should be developed to strategically facilitate coordination for this work within the Reserve.

Recommendations

Table 34: Heritage Strategy Recommendations

9	Recommendations	Priority	Responsible Party
9.01	Involve relevant City officers responsible for indigenous, social and cultural heritage in collaborative work with local Aboriginal Groups and elders in the development of interpretative elements including signage, artworks and nature based play elements.	Moderate	City
9.02	Promote local native flora and fauna that have Aboriginal cultural significance as a means of promoting the natural heritage values of the Reserve.	Moderate	City
9.03	Develop and implement a Wayfinding and Interpretation Plan for the foreshore to facilitate a co-ordinated plan for interpretation and education.	High	City
9.04	Review and liaise with local community groups and historians to develop interpretative themes and elements including signage, artworks and nature based play elements.	Moderate	City

EDUCATION NODE

PORTER STREET

LUDGATE WAY

WALDERMAR STREET

MARCH STREET

PASSIVE NODE

ACTIVE NODE

SEGRAVE STREET

SEGRAVE STREET

HUNTRISS ROAD

NORTH BEACH ROAD

NOTE:

THIS MAP IS CONCEPTUAL ONLY - SUBJECT TO FURTHER ANALYSIS AND PUBLIC CONSULTATION

NATURE PLAYGROUND

INTERPRETIVE SIGNAGE ALONG EDUCATION TRAIL

EDUCATION TRAIL SEATING NODE

EXCERCISE ENSEMBLE

CONSTRUCTED BIRD NESTING HABITAT

ATTRACTIVE ENDEMIC PLANTS TO INSPIRE NATIVE GARDENS

DOG EXERCISE AREA

LEGEND

EXISTING SITE FEATURES

- TREES
- SCOUT CLUBHOUSE
- GAZEBO
- BIRD HIDE
- TOILET BLOCK
- TENNIS COURT
- TENNIS HIT-UP WALL
- CRICKET NET
- 1.2M HIGH FENCING
- VEGETATION
- TURF
- CARPARK
- SEASONAL WETLAND
- STREAM, CONSIDER REVEGETATION
- BOARDWALK, CONSIDER RESTORATION
- BENCH, CONSIDER RELOCATING
- ROTUNDA
- BUS STOP
- CYCLE ROUTE
- POTENTIAL CAR PARK

PROPOSED SITE FEATURES

- PRIMARY NODE
- SECONDARY NODE
- DUAL USE / EQUAL ACCESS PATH (MAINTENANCE TRUCK ACCESS)
- WAYFINDING SIGNAGE
- 3 INTERPRETATION OPPORTUNITY
- DRAINAGE CHANNEL CONNECTIVITY
- WETLAND REVEGETATION
- TRANSITION REVEGETATION
- UPLAND REVEGETATION
- TYPHA REMOVAL
- 5 POTENTIAL KEY ELEMENTS - REFER IMAGERY
- HALF BASKETBALL COURT

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SCALE 1:5000 @ A3

0 25 50 75 100 125 250m

LAKE GWELUP MANAGEMENT PLAN
City of Stirling

CONCEPT PLAN
FIGURE 6

6.3.2 Access and Infrastructure

Objectives

The objectives of the Access and Infrastructure Strategy are to:

- provide variety of access types for public use of the Reserve
- provide access for local authorities for management of the Reserve
- provide access for fire and emergency services
- increase social infrastructure amenities and rationalise existing amenities
- preserve and enhance the character of the Reserve
- improve safety.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Sporting, Recreation).

Issues

1. Parking

The informal car parking at Lake Gwelup is limited to the major node in association with the Scout Hall. Car parking for everyday use is adequate; however when sporting events are held the limited spaces and poor circulation are an issue. This leads to overflow parking on adjacent turf areas, particularly along Segrave street verge.

2. Access Paths

The access hierarchy of the formal path network and the identification of major and minor access nodes are poorly defined, making it difficult to differentiate the bicycle, pedestrian and shared usage paths. This has resulted in poor wayfinding and made this the primary issue associated with access. A lack in definition combined with poorly defined connections to cycle and pedestrian networks outside the Reserve has contributed to informal tracks through remnant bushland and across turf areas. Material selection of both formal and informal path networks requires rationalisation.

3. Fencing

The City is currently in the process of replacing the fencing surrounding the Reserve in stages. The cricket nets and tennis courts are also fenced.

4. Signage

The existing signage is ad hoc in size, type and form throughout the Reserve, with limited wayfinding signage. Signage is typically located at Reserve entry points, however this often includes a cluster of multiple signs of varying materials and graphics which causes visual clutter and limits the effectiveness of communicating information to the user. There is limited information provided through signage of potential fauna risks and the status of the environment which could affect how a visitor interacts with the Reserve.

5. Picnic Amenity and Playgrounds

The Reserve has picnic amenity and play equipment centrally located near the Scout Hall on Huntriss Road. Generally the amenity is in a functional state, however it is dated and has extensive bore staining. The play equipment is all off the shelf equipment and has no relationship to the site in which it is set. There is limited shading for picnic and barbeque areas throughout the reserve.

Bench seats are scattered throughout the Reserve and generally located without consideration of shade or view.

6. Structures

The Reserve has a number of structures in various states of access, condition and appearance. These include:

- boardwalk
- viewing deck
- bird hide
- scout hall
- rotunda
- shade sails.

In addition, the Rotary Club of Karrinyup has requested that a suitable “Men’s Shed” building be installed adjacent for the scout hall for community use.

Currently there are no cafés or kiosks available in the reserve. The nearest available facility is in the Lake Gwelup shopping Centre, adjacent to the eastern side of the reserve.

7. Sporting Amenity

Lake Gwelup Reserve has a number of sporting amenities including:

- tennis courts
- cricket pitch with lights
- cricket nets
- oval.

Generally the sporting amenity is in good condition however is dated. Access issues need to be resolved.

Strategy

1. Parking

A review of the existing car park is necessary to rationalise the layout and functionality of the space. Additionally, a review of the Reserve as a whole would be beneficial to establish key entry nodes and associated parking opportunities to reduce overflow impacts on the main cark park. Furthermore, there is an opportunity to provide a better connection with Karrinyup Reserve adjacent to the site. Installation of any additional car parks will involving attempting to not clear any native vegetation if possible.

2. Access Paths

The access hierarchy of the formal path network and the identification of major and minor access nodes are poorly defined, making it difficult to differentiate the bicycle, pedestrian and shared usage paths which have resulted in poor wayfinding and the creation of various tracks throughout the Reserve. An investigation should be undertaken to assess and rationalise the current internal informal and formal path networks, to guide the preparation of a Landscape Master Plan which can be implemented over time and meets the City’s maintenance requirements.

Lake Gwelup Reserve is effectively bounded on all sides by a network of designated cycle paths which form part of the Bikewest cycleway system. The internal path system is also part of the City of Stirling's 'Bushlinks' Walk Trail. Interpretation and wayfinding should be located at each entry point in the Reserve, for the user to orientate themselves and provide opportunities of how to connect to the broader pedestrian and cycle network.

Increased pedestrian connectivity with the neighbouring Karrinyup Reserve to the east could also provide an opportunity to share facilities and amenities.

3. Fencing

The City is currently replacing the perimeter fence. A review of all other fencing should be undertaken to assess safety compliance, condition and whether or not restricted access is required.

4. Signage

Signage is a critical component in the short and long-term management of public open space for communicating risks, regulations and points of interest. The key is providing a balance of information and the number of signs as too much signage can detract from the visual amenity of a place and can lessen the impact of the content of the information.

The Reserve currently has a variety of signage types. Prior to installing additional signage an audit should be conducted to assess the style, format, location, safety compliance and condition of the existing directional, informative and interpretive signage. This will provide an overview of the current situation and highlight any gaps in signage requirements.

Establishing well-defined entry nodes and implementing a Wayfinding and Interpretation Strategy will capitalise on the local landscape character, recreational assets and provide physical and visual references for the local community and visitors to the Reserve. Ultimately a Wayfinding and Interpretation Strategy will utilise existing public meeting places and highlight the destinations within walking distance, thereby promoting a healthy and vibrant community environment.

Primary way finding signage should be located at each point of entry to the Reserve, so that all users can orientate themselves.

Risk and legislative signage is critical to ensuring users of the Reserve are aware of the issues associated with accessing the site. Specific risks should be communicated at the location where the risk is located, and should be incorporated into the overall signage strategy.

5. Picnic Amenity and Playgrounds

The preparation of a Landscape Master Plan will provide a long term strategy to rationalise the main picnic and play node associated with the Scout Hall on Huntriss Road. Integration of nature-based play will provide opportunities for imaginative play that relates directly to the environment the child is in; with a focus on the Reserve's natural and cultural values. Key elements that could be considered include:

- dry creek beds
- salvaged logs and other materials
- balance beams and creek crossings
- interactive interpretation and artwork i.e. sensory experiences
- forts and tree houses
- earth mounding.

Similar playgrounds which to draw inspiration include Dianella Playspace, Rannoch-Tay-Earn Reserve, Yokine Reserve and Kadidjiny Park.

Benches should be increased in number and better located, considering access, views and shade.

Additional shading and under-cover space for picnic and barbeque areas will also be considered.

6. Structures

The Reserve has a range of structures in various states of condition, usage and appearance. An assessment of each of the structures should be undertaken to establish:

- current condition
- current usage and access
- date installed
- proposed recommendations for improvement or management / replacement
- proposed timeframe for improvement or management.

The City is currently reviewing the request of the Rotary Club of Karrinyup for a Men's Shed building to be constructed within the Reserve.

The City will investigate the possibility of a mobile café or kiosk being allowed to operate within the reserve. Issues to be examined will include licencing location and operating times for such a mobile operator and potential impacts on the adjacent Lake Gwelup shopping centre.

7. Sporting Amenity

As the Reserve attracts BMX users informally with adverse effects on the natural bushland; the short and long-term management could consider the inclusion of a simple youth node, which may include BMX and skateboard park. The inclusion of such a design feature is aimed at redirecting BMX riders away from the remnant vegetation areas and should help deter anti-social behaviour within the Reserve. The City will investigate at further date the possibility, type and location of a youth node in or near Lake Gwelup Reserve. Public consultation will be part of the investigation process. The park could be integrated in into the City's Skate and BMX facility strategy. More information on the Strategy is located on the City's website **here**.

In conjunction with the rationalisation of the path network, an exercise trail could be incorporated to promote a healthy active lifestyle for the local community. The trail should be located away from the wetland to avoid any adverse impacts on the vegetation and fauna. A circuit design in close proximity to the main car park and node would be appropriate to provide a point of origin and maintain passive surveillance of the path. And alternative location would be to use the adjacent Karrinyup Reserve, which is an active and reticulated recreation area.

Residents are encouraged to contact the City and book the tennis courts for use. Contacts details can be found on the City's website **here**.

Recommendations

Table 35: Access and Infrastructure Strategy Recommendations

10	Recommendations	Priority	Responsible Party
10.01	Prepare a detailed Landscape Master Plan and costing to guide the upgrade of the Reserve's facilities, amenities and fencing on a stage by stage basis.	High	City
10.02	Undertake a review of the existing car parks to ensure they meet standards and safety requirements.	High	City
10.03	Assess access points for equal access and ensure adequate access is achieved at regular locations by all users.	High	City
10.04	Investigate and assess feasibility of access opportunities at key locations to cater for large maintenance/ works vehicles.	High	City
10.05	Conduct an audit of existing facilities, amenities and fencing to assess safety compliance, condition and accessibility.	High	City
10.06	Ensure all amenities are complementary in colour and style and blend in with the natural environment.	Moderate	City
10.07	Investigate feasibility of a mobile kiosk/ café operating within the reserve.	Moderate	City
10.08	Investigate at further date the possibility, type and location of a youth node in or near Lake Gwelup Reserve. Involve public consultation.	High	City

6.3.3 Education and Interpretation

Objectives

The objectives of the Education and Interpretation Strategy are to:

- educate the public of the social and environmental values of the Reserve
- inform the public of what the City of Stirling is doing to conserve and enhance these values
- increase the sense of community ownership of the Reserve.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Sporting, Recreation).

Issues

A lack of knowledge and appreciation of the Reserve may have contributed to the graffiti, wilful damage and anti-social behaviour associated with the Reserve. The signage currently doesn't provide enough information about the complex natural and cultural sensitivities of the site.

The Reserve has limited interpretation of the natural and cultural aspects of the site and how the wetland is part of a bigger wetland system. Likewise, interpretation of how the climate is affecting the maintenance of the Reserve, such as why only certain parts are irrigated and the natural processes associated with this particular wetland type.

Strategies

1. Education

Community education and involvement is critical for the long-term conservation of the site's environmental and cultural values. Raising awareness can be achieved through a number of methods including local newspaper articles, signage, guided walks and tours and visits to local schools. These should always be positive and community orientated rather than as rules and regulations. Developing a sense of ownership within the community will empower people and encourage them to devote their own resources to appropriate care and management. The local community and school groups could also be involved in activities around the area such as bird watching, weeding, tree planting, plant identification, creating herbariums and assisting in the preparation of signage.

Increased public education about the social and ecological significance of Lake Gwelup can lead to improved behaviour and activities that may be beneficial to both visitors and the Reserve. The Rainbow Bee Eater signs have been a success within the Reserve, and the strategy to improve education could consider similar design solutions to promote significant flora and fauna to the public.

Currently the City provides environmental theme pamphlets to locals, detailing garden friendly native plants and species which are considered bushland weeds to dissuade planting in adjacent residential communities. This same method of communication could be used to communicate other significant issues facing the Reserve including fauna, wetland and water use.

Bushland rehabilitation and an understanding of environment is increasingly becoming an important part of school curricula at all levels. Liaison between the City's Environmental Officer and local schools will help facilitate conservation programs. The local Scout group and Lake Gwelup Primary School as well as other local sporting clubs could also contribute to the management of the area. In approaching these groups it is important to always stress the community's ownership of the resource, as this will encourage people to respect the Reserve if it is regarded as common property.

2. Interpretation

Interpretation media is critical in communicating the complex environmental and cultural complexities of the Reserve. This may take various forms in addition to traditional signage to communicate season based knowledge including art works, pod-casts or ephemeral interpretation.

Interpretation of the site's histories will be a key component to establishing a strong connection between the user and the site and ensuring the community value. The Reserve has a strong Aboriginal history with many stories that can be expressed via multiple forms of media or play elements. In addition to the Aboriginal culture, the site is exposed to complex environmental processes. Creating a balance and sense of journey throughout the Reserve and connections to the wetlands function on the Swan Coastal Plain will be key to the implementation of a successful Interpretation Strategy. The City will investigate whether funding may be available to further develop the interpretation strategy, particularly the heritage trail. Possible sources include the State government and Lottery West.

Recommendations

Table 36: Education and Interpretation Strategy Recommendations

11	Recommendations	Priority	Responsible Party
11.01	Conduct an audit of existing directional, informative and interpretive signage assessing style, format, location, safety compliance and condition.	High	City
11.02	Research and develop strong themes for interpretation based on the social, cultural and environmental complexities of the site.	High	City
11.03	Develop and implement a Wayfinding and Interpretation Plan for the Reserve to facilitate a co-ordinated plan for interpretation and education. This plan should also address digital methods of communication as well as physical signage.	High	City
11.04	Establish an Eco-news column in the local paper to raise awareness about the environment.	Low	City
11.05	Provide opportunities for the Scouts groups and local primary school to hold educational programs within the Reserve, through science, art and cultural projects.	Low	City

6.3.4 Community Involvement

Objectives

The objectives of the Community Involvement Strategy are to:

- provide opportunities for the community to be involved in the management and maintenance of the Reserve
- increase the sense of community ownership of the Reserve.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Sporting, Recreation).

Issues

Community involvement in revegetation, arson and illegal activities surveillance, fauna surveying and maintenance programs has the potential to foster a sense of shared ownership of the Reserve, which can lead to improved responsible use and management of the site and improving natural values.

Strategies

The public, particularly local residents and Lake Gwelup Primary School should be encouraged to engender a spirit of care and sense of ownership. This would increase the level and quality of information available to the community on the cultural heritage, flora, vegetation communities and fauna of the Reserve. The following are strategies to facilitate community involvement:

- Encourage the public to participate in the management and maintenance of the Reserve through the reinstatement of the Friends of Lake Gwelup.
- Scouts and Primary School students involvement in ownership of the Reserve through revegetation / weed work / fauna habitat identification and protection.
- Opportunity for Friend's Group, Scouts and Primary School students to be involved with the interpretation and education signage for the Reserve including tour guides, promoting native plants, bush tucker foods and heritage.
- Opportunity for Reserve to help Scouts earn badges such as camp craft, land care and environment.
- Review the role, status and use of the scout hall and if appropriate, assess opportunities for multiple users.

- Report any illegal or harmful activities occurring in the reserve to the City, such as:
    - motorbikes
    - push bikes riding in the bushland or endangering the public
    - drug use
    - dumping rubbish
- Promote the local residents and businesses to participate in the City's "Adopt a Park" program. More information can be found on the City's website **here**.

Recommendations

Table 37: Community Involvement Strategy Recommendations

12	Recommendations	Priority	Responsible Party
12.01	Involve the community and local businesses in management of the Reserve where possible. Always reinforce community 'ownership' in this respect.	Moderate	City
12.02	Involve school groups, Scout groups and the local community in educational activities in the natural areas of the site including stencilling projects, signs, media and holiday recreation programs.	Moderate	City
12.03	Continue support for the reformation and involvement of a local friends group to assist the City with environmental monitoring and conservation work.	Moderate	City
12.04	Provide bushland regeneration courses to interested members of the public who actively commit more than 40 hours per annum to bushland and wetland maintenance.	Low	City
12.05	Review role, status and use of the scout hall and if appropriate, assess opportunies for multiple users.	Moderate	City

6.3.5 Maintenance

Objectives

The objectives of the Maintenance Strategy are to:

- design and material selection to reduce maintenance requirements
- increase public awareness
- limit risk by not posing a health or safety hazard.

Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Sporting and Recreation (Sporting, Recreational).

Issues

1. Infrastructure Maintenance

Lake Gwelup Reserve has a variety of amenity in the form of hard infrastructure including:

- path ways
- fencing
- play equipment
- built form including scout hall / toilets
- irrigation bore
- boardwalk and viewing platform
- lighting
- picnic amenity including tables and barbeque
- rubbish bins

- signage
- tennis courts
- cricket nets and pitches
- cricket pitch
- pathways
- drains.

Generally the infrastructure within the Reserve is in an adequate condition, and in need of minor repairs.

Various maintenance and infrastructure items that need to be address include the following:

- The pathway along the Lagonda street has been observed to often be covered by sand after rainfall.
- There are no dog drinking bowls.

2. Litter Collection

Rubbish within the Reserve is unacceptable, especially when sporting events are held, which result in large amounts scattered throughout the main node in the southern section of the Reserve. Litter is also a problem within the wetland as it often washes up along the lake edges.

Dumping of domestic green waste has also been an issue including lawn clippings and leaves. This illegal dumping may introduce weed species and diseases to the sensitive wetland flora and in time can pose a fire ignition risk in close proximity to houses and property.

3. Irrigation

The Reserve utilises a site bore, located within the main node area. This bore is located in an iron-rich geology, which has resulted in staining of social infrastructure, signage and sporting amenity. The City should consider installing iron filter cartridges on the main line before distribution.

4. Graffiti and Wilful Damage

Lake Gwelup Reserve, like many remnant urban environmental assets is exposed and susceptible to anti-social behaviour.

Proliferation of adult ‘cubbies’:

- Rangers are constantly removing mattresses, couches, bottles and rubbish from bush areas within the Reserve.
- These cubbies have been deemed not a child cubby activity and appear to be more a refuge for teenagers / adults to undertake illicit activities.
- Cubbies are causing destruction to vegetation, increasing fire risk and hazards associated with discarded drug apparatus
- Should be removed as soon as is practical.

Evidence of BMX activities:

- Tracks and bike activity throughout the bush areas is degrading the vegetation condition, trampling vegetation and dissecting the vegetation communities.
- There is also evidence of BMX riders digging up soil for ramps, which may provide hazards if holes are not filled in and is damaging vegetation.

Public picking wildflowers:

- Most often the public are picking orchids, which die after the flower is plucked.
- Reserve has several significant orchid species at threat from this activity.

Minor problem of graffiti:

- City staff have a system to regularly check for graffiti and report it to be removed by a contractor.
- Graffiti in highly visible places has higher priority (e.g. near picnic areas).

Dogs control:

- Some reserve users ignore signage regarding dog owner responsibility only and let their dogs run freely into bushlands and the lake.
- Dogs may harm or kill wild life and damage fauna habitat and can be a public nuisance.

Strategies

A City representative quoted that "*Negative changes in society are being reflected in Perth's bushlands*" (Taylor pers comm.). Therefore the need to incorporate strategies to help reverse the impacts of negative social activities is critical. The following strategies are proposed to assist in mitigating anti-social behaviour and resilience into the management and maintenance of the Reserve.

1. Infrastructure Maintenance

Existing infrastructure including dual use paths, signage, fences, tracks and existing and future infrastructure such as toilet and water facilities, picnic facilities, play equipment and barbecues should be regularly assessed, maintained and upgraded as necessary so that they may continue to:

- function in good working order
- have a good appearance with uniform style
- not pose a health or safety hazard
- function as they were designed.

Wear and tear over time, vandalism and changing user requirements mean that regular assessment of infrastructure needs to take place depending on the circumstances and type of infrastructure.

The pathway adjacent to Lagonda street is adjacent to a stormwater drain. After heavy rainfall, sand is deposited onto the pathway from the drain. The City's Engineering and Operations section will investigate the drain and attempt to prevent further deposits of sand form the drain in future heavy rainfall events.

As drinking fountains are upgraded during maintenance works, drinking fountains with integrated dog drinking bowl will be installed.

Table 38: Typical Infrastructure Maintenance Schedule

Item	Maintenance Issue	Inspection Frequency
Dual Use Pathway	Dips, hollows and irregularities Surface Degradation Vandalism Public Risk	Quarterly
Walking tracks	Erosion Surface Degradation Public Risk	Bi-annually
Fencing	Breaks Appearance Public Risk Vandalism	Quarterly
Bollards	Appearance Public Risk Vandalism Structural integrity	Quarterly
Signage	Visibility Appearance Public Risk Vandalism	Monthly
Seats, benches and tables	Wear and Tear Public Risk Vandalism	Monthly
Rubbish bins	Vandalism Rubbish removal	Monthly/ fortnightly (rubbish removal)
Edging	Appearance Public Risk Vandalism	Quarterly
Barbeque	Wear and Tear Public Risk Vandalism Structural integrity	Monthly
Play Equipment	Wear and tear Appearance Public Risk Vandalism Structural integrity	Annually
Irrigation	Broken pipes and fixtures Public Risk Vandalism Efficiency	Monthly
Boardwalks and Viewing Platforms	Appearance Public Risk Vandalism Structural integrity	Monthly
Toilets	Appearance Public Risk Vandalism Structural integrity	Weekly

2. Litter Collection

Litter is an environmental hazard promoting feral fauna species and detracting from the overall experience of visiting a site. The location of rubbish stations at strategic nodes and locations around the Reserve will aid in limiting any adverse impacts associated with litter.

It may be possible to involve the community in the management of litter through the involvement of friends groups and participation in national clean up days such as 'Clean-up Australia Day'. . Any insurance and public liability issues must be resolved before involving the public in these activities.

Discarded syringes continue to be a problem in many parks in Perth. If reports of discarded needles increase, sharps disposal should be provided at selected locations, such as within the toilet facilities. The toilets should also be locked at night to further deter antisocial behaviour.

3. Irrigation

To address the Department of Water allocation reductions scheduled over the coming years, the City should consider implementing hydro-zoning and eco-zoning strategies to proposed landscape designs and retrofitting existing sporting ovals.

Hydrozoning is a landscape practice that groups plants with similar water requirements together in an effort to conserve water. This practice seeks to take advantage of microclimates. Plants that tolerate more heat and wind might be planted near the street, while more sensitive plants might be planted in shade, under roof overhangs, or in fenced areas.

Ecozoning is the division of a park or reserve into zones of turf and natural areas to promote biodiversity and conserve water, while keeping the area's amenity and function. Ecozones are the park areas featuring mulched areas planted with native and 'water wise' vegetation. Typically these areas are not irrigated and rely on rain events for water.

4. Graffiti and Wilful Damage

Graffiti, other vandalism and anti-social behaviour should be repaired and or deterred as soon as possible after its occurrence, as its continued presence tends to invite further acts of vandalism or anti-social behaviour. Graffiti resistant compounds should also be applied to any property that is targeted constantly. The community should also be encouraged to report any acts of vandalism or antisocial behaviour to the police and Council. Successful arrests should then be followed up with a note of thanks to the person who reported. The City should also consider encouraging local street art to direct youth away from further illegal graffiti.

The City should consider allocating dog exercise areas in some parts of the parkland areas, well away from native vegetation. In all other areas dogs must be kept under control. Methods of informing the public may include the use of signs and leaflets. City Rangers may also inform members of the public using the Reserve.

Recommendations

Table 39: Maintenance Strategy Recommendations

13	Recommendations	Priority	Responsible Party
13.01	Prepare a detailed Landscape Master Plan and costing to assist in planning for: • sign posting of dog owner control and responsibilities • location of rubbish stations • access restrictions including BMX access • identify maintenance access • hierarchy of all signs • bushland firebreaks • pedestrian access tracks and trails.	High	City
13.02	Review and consolidate turf areas to sporting recreation areas only.	High	City
13.03	Undertake regular inspections of infrastructure and repair or replace where necessary.	High	City
13.04	Investigate the storm drain next to Lagonda St to prevent it depositing sand on the adjacent footpath in future heavy rainfall events.	Moderate	City
13.05	Involve the community in litter collection through the Clean-Up Australia Day.	Moderate	City
13.06	Investigate the feasibility of providing syringe disposal at key locations if the incidence of carelessly discarded needles is high.	High	City
13.07	Prepare and implement a Water Conservation Plan for the Reserve, detailing hydro zoning and eco zoning strategies to assess and monitor the watering requirements for the Reserve.	High	City
13.08	Repair all damaged facilities immediately after any act of vandalism to discourage vandals.	High	City
13.09	Remove graffiti and repair damage to infrastructure as soon as possible after it occurs to discourage graffitists.	Low	City
13.10	Encourage the community to report anti-social and destructive behaviour to the police and council authorities.	Low	City

6.1 PERFORMANCE MEASURES

Table 40: Performance Measures for Lake Gwelup Reserve Management Plan

Topic	Issue	Action	Performance Measure
Conservation Management			
1. Hydrology	a) Declining groundwater	i) Revegetate transition areas with local native species that can tolerate a range of soil moisture conditions	i) Suitable native species used in revegetating transition areas
	b) Water quality	i) Liaise with adjacent land managers to minimise contamination of water entering wetland ii) install and maintain GPT and bioretention basins to filter incoming water, including Brushfield drain	i) Liaison with adjacent land managers established and maintained ii) GPTs and bioretention basins installed and maintained
2. Acid Sulphate Soils	a) ASS exposure	i) Ensure no PASS is exposed from on ground works ii) Continue to monitor groundwater and wetland water levels to detect any decline and possible exposure of PASS	i) No PASS exposed from on ground works ii) Ongoing monitoring scheduled and implemented
3. Weed Control	a) Weed cover	i) Reduce presence of weeds in bushland, transition and wetland areas	i) >30% weed cover reduced in all three vegetation types
	b)high Priority weed species	i) Reduce number of high priority weed species	i) >30% reduction of high priority weed species
	c) Weed species	i) Reduce number of weed species ii) No new weed species introduced	i) >30% reduction of all weed species ii) No new weed species detected
4. Revegetation	a) Biodiversity	i) Improve the vegetation condition of in bushland, transition and wetland areas by minimising disturbances and conducting weed control and revegetation works ii) Increase the biodiversity in each vegetation community with appropriate local native species	i) 50% of existing vegetation in Good or better condition. ii) 30% increase of flora species in each vegetation community, with appropriate flora
	b) Ecozones	i) Revegetate Ecozones (areas of former parkland) to native vegetation using appropriate flora species	i) Ecozones revegetated with appropriate flora
	c) Land use boundaries	i) Install paths as buffer and to separate conservation and recreation land uses	i) Paths installed along conservation/ recreation land use boundaries
	d) Significant flora	i) Survey, map and monitor all significant flora species and conduct appropriate management works if flora is threatened ii) Promote planting of significant flora species in revegetation works	i) All significant flora species surveyed, monitored and conserved ii) New significant flora populations established
	e) Non-indigenous trees	i) Not to plant any more non-indigenous trees in Reserve ii) Target *Agonis flexuosa* and *Callitris preissii* as weed species	i) No more non-indigenous tree species planted ii) Seedlings of non-indigenous tree species targeted in weed control works
5. Fauna and Habitat	a) Significant fauna	i) Determine what other significant fauna may occur in reserve and amend management practices to conserve the species and improve habitats	i) Level 2 fauna surveys conducted and appropriate conservation works implemented.
	b) Fauna habitat	i) Promote local native plant species that provide habitat value for local native fauna	i) Local native flora with fauna habitat value included in revegetation works.
	b) Bushland and Transitions Areas	i) Retain old mature trees for local native habitat ii) Promote understorey species to provide screening and food sources for local fauna iii) Install logs/ timer and nesting boxes to prove shelter for local fauna.	i) No old mature trees removed, excepted under special circumstances (e.g. safety)
	c) Wetland Areas	i) Bulrush populations to be reduced and replaced with native reeds and sedges	i) Bulrush populations successfully reduced and native reeds and sedges established
	d) Public Actions	i) Local public educated in handling native wildlife and in controlling their dog	i) Education signs installed, leaflets developed and distributed to local community, Ranger activity educating any public member feeding wildlife or not controlling dog adequately.
6. Feral and Overabundant Fauna	a) Feral Fauna	i) Continue to monitor for foxes and employ professional pest contractor to recue fox populations using appropriate techniques ii) Local residents to be informed on securing food sources to prevent feeding of rats and mice iii) Implement appropriate management for introduced birds iv) natural areas staff to monitor for European bee hives and City to employ a qualified pest controller to eradicate any detected populations	i) Foxes caught using appropriate techniques ii) Residents informed of importance of securing food sources iii) Appropriate measures for introduced bird control implemented iv) Bee hives regularly monitored for and any detected hives eradicated.
	e) Midges	i) Improve water quality entering reserve to minimise eutrophication (See 1b)	i) Same as 1b
7. Plant Disease	a) Prevention	i) Natural Areas staff to continue by trained and carry out hygiene practices ii) Contractors to be made aware of disease risk and management measures before entering Reserve iii) Educate local public in risks of introducing plant disease and how this may be minimised	i) Natural Areas staff trained and carrying out hygiene practices ii) Contractors informed dieback risk iii) Local public informed
8. Fire Management	a) Fire Prevention	i) Educate local public on risks of fire outbreak and how they may prevent outbreak ii) maintain ongoing liaison with DEFS on fire prevention actions	i) Local public educated ii) Ongoing liaison with DEFS maintained
	b) Fire Preparation	i) Reduce ignitable materials and fuel loads ii) maintain ongoing liaison with DEFS on fire preparation actions	i) Procedure for regularly minimising ignitable materials and fuel loads in place and being carried out ii) Ongoing liaison with DEFS maintained
Social Management			
9. Heritage	a) Local indigenous knowledge	i) Work with Local Aboriginal groups to learn of Reserve's Aboriginal cultural heritage ii) Promote local flora that has Aboriginal cultural significance iii) Develop and implement Wayfinding and Interpretation Plan that includes Aboriginal culture iv) Involve Aboriginal culture in site works and infrastructure	i) Local Aboriginal culture learnt ii) Local flora with Aboriginal significance planted in revegetation works iii) Wayfinding and Interpretation plan developed that includes Aboriginal culture iv) Aboriginal culture incorporated in at least some of the site works and infrastructure
	b) Local European knowledge	i) Work with local community groups and historians to learn of Reserve's European history	i) Local European history learnt
10. Access and Infrastructure	Landscape Master Plan	i) Develop Landscape Master Plan	i) Landscape master Plan developed
	a) Access	i) Review existing car parks, access points to ensure they meet safety standards and requirements, are suitable for large vehicles	i) Car parks and access points successful reviewed and any identified issues either corrected or being corrected
	b) Facilities and Fencing	i) Conduct audit on facilities and fencing for safety, compliance and condition	i) Facilities and fencing audited and any identified issues either corrected or being corrected
	c) Colour Scheme	i) Ensure amenities use colour scheme that allows it to blend in with the natural environment	i) Colour scheme developed and used on all amenities
11. Education and Interpretation	a) Wayfinding and Interpretation Plan	i) Develop Wayfinding and Interpretation Plan	i) Wayfinding and Interpretation Plan developed
	b) Signage	i) Audit all signage to assess style, format, location, safety compliance and condition	i) Audit conducted and any identified issues either corrected or being corrected
	c) Eco-news column	i) Establish Eco-News column in local paper	i) Eco-news column established
12. Community Involvement	a) Local community	i) Involve local community in management of reserve	i) Activities conducted that involved local community
	b) Education Opportunities	i) Involve school groups, Scout and other local community members in education activities involving the Reserve ii) Provide bushland regeneration courses to interested members of the public	i) At least 1 educational activity involving the Reserve conducted for local public ii) At least 1 bushland regeneration course offer to interested members of the public
	c) Friends group	i) Continue support for Friends group	i) Support continued
13. Maintenance	a) Turf	i) Review and consolidate turf to sporting recreation area only	i) Review conducted, turf consolidated
	b) Inspections	i) Undertake regular inspections of infrastructure and repair if necessary	i) Procedure fo regular inspection developed, implemented and any identified issues repaired or being repaired
	c) Rubbish	i) Involve community in litter collection in Reserve on Clean Up Fay Australia ii) Investigate feasibility of providing a syringe needle disposal system	i) At least one litter day conducted ii) syringe needle disposal system feasibility investigated and implement if found to be required
	d) Graffiti and Wilful Damage	i) Promptly repair any facilities found damaged from vandalism ii)Promptly remove graffiti	i) Vandalised facilities always promptly repaired ii) Graffiti always promptly removed
	3) Public	i) Encourage local community to report antisocial behaviour to police and council authorities	i) Local public been regularly encouraged to report antisocial activities.

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APPENDIX ONE: MAPS

384000
385000
386000
387000
6474000
6473000
6472000
6471000
Reid Hwy
North Beach Rd
Marmion Av
Duffy Rd
Balcatta Rd
Edinvale Rd
Amelia St
Mitchell Fwy
Karrinyup Rd
Huntriss Rd
Sackville Tce
Barnes St
Duke St
Cedric St
Scarborough Beach Rd

IMAGERY DATE SEP. 2013; SUPPLIED BY CITY OF STIRLING

GDA 1994 MGA Zone 50

LEGEND

- Freeway
- Highway
- Main Road
- Local Road
- Lake Gwelup Reserve

Digital Elevation Model (m AHD)

- < 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65

OVERVIEW

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DATE: APR-14 PROJECT NO: 3120-13

LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

TOPOGRAPHY

MAP 1

SCALE 1:15,000 @ A3

0 200 400 600 800 m

384000 385000 386000 387000

6474000 6473000 6472000 6471000

Reid Hwy
North Beach Rd
Marmion Av
Duffy Rd
Balcatta Rd
Erindale Rd
Amelia St
MITCHELL FWY
Hutchinson St
Jones St
Karrinyup Rd
Barnes St
Sackville Tce
Duke St
Scarborough Beach Rd

211Sp__Cps
211Sp__S7
211SpW_LAKE
Spearwood System
211Sp__LS1
211Qu__S2
Quindalup South System
211SpW_LAKE
211Sp__Cps
211Sp__LS1
211Sp__LS1
211Sp__P

LEGEND

- Freeway
- Highway
- Main Road
- Local Road
- Lake Gwelup Reserve
- Soil-Landscape Systems (DAFWA 2012)

Soil-Landscape Sub-systems (DAFWA 2012)

- 211Qu__S2: CALCAREOUS SAND - white, fine to medium-grained, sub-rounded quartz and shell debris, of eolian origin
- 211SpW_LAKE: Lake
- 211Sp__Cps: peaty clay - dark grey and black, soft, variable organic content, some quartz sand in places, of lacustrine origin
- 211Sp__LS1: LIMESTONE - light, yellowish brown, fine to coarse-grained, sub-angular to well rounded, quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin. Minor heavy minerals.
- 211Sp__P: PEAT - black, clayey in part, saturated fibrous organic soil
- 211Sp__S7: SAND - pale and olive yellow, medium to coarse-grained, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, of residual origin

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LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

SOIL LANDSCAPE MAPPING

MAP 2

SCALE 1:15,000 @ A3

0 200 400 600 800 m

IMAGERY DATE SEP. 2013; SUPPLIED BY CITY OF STIRLING

GDA 1994 MGA Zone 50

385500 386000 386500

6473000

6472500

Riskclass 3

Riskclass 1

Pascoe St
Finnerty St
Ramsay St
Mallee Way
Edindale Rd
Manjimup Pl
Dardanup Grn
Porter St
Ludgate Way
Abdale St
Valance Way
Cinnamon Rd
Waldemar St
Wanstead St
Lyndale St
Ufton St
March St
Rainbow Way
Blackbird Av
Pomaline Dr
MITCHELL FWY
Lagonda Dr
North Beach Rd
Wishart St
Allanson Rd
Waterside Cr
Gwelup St
Bartlett Cr
Stoneman St
Huntriss Rd
Panton Cr
Segrave St

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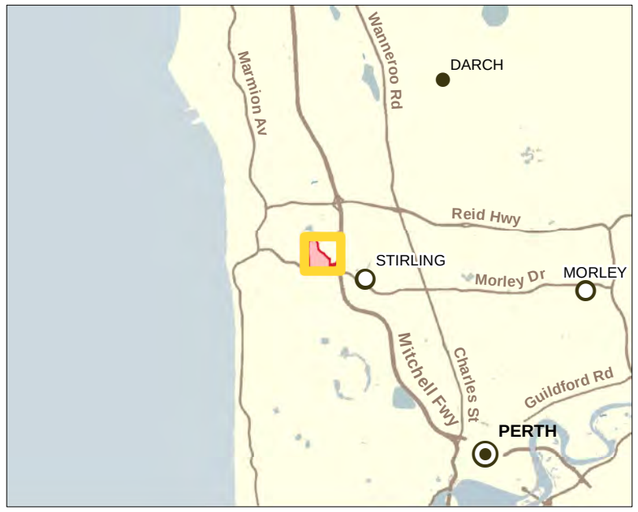
LEGEND

- Freeway
- Main Road
- Local Road
- Lake Gwelup Reserve

Acid Sulfate Risk Mapping SCP (DAFWA 2008)

- 1, High to moderate risk
- 2, Moderate to low risk
- 3, No known risk

OVERVIEW



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LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

ACID SULFATE SOIL RISK

MAP 3

SCALE 1:5,000 @ A3

0 100 200 300 m

385500 386000 386500

6473000 6472500 6472000

Pascoe St
Porter St
Mallee Way
Ludgate Way
Abdale St
Valance Way
Waldemar St
Wainstead St
Lyndale St
Ufton St
March St
Rainbow Way
Blackbird Av
Lagonda Pl
North Beach Rd
Wishart St
Pomarine Dr
Pemberton Cl
Silvergum Cl
Odin Dr
Gardon Rise
Segrave St
Karrinyup Rd
Gwelup St
Bartlett Cr
Stonehan St
Panton Cr
Chuditch Rd
Ramsay St
Finnerty St
Erindale Rd
Manjimup Pl
Dardanup Grn
Cinnamon Rd
Covent Gdns
St Anthony Dr
MITCHELL FWY
Brushfield Drain

B Soakwell
Su Sump
B to Water Corp. Balcatta Branch Drain
Br to Brushfield Drain
G to Lake Gwelup Basin

IMAGERY DATE SEP. 2013; SUPPLIED BY CITY OF STIRLING

GDA 1994 MGA Zone 50

LEGEND

Discharge points

- S Soakwell
- Su Sump
- B to Water Corp. Balcatta Branch Drain
- Br to Brushfield Drain
- G to Lake Gwelup Basin

Water Quality Control Device Locations

- Gross Pollutant Trap Location
- Trap Location
- Potential Water Qualiy Device Location

- Freeway
- Highway
- Main Road
- Local Road
- Lake Gwelup Reserve

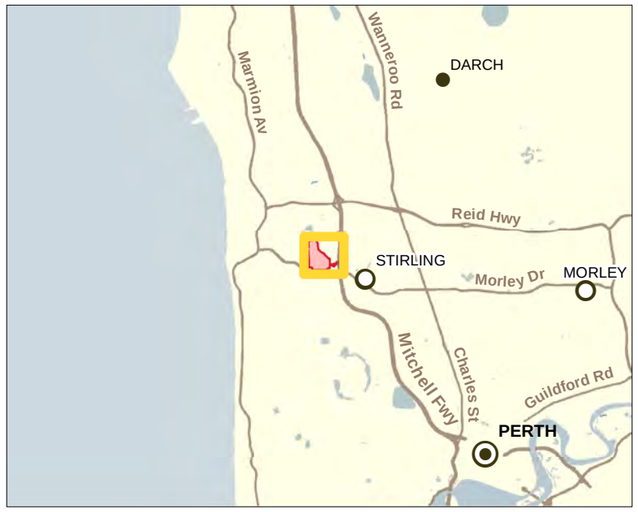
Site Drainage (Water Corporation 2014)

- Open Channel
- Buried Pipe
- Basin

Local Government Drainage

- Pipes

OVERVIEW



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LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

DRAINAGE AND IRRIGATION

MAP 4

SCALE 1:5,500 @ A3

0 100 200 300 m

385500 386000 386500

6473000

6472500

Mallee Way
UFI - 8182
Erindale Rd
Manjimup Pl
Dardanup Grn
Porter St
Pascoe St
UFI - 8171
Cinnamon Rd
Ludgate Way
Abdale St
Valance Way
Finnerty St
Ramsay St
Waldemar St
Wanstead St
Lyndale St
Ufton St
March St
Rainbow Way
MITCHELL FWY
Blackbird Av
Pomarine Dr
Lagonda Dr
North Beach Rd
Wishart St
Allanson Rt
Waterside Cr
Gwelup St
UFI - 8173
UFI - 8172
Bartlett Cr
Stoneman St
UFI - 8176
Huntriss Rd
Panton Cr
Segrave St

IMAGERY DATE SEP. 2013; SUPPLIED BY CITY OF STIRLING

GDA 1994 MGA Zone 50

LEGEND

- Freeway
- Main Road
- Local Road
- Lake Gwelup Reserve
- Groundwater Contours, May 2003 (m AHD, DoW 2004)
- Environmental Protection Policy Lakes (EPA 1993)

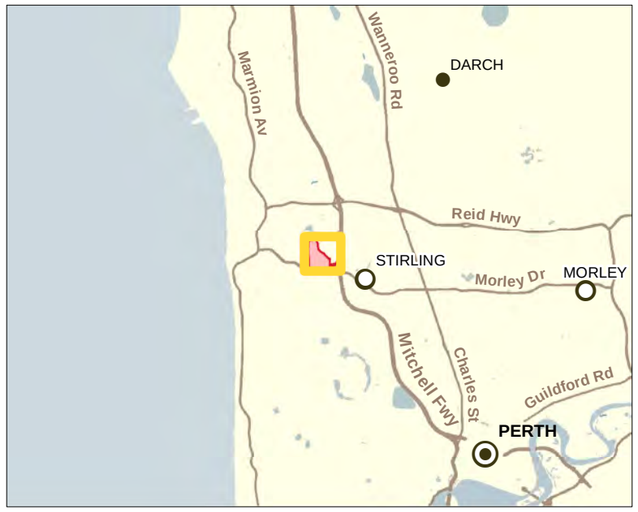
Geomorphic Wetlands SCP (DEC 2011)

- Conservation
- Resource Enhancement
- Multiple Use

Public Drinking Water Source Area (DoW 2010)

- Priority Three

OVERVIEW



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LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

WETLANDS AND GROUNDWATER

MAP 5

SCALE 1:5,000 @ A3

0 100 200 300 m

385500 386000 386500

6473000

6472500

Pascoe St
Mallee Way
Elmdale Rd
Manjimup Pl
Dardanup Grn
Porter St
Cinnamon Rd
Ludgate Way
Abdale St
Valance Way
Finnerty St
Ramsay St
Waldemar St
Wanstead St
Lyndale St
Ufton St
Rainbow Way
MITCHELL FWY
March St
Blackbird Av
Pomarine Dr
Lagonda Dr
North Beach Rd
Wishart St
Waterside Cr
Allanson Rd
Gwelup St
Bartlett Cr
Stoneman St
Huntriss Rd
Panton Cr
Segrave St

IMAGERY DATE SEP. 2013; SUPPLIED BY CITY OF STIRLING

GDA 1994 MGA Zone 50

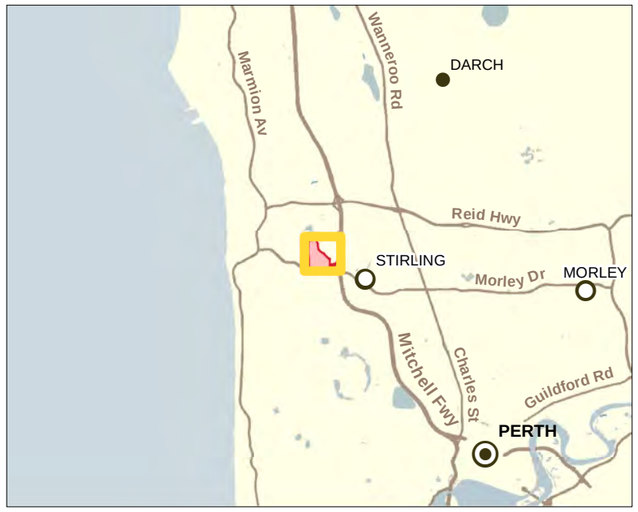
LEGEND

- Freeway
- Main Road
- Local Road
- Lake Gwelup Reserve

Vegetation Condion (Keighery (1994) Scale)

- Pristine (n/a)
- Excellent (n/a)
- Very Good (n/a)
- Good
- Degraded
- Completely Degraded
- Revegetation

OVERVIEW



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AUTHOR: JN CHECKED: SB
DATE: APR-14 PROJECT NO: 3120-13

LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

VEGETATION CONDITION

MAP 6

SCALE 1:5,000 @ A3

0 100 200 300 m

384000 385000 386000 387000

6474000 6473000 6472000 6471000

Reid Hwy
Marmion Av
North Beach Rd
Duffy Rd
Balcatta Rd
Erindale Rd
Amelia St
MITCHELL FWY
Karrinyup Rd
Huntriss Rd
Sackville Tce
Barnes St
Duke St
Scarborough Beach Rd
Cedric St

HERDSMAN
KARRAKATTA -CENTRAL AND SOUTH
COTTESLOE -CENTRAL AND SOUTH

IMAGERY DATE SEP. 2013; SUPPLIED BY CITY OF STIRLING

GDA 1994 MGA Zone 50

LEGEND

- Freeway
- Highway
- Main Road
- Local Road
- Lake Gwelup Reserve
- Native Vegetation Extent (DAFWA 2012)

Heddle Vegetation Complexes (DEC 2006)

- COTTESLOE - CENTRAL AND SOUTH: Mosaic of woodland of *E. gomphocephala* and open forest of *E. gomphocephala* - *E. marginata* - *Corymbia calophylla*; closed heath on the limestone outcrops.
- HERDSMAN: Sedgelands and fringing woodland of *E. rudis* - *Melaleuca* spp.
- KARRAKATTA - CENTRAL AND SOUTH: Predominantly low open forest of *E. gomphocephala* - *E. marginata* - *C. calophylla* and woodland of *E. marginata* - *Banksia* spp.

OVERVIEW

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AUTHOR: JN CHECKED: SB
DATE: APR-14 PROJECT NO: 3120-13

LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

VEGETATION COMPLEXES

MAP 7

SCALE 1:15,000 @ A3

0 200 400 600 800 m

385500 386000 386500

6473000

6472500

Mallee Way
Erindale Rd
Manjimup Pl
Dardanup Grn
Pascoe St
Porter St
Cinnamon Rd
Ludgate Way
Abdale St
Valance Way
Finnerty St
Ramsay St
Waldemar St
Wanstead St
Lyndale St
Ufton St
Rainbow Way
March St
Blackbird Av
Lagonda Dr
North Beach Rd
Pomarine Dr
MITCHELL FWY
Wishart St
Allanson Rd
Waterside Cr
Gwelup St
Bartlett Cr
Stoneman St
Huntriss Rd
Panton Cr
Segrave St

IMAGERY DATE SEP. 2013; SUPPLIED BY CITY OF STIRLING

GDA 1994 MGA Zone 50

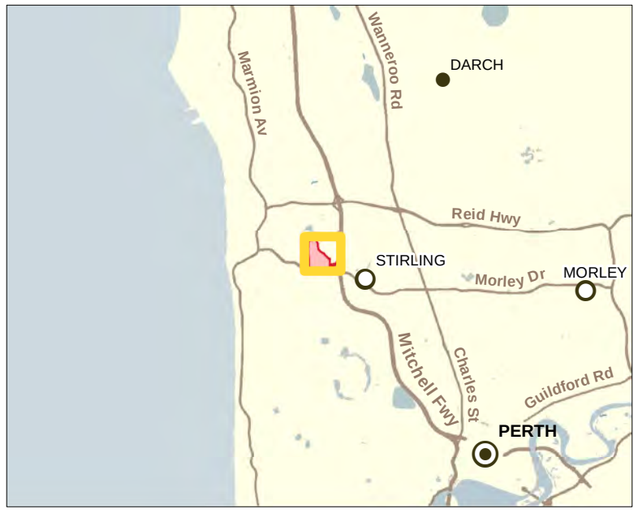
LEGEND

- Freeway
- Main Road
- Local Road
- Lake Gwelup Reserve

Vegetation Communities

- Bulrush Sedgeland
- Flooded Gum Open Forest
- Freshwater Paperbark Woodland
- Jarrah-Marri Open Woodland
- Mixed Flooded Gum - Paperbark Woodland
- Tuart Open Forest
- Revegetation
- Proposed revegetation
- Parkland
- Tree Parkland
- Tracks

OVERVIEW



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LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

VEGETATION COMMUNITIES

MAP 8

SCALE 1:5,000 @ A3

0 100 200 300 m

384000 385000 386000 387000

6474000 6473000 6472000 6471000

CARINE
GWELUP
KARRINYUP
BALCATTA
STIRLING
SCARBOROUGH
DOUBLEVIEW
INNALOO

Reid Hwy
North Beach Rd
Dudley Rd
Balcatta Rd
Erindale Rd
Mitchell Fwy
Amelia St
Karrinyup Rd
Hutton St
Barnes St
James St
Cedric St
Sackville Tce
Duke St
Scarborough Beach Rd

25379
3500
3642
212
3393
3206
3501
308
3642
21538

LEGEND

- Freeway
- Highway
- Main Road
- Local Road
- Lake Gwelup Reserve
- Suburb Boundary
- Native Vegetation Clearing Regulation Areas - Environmentally Sensitive Areas (DER 2013)
- Aboriginal Hertiage Sites (DIA 2012)
- Bush Forever (DPI 2004)
- Perth Metropolitan Regional Ecological Linkages (WALGA 2003)
- Contaminated Sites Register (DER 2013)

OVERVIEW

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DATE: APR-14 PROJECT NO: 3120-13

LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

ENVIRONMENTAL PLANNING

MAP 9

SCALE 1:15,000 @ A3

0 200 400 600 800 m

IMAGERY DATE SEP. 2013; SUPPLIED BY CITY OF STIRLING

GDA 1994 MGA Zone 50

385500 386000 386500

6473000

6472500

Pascoe St
Mallee Way
Ennale Rd
Manjimup Pl
Dardanup Grn
Porter St
Cinnamon Rd
Ludgate Way
Abdale St
Valance Way
Finnerty St
Ramsay St
Waldemar St
Wanstead St
Lyndale St
Ufton St
Rainbow Way
March St
Blackbird Av
Pomarine Dr
MITCHELL FWY
Lagonda Dr
North Beach Rd
Wishart St
Allanson Rd
Waterside Cr
Gwelup St
Bartlett Cr
Stoneman St
Huntriss Rd
Panton Cr
Segrave St

IMAGERY DATE SEP. 2013; SUPPLIED BY CITY OF STIRLING

GDA 1994 MGA Zone 50

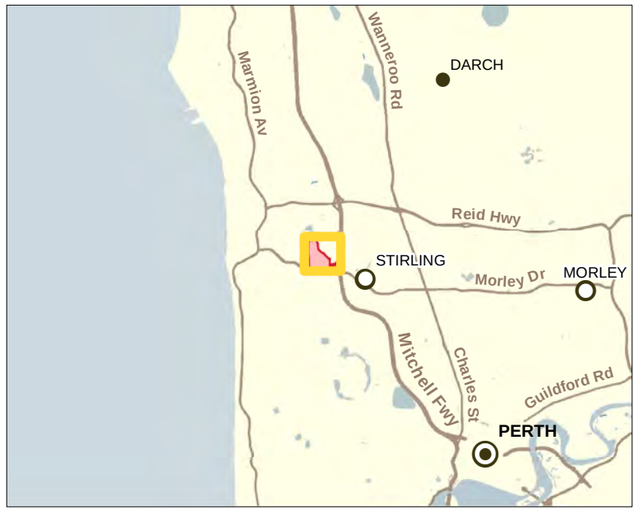
LEGEND

- Freeway
- Main Road
- Local Road
- Lake Gwelup Reserve

Fire Hazard Risk

- Extreme
- Moderate
- Low
- n/a

OVERVIEW



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DATE: APR-14 PROJECT NO: 3120-13

LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

FIRE RISK HAZARD

MAP 10

SCALE 1:5,000 @ A3

0 100 200 300 m

385500 386000 386500

6473000

6472500

Pascoe St
Finnerty St
Ramsay St
Malitee Way
Erindale Rd
Manjimup Pl
Dardanup Gr
Porter St
Ludgate Way
Abdale St
Valance Way
Cinnamon Rd
Eyrean Way
Waldemar St
Wansted St
Lyndale St
Ufton St
Rainbow Way
March St
Blackbird Av
Lagonda Dr
North Beach Rd
Pomarine Dr
MITCHELL FWY
Wishart St
Gwelup St
Bartlett Cr
Waterside Cr
Allanson Rtt
Brushfield Drain
Gardon Rise
Stoneman St
Huntriss Rd
Panton Cr
Segrave St
Kellett Cl

LEGEND

- Freeway
- Main Road
- Local Road

Land Use Zones

Conservation Landuse Zone

- C1 - Wetland
- C2 - Transition
- C3 - Dryland

Recreation Landuse Zone

- R1- Recreation Areas
- R2 - Sporting Areas
- Lake Gwelup Reserve

Site Drainage (Water Corporation 2014)

- Open Channel
- Buried Pipe
- Basin

OVERVIEW

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DATE: APR-14 PROJECT NO: 3120-13

LAKE GWELUP MANAGEMENT PLAN

CLIENT: CITY OF STIRLING

LANDUSE AND ZONES

MAP 11

SCALE 1:5,000 @ A3

0 100 200 300 m

IMAGERY DATE SEP. 2013; SUPPLIED BY CITY OF STIRLING

GDA 1994 MGA Zone 50

APPENDIX TWO: NAIA ASSESSMENT

Natural Area Initial Desktop Assessment

Date of assessment January 2014 Native Vegetation Unique ID No.

Name of area Lake Gwelup Reserve

Other names used -

Location (address/street name incl. suburb, nearest street corner, Local Government)

North of Seagrave St; South of Pascoe St, Porter St & Lake Karrinyup Gold Club; East of Finnerty St & Huntress Rd; West of North Beach Road, Lagonda Drive & Wanstead St, Gwelup, City of Stirling

Street Directory Page and Grid Ref. (Street Smart/ Gregorys/ UBD) UBD, Page 226, Grid Ref P11

Prepare the following maps and label with the name of the area.

Map 1: Location of Lake Gwelup Reserve

Photocopy of street directory showing location of site

Map 2: Reference Sites/Plots and Linkage for Lake Gwelup Reserve

A GIS print-out of general area showing vegetation complexes, potential reference sites and plots, mapped wetlands and their management category, areas of any previously recorded Declared Rare Flora, Specially Protected Fauna, Priority Flora or Fauna or Threatened Ecological Communities plus location of Draft Regional and, if available, Local Ecological Linkages. If no Local Ecological Linkages have been determined for the Local Government area, use this map to mark potential local ecological linkages to other natural areas.

Map 3: Aerial photograph of Lake Gwelup Reserve

Date of photography Scale

GIS print-out of aerial photography (with topography, if available) at a scale that ensures site covers most of an A4 page. Easy-to-use scales are 1:2000 (1 cm = 20 m), 1:3000 (1 cm = 30 m), 1:4000 (1 cm = 40 m) or 1:5000 (1 cm = 50 m). For large sites, spread over several A4 pages at one of these scales if necessary.

Area (ha) 75 (including open water) Perimeter (m) 4,130

Perimeter (m) to area (m^2) ratio 0.006 Priority for Further Investigation

Lot/Location/Reserve Number/s 8644, 9551 Langonda Dr, 9507 Karrinyup Rd, 9754 Seagrave St, 119201 Wanstead St, 784 Huntress Rd, 523 Finnerty St, 7-8 Porter St, 6 Pascoe St

Ownership (Local Government Reserve / Other Govt (Agency?) / Private) City of Stirling

Land Manager City of Stirling

Vesting Purpose Conservation, Parks and Recreation, Bush Forever

MRS Reservation or Zoning Parks and Recreation, Urban, Urban Development

TPS Reservation or Zoning Landscape

Protection Status (circle) none / conservation covenant / conservation zone / conservation vesting purpose / **Bush Forever & Parks and Recreation in the MRS** / protected CALM land

Current Status/Use of land Recreation and Conservation

Long term plans? Conservation, Resource Development

Initial Desktop Assessment

Name of area: Lake Gwelup Reserve

Recognised International/ National/ State/ Regional Conservation Value **yes** /no

Specify Conservation Category Wetland (UFI: 8173 and 8176) (DEC 2011)

Part of a Draft Regional Ecological Linkage **yes** /no

Specify (links which areas?): Regional Linkage ID: 3 (links Carine with Osborne Park)

Mapped Vegetation Complex/es Heddle: Karrakatta Central &South, Cottesloe Central & South, Herdsman

Mapped Soil Type/s (if mapping available) Spearwood Dunes: 211Sp Cps (peaty clay), 211Sp LS1 (Limestone), 211sp S7 (Sand)

Mapped wetland/s: **yes**/no Environmental Protection Policy (EPP) Lake: **yes**/no

Wetland Management Category: **CC** / RE /MU

Is it a mapped floodplain area? yes/ **no**

Potential Reference Sites and Plots (e.g. Bush Forever Sites; CALM Reserves, see Map 2). For Bush Forever Sites note floristic community type/s (FCTs) and whether FCTs actual or inferred.

Bush Forever Site 212, no FCTs found or inferred

Existing biological information for area or for potential Reference Sites (reports/ surveys/ species lists)

Ecoscape (2005) Lake Gwelup Reserve Management Plan

Halpern Glick Maunsell (1002) Lake Gwelup Environmental Management Plan for City of Stirling

Conservation Management Plan yes Current or Review needed? Review in progress

Title/Author/Year Lake Gwelup Reserve Management Plan/ Ecoscape/ 2005

Part of a Local Ecological Linkage yes

(if these have not already been determined by Local Government mark potential linkages on Map 2)

Time since isolation from other natural areas 5 - 20 years

Initial Desktop Assessment

Name of area: Lake Gwelup Reserve

(consult local community, historical aerial photography)

Does it contain any mapped Threatened Ecological Communities (see Map 2)? no

Specify: -

Does it contain any mapped Declared Rare Flora (see Map 2) or is it a known location for any Specially Protected Fauna or significant habitat for these fauna? Yes

Specify: Eastern Great Egret, Sharp-tailed Sandpiper, Carnaby's Cockatoo (short-billed black-cockatoo), Carnaby's Cockatoo, Bar-tailed Godwit, Peregrine Falcon, Rainbow Bee-eater, Glossy Ibis, Common Greenshank, Marsh Sandpiper

Does it contain any mapped Priority (see Map 2) or other significant flora (e.g. see Table 13, Bush Forever, Vol. 2, p. 51) or is it a known location for any Priority or other significant fauna (e.g. see Tables 14 and 15, Bush Forever, Vol. 2, pp. 59-63) or significant habitat for these fauna? yes

Specify

Baeckea sp. Limestone (N. Gibson & N. Lyons 1425) – P1

Jacksonia sericea – P4

Lepidium pseudohyssopifolium – P1

Riparian streamline vegetation expected no

Estuarine fringing vegetation expected no

Coastal vegetation expected (foredunes or secondary dunes) no

Fire History (consult with FESA/Volunteer Fire Brigades, local community, historical aerial photography)

Frequent fires as result of arson

Known to be of particular value to the local community for conservation no

Active Friends/Environmental Group no

Name of group and contact details -

Surrounding land uses with potential for community interest and possibly assistance with management

- educational facility **yes**/no
- residential development **yes**/no
- other (specify) yes/**no**

Indigenous or European Cultural or Historical Heritage Value **yes**/no

Notes See attached search results from the Department of Indigenous Affairs online *Aboriginal Heritage Enquiry System*

Natural Area Initial Field Assessment A

Date of assessment 19/3/2014 Native Vegetation Unique ID No. _____

Name of area Lake Gwelup

Location (address/street name) Corner of Huntriss St and Karrinyup Rd, Gwelup

Assessor Markus Mikli *Skill Level 6c

Recorder _____ Skill Level _____

Recorder _____ Skill Level _____

Recorder _____ Skill Level _____

**Important Note: Skill level 4 or above is required by the assessor to complete this template (see Appendix 1).*

Photographs

Indicate film roll no. and photograph no., location and direction of each photo on Map 4 during the field assessment. e.g. R1/P4 ⇗ (Roll 1/Photo 4 looking ⇗)

Photographer's Name Markus Mikli

Latitude And Longitude (for various locations noted during assessment, optional)

GPS used: yes/no GPS datum: _____

Descriptor and Location No. (eg. BMX jump GPS 1)	Reading/calculation (mark location number on Map 4) Latitude (S) or Northing	Longitude (E) or Easting

Prepare the following map during the field assessment and label with the name of the area.

Map 4 (transparent overlay on aerial photograph, Map 3): Uplands/Wetlands, Structural Plant Communities, Vegetation Condition, Spot Weed Occurrences, Areas of Disturbance and Management Infrastructure of _____

Uplands, Wetlands And Structural Plant Communities – Description And Mapping

On Map 4 divide the site into upland versus wetland areas and then into broad sections based on structural plant communities. Allocate a number to each community and describe each community using a representative sample point. Note the vegetation condition of each sample point as well as drawing a vegetation condition map for the whole site.

Describe each community using page 5 of these templates OR if preferred the templates of Keighery(1994) (see Appendix 3). If using the Keighery templates, describe each community on Recording Sheets 1 & 2 and list common native species present on Recording Sheet 3. Note that Appendix 3 contains minor modifications to the Keighery (1994) templates to include the additional information required on page 5.

Each structural plant community is described by noting the dominant species in each growth form layer of the community (see Appendix 2). Collect specimens for identification if necessary provided you have a licence from CALM and land owner permission. Carefully label all specimens. DO NOT collect species suspected of being DECLARED RARE FLORA instead take a good photo and accurately note location. Do not collect whole plants unless they are very small species and do not collect at all if only a few are present, take a good photo as an alternative

Photocopy page 5 or Appendix 3 and complete for **each** structural plant community identified.

Initial Field Assessment A

Name of area _____

Structural Plant Community **No. 1- Bulrush Sedgeland**

Latitude and Longitude

GPS used: yes/no GPS datum: _____Lat.: _____ Long.: _____

Landform and Soils

SLOPE: flat ASPECT: n/a

SURFACE SOIL: Colour: grey Texture: loamy sand

EXPOSED ROCK (type and % of surface): none

SUB-SURFACE SOIL: Colour: grey Texture: loamy sand

UNDERLYING ROCK (type and depth if known): None

DRAINAGE: well WET: all year

CURRENT WATER DEPTH: 30 cm

LITTER (% cover & depth): 5%, 2mm BARE GROUND (% cover) 5%

Topographic Position Circle position of point described on a transect diagram of site below.

Wetland

Growth Form Layer	**Dominant species** for each growth form layer list all dominant species, in their order of dominance, up to a maximum of 3*. (* if more than 3 species are obviously dominant record as many as appropriate to describe the layer)	**Crown Cover (Keighery 1994)** 2-10% / 10-30% / 30-70% / over 70%	**Height & Crown Cover (NVIS)** Record max. height of layer & % crown cover to nearest 5%
Trees over 30 m			
Trees 10–30 m			
Trees under 10 m			
Mallees over 8 m			
Mallees under 8 m			
Shrubs over 2 m			
Shrubs 1-2 m			
Shrubs under 1 m			
Herbs	*Conyza bonariensis		
Sedges/ Rushes	*Typha orientalis, Cyperus vaginatus, Juncus pallidus		
Grasses			
Other (e.g. climbers)			

Common Native Species Note species observed.

Eucalyptus rudis, Lepidosperma longitudinale, Persicaria decipiens

Icon Flora Species (Note if present)

Vegetation Condition (Give reasoning and note scale used) (see Appendix 4) _____

Degraded (extremely high weed presence)

Description Of Structural Plant Community No. ___ (see Appendix 2) _____

Bulrush Sedgeland

Icon Community (tick if an icon community)

Initial Field Assessment A

Name of area _____

Structural Plant Community **No. 2 – Freshwater Paperbark Woodland**

Latitude and Longitude

GPS used: yes/no GPS datum: _____Lat.: _____ Long.: _____

Landform and Soils

SLOPE: flat ASPECT: n/a

SURFACE SOIL: Colour: brown/ grey Texture: loamy sand

EXPOSED ROCK (type and % of surface): None

SUB-SURFACE SOIL: Colour: grey Texture: loamy sand

UNDERLYING ROCK (type and depth if known): None

DRAINAGE: well WET: winter and spring only

CURRENT WATER DEPTH: 5 cm

LITTER (% cover & depth):10% , 2mm BARE GROUND (% cover) 50%

Topographic Position Circle position of point described on a transect diagram of site below.

Wetland

Growth Form Layer	**Dominant species** for each growth form layer list all dominant species, in their order of dominance, up to a maximum of 3*. (* if more than 3 species are obviously dominant record as many as appropriate to describe the layer)	**Crown Cover (Keighery 1994)** 2-10% / 10-30% / 30-70% / over 70%	**Height & Crown Cover (NVIS)** Record max. height of layer & % crown cover to nearest 5%
Trees over 30 m			
Trees 10–30 m			
Trees under 10 m	Melaleuca rhaphiophylla	10-30	25
Mallees over 8 m			
Mallees under 8 m			
Shrubs over 2 m	Acacia saligna	2-10	2
Shrubs 1-2 m			
Shrubs under 1 m			
Herbs	*Hypochaeris sp., *Conyza bonariensis	2-10	2
Sedges/ Rushes			
Grasses	*Cenchrus clandestinus, *Cynodon dactylon	2-10	10
Other (e.g. climbers)			

Common Native Species Note species observed.

Acacia saligna

Icon Flora Species (Note if present)

Vegetation Condition (Give reasoning and note scale used) (see Appendix 4) _____

Description Of Structural Plant Community No. ___ (see Appendix 2) _____

Icon Community (tick if an icon community)

Initial Field Assessment A

Name of area _____

Structural Plant Community **No. 3 – Mixed Flooded Gum – Paperbark Woodland**

Latitude and Longitude

GPS used: yes/no GPS datum: _____Lat.: _____ Long.: _____

Landform and Soils

SLOPE: flat ASPECT: n/a

SURFACE SOIL: Colour: brown/ grey Texture: loamy sand

EXPOSED ROCK (type and % of surface): none

SUB-SURFACE SOIL: Colour: grey Texture: loamy sand

UNDERLYING ROCK (type and depth if known): none

DRAINAGE: well WET: n/a

CURRENT WATER DEPTH: n/a

LITTER (% cover & depth):5%, 2mm BARE GROUND (% cover) 5%

Topographic Position Circle position of point described on a transect diagram of site below.

Transition

Growth Form Layer	**Dominant species** for each growth form layer list all dominant species, in their order of dominance, up to a maximum of 3*. (* if more than 3 species are obviously dominant record as many as appropriate to describe the layer)	**Crown Cover (Keighery 1994)** 2-10% / 10-30% / 30-70% / over 70%	**Height & Crown Cover (NVIS)** Record max. height of layer & % crown cover to nearest 5%
Trees over 30 m			
Trees 10–30 m			
Trees under 10 m	Eucalyptus rudis, Melaleuca rhaphiophylla	30-70	60
Mallees over 8 m			
Mallees under 8 m			
Shrubs over 2 m			
Shrubs 1-2 m			
Shrubs under 1 m			
Herbs			
Sedges/ Rushes			
Grasses	*Cenchrus clandestinus, *Avena barbata	30-70	65
Other (e.g. climbers)			

Common Native Species Note species observed.

Acacia saligna, Banksia littoralis, Jacksonia sternbergiana, Lepidosperma longitudinale

Icon Flora Species (Note if present)

Vegetation Condition (Give reasoning and note scale used) (see Appendix 4) _____

Description Of Structural Plant Community No. ___ (see Appendix 2) _____

Icon Community (tick if an icon community)

Initial Field Assessment A

Name of area _____

Structural Plant Community **No. 4 – Flooded Gum Open Forest**

Latitude and Longitude

GPS used: yes/no GPS datum: _____Lat.: _____ Long.: _____

Landform and Soils

SLOPE: flat ASPECT: n/a

SURFACE SOIL: Colour: brown/ grey Texture: loamy sand

EXPOSED ROCK (type and % of surface): none

SUB-SURFACE SOIL: Colour: grey Texture: loamy sand

UNDERLYING ROCK (type and depth if known): none

DRAINAGE: well WET: n/a

CURRENT WATER DEPTH: n/a

LITTER (% cover & depth): 90%, 5mm BARE GROUND (% cover) 5%

Topographic Position Circle position of point described on a transect diagram of site below.

Transition

Growth Form Layer	**Dominant species** for each growth form layer list all dominant species, in their order of dominance, up to a maximum of 3*. (* if more than 3 species are obviously dominant record as many as appropriate to describe the layer)	**Crown Cover (Keighery 1994)** 2-10% / 10-30% / 30-70% / over 70%	**Height & Crown Cover (NVIS)** Record max. height of layer & % crown cover to nearest 5%
Trees over 30 m			
Trees 10–30 m			
Trees under 10 m	Eucalyptus rudis	30-70	40
Mallees over 8 m			
Mallees under 8 m			
Shrubs over 2 m	Melaleuca rhaphiophylla	2-10	5
Shrubs 1-2 m			
Shrubs under 1 m			
Herbs			
Sedges/ Rushes			
Grasses	*Cenchrus clandestinus	10-30	15
Other (e.g. climbers)			

Common Native Species Note species observed.

Banksia grandis, Hakea prostrata, Macrozamia riedlei

Icon Flora Species (Note if present)

Vegetation Condition (Give reasoning and note scale used) (see Appendix 4) _____

Description Of Structural Plant Community No. ___ (see Appendix 2) _____

Icon Community (tick if an icon community) ☐

Initial Field Assessment A

Name of area _____

Structural Plant Community **No. 5 – Jarrah – Marri Open Woodland**

Latitude and Longitude

GPS used: yes/no GPS datum: _____Lat.: _____ Long.: _____

Landform and Soils

SLOPE: flat ASPECT: n/a

SURFACE SOIL: Colour: brown, grey Texture: loamy sand

EXPOSED ROCK (type and % of surface): none

SUB-SURFACE SOIL: Colour: grey Texture: loamy sand

UNDERLYING ROCK (type and depth if known): none

DRAINAGE: well WET: n/a

CURRENT WATER DEPTH: n/a

LITTER (% cover & depth): 90%, 3 mm BARE GROUND (% cover) 5%

Topographic Position Circle position of point described on a transect diagram of site below.

Upland

Growth Form Layer	**Dominant species** for each growth form layer list all dominant species, in their order of dominance, up to a maximum of 3*. (* if more than 3 species are obviously dominant record as many as appropriate to describe the layer)	**Crown Cover (Keighery 1994)** 2-10% / 10-30% / 30-70% / over 70%	**Height & Crown Cover (NVIS)** Record max. height of layer & % crown cover to nearest 5%
Trees over 30 m			
Trees 10–30 m	Eucalyptus marginata, Corymbia calophylla	2-10	15
Trees under 10 m			
Mallees over 8 m			
Mallees under 8 m			
Shrubs over 2 m	Jacksonia sternbergiana, Hakea prostrata	2-10	8
Shrubs 1-2 m	Xanthorrhoea preissii	10-30	25
Shrubs under 1 m	Hibbertia hypericoides, Bossiaea eriocarpa	2-10	2
Herbs	Conostylis candicans, Haemodorum paniculatum	2-10	5
Sedges/ Rushes	Desmocladus fasciculatus	2-10	2
Grasses	*Ehrharta calycina	10-30	20
Other (e.g. climbers)			

Common Native Species Note species observed.

Acacia pulchella, Gompholobium tomentosum, Jacksonia furcellata, Macrozamia riedlei

Icon Flora Species (Note if present)

Vegetation Condition (Give reasoning and note scale used) (see Appendix 4) _____

Good (some weeds and clearance disurbance)

Description Of Structural Plant Community No. ___ (see Appendix 2) _____

Icon Community (tick if an icon community)

Initial Field Assessment A

Name of area _____

Structural Plant Community **No. 6 - Tuart Open Forest**

Latitude and Longitude

GPS used: yes/no GPS datum: _____Lat.: _____ Long.: _____

Landform and Soils

SLOPE: flat ASPECT: n/a

SURFACE SOIL: Colour: grey/ brown Texture: loamy sand

EXPOSED ROCK (type and % of surface): none

SUB-SURFACE SOIL: Colour: grey Texture: loamy sand

UNDERLYING ROCK (type and depth if known): none

DRAINAGE: well WET: n/a

CURRENT WATER DEPTH: n/a

LITTER (% cover & depth): 5mm, 95% BARE GROUND (% cover) **5%**

Topographic Position Circle position of point described on a transect diagram of site below.

Upland

Growth Form Layer	**Dominant species** for each growth form layer list all dominant species, in their order of dominance, up to a maximum of 3*. (* if more than 3 species are obviously dominant record as many as appropriate to describe the layer)	**Crown Cover (Keighery 1994)** 2-10% / 10-30% / 30-70% / over 70%	**Height & Crown Cover (NVIS)** Record max. height of layer & % crown cover to nearest 5%
Trees over 30 m			
Trees 10–30 m	Eucalyptus gomphocephala	2-10	10
Trees under 10 m	Eucalyptus marginata	10-30	20
Mallees over 8 m			
Mallees under 8 m			
Shrubs over 2 m	Jacksonia furcellata, Jacksonia sternbergiana, Macrozamia riedlei		
Shrubs 1-2 m	Xanthorrhoea preissii. Acacia pulchella		
Shrubs under 1 m			
Herbs	Haemodorum paniculatum, *Pelargonium capitulatum	2-10	5
Sedges/ Rushes	Mesomelaena stygia	2-10	2
Grasses	Ehrharta calycina	10-30%	25%
Other (e.g. climbers)			

Common Native Species Note species observed.

Acacia pulchella, Banksia attenuata, Banksia menziesii, Dianella revoluta, Gompholobium tomentosum, Hakea prostrata, Hakea lissocarpha, Petrophila macrostachya, Phyllanthus calycinus

Icon Flora Species (Note if present)

Vegetation Condition (Give reasoning and note scale used) (see Appendix 4) _____

Description Of Structural Plant Community No. ___ (see Appendix 2) _____

Icon Community (tick if an icon community) ☐

Weed Species Note species observed, especially the occurrence of species in better condition areas, even if they only occur in small numbers or in small patches at present. Note the distribution of each species across the site, e.g. throughout the site, spot occurrences or disturbed areas only (edges/tracks/cleared areas). Mark spot occurrences and easily mapped distributions on Map 4. If a species is widespread, note whether it is restricted to specific plant communities or wetland areas.

Weed Species	**Distribution** e.g. throughout the site, spot occurrences or disturbed areas only (edges/tracks/cleared areas)
Amaranthus viridis	Bulrush Sedgeland
Avena barbata	Tuart Open Forest, Jarrah-Marri Open Woodland
Cenchrus clandestinus	Bulrush Sedgeland, Mixed Flooded Gum-Paperbark Woodland
Conyza bonariensis	Mixed Flooded Gum-Paperbark Woodland, Flooded Gum Open Forest
Cynodon dactylon	Jarrah-Marri Open Woodland, Mixed Flooded Gum-Paperbark Woodland
Ehrharta calycina	Tuart Open Forest, Jarrah-Marri Open Woodland
Euphorbia terracina	Flooded Gum Open Forest
Foeniculum vulgare	Bulrush Sedgeland
Hypochaeris sp.	Tuart Open Forest, Jarrah-Marri Open Woodland
Lagurus ovatus	Mixed Flooded Gum-Paperbark Woodland
Pelargonium capitatum	Tuart Open Forest, Jarrah-Marri Open Woodland
Ricinus communis	Bulrush Sedgeland, Mixed Flooded Gum-Paperbark Woodland
Rubus sp.	Mixed Flooded Gum-Paperbark Woodland, Flooded Gum Open Forest
Solanum nigrum	Mixed Flooded Gum-Paperbark Woodland, Flooded Gum Open Forest
Sonchus asper	Mixed Flooded Gum-Paperbark Woodland, Flooded Gum Open Forest

Initial Field Assessment A

Name of area _____

Feral Fauna Note species observed or evidence for presence of species (scats, tracks or traces).

	✓	Comments
Evidence of Foxes (burrows, wildlife kills)		
Evidence of Rabbits (burrows, dung piles, grazing)		
Evidence of Dogs (droppings, scratchings)	✓	Directly observed, droppings
Evidence of Cats (wildlife kills)		
European Honey Bees (hives in tree hollows)	✓	Directly observed
Evidence of Horses/ Cattle/ Sheep (foot prints, droppings)		
Evidence of Pigs (soil disturbance)		
Rainbow Lorikeets		
Other		

Native Fauna and Fungi. Note species observed or evidence of presence for fauna species.

Species	**Comments:** Observed directly, evidence of presence (scats, tracks and traces) or likely habitat?
? Pycnoporus sp.	Observed growing on fallen Melaleuca log in northeast corner of study area

Native Fauna and Fungi Habitat

Habitat	✓	Comments
Areas of trees (with or without understorey)	✓	
Areas of dense understorey vegetation		
Tree hollows in old mature trees	✓	
Dead branches as perches for hunting/ look outs	✓	
Dead vegetation for fungi/invertebrate habitat (leaf litter, branches/logs)	✓	
Large fallen logs on the ground	✓	
Granite or other natural rocky outcrops		
Moss beds for fungi habitat		
Wetlands or waterways	✓	

Vegetation Health

Note dead or dying trees, shrubs, herbs and so on. Note the species concerned and the pattern of deaths/changes in the vegetation. *Phytophthora* Root Rot moves in fronts and along drainage lines therefore noting patterns helps to determine whether *Phytophthora* spp. are present. Appendix 5 defines and provides the website address for a list of common indicator species that are affected by *Phytophthora* spp. Do not automatically assume dead or dying plants means that *Phytophthora* is present.

	✓	Comments
Numerous tree stumps (not from logging)		
Dead or dying species	✓	
Obvious reduction of tree canopies (e.g. staghorns)		
Heavy leaf/stem damage by insects (e.g. lerps, stem borers)		
Diseases/pests suspected		
Drought/lowering of groundwater table suspected	✓	
Flooding/rise in groundwater table suspected		

Miscellaneous Disturbance Factors and Threatening Processes

Determine the range and extent of disturbance factors and threatening processes occurring at the site. If appropriate, mark on Map 4 and photograph as required. If site is large it may be beneficial to divide into sections and evaluate each separately.

Factor/Process	✓	Comments
Evidence of salinisation (e.g. scalding, seeps)		
Erosion (e.g. gullies, bank collapse)		
Wetland eutrophication (e.g. algal blooms)		
Stormwater drains/sumps	✓	
Service corridors (e.g. Water Corp, Telstra, Western Power, Alinta Gas)		
Mining/extraction		
Evidence of past logging (e.g. selective removal of large trees)		
Previous clearing (may be partially cleared areas or evidence of previous clearing and regrowth over much of site)		
Overgrazing (e.g. rabbits, stock, goats; over-population by kangaroos)		
Firewood collection (e.g. recent chainsaw/axe cuts, sawdust piles)		
Dope plants/ production equipment		
Soil movement (dumping or removal)	✓	
Rubbish dumping (note type, e.g. construction, garden waste, weed source?)	✓	littering
Proliferation of tracks (fire breaks, walk trails)	✓	
Off road vehicle use (4WD / trail bikes/ BMX/ mountain bikes)	✓	
Cubby construction	✓	
Vandalism (damage to plants)		
"Enrichment Planting" (revegetation with species not found in that local plant community, are these becoming weeds?)		
Impacts of High Fire Frequency and/or Intensity		
• Reduced range of tree ages		
• Fire scars high up (due to a hot burn)		
• Major trunk damage		
• Trees suckering from trunk and branches		
• Amount of leaf litter reduced		
• Large fallen logs nearly burnt away		
• Evidence of arson (burnt grass tree skirts, matches, cigarette lighters, exploded spray cans)		
Time since last fire (estimate)		<10 years

Initial Field Assessment A

Name of area _____

Vegetation Condition Map

For initial assessment, the overall vegetation condition of the site can be determined after familiarising yourself with the site. On Map 4, divide the site into broad sections based on condition, draw the boundaries of each section and record their condition. Using the map, estimate the % area each section occupies of the total site and note in the relevant boxes below using either the Keighery (1994) or Kaesenhagen (1994) condition scale(see Appendix 4). For example, 'Very Good: Section 1, 75% of site.' 'Degraded: Section 2, 25% of site.' For most sites there will be very degraded areas along tracks, for example, where rubbish has been dumped. If not extensive, these can be referred to by adding a statement such as 'areas of severe localised disturbance' in the comments.

Vegetation Condition Scales Indicate % area each section occupies of the total site (ensure adds up to 100%).						
Keighery (1994)	Pristine	Excellent	Very Good	Good	Degraded	Completely Degraded
% area	0	0	0	9.3	48.5	42.2
Kaesehagen (1994)		Very Good to Excellent	Fair to Good		Poor	Very Poor
% area						

Comments

Existing Management Infrastructure

Describe type in box below and mark location on Map 4, photograph if required.

	✓	**Comments**
Fencing	✓	
Fence condition	✓	good to excellent
Gates	✓	Chains
Paths	✓	Limestone, concrete
Path condition		Good to slightly eroded
Path fencing		
Path fence condition		
Fire access tracks	✓	Slashed
Signs	✓	Name of area, warnings, entrance signs
Previous works		

Social Significance Values

	✓	**Comments**
Evidence of Community/ Passive recreation/ Education interest	✓	Sporting fields, dog walking, bike riding
Landscape amenity (e.g. area screens/ buffers conflicting land uses)	✓	
Scenic features (e.g. high point in landscape)	✓	Lake views
Indigenous/ European Heritage (Cultural or Historical)	✓	Known European history, limited known Aboriginal history
Other		

Initial Field Assessment A

Name of area _____

Surrounding Land Uses (mark on Map 4)

	Comments
Surrounding Land Uses (note type/s and indicate likely impacts/benefits e.g. source of rubbish; weed seeds blowing into site; potential for community interest and perhaps volunteers to assist management)	Residential, scout hall, sporting field Likely Benefits – local residents and communities having involvement and developing ownership responsibility of land Likely Impacts – rubbish, trampling, arson, vandalism

Recommendations for Management List potential management actions (for example, assessment for the presence of *Phytophthora* species by an accredited assessor; fencing; signage to identify as a conservation area; rubbish removal; detailed weed survey and mapping; fire response and management planning; detailed flora/fauna/fungi surveys).

Initial Field Assessment A

Name of area _____

Confirmation of GIS Mapped Boundaries

Prepare the following map if recommending changes to native vegetation (A) or wetland (B) mapping and label with the name of the area.

Map 5: (overlay on aerial photo): Recommended GIS Boundary Changes for

When recommending changes, forward a completed copy of all 4 Initial Natural Area Assessment templates to the Perth Biodiversity Project, WALGA, 15 Altona St, West Perth 6005 for distribution to relevant custodian of database.

GIS dataset		**Changes recommended (yes/no)** Outline the rationale for each change against the relevant category (A, B or C). Prepare Map 5 if recommending changes to A or B only. Draw boundaries that correspond to your field assessment and assign accordingly to 'A' and/or 'B'.
A	**Mapped Native Vegetation** (DPI/Dept of Agriculture 2001)	Yes / No
	Rationale: _____	
B	**Mapped Wetland/s and Management Category** CC, RE or MU (DoE current update)	Yes / No / NA For changes to the mapping of wetlands on the Swan Coastal Plain complete and attach EPA Bulletin 686 (EPA 1993) to determine the new boundary and management category.
	Rationale: _____	
C	**Mapped Vegetation Complex/es** (Heddle, Loneragan and Havel 1980 or Mattiske & Havel 1998)	Yes / No More likely to be _____
	Rationale: (do not map)_____	

Name of area _____

Natural Area Initial Assessment Summary

ECOLOGICAL CRITERIA	
1. Representation	
1a. Regional Representation	
i) recognised International, National, State or Regional conservation value but not already protected Specify: It is protected as a CCW, EPP Lake and Bush Forever Site 212	no
ii) of an ecological community with only 1500 ha or 30% or less (whichever is the greater) remaining in IBRA subregion Specify: Karrakatta Central and South Complex has less than 30% remaining on the SCP but ~14,000ha.	no
iii) large (greater than 20 ha), viable natural areas in good or better condition of an ecological community with more than 30% remaining within the IBRA subregion	no
iv) of an ecological community with only 1500 ha or 15% or less (whichever is the greater) protected for conservation in the Jarrah Forest IBRA subregion Specify:	no
v) of an ecological community with only 400 ha or 10% or less (whichever is the greater) protected for conservation in the Bush Forever Study Area Specify:	no
1b. Local Representation	
i) of an ecological community with 10% or less remaining of its pre-European extent within the Local Government Area Specify: Karrakatta Central and South has 5% and Herdsman has 5% within the City of Stirling.	yes
ii) of an ecological community with 30% or less remaining of its pre-European extent within the Local Government Area Specify: Cottesloe Central and South has 11% remaining within the City of Stirling.	yes
iii) large (greater than 10 ha), viable natural areas in good or better condition of an ecological community with more than 30% remaining within the Local Government Area	no
2. Diversity	
i) natural area in good or better condition that contains both upland and wetland structural plant communities	yes
3. Rarity	
i) of an ecological community with only 1500 ha or 10% or less (whichever is the greater) remaining in the IBRA subregion Specify:	no
ii) of an ecological community with only 400 ha or 10% or less (whichever is the greater) remaining in the Bush Forever Study Area Specify:	no
iii) contains a Threatened Ecological Community Specify:	no
iv) contains Declared Rare Flora, Specially Protected Fauna or significant habitat for these fauna Specify:	yes
v) contains Priority or other significant flora or fauna or significant habitat for these fauna Specify:	yes
4. Maintaining Ecological Processes or Natural Systems - Connectivity	
i) natural areas acting as stepping stones in a Regionally Significant Ecological Linkage	yes
ii) natural areas acting as stepping stones in a locally significant ecological linkage	yes
5. Protection of Wetland, Streamline and Estuarine Fringing Vegetation and Coastal Vegetation	
i) Conservation or Resource Enhancement category wetland plus buffer	yes
ii) EPP Wetland plus buffer	yes
iii) riparian vegetation plus buffer	yes
iv) floodplain area plus buffer	no
v) estuarine fringing vegetation plus buffer	no
vi) coastal vegetation on foredunes and secondary dunes	no

Initial Assessment Summary

Name of area _____

VIABILITY ESTIMATE		
Viability Factor	**Category**	**Score**
Size	Greater than 20 ha	5
	Greater than 10 ha less than 20 ha	4
	Greater than 4 ha less than 10 ha	3
	Greater than 1 ha less than 4 ha	2
	Less than 1 ha	1
Shape	Circle, square or squat rectangle	3.5
	Oval, rectangle or symmetrical triangle	3
	Irregular shape with few indentations	2.5
	Irregular shape with many indentations	2
	Long thin shape with large proportion of area greater than 50 m wide	1.5
	Long thin shape with large proportion of area less than 50 m wide	1
Perimeter to area ratio	Less than 0.01	4
	Greater than 0.01 less than 0.02	3
	Greater than 0.02 less than 0.04	2
	Greater than 0.04	1
Vegetation condition NB: based on Keighery (1994) condition scale	Pristine 10 x 0 % =	
	Excellent 8 x 0 % =	
	Very Good 6 x 0 % =	
	Good 4 x 9.3 % =	
	Degraded 2 x 48.5 % =	
	Completely Degraded 0 x 42.2% =	
	Total calculated score =	1.34
Connectivity	Forms part of a Regional Ecological Linkage and is contiguous with a protected natural area greater than 4ha	5
	Not part of a Regional Ecological Linkage but contiguous with a protected natural area greater than 4ha	4.5
	Forms part of a Regional Ecological Linkage and is within 500 m of more than 4 protected natural areas having an area greater than 4 ha	4
	Not part of a Regional Ecological Linkage but within 500 m of more than 4 protected natural areas having an area greater than 4 ha	3.5
	Forms part of a Regional Ecological Linkage and is within 500 m of 3 or 4 protected natural areas having an area greater than 4 ha	3
	Not part of a Regional Ecological Linkage but within 500 m of 3 or 4 protected natural areas having an area greater than 4 ha	2.5
	Forms part of a Regional Ecological Linkage and is within 500 m of 2 protected natural areas having an area greater than 4 ha	2
	Not part of a Regional Ecological Linkage but within 500 m of 2 protected natural areas having an area greater than 4 ha	1.5
	Forms part of a Regional Ecological Linkage and is within 500 m of less than 2 protected natural areas having an area greater than 4 ha	1
	Not part of a Regional Ecological Linkage but within 500 m of less than 2 protected natural areas having an area greater than 4 ha	0.5
	Forms part of a Regional Ecological Linkage but is not within 500 m of any protected natural areas having an area greater than 4 ha	0.25
TOTAL SCORE (Viability Estimate)		**13.09**

Plate 5: Quadrat 1 - Bulrush Sedgeland

Plate 6: Quadrat 2 - Freshwater Paperbark Woodland

Plate 7: Quadrat 3 - Mixed Flooded Gum – Freshwater Paperbark Woodland

Plate 8: Quadrat 4 - Flooded Gum Open Forest

Plate 9: Jarrah – Quadrat 5 - Marri Open Woodland

Plate 10: Quadrat 6 - Tuart Open Forest

APPENDIX THREE: TABLES

Table 41: Definitions and criteria for PECs

Criteria	Definition
Priority One	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, state forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities, but do not meet adequacy of survey requirements, and / or are not well defined, and appear to be under threat from known threatening processes.
Priority Three	i. Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or; ii. Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; iii. Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities, but do not meet adequacy of survey requirements and / or are not well defined, and known threatening processes exist that could affect them.
Priority Four	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. a. ***Rare***. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change These communities are usually represented on conservation lands. b. ***Near Threatened***. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c. Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five	*Conservation Dependent Ecological Communities* Ecological Communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Table 42: Definitions and criteria for TECs

Criteria	Definition
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B) All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C): A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

Table 43: EPBC Act categories for TECs

EPBC Act Category	Definition
Critically Endangered (CR)	An ecological community that is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN)	An ecological community that is not critically endangered, and is facing a very high risk of extinction in the wild in the new future.
Vulnerable (VU)	An ecological community that is not critically endangered or endangered, and is facing a high risk of extinction in the medium-term future.

Table 44: EPBC Act categories for species

EPBC Act Category	Definition
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table 45: DEC Definitions of Declared Rare and Priority Flora

Code	DEC Rating	Definition
R	Declared Rare Flora - Extant Taxa	Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
X	Declared Rare Flora - Presumed Extinct Taxa	Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
1	Priority One - Poorly known Taxa	Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
2	Priority Two - Poorly Known Taxa	Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
3	Priority Three - Poorly Known Taxa	Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.
4	Priority Four - Rare Taxa	Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

Table 46: DEC Definitions of Priority Fauna

Code	DEC Rating	Definition
1	Priority One - Taxa with few, poorly known populations on threatened lands	Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
2	Priority Two - Taxa with few, or poorly known populations on conservation lands	Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
3	Priority Three - Taxa with several, poorly known populations, some on conservation lands	Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
4	Priority Four - Taxa in need of monitoring	Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
5	Priority Five - Taxa in need of monitoring	Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Table 47: DEC schedules and definitions for declaration of specially protected fauna

Schedule	Definition
Schedule 1	Fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection
Schedule 2	Fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection
Schedule 3	Birds that are subject to an agreement between the Governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of special protection
Schedule 4	Declared to be fauna that is in need of special protection, otherwise than for the reasons mentioned in Schedules 1 to 3 (mentioned above)

APPENDIX FOUR: FLORA AND FAUNA

Table 48: Known native flora recorded at Lake Gwelup Reserve

Family	Scientific Name	Common Name
AMARANTHACEAE	*Ptilotus polystachyus*	Prince of Wales Feather
ASPARAGACEAE	*Lomandra preissii*	
	Sowerbaea laxiflora	Purple Tassels
	Thysanotus sparteus	Purple Fringe Lily
CASUARINACEAE	*Allocasuarina fraseriana*	Forest Sheoak
	Allocasuarina humilis	Dwarf Sheoak
CHENOPODIACEAE	*Chenopodium ?desertorum*	Frosted Goosefoot
COLCHICACEAE	*Burchardia congesta*	Milk Maids
CYPERACEAE	*Baumea articulata*	Jointed Rush
	Cyperus vaginatus	
	Isolepis marginata	Coarse Club Rush
	Lepidosperma costale	Sedge
	Lepidosperma leptostachyum	Sedge
	Lepidosperma longitudinale	Pithy Sword-sedge
	Lepidosperma scabrum	
	Mesomelaena pseudostygia	Sedge
	Schoenoplectus validus	Lake Club Rush
	Tetraria octandra	Native Grass
DASYPOGONACEAE	*Dasypogon ?bromeliifolius*	Pineapple Bush
DILLENIACEAE	*Hibbertia hypericoides*	Yellow Buttercups
	Hibbertia racemosa	Stalked Guinea Flower
DROSERACEAE	*Drosera erythrorhiza*	Red Ink Sundew
	Drosera macrantha	Bridal Rainbow
	Drosera menziesii	Pink Rainbow
	Drosera pallida	Pale Rainbow
ERICACEAE	*Astroloma pallidum*	Kick Bush
	Conostephium ?minus	Pink Tipped Pearl Flower
	Conostephium preissii	
	Leucopogon parviflorus	Coast Beard-heath
FABACEAE	*Acacia pulchella*	Prickly Moses
	Acacia saligna	Orange Wattle
	Acacia stenoptera	Narrow Winged Wattle
	Bossiaea eriocarpa	Common Brown Pea
	Daviesia decurrens	Prickly Bitter Pea
	Gompholobium aristatum	
	Gompholobium tomentosum	Hairy Yellow-Pea
	Hardenbergia comptoniana	Native Wisteria
	Hovea trisperma	Common Hovea
	Jacksonia calcicola	
	Jacksonia furcellata	Grey Stinkwood
	Jacksonia sericea	Waldjumi
	Jacksonia sternbergiana	Stinkwood
	Kennedia prostrata	Running Postman
	Templetonia retusa	Cockies Tongue
GERANIACEAE	*Erodium cygnorum*	Blue Herons Bill
GOODENACEAE	*Scaevola canescens*	Grey Scaevola
	Scaevola ?paludosa	
	Scaevola repens	
HAEMODORACEAE	*Anigozanthos manglesii*	Mangles Kangaroo Paw
	Conostylis candicans	Grey Cottonhead
	Haemodorum paniculatum	Mardja
HEMEROCALLIDACEAE	*Caesia micrantha*	Pale Grass Lily
	Corynotheca micrantha	Sand Lily
	Dianella revoluta var. *divaricata*	Blueberry Lily
	Tricoryne elatior	Yellow Autumn lily
IRIDACEAE	*Orthrosanthus laxus* var. *laxus*	Morning Iris
	Patersonia occidentalis	Purple Flag
JUNCACEAE	*Juncus articulatus*	Jointed Rush
	Juncus pallidus	Pale Rush
MENYANTHACEAE	*Ornduffia ?albiflora*	
MYRTACEAE	*Calothamnus quadrifidus*	One-sided Bottlebrush
	Calytrix? fraseri	Pink Summer Calytrix

Family	Scientific Name	Common Name
	Corymbia calophylla	Marri
	Eucalyptus ?decipiens	
	Eucalyptus gomphocephala	Tuart
	Eucalyptus marginata	Jarrah
	Eucalyptus rudis	Flooded Gum
	Hypocalymma robustum	Swan River Myrtle
	Melaleuca rhaphiophylla	Swamp Paperbark
ORCHIDACEAE	*Caladenia arenicola*	Carousel Spider Orchid
	Caladenia flava subsp. *flava*	Cowslip Orchid
	Caladenia latifolia	Pink Fairy Orchid
	Caladenia longicauda	White Spider Orchid
	Caladenia ?marginata	White Fairy Orchid
	Cyanicula ?deformis	Blue Fairy Orchid
	Cyanicula sp.	
	Diuris corymbosa	Wallflower Donkey Orchid
	Diuris longifolia	Common Donkey Orchid
	Elythranthera ?brunonis	Purple Enamel Orchid
	Microtis media	Tall Mignonette Orchid
	Pterostylis ?concava	
	Pterostylis sanguinea	
	Pterostylis vittata	Banded Greenhood
PHYLLANTHACEAE	*Phyllanthus calycinus*	False Boronia
POACEAE	*Lachnagrostis filiformis*	
POLYGONACEAE	*Persicaria decipiens*	
	Polygonum salicifolia	Slender Knotweed
POTAMOGETONACEAE	*Potamogeton crispus*	Curly Pond Weed
PROTEACEAE	*Adenanthos cygnorum*	Common Woolly Bush
	Banksia attenuata	Slender Banksia
	Banksia grandis	Bull Banksia
	Banksia littoralis	Swamp Banksia
	Banksia menziesii	Firewood Banksia
	Banksia prionotes	Acorn Banksia
	Banksia sessilis	Parrot Bush
	Hakea lissocarpha	Honey Bush
	Hakea prostrata	Harsh Hakea
	Petrophile axillaris	
	Petrophile linearis	Pixie Mops
	Petrophile macrostachya var. *macrostachya*	
	Stirlingia latifolia	Blue Boy
	Synaphea spinulosa	
RANUNCULACEAE	*Clematis linearifolia*	
	Clematis pubescens	Common Clematis
RESTIONACEAE	*Desmocladus fasciculatus*	
	Desmocladus flexuosus	Twine Rush
STYLIDIACEAE	*Stylidium calcaratum*	Book Trigger Plant
	Stylidium ?schoenoides	Cow Kicks
VIOLACEAE	*Hybanthus calycinus*	Wild Violet
XANTHORROEACEAE	*Xanthorrhoea ?brunonis*	
	Xanthorrhoea preissii	Grass Tree
ZAMIACEAE	*Macrozamia fraseri*	Zamia Palm

? species identification to be confirmed

Table 49: Known weed species in Lake Gwelup Reserve

GROWTH FORM	WEED SPECIES		
	COMMON NAME	SCIENTIFIC NAME	Possible Garden Escape
Geophyte (7 spp.)	African Corn Flag	*Chasmanthe floribunda*	*
	Arum Lily	*Zantedeschia aethiopica*	*
	Bridal Creeper	*Asparagus asparagoides*	
	False Onion Weed	*Nothoscordum gracile*	
	Freesia	*Freesia alba x leichtlinii*	*
	One-leaf Cape Tulip	*Moraea flaccida*	
	Soursob	*Oxalis* sp.	*
Graminoid (24 spp.)	African Lovegrass	*Eragrostis curvula*	
	Annual Cat's-tail	*Rostraria cristata*	
	Annual Rye	*Lolium rigidum*	
	Bearded Oat	*Avena barbata*	*
	Blowfly Grass	*Briza maxima*	
	Buffalo Grass	*Stenotaphrum secundatum*	*
	Bulrush	*Typha orientalis*	
	Bunchy Sedge	*Cyperus polystachyos*	
	Coarse Club-rush	*Isolepis marginata*	
	Couch	*Cynodon dactylon*	*
	Giant Reed	*Arundo donax*	*
	Great Brome	*Bromus diandrus*	
	Hare's Tail Grass	*Lagurus ovatus*	*
	Italian Ryegrass	*Lolium multiflorum*	
	Jointed Rush	*Juncus articulatus*	
	Kikuyu	*Cenchrus clandestinus*	*
	Madrid Brome	*Bromus madritensis*	
	Pampas Grass	*Cortaderia selloana*	*
	Perennial Ryegrass	*Lolium perenne*	
	Perennial Veldt Grass	*Ehrharta calycina*	
	Rat's Tail Fescue	*Vulpia myuros*	
	Scaly Sedge	*Cyperus tenuiflorus*	
	Vasey Grass	*Paspalum urvillei*	
	Water Couch	*Paspalum distichum*	
Herb (32 spp.)	American Nightshade	*Solanum americanum*	
	Black Nightshade	*Solanum nigrum*	*
	Blue Lupin	*Lupinus cosentinii*	*
	Burr Medic	*Medicago polymorpha*	
	Common Meliot	*Melilotus indicus*	
	Common Sowthistle	*Sonchus oleraceus*	*
	Curled Dock	*Rumex crispus*	
	Dandelion	*Taraxacum officinale*	
	Fennel	*Foeniculum vulgare*	
	Flat Weed	*Hypochaeris glabra/ radicata*	*
	Flaxleaf Fleabane	*Conyza bonariensis*	
	Gazania	*Gazania linearis*	*
	Geraldton Carnation Weed	*Euphorbia terracina*	*
	Green Amaranth	*Amaranthus viridis*	
	Hairy Vetch	*Vicia hirsuta*	
	Hop Clover	*Trifolium campestre*	*
	Lesser Broomrape	*Orobanche minor*	
	Nasturtium	*Tropaleum majus*	*
	Petty Spurge	*Euphorbia peplus*	
	Pimpernel	*Lysmachia arvensis*	*
	Prickly Lettuce	*Lactuca serriola*	*
	Prickly Paddy Melon	*Cucumis myriocarpus*	
	Procumbent Siloxerus	*Siloxerus humifusus*	
	Rose Pelargonium	*Pelargonium capitatum*	
	Strap Lily	*Trachyandra divaricata*	
	Tall Fleabane	*Conyza sumatrensis*	
	Ursinia	*Ursinia anthemoides*	
	Velvet Pink	*Petrorhagia dubia*	
	Vetch	*Vicia sativa*	
	Whiteflower Fumitory	*Fumaria capreolata*	*
	Wild Radish	*Raphanus raphanistrum*	*
	Woolly Clover	*Trifolium tomentosum*	
Woody (4 spp.)	African Boxthorn	*Lycium ferocissimum*	
	Blackberry	*Rubus fruticosus*	
	Castor Oil Plant	*Ricinus communis*	*
	Flinders Range Wattle	*Acacia iteaphylla*	*
	Olive Tree	*Olea europea*	*
	Peppermint Tree	*Agonis flexuosa*	
	Rottnest island Pine	*Callitris preissii*	
TOTAL WEED SPECIES (68 spp.)			

Table 50: Known or likely native vertebrate fauna at Lake Gwelup Reserve

FAMILY	SCIENTIFIC NAME	COMMON NAME
Mammals		
Macropodidae	*Macropus fuliginosus*	Western Grey Kangaroo
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum
Muridae	*Hydromys chrysogaster*	Water Rat, Rakali
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat
	Nyctophilus geoffroii	Lesser Long-eared Bat
	Vespadelus regulus	Southern Forest Bat
Birds		
Phasianidae	*Coturnix pectoralis*	Stubble Quail
Anatidae	*Anas castanea*	Chestnut Teal
	Anas gracilis	Grey Teal
	Anas rhynchotis	Australasian Shoveler
	Anas superciliosa	Pacific Black Duck
	Aythya australis	Hardhead
	Biziura lobata	Musk Duck
	Chenonetta jubata	Australian Wood Duck
	Cygnus atratus	Black Swan
	Malacorhynchus membranaceus	Pink-eared Duck
	Oxyura australis	Blue-billed Duck
	Tadorna tadornoides	Australian Shelduck
Podicipedidae	*Podiceps cristatus*	Great Crested Grebe
	Poliocephalus poliocephalus	Hoary-headed Grebe
	Tachybaptus novaehollandiae	Australasian Grebe
Anhingidae	*Anhinga melanogaster*	Darter
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant
	Phalacrocorax melanoleucos	Little Pied Cormorant
	Phalacrocorax sulcirostris	Little Black Cormorant
	Phalacrocorax varius	Pied Cormorant
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican
Ardeidae	*Ardea modesta*	Eastern Great Egret
	Ardea pacifica	White-necked Heron
	Botaurus poiciloptilus	Australasian Bittern
	Egretta garzetta	Little Egret
	Egretta novaehollandiae	White-faced Heron
	Nycticorax caledonicus	Nankeen Night Heron
Threskiornithidae	*Platelea flavipes*	Yellow-billed Spoonbill
	Platelea regia	Royal Spoonbill
	Plegadis falcinellus	Glossy Ibis
	Threskiornis molucca	Australian White Ibis
	Threskiornis spinicollis	Straw-necked Ibis
Accipitridae	*Accipiter cirrhocephalus*	Collared Sparrowhawk
	Accipiter fasciatus	Brown Goshawk
	Circus approximans	Swamp Harrier
	Elanus axillaris	Black-shouldered Kite
	Haliastur sphenurus	Whistling Kite
	Hieraaetus morphnoides	Little Eagle
Falconidae	*Falco berigora*	Brown Falcon
	Falco cenchroides	Nankeen Kestrel
	Falco longipennis	Australian Hobby
	Falco peregrinus	Peregrine Falcon
Rallidae	*Fuica atra*	Eurasian Coot
	Gallinula tenebrosa	Dusky Moorhen
	Gallirallus philippensis	Buff-banded Rail
	Porphyrio porphyrio	Purple Swamphen
	Porzana fluminea	Australian Spotted Crake
	Porzana pusilla	Baillon's Crake
	Porzana tabuensis	Spotless Crake
	Tribonyx ventralis	Black-tailed Native-hen
Recurvirostridae	*Cladorhynchus leucocephalus*	Banded Stilt
	Himantopus himantopus	Black-winged Stilt
Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel

FAMILY	SCIENTIFIC NAME	COMMON NAME
Scolopacidae	*Tringa nebularia*	Common Greenshank
	Tringa stagnatilis	Marsh Sandpiper
Laridae	*Chlidonias hybridus*	Whiskered Tern
	Chroicocephalus novaehollandiae	Silver Gull
	Thalasseus bergii	Crested Tern
Cacatuidae	*Cacatua sanguinea*	Little Corella
	Calyptorhynchus latirostris	Short-billed Black-Cockatoo
	Eolophus roseicapillus	Galah
Psittacidae	*Barnardius zonarius*	Australian Ringneck
	Platycercus icterotis	Western Rosella
	Cacomantis pallidus	Pallid Cuckoo
	Chalcites lucidus	Shining Bronze-Cuckoo
Strigidae	*Ninox novaeseelandiae*	Southern Boobook
Halcyonidae	*Todiramphus sanctus*	Sacred Kingfisher
Meropidae	*Merops ornatus*	Rainbow Bee-eater
Maluridae	*Malurus splendens*	Splendid Fairy-wren
Acanthizidae	*Acanthiza apicalis*	Inland Thornbill
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill
	Acanthiza inornata	Western Thornbill
	Gerygone fusca	Western Gerygone
	Smicrornis brevirostris	Weebill
Pardalotidae	*Pardalotus striatus*	Striated Pardalote
Meliphagidae	*Acanthorhynchus superciliosus*	Western Spinebill
	Anthochaera carunculata	Red Wattlebird
	Anthochaera chrysoptera	Little Wattlebird
	Gavicalis virescens	Singing Honeyeater
	Lichmera indistincta	Brown Honeyeater
	Phylidonyris niger	White-cheeked Honeyeater
	Phylidonyris novaehollandiae	New Holland Honeyeater
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-Shrike
	Lalage sueurii	White-winged Triller
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush
	Pachycephala pectoralis	Golden Whistler
	Pachycephala rufiventris	Rufous Whistler
Artamidae	*Artamus cinereus*	Black-faced Woodswallow
	Cracticus tibicen	Australian Magpie
	Cracticus torquatus	Grey Butcherbird
Rhipiduridae	*Rhipidura fuliginosa*	Grey Fantail
	Rhipidura leucophrys	Willie Wagtail
Corvidae	*Corvus coronoides*	Australian Raven
Monarchidae	*Grallina cyanoleuca*	Magpie-Lark
Petroicidae	*Microeca fascinans*	Jacky Winter
Acrocephalidae	*Acrocephalus australis*	Australian Reed-Warbler
Megaluridae	*Megalurus gramineus*	Little Grassbird
Timaliidae	*Zosterops lateralis*	Silvereye
Hirundinidae	*Cheramoeca leucosternum*	White-backed Swallow
	Hirundo neoxena	Welcome Swallow
	Petrochelidon nigricans	Tree Martin
Reptiles and Amphibians		
Hylidae	*Litoria adelaidensis*	Slender Tree Frog
	Litoria moorei	Motorbike Frog
Limnodynastidae	*Heleioporus eyrei*	Moaning Frog
	Limnodynastes dorsalis	Western Banjo Frog
Myobatrachidae	*Crinia georgiana*	Quacking Frog
	Crinia glauerti	Clicking Frog
	Crinia insignifera	Squelching Froglet
	Myobatrachus gouldii	Turtle Frog
Cheluidae	*Chelodina colliei*	Oblong Turtle
Agamidae	*Ctenophorus adelaidensis*	Western Heath Dragon
	Pogona minor	Western Bearded Dragon
Gekkonidae	*Christinus marmoratus*	Marbled Gecko

FAMILY	SCIENTIFIC NAME	COMMON NAME
Diplodactylidae	*Diplodactylus polyophthalmus*	Spotted Sandplain Gecko
	Strophurus spinigerus	Soft Spiny-tail Gecko
Pygopodidae	*Aprasia repens*	Sandplain Worm-lizard
	Liasis burtonis	Burton's Legless Lizard
Scincidae	*Acritoscincus trilineatus*	Western Three-lined Skink
	Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink
	Ctenotus australis	Western Limestone Ctenotus
	Ctenotus fallens	West-coast Laterite Ctenotus
	Cyclodomorphus celatus	Western Slender Bluetongue
	Hemiergis quadrilineata	Two-toed Earless Skink
	Lerista elegans	Elegant Slider
	Lerista lineopunctulata	Dotted-line Robust Slider
	Lerista praepedita	Blunt-tailed West-coast Slider
	Menetia greyii	Common Dwarf Skink
	Morethia obscura	Shrubland Morethia Skink
	Tiliqua rugosa rugosa	Bobtail
Typhlopidae	*Ramphotyphlops australis*	Southern Blindsnake
Elapidae	*Brachyurophis f. fasciolatus*	Narrow-banded Snake
	Brachyurophis semifasciatus	Southern Shovel-nosed Snake
	Neelaps bimaculatus	Western Black-naped Snake
	Neelaps calonotos	Western Black-striped Snake
	Notechis scutatus	Tiger Snake
	Pseudonaja affinis	Dugite
	Simoselaps bertholdi	Jan's Banded Snake
Fish		
Galaxiidae	*Galaxias occidentalis*	Western Minnow
Gobiidae	*Pseudogobius olorum*	Swan River Goby
Percichthyidae	*Bostockia porosa*	Nightfish
	Edelia vittata	Western Pygmy Perch

(Notes to Table 50)

Australasian Bittern *Botaurus poiciloptilus* (Ardeidae): Lake Gwelup is considered to possess suitable habitat for three species of bitterns and has been surveyed repeatedly; there are no confirmed sightings, but one call of this species was reported in 2009 (Pickering 2013). Included in table as the species is resident in the general area.

Jacky Winter *Microeca fascinans* (Petroicidae): rarely seen in the Perth area but recorded twice at Lake Gwelup in 1999 (NatureMap).

Vagrant: White Wagtail *Motacilla alba* (Motacillidae) (Woodford 2012).

Records of some extralimital species on ALA database (e.g. *Litoria infrafrenata, L. rothi, Intellagama lesueurii, Lampropholis* spp., *Hemidactylus frenatus*) are omitted; some may occur as rare accidental imports or escaped pets, but no established populations occur in the Perth area and some of these records are certainly misidentifications.

Ferals: See **Table 19**.

Table 51: Invertebrates known or likely to occur in Lake Gwelup Reserve

Non-marine species recorded within 5 km radius on ALA database, or listed by Halpern Glick Maunsell (1992) or references cited therein

ORDER	FAMILY	SCIENTIFIC NAME	COMMON NAME
CNIDARIANS			
Hydrozoa	Hydridae	*Hydra* spp.	(hydra)
FLATWORMS			
Turbellaria		Indeterminate sp.	(flatworm)
NEMATODES			
		Indeterminate sp.	(roundworm)
MOLLUSCS			
Gastropoda	Planorbidae	*Ameirianna carinata*	(freshwater snail)
	Physidae	**Physa acuta*	Tadpole Snail
ANNELIDS			
Oligochaeta		Indeterminate sp.	(earthworm)
Hirudinea	Glossiphoniidae	Indeterminate spp.	(leeches)
CRUSTACEANS			
Cladocera	Chydoridae	*Alona* (ex *Biapertura*) sp.	(waterflea)
		Chydorus cf. *sphaericus*	(waterflea)
		Kurzia latissima	(waterflea)
	Daphniidae	*Daphnia carinata*	(waterflea)
		Simocephalus latirostris	(waterflea)
Ostracoda	Cyprididae	*Alboa wooroa*	(ostracod)
		Bennelongia australis	(ostracod)
		Canoncypris novaezelandiae	(ostracod)
		Cypris sp.	(ostracod)
		Ilyodromus sp.	(ostracod)
		Sarscypriopsis aculeata	(ostracod)
Amphipoda	(Family?)	Indeterminate sp.	(amphipod)
Cyclopoida	Cyclopidae	*Cyclops* sp.	(copepod)
		Microcyclops spp.	(copepod)
Calanoida	Centropagidae	*Calamoecia tasmanica subattenuata*	(copepod)
		Calamoecia attenuata	(copepod)
Isopoda	Amphisopodidae	*Paramphisopus palustris*	(slater)
INSECTS			
Ephemeroptera	Caenidae	*Tasmanocoensis* sp.	(mayfly)
	Baetidae	*Cloeon sp.*	(mayfly)
		Indeterminate spp.	(mayfly)
Odonata	Coenagrionidae	*Ischnura aurora*	(damselfly)
		Austroagrion coerule	(damselfly)
		Xanthagrion erythroneurum	Red and Blue Damselfly
	Megapodagrionidae	*Argiolestes pusillis*	(damselfly)
	Aeshnidae	*Adversaeschna brevistyla*	Blue-spotted Hawker
		Hemianax papuensis	Australian Emperor Dragonfly
	Corduliidae	*Hemicordulia australiae*	Australian Emerald Dragonfly
		Hemicordulia tau	Emerald Tau
		Procordulia affinis	
	Lestidae	*Austrolestes aleison*	
		Austrolestes analis	Slender Ringtail
		Austrolestes annulosus	
		Austrolestes io	
	Libellulidae	*Diplacodes bipunctata*	Wandering Percher
		Diplacodes haematodes	
		Orthetrum caledonicum	Blue Skimmer
	(Family?)	*Austrothermis nigrescens*	
Orthoptera	Tettigoniidae	*Kawanaphila nartee*	Nartee
Phasmatodea	Phasmatidae	*Podacanthus keyi*	Key's Stick Insect
Mantodea	Mantidae	*Orthodera ministralis*	Common Green Mantis
Blattodea		Indeterminate spp.	(roaches)
Hemiptera	Cicadidae	*Cyclochila australasiae*	Blue Moon Cicada

ORDER	FAMILY	SCIENTIFIC NAME	COMMON NAME
	Corixidae	*Agraptocorixa eurynome*	(water boatman)
		Micronecta robusta	(water boatman)
		Sigara truncatipala	(water boatman)
	Notonectidae	*Anisops* sp.	(backswimmer)
	Psyllidae	*Anoeconeossa vespertina*	(jumping plant louse)
	Pentatomidae	*Cermatulus nasalis*	Predatory Shield Bug
	Hydrometridae	Indeterminate	(marsh treader)
	Saldidae	Indeterminate	(shore bug)
	Veliidae	Indeterminate	(broad-shouldered water-strider)
Hymenoptera	Apidae	**Apis mellifera*	European Honeybee
		Exoneura pictifrons	
		Thyreus waroonensis	
	Collettidae	*Euryglossina perpusilla*	
		Hylaeus elegans	
		Hylaeus sanguinipictus	
		Hyleoides waterhousei	
	Halictidae	*Homalictus bremerensis*	
		Lasioglossum castor	
		Lasioglossum sculpturatum	
	Megachilidae	*Megachile canifrons*	
		Megachile duboulaii	
		Megachile aurifrons	
		Megachile ignita	
		Megachile semiluctuosa	
		Megachile remotula	
		Megachile erythropyga	
		Megachile chrysopyga	
		Megachile chrysopygopsis	
	Vespidae	**Vespula germanica*	European wasp
	Formicidae	*Camponotus* sp.	(sugar ant)
		Iridomyrmex chasei	(meat ant)
		Myrmecia desertorum	(bull ant)
Coleoptera	Buprestidae	*Anilara* sp.	(jewel beetle)
		Castiarina cupreoflava	(jewel beetle)
		Cisseis maculata	(jewel beetle)
		Stigmodera sp.	(jewel beetle)
		Temognatha chalcodera	(jewel beetle)
		Temognatha lessonii	(jewel beetle)
	Cerambycidae	*Phoracantha acanthocera*	Bullseye Borer
	Coccinellidae	*Harmonia conformis*	Common Spotted Ladybird
	Curculionidae	Indeterminate sp.	(weevil/s)
	Hydrochidae	Indeterminate sp.	(water beetle)
	Hydrophilidae	*Berosus* sp.	(water beetle)
		Indeterminate sp.	(water beetle)
	Hecteroceridae	Indeterminate sp.	(water beetle)
	Dytiscidae	*Dytiscus sp.*	(water beetle)
		Hyphydrus elegans	(water beetle)
		Megaporus sp	(water beetle)
	Scarabaeidae	*Metallesthes metallescens*	(scarab)
Lepidoptera	Castniidae	*Synemon gratiosa*	Graceful Sunmoth
	Arctiidae	*Anestia ombrophanes*	(moth)
	Geometridae	*Boarmia zaloschema*	(moth)
	Noctuidae	*Apina callisto*	(moth)
		Chrysodeixis argentifera	Tobacco Looper
		Dasypodia selenophora	Southern Old Lady Moth
		Pantydia sparsa	(moth)
	Nolidae	*Earias huegeliana*	Rough Bollworm
	Notodontidae	*Epicoma melanosticta*	Common Epicoma Moth
		Psalidostetha banksiae	(moth)
		Trichiocercus sparshalli	(moth)
	Nymphalidae	*Danaus chrysippus*	Lesser Wanderer
		Heteronympha merope	Common Brown

ORDER	FAMILY	SCIENTIFIC NAME	COMMON NAME
	Sphingidae	*Hippotion scrofa*	Scrofa Hawk Moth
		Hippotion celerio	Grapevine Hawk Moth
	Pieridae	*Pieris rapae*	Cabbage White Butterfly
	Lycaenidae	*Candalides hyacinthina*	Varied Dusky-Blue
Trichoptera	Hydroptilidae	*Acritoptila globosua*	(caddisfly)
	Leptoceridae	*Notalina fulva*	(caddisfly)
		Oecetis sp.	(caddisfly)
Diptera	Chironomidae	*Chironomus alternans*	(non-biting midge)
		Chironomus occidentalis	(non-biting midge)
		Cladopelma curtivalva	(non-biting midge)
		Cricotopus albitibia	(non-biting midge)
		Cryptochironomus griseidorsum	(non-biting midge)
		Dicrotendipes conjunctus	(non-biting midge)
		Kiefferulus intertinctus	(non-biting midge)
		Lundstroemia parthenogenetica	(non-biting midge)
		Polypedilum nubifer	(non-biting midge)
		Procladius villosimanus	(non-biting midge)
		Tanytarsus fuscithorax	(non-biting midge)
		Indeterminate/unnamed spp.	(non-biting midge)
	Culicidae	*Aedes notoscriptus*	(mosquito)
		Aedes alboannulatus	(mosquito)
		Aedes camptorhynchus	(mosquito)
		Anopheles annulipes	(mosquito)
		Coquillettidia linealis	(mosquito)
		Culex annulirostris	(mosquito)
		Culex fatigans	(mosquito)
		Culex australicus	(mosquito)
		Culex latus	(mosquito)
		Culex globocoxitus	(mosquito)
	Psychodidae	Indeterminate sp.	(moth fly/drain fly)
	Sciomyzidae	Indeterminate sp.	(marsh fly)
	Stratiomyidae	Indeterminate sp.	(soldier fly)
MILLIPEDES			
Iulida	Iulidae	**Ommatoiulus moreletii*	Portuguese Millipede
Polydesmida	Paradoxosomatidae	*Antichiropus whistleri*	(millipede)
CENTIPEDES			
Lithobiomorpha	Henicopidae	*Henicops dentatus*	(stone centipede)
Scolopendromorpha	Scolopendridae	*Cormocephalus aurantiipes*	Orange-footed Centipede
		Notiasemus glauerti	(scolopendrid)
CHELICERATES			
Araneae	Nemesiidae	*Aname mainae*	(wishbone spider)
	Theraphosidae	*Selenocosmia stirlingi*	Common Whistling Spider
	Barychelidae	*Synothele michaelseni*	(trapdoor spider)
	Idiopidae	*Idiosoma sigillatum*	Rugose Trapdoor Spider
	Actinopodidae	*Missulena granulosa*	Mouse Spider
		Missulena occatoria	Red-headed Mouse Spider
	Pholcidae	*Pholcus phalangioides*	Cellar Spider
	Oecobiidae	*Oecobius navus*	Wall Spider
	Micropholcommatidae	*Raveniella peckorum*	(tiny spider)
		Raveniella subcirrata	
	Pararchaeidae	*Westrarchaea sinuosa*	
	Araneidae	*Arachnura higginsi*	Scorpion-tailed Spider
		Araneus cyphoxis	(orb-weaver)
		Araneus senicaudatus	(orb-weaver)
		Argiope protensa	(orb-weaver)
		Argiope trifasciata	Banded Orb-weaver
		Austracantha minax	Jewel Spider
		Backobourkia brounii	(orb-weaver)
		Eriophora biapicata	Garden Orbweaving Spider
		Gasteracantha fornicata	(orb-weaver)
		Gea theridioides	(orb-weaver)
	Linyphiidae	*Ostearius melanopygius*	

ORDER	FAMILY	SCIENTIFIC NAME	COMMON NAME
	Nephilidae	*Nephila pilipes*	Giant Golden Orb-weaving Spider
		Nephila plumipes	Humped Golden Orb-weaving Spider
	Theridiidae	*Cristulina bicruciata*	(cobweb spider)
		Latrodectus hasseltii	Redback Spider
	Lycosidae	*Artoria linnaei*	Linnaeus Wolf Spider
		Artoria taeniifera	(wolf spider)
		Artoriopsis expolita	(wolf spider)
		Dingosa serrata	(wolf spider)
		Hoggicosa bicolor	(wolf spider)
		Hogna crispipes	(wolf spider)
		Hogna immansueta (ex Venator)	Western Rough Wolf Spider
		Lycosa australicola	(wolf spider)
		Lycosa gilberta	(wolf spider)
		Lycosa godeffroyi	(wolf spider)
		Tetralycosa oraria	(wolf spider)
		Venatrix pullastra	(wolf spider)
	Desidae	*Phryganoporus candidus*	(spider)
	Nicodamidae	*Nicodamus mainae*	(spider)
	Sparassidae	*Eodelena convexa*	(huntsman spider)
		Isopeda leishmanni	(huntsman spider)
		Pediana occidentalis	(huntsman spider)
	Selenopidae	*Karaops jarrit*	
	Zodariidae	*Habronestes australiensis*	
		Masasteron tuart	
	Miturgidae	*Mituliodon tarantulinus*	(long-legged sac spider)
	Ammoxenidae	*Austrammo harveyi*	(small ground spider)
	Gallieniellidae	*Meedo harveyi*	
	Lamponidae	*Lampona brevipes*	(ground spider)
		Lampona cylindrata	White-tailed Spider
		Lamponella kimba	(ground spider)
		Longepi woodman	(ground spider)
		Prionosternum scutatum	(ground spider)
		Pseudolampona woodman	(ground spider)
	Prodidomidae	*Cryptoerithus quobba*	
		Molycria vokes	
		Myandra bicincta	(long-spinneret ground spider)
	Salticidae	*Bianor maculatus*	(jumping spider)
		Breda jovialis	Australian Jumping Spider
		Lycidas michaelseni	(jumping spider)
		Maratus pavonis	Peacock Jumping Spider
		Ocrisomia leucocomis	(jumping spider)
		Servaea melaina	(jumping spider)
	Corinnidae	*Supunna picta*	Spotted Ground Swift Spider
		Supunna funerea	
Opiliones	Neopilionidae	*Ballarra longipalpus*	(harvestman)
Ixodida	Ixodidae	*Amblyomma triguttatum*	Kangaroo Hard Tick
Mesostigmata	Macronyssidae	*Ornithonyssus bacoti*	Rat Mite
Oribatida	(Family?)	Indeterminate sp.	(oribatid mite)
Sarcoptiformes	Epidermoptidae	*Myialges ancistronae*	(parasitic mite)
Trombidiformes	Unionicolidae	*Encentridophorus* sp.	(watermite)
	Pionidae	*Piona cumberlandensis*	(watermite)
	Arrenuridae	*Arrenurus balladoniensis*	
	Halacaridae	Indeterminate sp.	
Scorpiones	Bothriuridae	*Cercophonius granulosus*	(scorpion)
		Cercophonius sulcatus	Spiral-burrow Scorpion
	Urodacidae	*Urodacus hartmeyeri*	(scorpion)
		Urodacus novaehollandiae	(scorpion)
Pseudoscorpionida	Geogarypidae	*Geogarypus taylori*	(pseudoscorpion)

Table 52: Known native fungi at lake Gwelup Reserve

SCI NAME	COMMON NAME	FORM	HABITAT	LIFE MODE
Amanita sp.		mushroom	litter/ground	Mycorrhizal
Arcyria cinerea		slime mold	litter/ground	Saprotrophic
Asterostroma persimile	Rosy Skin Fungus	resupinate	dead wood	Saprotrophic
Bovista sp.		puffball	litter/ground	Saprotrophic
Calocera guepinioides	Scotsman's Beard	jelly fungus	dead wood	Saprotrophic
Clavulina sp.		coral	litter/ground	Mycorrhizal
Clitocybe semiocculta	Shy Funnel Cap	shell	dead wood	Saprotrophic
Clitocybe sp.		mushroom	litter/ground	Saprotrophic
Coltricia cinnamomea	Tough Cinnamon Fungus	mushroom	litter/ground	Saprotrophic
Coprinopsis cf. stangliana	WA Magpie Fungus	mushroom	litter/ground	Saprotrophic
Coprinus sp.		mushroom	litter/ground	Saprotrophic
Cortinarius sp.		mushroom	litter/ground	Mycorrhizal
Cortinarius vinaceolamellatus		mushroom	litter/ground	Mycorrhizal
Crepidotus eucalyptorum	Eucalypt Crepidotus	shell	dead wood	Saprotrophic
Crepidotus sp.		shell	dead wood	Saprotrophic
Dacrymyces sp.		jelly fungus	dead wood	Saprotrophic
Dasyscyphus sp.		cup	dead wood	Saprotrophic
Dermocybe clelandii		mushroom	litter/ground	Mycorrhizal
Exidia sp.		jelly fungus	dead wood	Saprotrophic
Gymnopilus allantopus	Golden Wood Fungus	mushroom	dead wood	Saprotrophic
Gymnopilus cf. purpuratus		mushroom	dead wood	Saprotrophic
Gymnopilus purpuratus		mushroom	dead wood	Saprotrophic
Gymnopilus sp.		mushroom	dead wood	Saprotrophic
Harknessia uromycoides	Tuart Nut Fungus	pustules	dead wood	Saprotrophic
Henningsomyces candidus	Miniature Chimney Pots	tubular	dead wood	Saprotrophic
Hexagonia vesparia	Wasp Nest Polypore	bracket	dead wood	Saprotrophic
Laccaria lateritia	Brick Red Laccaria	mushroom	litter/ground	Mycorrhizal
Laccaria sp.		mushroom	litter/ground	Mycorrhizal
Leocarpus fragilis		slime mould	dead wood	Saprotrophic
Lycoperdon sp.		puffball	litter/ground	Saprotrophic
Megalocystidium sp.		resupinate	dead wood	Saprotrophic
Mycena clarkeana	Clarke's Pixie Cap	mushroom	bark, tree	Saprotrophic
Mycena sp.		mushroom	litter/ground	Saprotrophic
Mycena vinacea		mushroom	litter/ground	Saprotrophic
Omphalotus nidiformis	Ghost Fungus	mushroom	dead wood	Saprotrophic /Parasitic
Phallus hadriani		phalloid	litter/ground	Saprotrophic
Phellinus sp.		bracket	dead wood	Saprotrophic
Pluteus atromarginatus		mushroom	dead wood	Saprotrophic
Pluteus lutescens		mushroom	dead wood	Saprotrophic
Pluteus sp.		mushroom	dead wood	Saprotrophic
Psathyrella sp.		mushroom	litter/ground	Saprotrophic
Pycnoporus coccineus	Scarlet Bracket Fungus	bracket	dead wood	Saprotrophic
Schizophyllum commune	Split Gill Fungus	shell	dead wood	Saprotrophic
Schizopora sp.		resupinate	dead wood	Saprotrophic
Scutellinia scutellata	Eyelash Cup Fungus	cup	dead wood	Saprotrophic
Tremella mesenterica group	Yellow Brain Fungus	jelly fungus	dead wood	Saprotrophic
Tubaria serrulata		mushroom	litter/ground	Saprotrophic
Tubaria sp.		mushroom	litter/ground	Saprotrophic
Tubifera ferruginosa	Strawberry Slime Mould	slime	dead wood	Saprotrophic
Undetermined Ascomycete		cup	litter/ground	Saprotrophic
Undetermined Jelly Fungus		jelly	dead wood	Saprotrophic
Undetermined Resupinate		resupinate	dead wood	Saprotrophic
Volvariella speciosa	Common Rosegill	mushroom	litter/ground	Saprotrophic

APPENDIX FIVE: WEED PRIORITISATION

Methodology of Prioritising Weeds

Rating Systems

The priority ratings of each weed species were determined after examining:

- the ratings under the:
  - Environmental Weed *Strategy* of Western Australia (EWSWA) by the Department of Conservation and Land Management (Department of Environment and Conservation 2008a)
  - Environmental Weed Census and Prioritisation (EWCP) by the Swan Natural Resource Management (Swan NRM 2008)
  - Dixon and Keighery (Dixon & Keighery 1995) *Recommended* methods to control specific weed species
- whether it was listed as a:
  - Declared Pest under the Department of Agriculture and Food (DAFWA 2007) *Biosecurity and Agriculture Management Act* (BAM)
  - *Weed of National Significance* (WONS) (Weeds Australia 2012)
- its local significance to the natural areas.

The role of EWSWA is to highlight which weed species pose significant environmental risk in Western Australia. The EWSWA rating provides a basis for determining which weeds are most critical to control. The three characteristics used for determining the EWSWA rating are:

- *invasiveness* – ability to invade bushland in good to excellent condition
- *distribution* – wide current or potential distribution including consideration of known history of wide distribution elsewhere in the world
- *environment* impacts – ability to change the structure, composition and function of ecosystems, in particular to form a monoculture in a vegetation community.

EWSWA weed species were rated accordingly:

- High – have all three of the characteristics
- Moderate – have two of the characteristics
- Mild – have one of the characteristics
- Low – not deemed to have any of the characteristics.

However, EWSWA is a general guide for prioritising weeds across the State. The Swan Natural Resource Management (2008) *Environmental Weed Census and Prioritisation* (EWCP) rates weeds species as a threat in Perth bushland conditions. A total of eight ratings are used, according to the risk each species poses to environmental assets in the region, based on invasiveness, ecological impact, current and potential distribution, and thus priority for management. In order of descending, priority, they are:

- Very High
- High
- Further Assessment Required (FAR)/ High
- Moderate/ High
- Moderate
- Low/ Moderate
- Low
- Further Assessment required (FAR).

Dixon and Keighery (Dixon & Keighery 1995) developed a rating system for 145 weed species. The rating system classified each species according to the threat they pose to bushland in the Perth Metropolitan region. The three classifications used were:

- Priority 1 – major weeds, which are the most serious weeds within their ecosystem, often affecting many reserves or habitats in ways likely to permanently degrade them -
- Priority 2 – nuisance weeds, which are generally found only in a few locations or ecosystems, usually in disturbed areas
- Priority 3 – minor weeds, which have little known effect and occur in smaller numbers or are less competitive than Priority 2 weeds.

Under the BAM Act 2007, all declared pests are placed in one of three categories:

- C1 Category (Exclusion) – Pests not established in Western Australia. Control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
- C2 Category (Eradication) – Pests present in Western Australia in low enough numbers or sufficiently limited areas that their eradication is still a possibility.
- C3 Category (Management) – Pests established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage.

WONS was jointly declared by the Minister for Forestry and Conservation, the Minister for Agriculture, Fisheries and Forestry and the Minister for The Environment in 1999 as part of the *National Weeds Strategy*. The four characteristics used for determining where the species was of national significance were:

- invasiveness
- impacts
- potential for spread
- socioeconomic and environmental values.

Ranking Priority Weeds

The above sources were used to rank the recorded weed species in order of priority for control. Both the EWCP (Swan Natural Resource Management 2008) and EWSWA (CALM 1999) ratings were used because it allowed most weeds identified in the study area to be assigned a rating and thereby ranked. If only one source had been used, some of the weed species would have not been assigned a rating score.

The use of two rating systems does result in some conflict when assigning a ranking for a weed species. To overcome this issue, a matrix scoring system was developed to enable the ranking of the weed species. The matrix scoring system is summarised in **Table 53.** For the purposes of this study, the system gave a slight bias to the EWCP system, as this system was more relevant for the study area.

In addition, as weed species listed under either the BAM Act or WONS are required by legislation to be controlled, any of these listed weed species recorded were automatically given a rating of 6.

If any weed species not assigned a rating by these any of the previous sources, the Dixon and Keighery (Dixon & Keighery 1995) rating system would then be used:

- Priority 1 = Rating 6
- Priority 2 = Rating 4
- Priority 3 = Rating 2

If any weed species were not given a rating be any of the previous systems, they would receive a default rating of 1.

Table 53: Matrix scoring system for rating weed priority

RATING SYSTEM		EWSWA				
		Unrated	Low	Mild	Moderate	High
EWCP	Unrated	1	1	3	4	5
	FAR	1	1	3	4	5
	Low	2	2	3	4	5
	L/M	2	3	4	4	5
	M	3	4	4	4	5
	M/H	4	4	4	5	6
	FAR/H	5	5	5	5	6
	H	5	5	5	6	6
	VH	6	6	6	6	6

The calculated ratings were then adjusted according to whether the species were more or less of a threat or dominant in the local native areas. Species with low ratings that were posing a greater threat or were already highly dominant had the rating raised. In contrast, species with high ratings but were not considered to be a local threat had their rating lowered accordingly.

The priority of each weed species was then classified by the final rating:

- Species given a rating of 5 or 6 were High Priority Weeds.
- Species with a final rating of 3 or 4 were Moderate Priority Weeds.
- Species with a rating of 1 or 2 were Low Priority Weeds.

Results

State and National Significance

The following four weed species were listed by either/both WONS and BAM were given Ratings of 6 (High Priority):

- Arum Lily (*Zantedeschia aethiopica*) - BAM (C3)
- Blackberry (Rubus fruticosus) – WONS and BAM (C3)
- Bridal Creeper (*Asparagus asparagoides*) – WONS and BAM (C3)
- Cape Tulip (*Moraea flaccida*) - BAM (C3)

Local Significance

Flat Weed (*Hypochaeris glabra/ radicata*), Olive Tree (*Olea europea*), Peppermint Tree (*Agonis flexuosa*) and Prickly Lettuce (*Lactuca serriola*) were both calculated to having ratings of 6 (High Priority), however were downgraded to a rating of 4 (Moderate Priority) as they were all considered to be minor threats to the local bushland.

African Corn Flag (*Chasmanthe floribunda*), American Nightshade (Solanum americanum), Black Nightshade (Solanum nigrum) were each calculated to have a rating of 4 (Moderate Priority). Also, Gazania (Gazania linearis) and tall Fleabane (Conyza sumatrensis) was calculated to have a rating of 1 (Low Priority) All of these species were upgraded to a rating of 5 (High Priority) as they is considered problem species by the City in the Reserve.

Table 54: Prioritisation of weed species in Lake Gwelup Reserve

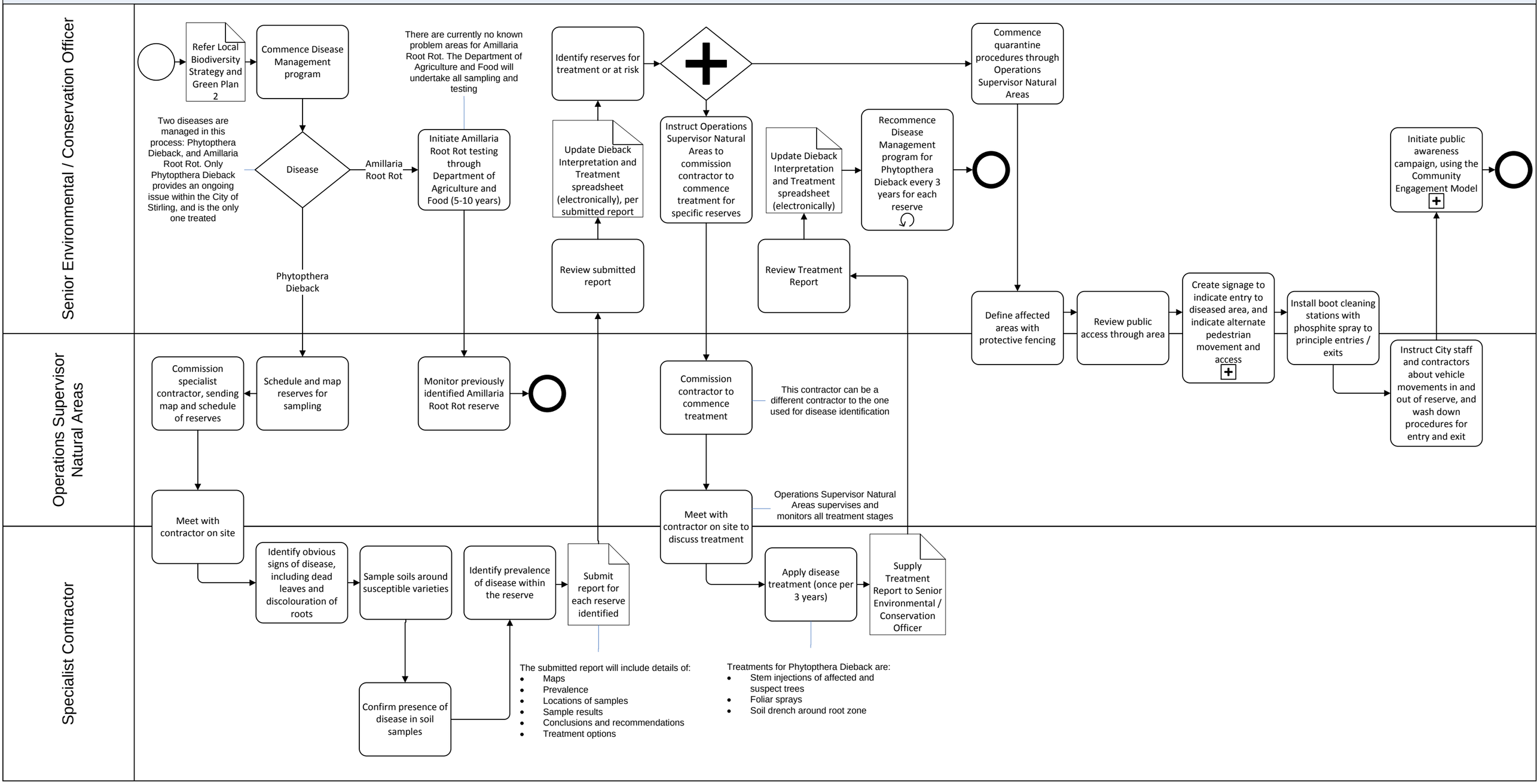
WEED SPECIES		PRIORITISATION								
Common Name	**Scientific Name**	**EWCP**	**EWSWA**	**Weeds Australia**	**BAM**	**Dixon & Keighery**	**Calculated Rating**	**Local significance**	**Final Rating**	**PRIORITY**
African Boxthorn	*Lycium ferocissimum*	Very High	High				6		**6**	**HIGH**
African Love Grass	*Eragrostis curvula*	High	High			1	6			
Arum Lily	*Zantedeschia aethiopica*	Very High	High		C3	1	6			
Bearded Oat	*Avena barbata*	Very High	Moderate			1	6			
Blackberry	*Rubus fruticosus*	Unrated	Low	WONS	C3		6			
Bridal Creeper	*Asparagus asparagoides*	Very High	High	WONS	C3	1	6			
Buffalo Grass	*Stenotaphrum secundatum*	Moderate	High			1	6			
Bulrush	*Typha orientalis*	Very High	High			1	6			
Couch	*Cynodon dactylon*	Very High	Moderate			1	6			
Geraldton Carnation Weed	*Euphorbia terracina*	Very High	High			1	6			
Great Brome	*Bromus diandrus*	Very High	High			3	6			
Hare's Tail Grass	*Lagurus ovatus*	High	High			2	6			
Kikuyu	*Cenchrus clandestinus*	High	Moderate			1	6			
One-leaf Cape Tulip	*Moraea flaccida*	Very High	High		C3	1	6			
Pampas Grass	*Cortaderia selloana*	Very High	High			1	6			
Perennial Veldt Grass	*Ehrharta calycina*	Very High	High			1	6			
Petty Spurge	*Euphorbia peplus*	High	Moderate			3	6			
Water Couch	*Paspalum distichum*	High	Moderate			2	6			
African Corn Flag	*Chasmanthe floribunda*	Moderate	Moderate			3	4	Yes	**5**	
American Nightshade	*Solanum americanum*	FAR	Moderate			3	4	Yes		
Blue Lupin	*Lupinus cosentinii*	Unrated	High			1	5			
Freesia	*Freesia alba x leichtlinii*	Very High	High				6			
Gazania	*Gazania linearis*	Unrated	Low			3	1	Yes		
Rose Pelargonium	*Pelargonium capitatum*	Moderate/ High	High			1	5			
Soursob	*Oxalis pes-caprae*	High	Mild			2	5			
Tall Fleabane	*Conyza sumatrensis*	Unrated	Low			3	1	Yes		
Vasey Grass	*Paspalum urvillei*	High	Low			2	5			
Annual Cat's-tail	*Rostraria cristata*	Unrated	Moderate				4		**4**	**MOD**
Annual Rye Grass	*Lolium rigidum*	Unrated	Moderate			3	4			
Black Nightshade	*Solanum nigrum*	Moderate	Moderate			2	4			
Blowfly Grass	*Briza maxima*	FAR	Moderate			2	4			
Bunchy Sedge	*Cyperus polystachyus*	Low	Moderate				4			
Coarse Club-rush	*Isolepis marginata*	FAR	Moderate				4			
Common Meliot	*Melilotus indicus*	Moderate	Unrated			3	4			
Common Sowthistle	*Sonchus oleraceus*	Moderate	FAR			3	4			
Flat Weed	*Hypochaeris glabra/ radicata*	High	Moderate			3	6	No		
Giant Reed	*Arundo donax*	Unrated	Unrated			2	4			
Hop Clover	*Trifolium campestre*	FAR	Moderate			3	4			
Lesser Broomrape	*Orobanche minor*	FAR	Moderate				4			
Olive Tree	*Olea europea*	Unrated	Low				6	No		
Peppermint Tree	*Agonis flexuosa*	High	Moderate			3	6	No		

WEED SPECIES		PRIORITISATION								
Common Name	**Scientific Name**	**EWCP**	**EWSWA**	**Weeds Australia**	**BAM**	**Dixon & Keighery**	**Calculated Rating**	**Local significance**	**Final Rating**	**PRIORITY**
Pimpernel	*Lysimachus arvensis*	Moderate	FAR			3	4			
Prickly Lettuce	*Lactuca serriola*	Moderate	High			3	6	No		
Ursinia	*Ursinia anthemoides*	Moderate	Moderate			3	4			
Velvet Pink	*Petrorhagia dubia*	Moderate	Mild			3	4			
Vetch	*Vicia sativa*	FAR	Moderate			3	4			
Whiteflower Fumitory	*Fumaria capreolata*	Moderate/ High	Mild			2	4			
Burr Medic	*Medicago polymorpha*	Mild	FAR			3	3			
Curled Dock	*Rumex crispus*	FAR	Mild			3	3			
Fennel	*Foeniculum vulgare*	Moderate	Unrated			2	3		**3**	**MOD**
Jointed Rush	*Juncus articulatus*	Unrated	Mild				3			
Strap Lily	*Trachyandra divaricata*	FAR	Mild			3	3			
Wild Radish	*Raphanus raphanistrum*	FAR	Mild			3	3			
Dandelion	*Taraxacum officinale*	Low	Low				2			
False Onion Weed	*Nothoscordum gracile*	Low	Low				2			
Flaxleaf Fleabane	*Conyza bonariensis*	Low	Low			3	2			
Flinders Range Wattle	*Acacia iteaphylla*	FAR	Low			3	2			
Green Amaranth	*Amaranthus viridis*	Low	Low				2			
Hairy Vetch	*Vicia hirsuta*	FAR	Low			3	2			
Italian Ryegrass	*Lolium multiflorum*	Low	Low				2		**2**	
Madrid Brome	*Bromus madritensis*	FAR	Low			3	2			
Nasturtium	*Tropaeolum majus*	Low	Low			3	2			**LOW**
Perennial Ryegrass	*Lolium perenne*	Low	Low			3	2			
Prickly Paddy Melon	*Cucumis myriocarpus*	Low	Unrated			3	2			
Rat's Tail Fescue	*Vulpia muyrus*	Unrated	Unrated			3	2			
Scale Sedge	*Cyperus tenuiflorus*	Low	Low				2			
Castor Oil Plant	*Ricinus communis*	Unrated	Low			3	1			
Procumbent Siloxerus	*Siloxerus humifusus*	Unrated	Unrated				1		**1**	
Woolly Clover	*Trifolium tomentosum*	FAR	Low				1			

APPENDIX SIX: DIEBACK PROCEDURE

City of Stirling
City of Choice

Directorate: Infrastructure
Business Unit: Parks and Reserves
Process: Natural Areas: Disease Management



APPENDIX SEVEN – PUBLIC FEEDBACK

Lake Gwelup Management Plans Public Comment Summaries

Ref.	Reviewer Comment	City Response
1	**GENERAL**	
1.01	**Support and Appreciation**	
a	General approval and support on management plan strategy and improvements	Appreciated by City
1.02	Objectives	
a	Request to detail difference between last MP and present MP, particularly how many/ which objectives of last MP were achieved	Main objectives are the same as last MP, new MP is to revise the plan to meet changes in environment, laws and regulations, threats and opportunities.
2	**PHYSICAL ENVIRONMENT**	
2.01	**Water Levels**	
a	Is Lake Gwelup drying out more often because Karrinyup Golf Course has access to its water?	Text added to Section 3.4.1 Paragraph 1
b	Request to top up lake, possibly from Water Corp's recycled water (e.g. Capel wetlands)	Text added 6.2.1, Strategy 1 Table 24, and Recommendation 1.3
2.02	**Water Quality**	
a	Request to install filters for incoming drains (reference to Sunday Times article)	Already included in plan (Section 6.2.1, Strategy 2)
b	What is green coloured oily film that appears on water when lake begins to dry out? Concern it is a threat to wildlife.	The oily film is the growth of blue green algae which may bloom as a result of fertiliser input. Not a threat to wildlife. Text discussing nutrient filtration present in Section 6..2.1, Strategy 2
2.03	**Acid Sulphate Soils**	
a	Request City to meet Minister and Water Corp to cease operations of all 22 bores east of lake Gwelup to allow lake to saturate	Text added Section 6.2.1, Strategy 1, Table 24 and Recommendation 1.3
b	More detail on Brushfield drain Acid Sulphate Soil management	Additional text added to Section 6.2.1, Strategy 2
3	**BIOLOGICAL ENVIRONMENT**	
3.01	**Weed Management**	
a	Object to "west Australian" freesias and red flowering gums being weed controlled	Freesias are weeds that have originated from South Africa. Red Flowering Gums are not native to the Perth region. Both species are to be controlled and replaced with local native flora.
b	Belief that weed spraying vehicles and staff more damaging to native vegetation than dogs	Text added to 6.2.3, Strategy 5b, Paragraph 1
c	Request more work on weed control, being careful to not harm existing native plants	Text added to Section 6.2.3, Strategy 5b, Para 1

Ref.	Reviewer Comment	City Response
d	Request to decrease weed spraying as herbicides are thought to harm environment and human health	Weed control strategy is aimed at using specific herbicides to target specific weed types at optimal times of year, to reduce amount of herbicide used. Strategy also recommends not using herbicides with surfactants near wetlands.
3.02	**Revegetation**	
a	Replace trees damaged/ lost after storms/ diseases	Text added to Section 6.2.4 Issues 7, Strategy 6 and Recommendation 4.4
b	Request more work on revegetation rather than just weeding	Please refer to Section 6.2.4
c	Is it possible to replant natives immediately after weed control, or even amongst weeds?	Native seedlings are plants as soon as practical after effective weed control works are completed, however this may be delayed until the onset of winter rains to sustain tubestock while they establish. Cannot plant native tubestock amongst established weeds, as the weeds will outcompete and kill the native tubestock. Need to remove weed population first before commencing revegetation.
3.03	**Fauna Inventories**	
a	Native bird inventory needs amending	Tables 17 and 50 amended
b	Invertebrate inventory need to be expanded	Tables 17 and 50 expanded
c	Queries on reptile/amphibian inventories	Tables 17 and 50 amended
d	Corrections required for which feral bird species occur in lake Gwelup	Table 19 amended text added to Section 4.3.2 Point 4
3.03	**Bird Habitats**	
a	Request to fence bird nesting sites	Nest fencing discussed in Section 4.3.1, State and Federal Significant Fauna Paragraph 7
b	Request more information on managing habitat for endangered Black Cockatoo, Australasian Bittern and Rainbow Bee-Eater	Text added to Section 4.3.1, State and Federal Significant Fauna Paragraph 7, Section 6.2.4 Strategy 6 and Section 6.2.5 Strategy 2
c	Request that removal of exotic habitat (e.g. Typha) to be gradual, not sudden but transitional to limit impact on bird species	City's weed control and revegetation practices is that of gradual removal
3.04	**Turtles**	
a	Turtle eggs regularly dug up (foxes or cats?) Request plan for turtle nest protection. Consider building non grassed areas for turtle laying habitats within Segrave St.	Text added to Section 6.2.5 Issue 3, Strategy 3 and Recommendation 5.3
3.05	**Native Vegetation**	
a	Flora data based on out of date survey and out of season data, needs new in season survey for correct inventory	Please refer to Section 6.2.4 Strategy 1 and Recommendation 4.1
b	Why protect poor quality vegetation	Please refer to 6.2.4 Objectives

Ref.	Reviewer Comment	City Response	
3.06	**Invertebrate Pest Control**		
a		Bullseye Borer Grubs (pg 69) - request further study whether species is identified correctly. This species only attack dead/ dying trees, so it water management issue Beetle Grubs (pg 71). Species should be properly identified. Management may not be viable	Text amended in Section 4.3.2 Item 6, Section 6.2.6 Issue 3, Strategy 7 and Recommendation 6.04
3.07	**Dieback Risk**		
a	Request to remove dieback infested trees and treat soils near lake	Text added to Section 6.2.7 Strategy 2 and Recommendation 7.4	
b	Request to educate residents on dieback	Already stated in Section 6.2.7 Strategy 1b and Recommendation 7.2	
4	**SOCIAL ENVIRONMENT**		
4.01	**Dog Management**		
a	Many residents unhappy in having dogs on leashes in environmental areas. Many residents state their dogs are well behaved. Perceived lack of running areas in the City for dogs. Some belief there is no studies to prove dogs are damaging vegetation. In contrast, other residents report seeing dogs off leash and: i> run into the lake and bush and (concerned on the impact on wildlife and plants. ii> present hazard to senior people or to those with trouble walking	Text added to Section 4.3.3a, Section 6.2.5 Issue 5, Strategy 5 and Recommendation 5.5	
b	Requests that lake be fenced off to keep dogs out of lake, either permanently or during bird breeding times	Fencing not feasible as it prevents movement of local native fauna such as turtles and is not aesthetic.	
c	Signs near water/bush to tell dog owners to keep their dogs out and under control	Signs to be considered as part of Public Awareness strategy (see Section 6.2.5 Strategy 6b)	
d	Ranger to be more present to educate dog owners on their responsibilities and hand out fines if necessary	Text added to Section 6.2.5 Strategy 5 and Recommendation 5.4.	
e	Return to previous MP's strategy that owners are to keep dogs under control, not on leash	Text added to Section 6.2.5 Strategy 6b	
f	Request for more doggy bags.	The City provides the doggie bags as a courtesy to the public. Bag supplies are frequently emptied by members of the public and drug dealers.	
g	Request for more drinking bowls for dogs	Text added to Section 6.3.5 Issue 1, Strategy 1	
h	Request for dog refuse bins to have plastic liners	The City only installs plastic liners in bins in particular areas in response to the persistent presence of specific types of waste. (e.g. iced creams in coastal areas during summer). Generally, City does not install bin liners in dog refuse bins and does not recommend it is required in Lake Gwelup Reserve.	

Ref.	Reviewer Comment	City Response
i	Request for dog exercise areas at north and south ends of reserve	Text added to 6.2.5 Strategy 5b. Consideration of need to be given to dog exercise area. If deemed appropriate, facility to be considered in central location to take advantage of existing infrastructure and supporting amenity.
4.02	**Cat Management**	
a	Some residents have seen cats in reserve, especially near Segrave St. Request more action than reminding cat owners to be responsible and to enforce Cat law, particularly for feral cats	Text added to Section 6.2.5 Strategy 6a
4.03	**Youth Node**	
a	Many requests that the youth node to either i> not proceed, (referring to COS Strategy 2013) and belief it won't work to deter antisocial behaviour ii> be relocated away from Segrave St to near the scout hall	Text added to 6.3.2 Strategy 7 and Recommendation 10.08. Figure 6 amended.
b	Youth node to be low cost and small, not large permanent and ugly	Cost, size and aesthetics of youth node will be part of investigation process outlined in Section 6.3.2 Strategy 7.
4.04	**Playgrounds/ Exercise Nodes**	
a	Supportive of nature play areas, but don't need 4 of them. Suggestion to locate one near Colin Moore Centre.	The two nature play areas indicated in the Concept Plan are suggestions only of potential locations for one or two sites. Secondary playground provision will be further considered in line with City's Playground Policy and Public Open Space Strategy.
b	Request for more shade cloths for playgrounds	The provision of shade sails over playgrounds is guided by the City's Playgrounds Policy which states that shade ails will only be installed over regional or major level playgrounds. As shade is still considered important, the City also looks to provide additional shade trees where possible.
c	Suggestion to include half basketball court	Half basketball courts can be noisy and disturb adjacent residents. May be included as part of youth node investigation.
4.05	**Community Involvement**	
a	Request to engage local businesses to have more ownership in managing the reserve.	Text added to Section 6.3.4 Strategies bullet point 6, and Recommendation 12.1.
b	Request that scout hall be reviewed and renovated for multiple users	Text added to Section 6.3.4 Strategies bullet point 5, and Recommendation 12.5 City will review the role, status and use of Scout Hall and if appropriate assess opportunities for multiple users.
c	Request to reactivate Friends group and promote its activities in Stirling Times, Gwelup Shopping Centre and Karrinyup Library	Already in in Section 6.3.4 Strategies bullet point 4, and Recommendation 12.3
d	Rotary Club of Karrinyup request for Mens Shed be established adjacent to Scout Hall for community use	Text amended in Section 6.3.2 Issue 6, Strategy 1.

Ref.	Reviewer Comment	City Response
4.02	**Antisocial Activities**	
a	Request action to address people using push bikes and motor bikes in bushland and at northern bridge i> prevent damage to vegetation and environment ii> dangerous to public, particularly at bridge	Text added to Section 6.3.4 Strategies bullet point 6
b	Request not to quarantine bushland areas for cubby building and BMX use.	Cubby building and BMX use in bushlands damages native vegetation. In addition, cubby building may encourage illegal activities such as drug use.
4.03	**Environmental and Cultural Education**	
a	Suggestion for regular tours to promote cultural education, and to advertise in primary schools	Already discussed in Section 6.3.3 Strategy 1
b	Primary education of reserve's values should be high priority, and performed in collaboration with Balcatta and Karrinyup Rotary.	Already discussed in Section 6.3.3 Strategy 1
c	Request that heritage trail be in partnership with State government and/or Lottery West	Text added to Section 6.3.3 Strategy 2
4.04	**Infrastructure/ Maintenance**	
a	Many requests for a café/ kiosk near scout hall. Karrinyup-Gwelup Local Area Plan resident survey also states need desire for café	Text added to Section 6.3.2 Issue 6, Strategy 6. City will investigate the possibility of a mobile café.
b	Request to update, minimise and relocate signs for location, heritage education and "do's and don'ts"	Already in Section 5.3.2, 6.2.5 Strategy 5, and Section 6.3.3 Strategy 1
c	Request for prompt sweeping of sand off Lagonda footpath (no 6 on map) after heavy rain	Text added to 6.3.5 Issue 1, Strategy 1
d	Request for more "caution snake" signs	Agreed in Section 5.3.2 Functionality, 6.2.5 Strategy 5a
e	More bins, especially near tennis court and footpath entrances	Already discussed in Section 6.3.5 Strategy 2
f	More undercover roof space for picnic/ bbq areas for shelter from winter rain/ summer sun	Text added Section 6.3.2 Issue 5, Strategy 5
g	Request not to build more car parks in locations that will result in loss of native habitat	Text added to Section 6.3.2 Strategy 1
h	Request for street parking to be constructed on Segrave St verge for public use and for the adjacent Aged Care facility. Bethanie Group willing to discuss contributing towards construction.	Request will be considered as part of car park review (Section 6.3.2, Strategy 1)