Bibra Lake

Landscape, Recreational and Environmental Management Plan

Updated for
City Of Cockburn
by Emerge Associates

19 May 2015

Disclaimer and Limitation

This report has been prepared for the City of Cockburn by Emerge Associates. It is an updated version of the document prepared by Strategen Environmental Consultants in 2009.

Client: City Of Cockburn

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Preliminary Draft Report	V0	MN		electronic	19/08/2014
Draft Report	V1	MN		electronic	28/10/2014
Final Report	V2	MN		electronic	07/04/2015

EXECUTIVE SUMMARY

1. INTRODUCTION

Bibra Lake Reserve and the adjacent Beeliar Regional Park form an important conservation and recreation asset. To provide long-term management direction and in order to maintain the key values of Bibra Lake, the City of Cockburn commissioned the review and update of the 2009 Landscape, Recreational and Environmental Management Plan. The areas covered by this plan (the Planning Area) are indicated in Figure 2. They are the waterbody, foreshore, adjacent road reserves, bushland, parkland and the adjacent commercial use areas. Though the latter are not under the management of the City, they are included within the Planning Area for their relevance to management of the reserve.

1.1 MANAGEMENT PLAN PREPARATION

This management plan is a synthesis of the 2009 plan and current information relating to the Planning Area. The previously established vision and management objectives were reviewed in light of changes to the physical and planning contexts and minor modifications made. Limited consultation was undertaken, the aim of which was to gauge the effectiveness of the 2009 management plan and to seek contributions of knowledge and observations relevant to the review of the management actions and strategies.

2. MANAGEMENT VISION

"To protect, enhance and promote the natural and cultural values of Bibra Lake; enabling sustainable community use of the lake and surrounds through the provision of a range of conservation, recreation and environmental education opportunities"

3. MANAGEMENT OBJECTIVES

The City of Cockburn acknowledges that the management of the planning area is occurring within the context of a drying climate, declining groundwater levels and rainfall reliability. In this context, it is unlikely that some management objectives can be achieved without very significant investment and external partnerships. Further, some of the values of the reserve may need to be reviewed in coming years.

The 2009 plan was founded on nine management objectives, the development of which the Project Working Group (PWG) contributed to. One new objective has been added (number 1), while numbers 5, 6 and 10 have been revised.

The management objectives are to:

1. Mitigate the impacts of the drying climate on the natural environmental values of Bibra Lake.

2. Protect, enhance and foster the natural environmental values of Bibra Lake to the extent possible in the context of a drying climate.

3. Protect and enhance the cultural and heritage values of Bibra Lake.

4. Create a distinctive identity for Bibra Lake as a community destination and place of connection to the natural environment.

5. Provide and maintain a network of access around Bibra Lake and its connections to other parts of the Beeliar Regional Park; enabling the values of the lake and surrounds to be explored and appreciated by the wider community while still protecting the natural environment.

6. Provide education and interpretation opportunities in the areas of environment, culture and heritage which are contemporary and diverse and which reflect the changing natural and built environments.

7. Support and expand community involvement in environmental protection and restoration activities and environmentally sensitive recreation.

8. Develop a revenue stream for the ongoing management of Bibra Lake and surrounds, based on commercial land use options that are compatible with other Management Plan objectives.

9. Develop and maintain a body of applied research knowledge which can be used in the management of the natural environmental values of Bibra Lake.

4. MANAGEMENT RECOMMENDATIONS AND MASTER PLAN

Fulfilment of the Management Plan objectives is addressed through the Management Recommendations. The Recommendations in this plan are an amalgam of contemporary items and those from the 2009 plan. They are based on:

- Identified management opportunities.
- Threats to the values and features of the Planning Area.
- Information provided by the PWG and other stakeholders
- Previous studies and reports on Bibra Lake and its surrounds.
- Consideration of the area's history and land-use context.
- The status of the Planning Area.
- Identified management constraints.

The framework for implementing the management recommendations is provided in the Bibra Lake Master Plan. The Master Plan defines management zones around the lake and describes a series of management actions for each zone. This includes maintenance activities, facility upgrades and proposed new facilities.

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1. INTRODUCTION

The environmental, heritage and recreation values of Bibra Lake Reserve are regionally significant. The foreshore and surrounds of the lake are highly accessible and, in contrast with other lakes in the southern suburbs of Perth, contain a range of well-developed and utilised recreation facilities. Scope exists to further develop and enhance recreation facilities and uses of the reserve, though such expansion needs to occur without degrading the environmental, cultural and heritage values of the lake and surrounds.

The area subject to this plan includes the waterbody, foreshore, adjacent road reserves, bushland and parkland. The plan makes recommendations on adjoining commercial land uses but the City of Cockburn cannot directly influence land management or development on them via this Management Plan.

This Management Plan establishes the directions and defined actions through which the City of Cockburn intends to achieve ecological and social outcomes which are sustainable while providing for community use and enjoyment. The scope for developing limited commercial opportunities is explored and addressed within the plan.

1.1 BACKGROUND

Bibra Lake, within the City of Cockburn, is part of the eastern chain of the Beeliar wetlands, which extend from Blue Gum Lake in the North to the Spectacles wetlands in the South (Figure 1). Along with the western areas, including Manning Lake and the Henderson Region, they collectively form the Beeliar Regional Park (BRP).

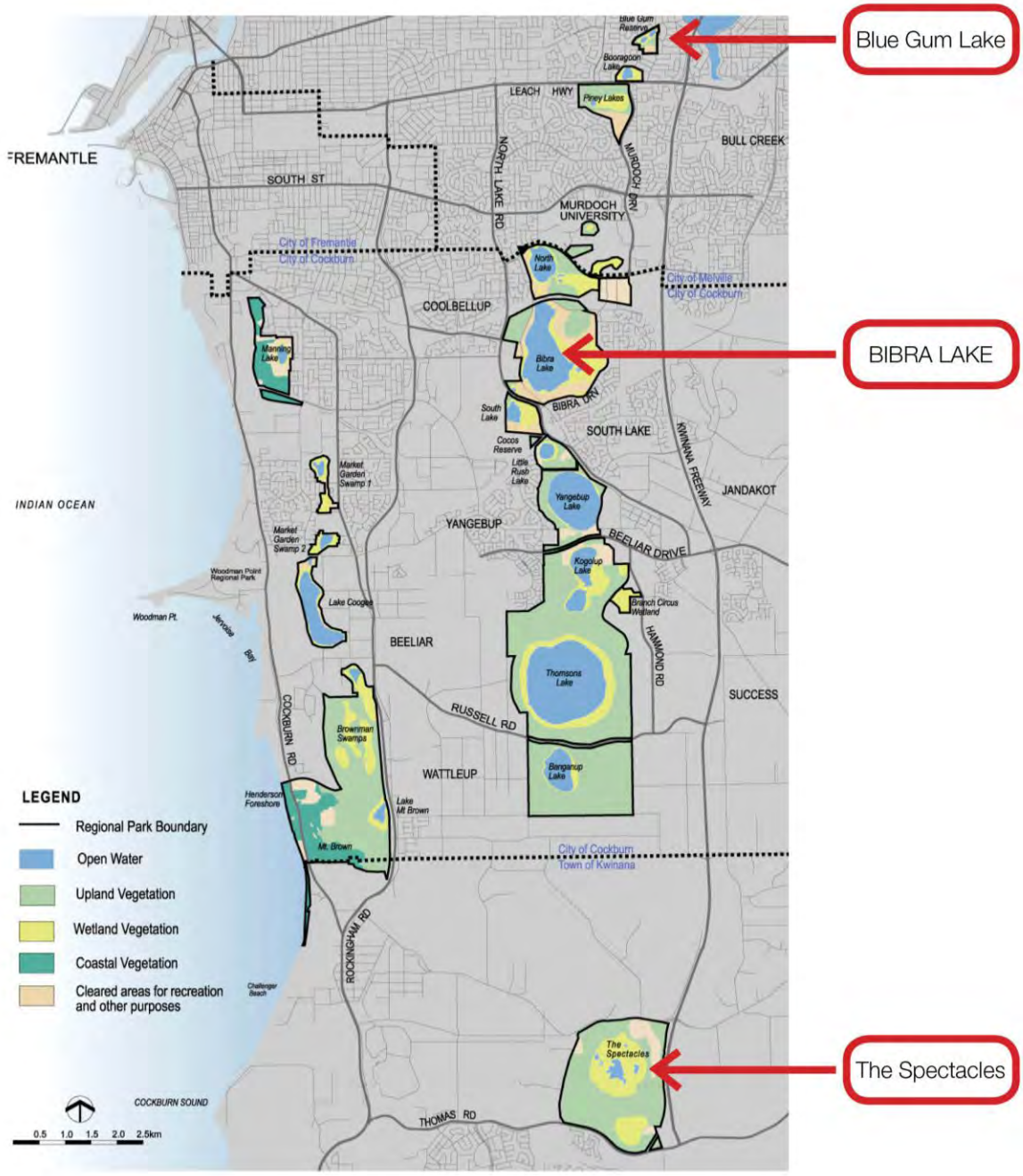
Bibra Lake and its immediate surrounds constitute an important conservation and recreation asset. The area attracts a large and growing number of visitors and contains a variety of recreation features and infrastructure. The Bibra Lake Reserve includes seasonal views across the open water, open parklands with green lawns, children's playgrounds, BBQ and toilet facilities, cycle paths. The adjacent visitor attractions are the Adventure World theme park, a private art gallery and function centre and the Cockburn Ice Arena (yet to commence operating).

Peaceful seclusion and an opportunity to experience natural bushland within a wider suburban setting are provided by the many woodland paths and the two boardwalks threaded through the native vegetation fringing the lake edge. The reserve hosts a number of community and educational facilities: including the Cockburn Wetlands Education Centre, Native ARC Wildlife Rehabilitation Centre and the 1st Bibra Lake Scout Group hall.

The BRP integrates a number of different land management agencies and private landowners to provide a unified approach to planning and management for shared

objectives. A Beeliar Regional Park Management Plan (BRPMP) was developed in 2006 and is administered by the Department of Parks and Wildlife (DPaW, formerly the DEC). The BRPMP provides overall strategic direction for the management of Bibra Lake, including guidance for the development of the Bibra Lake Landscape, Recreational and Environmental Management Plan. The City of Cockburn has management responsibility for Bibra Lake.

Figure 1 Regional Location of Bibra Lake



Source: Beeliar Regional Park Final Management Plan 2006.

1.2 PLANNING AREA

The Planning Area includes all land and water bodies bounded by the Roe Highway reserve, Bibra Drive and North Lake Road (Figure 2). It includes land within Bibra Lake Reserve, which is managed by the City Of Cockburn, as well as land between the West side of the lake and North Lake Road which is also managed by the City of Cockburn. Land titles/Lots are referenced by numbers on with additional descriptive information in Table 1.

Table 1 Land titles/Lots included in the Planning Area

Ref No.	Lot	Reserve No./description	Address	Area (ha)
Within Bibra Lake Park				
1	4719	46787	Progress Drive	132.2
2	536	6208 – the lake body	Hope Road	103.2
3	2016	26954	Gwilliam Drive	2.9
4	2901	40057	Bibra Drive	1.2
5	4185	44060	Meller Road	1.7
6	50		50L Bibra Drive	0.2
7	2033	27488	Progress Drive	0.4
8	40	Crown Grant EC 42-0 Owner unknown	Hope Road	6.6
9	53		Progress Drive	0.4177
10	3	CT 1476-17 Commissioner of Main Roads	Hope Road	0.4
11	27	City of Cockburn	Progress Drive	1.6
12	25	City of Cockburn	Progress Drive	3.3
13	800	WAPC vacant land	Gwilliam Drive	14.2
Lots outside Bibra Lake Park				
14	26	Privately owned – Cockburn Ice Arena	26L Progress Drive	2.4
15	24	Privately owned – Adventure World Pty Ltd	24L Progress Drive	1.2
16	21	Privately owned vacant land - – Adventure World Pty Ltd	21L Progress Drive	2.25

Ref No.	Lot	Reserve No./description	Address	Area (ha)
17	2	Privately owned - Adventure World Pty Ltd	351 Progress Drive	13.3
18	106	Privately owned - Bibra Lake Gallery Function Centre	Gwilliam Drive	2.6
19	105	Privately owned - Perth Waldorf School (member of the Rudolph Steiner Schools Association)	Gwilliam Drive	4.4
20		Roe Highway Reserve	Gwilliam Drive	

Lot 4719 originally consisted of several smaller parcels of land that were amalgamated. One of these was Lot 387, on which the City of Cockburn had granted a commercial concession to several community organisations that collectively comprise the Wetland Precinct. These groups have been allowed to continue to operate in Lot 4719.

Figure 2 The Planning Area, including Bibra Lake and surrounding areas

1.3 MANAGEMENT PLAN REVISION PARAMETERS

In March 2014, the City of Cockburn commissioned Emerge Associates to review and update the Management Plan completed in 2009 by the consultancy firms Strategen Environmental Consultants Pty Ltd and Plan E Landscape Architects. In 2014, the plan had been in effect for 5 years and was due for review, primarily to ensure that the management objectives and associated recommendations are still relevant.

The terms of the original commission were:

- the Management Plan is to address the long term management of the Planning Area, including consideration of adjacent land uses and landscape characteristics.

- the goal of the Management Plan is to produce a framework by which the desired recreational, social and ecological roles of the Planning Area will be identified and enhanced.
- the Management Plan will draw on the collation and analysis of the following information:
  - stakeholder views and interests, including Aboriginal cultural and heritage interests
  - user surveys and formal consultation
  - assessment of existing infrastructure and utilities
  - existing site survey and analysis
  - storm water and ground water characteristics such as inflow/outflow balance characteristics, flows and quality
  - public safety and access
  - environmental, social and amenity enhancements (current and future) that relate to the surrounding land forms and uses

The approach to developing the Management Plan included the following tasks:

- conducting a desktop review and preparing a summary:
  - of the history and current status of management undertaken in the Planning Area by the City of Cockburn
  - identifying existing values, opportunities, threats and constraints related to the future management of the Planning Area
- establishing a management vision to be agreed with key stakeholders for the Planning Area
- establishing draft management objectives for the Planning Area in consultation with key stakeholders
- developing a Draft Master Plan for future use and management of the Planning Area, designating management zones and specifying management actions within each zone
- developing a programme of works to guide the implementation of selected management options and opportunities
- continuing to involve community stakeholders through public review and comment on the Draft Management Plan.

The Draft Management Plan was released for public comment by the City of Cockburn in November 2008. Twenty submissions were received from government agencies, community groups and individuals. The final Management Plan was then prepared, taking into account public submissions received.

1.4 STAKEHOLDER AND COMMUNITY CONSULTATION

The planning and consultation process established for the 2009 plan is set out below, starting with the Project Working Group. For the 2014 review, letters were sent to a number of groups involved in the original consultation and where requested, meetings or telephone meetings were held. A number of representatives from the City of Cockburn were consulted and site visits undertaken.

In 2008, a Project Working Group (PWG) was formed at the commencement of the planning process. Representatives from the following key stakeholder organisations were invited and participated in the PWG:

- City of Cockburn
- Cockburn Wetlands Education Centre
- 1st Bibra Lake Scouts Group
- Bibra Lake Residents Association
- Strategen Environmental Consultants
- Plan E Landscape Architects.

The former Department of Environment and Conservation (now DPaW) and Native Arc Wildlife Rehabilitation Centre were also invited to participate in the PWG but declined. These stakeholders were consulted via individual meetings during the preparation of the draft Management Plan.

The PWG met four times during the preparation of the draft management plan, for the purposes of:

- developing a broadly supported vision for the Planning Area
- identifying the key values of the Planning Area
- identifying constraints, threats and opportunities relevant for management planning
- developing management objectives for the Planning Area
- contributing to the development of a Master Plan for the Planning Area, including management actions and options

A number of additional stakeholders were also consulted via individual meetings or phone calls during the preparation of the draft Management Plan including:

- Swan Catchment Council
- The City of Cockburn Aboriginal Reference Group.
- Adventure World
- Main Roads Western Australia

- Department of Water
- Waldorf Steiner School
- Water Corporation
- Beeliar Regional Park Community Advisory Committee.

2. MANAGEMENT DIRECTIONS AND PURPOSE

2.1 MANAGEMENT VISION

In 2008, the PWG formulated the following management vision for Bibra Lake:

"To protect, enhance and promote the natural and cultural values of Bibra Lake; enabling sustainable community use of the lake and surrounds through the provision of a range of conservation, recreation and environmental education opportunities"

The management vision is accepted as being relevant in 2014 and for the 5 year duration of the plan.

2.2 KEY VALUES

Bibra Lake has a range of intrinsic values resulting from its location, regional context, current condition and history of use. The identification of key values can enable their protection and enhancement through appropriate management strategies. It also allows new management opportunities to be identified.

The PWG identified nine key values associated with the Planning Area, relating to natural and cultural heritage, landscape diversity, area accessibility and community assets (Table 2).

Table 2 Key values of the Bibra Lake Planning Area

No.	Value	Description
1	Natural heritage	As a component of the Beeliar Regional Park, Bibra Lake has high importance as a conservation area. The Planning Area includes the water body, fringing native vegetation, and adjacent upland native vegetation. It provides important biological and ecological functions, including the provision of habitat for native fauna such as water birds.
2	Indigenous heritage and spiritual significance	Bibra Lake (referred to in the Noongar language as "Walliabup") is regarded as a sacred site by the indigenous community. There is a long history of Aboriginal use of the lake for camping, teaching and spiritual activities. There are five registered Aboriginal Heritage sites within the Planning Area (Section 0).
3	European heritage	Since the establishment of the Swan River colony, land in and around the Planning Area has been used for a variety of purposes. It is only relatively recently that conservation has become the most important management goal.
4	Landscape diversity	The Planning Area is characterised by a diverse combination of landscapes: from relatively pristine wetland areas and upland vegetation (multiple types) through to highly modified human-use environments.

No.	Value	Description
5	Ecological linkage	Bibra Lake is part of a largely continuous vegetation linkage between North Lake and South Lake. The Beeliar Regional Park Management Plan acknowledges the role of Bibra Lake in several greenway linkages (linkage numbers 73, 75, 90 as identified in Tingay and Associates 1998).
6	High Accessibility	Bibra Lake is largely surrounded by suburbs and roads, and includes existing parking facilities and public transport connections. It is highly accessible to a large sector of the community, which is in contrast with most other lakes within the Beeliar Regional Park.
7	Education and awareness	Bibra Lake facilitates a linkage between Perth's urban community and the natural and cultural heritage of the southern metropolitan region. There is existing environmental education and awareness-raising undertaken by community-based organisations operating at Bibra Lake.
8	Recreation and amenity	The Planning Area is utilised for a range of recreational pursuits, with an emphasis on enjoyment of the outdoors and the natural environment. It is a regionally significant recreation destination with substantial infrastructure already in place. The lake and its surrounding environs provide for a range of passive uses include walking, bird-watching, picnicking and relaxation.
9	Volunteering/ community involvement	A number of community based organisations are active at Bibra Lake. These organisations offer participatory activities and opportunities for community members.

2.3 MANAGEMENT OBJECTIVES

The management objectives have been developed based on an evaluation of the key values of the Planning Area. The City recognises that the objectives need to take into account the context of a drying climate.

The management objectives are to:

1. *Mitigate the impacts of the drying climate on the natural environmental values of Bibra Lake.*

2. *Protect, enhance and foster the natural environmental values of Bibra Lake to the extent possible in the context of a drying climate.*

3. *Protect and enhance the cultural and heritage values of Bibra Lake.*

4. *Create a distinctive identity for Bibra Lake as a community destination and place of connection to the natural environment.*

5. *Provide and maintain a network of access around Bibra Lake and its connections to the Beeliar Regional Park; enabling the values of the lake and surrounds to be explored and appreciated by the wider community while still protecting the natural environment.*

6. *Provide environmental education and interpretation opportunities at Bibra Lake which are contemporary and reflect the changing natural and built environments*.

7. *Enhance and diversify cultural and heritage education and interpretation opportunities at Bibra Lake.*

8. *Support and expand community involvement in environmental protection and restoration activities and environmentally sensitive recreation.*

9. *Develop a revenue stream for the ongoing management of Bibra Lake and surrounds, based on commercial land use options that are compatible with other Management Plan objectives.*

10. *Develop and maintain a body of applied research knowledge which can be used in the management of the natural environmental values of Bibra Lake.*

2.4 POLICY FRAMEWORK

2.4.1 Beeliar Regional Park Management Plan

The Beeliar Regional Park Management Plan (BRPMP) was prepared on behalf of the Conservation Commission of Western Australia in accordance with the Conservation and Land Management Act 1984. DPaW has responsibility for coordinating the implementation of the BRPMP. The City of Cockburn formally endorsed the strategies contained in the BRPMP in November 2005.

The Bibra Lake Management Plan is required to be consistent with the direction and principles contained in the BRPMP. These include, but are not limited to:

- managing the park for biodiversity conservation, and encouraging recreation and other uses to take place but only to the extent that they do not adversely impact on the other values of the park
- applying DPaW policies in managing the park
- preparing a management plan for specific park areas in the context of implementing the BRPMP
- establishing joint working parties that represent relevant managing agencies and the community for subsidiary plans
- consulting with the Beeliar Regional Park Community Advisory Committee when preparing subsidiary plans and annual project lists for the park
- supporting and where possible, seeking grant applications to undertake research within the park
- encouraging the participation of volunteers, educational institutions and other organisations in research projects within the park, and

- managing the park in accordance with the zoning plan.

Management Zones

The Planning Area has been divided into management zones (Figure 16) to guide implementation of the Management Plan. The BRPMP has defined management zones for the Beeliar Regional Park for the purposes of protecting conservation values, providing appropriate recreation and other uses and providing for efficient management of the park (CALM, 2006). The Planning Area is zoned primarily for conservation and protection, but includes natural environment use and recreation sectors (Table 3).

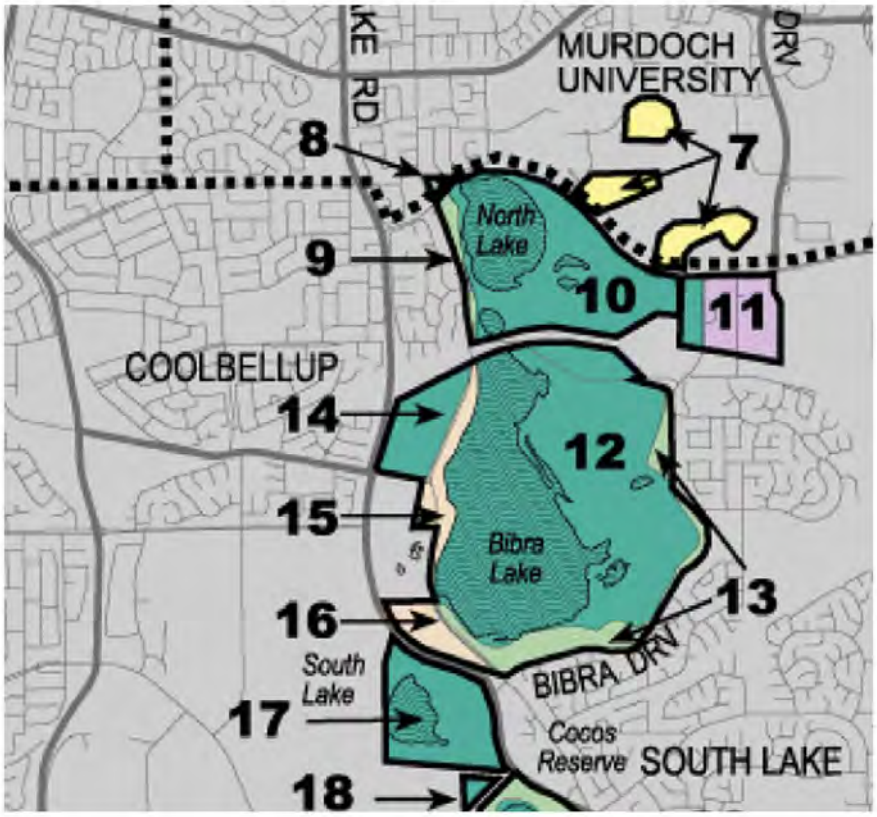
Table 3 BRPMP Management Zones for Bibra Lake

Management zone	Plan Area (Figure 3)	Management emphasis	Acceptable uses and facilities
Conservation and Protection	12 14	To protect and where possible, enhance the biodiversity conservation values and landscape qualities of the park. Priority will be given to maintaining the natural state of these areas with minimum impairment. Visible evidence of management will be minimal.	Wetland areas: Restricted public access. Unauthorised watercraft and vehicles prohibited. Development of facilities such as boardwalks and observation platforms are acceptable in certain locations. Protection and enhancement of natural habitats to ensure survival of wetland ecosystems is considered essential. Education and research uses allowed. Upland areas: Public access provided predominantly by nature trails, cycle tracks and through access ways. Development of facilities such as observation platforms and car parks are acceptable in limited locations. Rehabilitation of vegetation. Habitat protection for bird species and other fauna is considered essential. Education and research uses and facilities allowed.

Management zone	Plan Area (Figure 3)	Management emphasis	Acceptable uses and facilities
Natural Environment Use	13	To provide for appropriate uses that do not adversely affect the natural environment. Areas will be managed jointly for public use, conservation and enhancement of flora and fauna, and improvement of landscape qualities. Public use must be compatible with the assigned purpose of the relevant reserve. Visible evidence of management will be moderate to high. Management will encourage uses that promote conservation and education.	Areas are readily accessible by walking trails and cycle paths. Some development of facilities necessary. These may include education nodes and facilities (such as car parks) associated with visitor nodes. Commercial concessions compatible with the values of the area may be considered appropriate within this management zone. The provision of facilities will depend on the values of the area and the community demand for facilities. Rehabilitation and habitat protection will be necessary.
Recreation	15 16	To provide a variety of recreation opportunities. The type and scale of facilities provided will depend on the values of any given area, community demand for recreation and the appropriate management of the park. Management involves minimising the impact of visitor activities through the sensitive placement and provision of access and facilities. Visible evidence of management may be high.	Public use may be high in these areas. Predominantly passive recreation pursuits, allowing for park and picnic facility development. Commercial concessions may be considered appropriate within this management zone. Rehabilitation, landscaping and reticulation of areas may be necessary.

Source: CALM, 2006a

Figure 3 Beeliar Regional Park Management Plan management zones for Bibra Lake



Source: Beeliar Regional Park Final Management Plan 2006.

2.4.2 Local Government Biodiversity Guidelines

The Western Australian Local Government Association (WALGA) published 'Biodiversity Planning Guidelines for the Perth Metropolitan Region' in 2004. The Guidelines present Local Government authorities with a description of locally and regionally important biodiversity values and a methodology for preparing and implementing biodiversity conservation strategies. The guidelines include advice on the management of biodiversity in local reserves.

2.4.3 City Of Cockburn

This Management Plan has been prepared in accordance with the following objectives from the City of Cockburn's Strategic Plan 2012-2022:

- 4.2 To protect, manage and enhance our natural environment, open spaces and coastal landscapes;
- 5.1 Community facilities that meet the diverse needs of the community now and into the future;
- 5.2 Community infrastructure that is well planned, managed, safe, functional, sustainable and aesthetically pleasing.

City of Cockburn also has a range of administrative and strategic policies applicable to Bibra Lake (Table 4). The Management Plan has been developed so as to be compatible with these policies.

Table 4 City of Cockburn Policies relevant to the management of Bibra Lake

Division	Number	Policy
Planning and Development Services	SPD1	Bushland Conservation Policy
	SPD2	Community Facilities Infrastructure Planning
	SPD3	Native Fauna Protection
	SPD5	Wetland conservation
	APD20	Incorporating Natural Areas in Public Open Space and/or Drainage Areas
	APD7	Rural Subdivision
	APD30	Access Street , Road Reserve and Pavement Standards
	SEW3	Local Area Traffic Management
	PSEW5	Construction of Footpaths
	PSEW11	Subdivision Construction Standards
	PSEW 13	Approval Process for Local Area Traffic Management

Division	Number	Policy
	PSEW15	Removal and Pruning of Trees
Community Services	PSPD1	Access for People with Disabilities
	ACS5	Completion of Fire Breaks
	PSCS1	Access and Equity
	PSCS7	Financial Assistance to Local Organisations
	PSCS9	Joint Development of Community Facilities
	PSCS16	Public Art in the City of Cockburn
Finance and Corporate Services	AFCS2	Leasing of Council controlled land
	AFCS3	Disposal of assets
Council Services	SC37	Sustainability Policy
	SC39	Asset Management

Subject to Council endorsement, this Management Plan will be adopted through amendment to the City of Cockburn Town Planning Scheme 3, Section 5.

2.4.4 Legislative Framework

The City of Cockburn operates in accordance with the Local Government Act 1995. The City of Cockburn is responsible for adhering to a range of State and Commonwealth legislation relevant to the implementation of this Management Plan. This legislation spans environmental, heritage, public health and safety matters (Table 5).

Table 5 Commonwealth and State legislation relevant to the management of the Planning Area

Legislation	Relevance	Specific trigger	Regulatory authority
Commonwealth legislation			
Environment Protection and Biodiversity Conservation Act 1999	Protection of environmental matters of national significance.	Any threat to an environmental matter of national significance.	Department of the Environment
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	To preserve and protect places, areas and objects of particular significance to Aboriginals and related purposes.	Aboriginal heritage sites.	Commonwealth Government

Legislation	Relevance	Specific trigger	Regulatory authority
Native Title Act 1993	Provides for the recognition of the rights and interests over land and water possessed by Indigenous people in Australia.	Native title claims	National Native Title Tribunal
WA State legislation			
Aboriginal Heritage Act 1972	Provides for the protection of Aboriginal cultural materials and places of significance.	Aboriginal heritage sites.	Department of Aboriginal Affairs (DAA)
Bush Fires Act 1954	Provides for diminishing the dangers resulting from bush fires and for the prevention, control and extinguishment of bush fires.	Entire project area	Fire and Emergency Services Authority (FESA) City of Cockburn
Conservation and Land Management Act 1983	Use, protection and management of public lands and waters and the management of flora and fauna	Entire project area	Department of Parks and Wildlife (DPaW)
Contaminated Sites Act 2003	Regulates matters relating to the identification, assessment, recording, management and clean-up of contaminated land.	Management of potential contaminated sites	Department of Environment Regulation (DER)
Control of Vehicles (Off Road Areas) Act 1978	Prohibits the use of vehicles in certain places and makes provision as to the use of vehicles in off-road areas.	Off road areas within the Planning Area	City of Cockburn
Dog Act 1976	Regulates dog ownership and the control of dogs in public places (including specifying dog exercise areas)	Dog use within the Planning Area	City of Cockburn
Environmental Protection Act 1986	Prevention, control and abatement of pollution, and conservation protection and enhancement of environment.	Entire project area.	Department of Environment Regulation (DER)
Health Act 1911	Provision of public health (including matters such as sanitation, public conveniences, food and infectious diseases)	Entire project area	City of Cockburn

Legislation	Relevance	Specific trigger	Regulatory authority
Heritage of Western Australia Act 1990	Provision for conservation of places that have cultural and heritage significance	Places which have recognised or potential heritage significance	Heritage Council of Western Australia
Local Government Act 1995	Powers and functions of Local Government, creation of Local Laws	Entire project area	City of Cockburn
Litter Act 1979	Provision for the abatement of litter, including enforcement	Entire project area	City of Cockburn
Rights in Water and Irrigation Act 1914	Conservation and management of water and the associated land and environment.	Entire project area	Department of Water
Wildlife Conservation Act 1950	Provides for the conservation and protection of wildlife.	Entire project area.	DPaW

2.4.5 Local Laws

The City of Cockburn administers a number of Local Laws of relevance to the management of the Planning Area, responsibility for which can be grouped under City of Cockburn Service Divisions (Table 6).

Table 6 Local Laws relevant to the management of the Planning Area

City of Cockburn Service Division	Local Law
Ranger Services	Animals in public places
	Bush fires
	Beaches and reserves
	Car parking
Environmental Services and Planning Services	Buildings
	Camps, caravan parks and holiday accommodation
	Dangerous and offensive acts / objects
	Hawkers, stall holders and street traders
	Council property
Roads Services	Signs, hoardings and bill postings
	Streets and public places
	Traffic and vehicles

3. HISTORICAL OVERVIEW

3.1 PAST LAND USES

3.1.1 Aboriginal land use and significance

The Aboriginal name for Bibra Lake is "Walliabup" with the original inhabitants of the Cockburn district being the Beeliar Tribe of the Swan River Nyungars. This tribe made semi-permanent campsites along the eastern chain of wetlands in the Cockburn area where fresh water, pristine vegetation and significant components of their diet such as birds, fish, eggs, tortoises, lizards and snakes were found. The lake also provided other important resources such as Paperbark trees (Melaleuca) which were used for building materials owing to their waterproof qualities (Balla 1994). Sixteen Aboriginal campsites have been identified in the Cockburn District, the majority being located on the fringes of North Lake and Bibra Lake. Aboriginal camping grounds were situated on the southern side of Hope Road, close to the north-eastern edge of Bibra Lake and along its southern shore (O'Conner et al. 1989).

Bibra Lake is significant to Aboriginal people as it was a teaching area where oral history, corroborees, and the significance of animals and the land were shared. As a component of the eastern chain of Beeliar wetlands, Bibra Lake was part of a major trade route between Aboriginal people in the Swan and Murray River areas.

Bibra Lake is also spiritually significant to the Aboriginal people. According to Nyungar tradition, Bibra Lake was formed (along with other water bodies in the south west) by the water serpent, the Wagyl, as she surfaced from underground (NLRA 2008). The Wagyl is the dreaming ancestor and water-creative spiritual force with a serpent-like physical manifestation that maintains the flow of the springs (Drake and Kennealy 1998). It has also been suggested that the limestone pinnacles exposed during construction within Adventure World beside Forrest Road are a secret-sacred rainmaking site (O'Connor et al.1989).

Known Aboriginal Heritage Sites

A search of the Department of Aboriginal Affairs (DAA) Aboriginal Sites Register identified the existence of five registered Aboriginal sites within the Planning Area (Table 7; Appendix 1).

A number of archaeological investigations of the North Lake and Bibra Lake area have confirmed the enthnographic evidence that lake perimeters were utilised as camping areas with a diversity of activities undertaken. The main site of occupation was the narrow strip of land between North and Bibra Lake. Chert stone artefacts

have been found to be relatively abundant in the area. The chert can only be obtained from quarries presently below sea level which were last exposed 8000 years ago. A site on the northern fringe of North Lake has a stratified deposit indicating its continual use for at least 2000 years (NLRA 2008).

Table 7 Registered Aboriginal sites within the project area

Site ID	Site name	Site Type
3196	Lake Bibra: Forrest Road	Quarry
3293	Bibra Lake	Artefacts/scatter
3296	Hope Road Swamp, Bibra Lake	Artefacts/ scatter
3709	North Lake and Bibra Lake	Mythological, camp, hunting place
4107	Bibra Lake North	Artefacts/ scatter

It should be noted that Bibra Lake itself is a registered site for both mythological reasons and archaeological findings.

Waalitij Aboriginal Corporation

The Waalitij Corporation was established to provide Aboriginal cultural tours around Bibra Lake by local Aboriginal people. The corporation originated through the development of a TAFE tourism course being conducted within the North East Precinct of the Lake, which then led to tours run by Aboriginal people who were completing or had completed the course. The tours proved very successful and attracted a large number of school groups to the area (approximately 14,000 students participated in tours over three years). The success of the program had begun to arouse interest from commercial tour operators. However, allegedly due to a lack of administrative capacity and support, the corporation ceased operations (B. Warburton, Department of Education and Training, pers comm. Mar 2007). The Waalitij Corporation is presently inactive.

The Waalitij Corporation occupied a house and demountable building that was originally installed by the then Education Department in the north east of the Planning Area. Both buildings have been maintained by the City Of Cockburn and are used as part of the Native Arc facilities.

3.1.2 European history

There has been a long association between European settlers and Bibra Lake and its surrounds, dating from the early years of the Swan River Colony in Western Australia. The history of the area has been documented in the book “Cockburn – The making of a community”, written by Michael Berson and published in 1978 by the then, Town of Cockburn. The following information has been sourced largely from this book.

In 1830, George Robb took up a land grant of 2000 acres, extending from Hamilton Hill to North Lake, for pastoral purposes. Robb's holding included the northern end of Bibra Lake. In 1843, a carpenter named Benedict Von Bibra obtained 320 acres of fertile land south of Robb's grant. Von Bibra's selected area included the southern end of Bibra Lake and land to almost one mile south of the lake, including most of South Lake. The current name Bibra Lake is derived from Von Bibra's legacy.

In 1849, Samuel Caphorn took up an area of land, north of Hope Road, which he later sold in 1855 to James Baker. From 1855 to 1859, a number of additional small holdings east of Bibra Lake were acquired by the White and Tourner families and James Baker sold 11 acres of his block to George Cooper in 1859. Cooper built a four room house of white stone to the north east of the Planning Area (west of Baker Road), which was demolished in 1961.

A small settlement was established in the Bibra Lake area in the late 1880s as the wetland provided arable soil and fresh water. In the 1890s, stimulated by the gold rush, intensive agriculture was progressively adopted in the area. Joseph Meller took up 100 acres of land east of Bibra Lake during 1887 and established market gardens and vineyards. Meller built a brick home on what is now Hope Road.

In 1895, Mary Ann Tapper, with her son Daniel, purchased what had originally been Von Bibra's land, built two houses and cleared 20 acres for market gardens and an orchard, and later started a dairy. The Tappers leased part of the land to the Currie brothers who also bought land south of this lease and they also established a dairy enterprise. Around this time, a large community of Chinese market gardeners also established in the vicinity of Bibra Lake, leasing land from the owners of the day.

In 1899, George Robb's original grant was subdivided into 42 lots. The land between North Lake and Bibra Lake was purchased by John and Robert Dixon. The Dixons established a market gardening enterprise and sold firewood sourced from the upland areas.

By 1919, many of the market gardens had been replaced by dairy farmers. The Currie Brothers, along with other dairy farmers around Bibra Lake, also grew barley, oats and maize on the fertile lake fringes, taking advantage of the seasonal fluctuations of the lake. A group of Chinese market gardeners continued to operate near Bibra Lake.

During the 1920s, motorised transport of dairy products marginalised the dairy producing areas around Bibra Lake. Dairy farmers increasingly moved south onto better soils, further from the population centres. At this time, Bibra Lake was not attracting new settlers due to lack of electricity provision and poor roads. The Bibra and North Lake Progress Association was formed in 1921 and was active in trying to maintain the vibrancy of the Bibra Lake community.

Suburban expansion began to encroach on the Bibra Lake area in the post-war development period from the 1940s onwards, gradually replacing the earlier agricultural land uses. Suburban development in the vicinity of the lake proceeded rapidly in the 1970s and 1980s. During this time, the environmental and recreational values of Bibra Lake have also become increasingly recognised.

European heritage sites

The City of Cockburn has three European cultural heritage sites within the Planning Area that are registered in the City of Cockburn Municipal Heritage Inventory (Figure 4). This includes Bibra Lake itself, the values of which are described within this Management Plan, and an area comprising planted Moreton Bay Fig Trees and an area of planted Norfolk Island Pine Trees.

Pioneers Park is the name given to the parkland zone along Progress Drive, which contains playgrounds and other recreation amenities. The commemorative plaque in the parklands states that the park was dedicated "on Sunday 1st October 1978 to commemorate the opening of these parklands which are dedicated to the pioneer families associated with this area whose names appear hereunder".

Moreton Bay Fig Trees

Three mature Moreton Bay Fig Trees are located on Progress Drive, opposite Bibra Lake and adjacent to Adventure World (Figure 4). The trees were planted by early settlers and have aesthetic and historical significance. The land on which the trees are growing was originally owned by Benedict Von Bibra and then the Tapper family who were prominent landowners for many years. According to the Tapper family (D. Gildersleeve pers. comm. 15 June 2009), the most southern tree was planted by Mary Anne Tapper when she and her son Daniel settled there. When Daniel married Rosina Whitehead, they built a second house on the property and Rosina took two cuttings from the original tree and planted them adjacent to their new home.

The Tapper dairy continued on the property until the 1960s when the state government resumed the land and the homesteads were demolished.

A Pioneer Memorial has been established by the Bibra Lake Residents Association in the vicinity of these fig trees.

Norfolk Island Pine Trees

The mature pine trees on the corner of Hope Road and Progress Drive (Figure 4) have aesthetic, historic and representative cultural heritage significance. The trees are very tall and have streetscape and landmark qualities. The trees are from an era preceding urban development and are associated with early settlers, the Dixon Family, who owned a property between North Lake and Bibra Lake and established a dairy farm there. The pines were planted by John Dixon on the day of his marriage in

1860 (Mrs G. Mortimer pers. comm. 17 June 2009). The land on which the trees are growing was part George Robb's original land grant taken up in 1830.

Figure 4 European cultural heritage sites registered with the City of Cockburn

3.1.3 Public use and management history

Public use and management

Bibra Lake has a long history of use by Aboriginal people for camping and hunting (Section 3.1.1). There are also records of early settlers using the area for camping and shooting prior to 1900 (Berson 1978). Early pastoral leases, including those of George Robb and Benedict Von Bibra, involved construction of boundary fences but apparently little other significant land use modification.

The development of market gardens and dairy enterprises on land surrounding Bibra Lake from the 1890s onwards marked the beginning of significant land use change. In addition to running cattle, the early dairy farmers are reported to have grown oats

on the higher ground in winter and maize on the low ground when the lake levels were lower (Berson 1978). Chinese market gardeners near the lake are reported to have grown tomatoes, celery and spring onions (Berson 1978).

In 1898, Bibra Lake was reserved for recreation and all applications to lease land were strenuously opposed by the Fremantle District Roads Board, which was given control of the reserve in 1902. Tearooms were erected on the western side of the lake and the Reserve became a popular venue for picnics and sports gatherings (Berson 1978).

The Bibra and North Lake's Progress Association was formed in 1921 and contributed to the management of Bibra Lake and surrounding areas during the 1920s. The Association was responsible for many developments in the Bibra Lake area including the establishment of schools and an extension to North Lake Road (Berson 1978). However, the subsequent decline of the dairy and market gardening industries around Bibra Lake prevented any significant further development until the encroachment of suburban development in the 1970s and 1980s. The last market garden is reported to have ceased operating during World War II (Drake and Kennealy 1998). As recently as 1976, the bushland east of Bibra Lake was being used for horse paddocks (Anon. 1976).

Bibra Lake continued to be used for recreational purposes during the course of the 20th Century. A number of sanitary landfill sites are also known to have operated at sites around the lake during this time. These were documented in a study of the Bibra Lake undertaken by Riggert Consulting Ecologists Pty Ltd in 1983 (Figure 5). Since the 1970s, public open space and facilities were also progressively developed by the City of Cockburn, particularly on the western side of the lake.

In 1981, the Metropolitan Region Planning Authority recommended that a Bibra Lake Concept and Management Plan be prepared. This resulted in the first management plan for the Bibra Lake area being developed in 1983 (Riggert Consulting Ecologists Pty Ltd. 1983) The management plan proposed a range of actions designed to improve public amenity including:

- removal of old fences, stock yards, sheds and buildings from the east side of the lake
- construction of new pathways (pedestrian and cycle) around the lake
- dredging, and spraying and removal of *Typha orientalis*, to help control midge and mosquito
- numbers and improve water quality
- revegetation in areas designated for wildlife management
- new sporting facilities on the south west side of the lake
- new commercial use areas

- stormwater management using interceptor lakes
- fire control and hazard reduction measures
- traffic and parking controls.

The degree to which the recommendations of this management plan were adopted was not assessed in detail during the preparation of the current document; however, the upgrading of facilities around the lake during the 1980s is likely to be at least partially attributable to this plan.

Since the 1990s, a number of other studies and investigations into aspects of Bibra Lake have been completed. These are discussed further in Section 3.2.

Environmental management

A wetland survey undertaken in 1964 identified the significant wildlife values of Bibra Lake and recommended that the area be developed for wildlife protection and public amenity (Riggert Consulting Ecologists 1983). A study of the Cockburn Wetlands by Murdoch University in 1976 also identified the importance of the eastern side of the lake for conservation purposes (Anon. 1976). The Murdoch University study identified areas historically cleared around Bibra Lake (Figure 6); large areas on the eastern side of the lake were historically cleared for agricultural purposes.

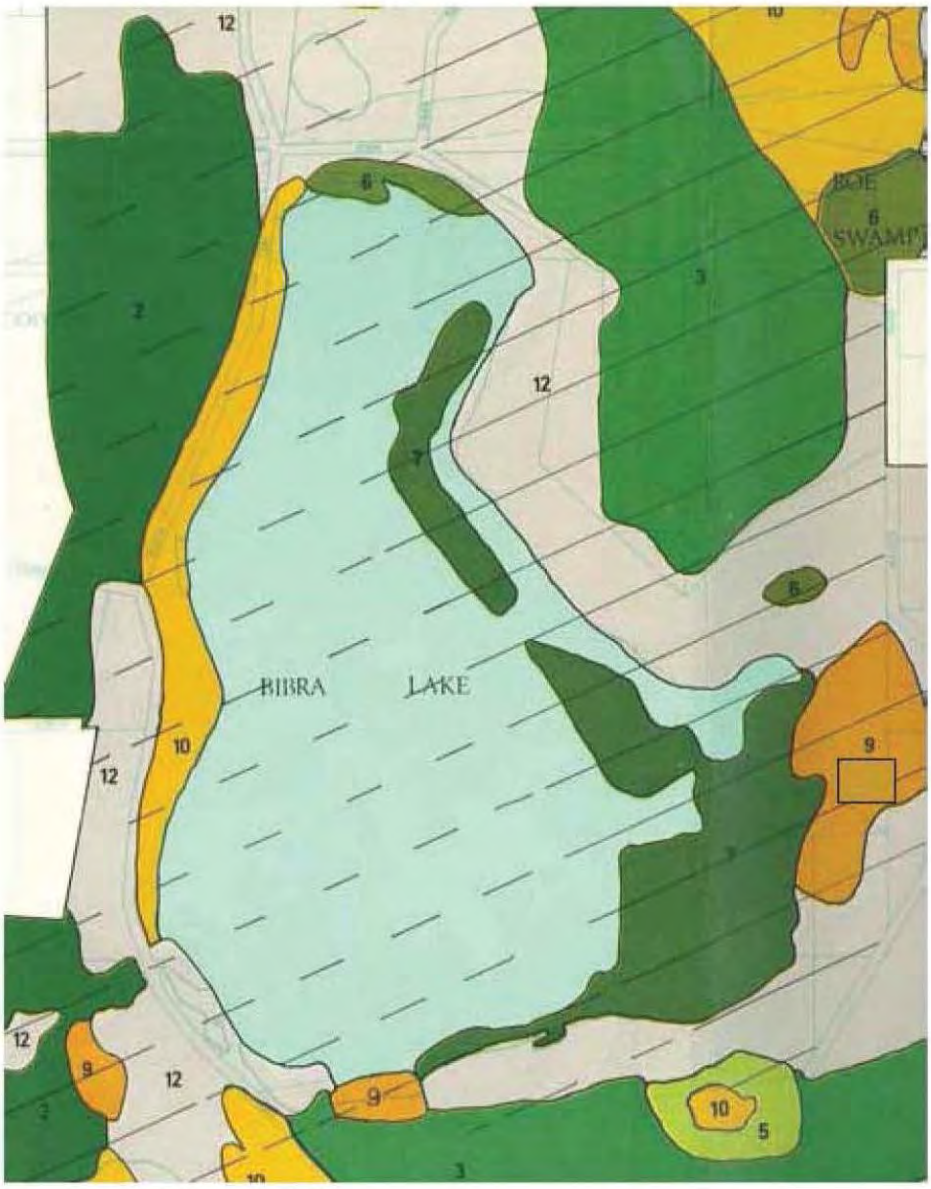
Since the 1970s, environmental management at Bibra Lake has not been guided by an overarching management plan. However, the City of Cockburn has actively pursued a range of environmental initiatives including weed control, vegetation rehabilitation, midge and mosquito control and contaminated site investigations. The Cockburn Wetlands Centre has provided an avenue for community input into weed control and vegetation rehabilitation since 1993.

Historically, midges have been a major nuisance at Bibra Lake, which in some years has significantly detracted from the appeal and utility of the lake for recreational purposes.

Figure 5 Locations of historical landfill sites at Bibra Lake (Source: after Riggert 1983)

Note: extents are approximate.

Figure 6 Areas historically cleared around Bibra Lake (Source: Anon. 1976)



PREVIOUSLY CLEARED AREAS AROUND BIBRA LAKE

Note: numbers refer to the vegetation types from the Anon. 1976 source.

3.1.4 Previous and current monitoring

The City of Cockburn has monitored water levels and water quality at Bibra Lake since the mid-1990s as part of an ongoing midge (chironomid) control programme. Water quality parameters measured include:

- chironomids per square meter
- visibility
- conductivity (EC)
- pH
- temperature
- phosphorus (total P, ortho P, organic P)
- nitrogen (total N, ammonia, nitrate/nitrite, organic N, Kjeldahl N)
- pigment (chlorophyll, phaeophytin, colour).

Monitoring is predominantly undertaken in the summer months (approximately fortnightly) when midge activity is at its highest.

Lake water levels have been consistently monitored since the early 1950s by the State Government. The Department of Water currently measures water levels on a monthly basis and maintains a lake level database. Water level readings are obtained by measuring down to the static water level with a tape gauge from a level point on the jetty at the eastern side of the lake.

The Department of Water also conducts annual vegetation monitoring and water bird monitoring at Bibra Lake. The results of this monitoring are reported annually to the Environmental Protection Authority (EPA).

As part of the Jandakot Groundwater Scheme Stage II, the Minister for the Environment set statutory conditions for the Department of Environment (now the Department of Water) regarding wetland monitoring for a number of wetlands across the Jandakot Groundwater Mound, under Part IV of the Environmental Protection Act 1986. Environmental Water Provisions (EWPs) for groundwater and wetlands were also set, which include a preferred minimum water level and an absolute minimum level. These levels apply to several wetlands within the Beeliar Regional Park, including Bibra Lake, with the aim of maintaining the historical water regimes and protecting wetland ecology. These Ministerial conditions are currently under review, following breaches at a number of sites across the Jandakot Groundwater Mound.

Through the implementation of other drainage operations, the Water Corporation also monitors the water levels of Bibra Lake. This data is collected by measuring a staff gauge installed on the eastern side of the lake near the end of the bird hide.

Groundwater monitoring wells have been installed by the Department of Water at a number of sites within the study area. The City had an additional well installed, for a total of four wells which have been used for repeated assessments in September 2010, July 2011 and March 2012. The purposes of the studies were:

- to verify the results from September 2010 and July 2011
- to evaluate if the known landfill activities have impacted on groundwater
- to evaluate if impacted groundwater was potentially discharging into Bibra lake
- to evaluate if impacted groundwater was potentially moving off-site

3.2 PREVIOUS STUDIES AND REPORTS

A number of studies have been completed at Bibra Lake area over the past decade, resulting in management recommendations related to water quality, nature conservation, vegetation rehabilitation and human use development (Table 8). These studies were reviewed as part of the development of this management plan. In consultation with the City of Cockburn, the management recommendations provided in these studies have been classified as adopted, applicable (but not yet adopted) or not adopted (not feasible to adopt). An assessment of the viability of adopting applicable recommendations has also been made.

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Table 8 Previous studies and management recommendations for Bibra Lake

Year	Focus area	Title	Author	Recommendations made	Status	Viability
2006	Environmental	Beeliar Regional Park Management Plan	CALM (now DPaW)	Bibra Lake is managed in accordance with management zones (Conservation and Protection, Natural Environment Use and Recreation) defined by the Beeliar Regional Park Management Plan	Adopted	Viable, provides strategic and policy direction
2006	Ecotourism	Urban Ecotourism- Recommendations for tourism development at the wetlands in the City of Cockburn	Judith White (Murdoch University)	Develop Wetlands Education Centre as tourism focal point Restore walk trails and establish self-guided and guided tours Provide interpretive material around the lake Involve community in development of Bibra Lake Establish a tourism volunteer association	Applicable Applicable Applicable Applicable Applicable	Viable Viable Viable Viable Viable
2005	Tourism/ education	Cockburn Wetlands Precinct Master Planning Report	Berbard Seeber Architects	Adopt a common vision for precinct and market precinct as a tourism focal point with ecologically sustainable practices and a common architecture	Applicable	Viable if design concept revisited
2005	Aboriginal heritage	Summary of Minutes of Aboriginal Advisory Committee	AAC	Signage be erected at the lake, stating the name as 'Walliabup' as well as the existing name 'Bibra Lake'. Artwork near playground area to outline the story of the tortoise Consideration be given to provide for a larger Aboriginal artwork project	Applicable Applicable Applicable	Viable Viable Viable

Year	Focus area	Title	Author	Recommendations made	Status	Viability
2004	Tourism	A Report of Bibra Lake Visitor Characteristics	Patterson Market Research	Upgrade of facilities including bins, toilets, paths and shelters	Applicable	Viable
				Construction of a café or kiosk	Not adopted	Viable if re-designed
				Re-introduction of native fauna and flora	Applicable	Possible
				Improve dog management	Applicable	Viable
2004	Community	Bibra Lake Community Action Plan	Bibra Lake Community Association	Provision of a café	Rejected	Concept able to be revisited
				Improve weed control and removal	Applicable	Viable
				Increase community involvement	Applicable	Viable
				Road modifications	Applicable	Viable

Year	Focus area	Title	Author	Recommendations made	Status	Viability
2002	Water quality	Bibra Lake Nutrient Management Study Stage 2 Final Report	Sinclair Knight Mertz	Reduce nutrient loading into lake through several means focussing on the landfill site, stormwater runoff and the lake sediment. Measures include: • specialised dredging of light floc layer of lake sediment to remove store of accumulated nutrients within the wetland • engineering solutions to intercept and remove nutrient influxes • catchment management through modifying use of fertiliser by residents/land owners in catchment • stormwater treatment prior to entry into lake • planting trees on landfill site to lower water table	Not adopted Not adopted Applicable Partially adopted Applicable	Many of the recommendations made were not practicable to implement because of cost. Engineering solutions require further evaluation.

Year	Focus area	Title	Author	Recommendations made	Status	Viability
2001	Flora	Bibra Lake Ecological Restoration Plan	D. Bright	Develop a separate flora species list for the three soil types around the lake	Applicable	Resourcing
				Improve the removal and control of weed species (multiple recommendations)	Applicable	Viable
				Revegetate with native species around the southern edge of the lake	Partially adopted	Viable
				Include the locally occurring Priority 4 species *Dodonaea hackettiana* in revegetation programs	Applicable	Viable
2000	Dieback	Management of Dieback at Bibra Lake Bushland, Bibra Lake	S. Kilgour	Minimise risk of introducing dieback to Bibra Lake Bushland by: • Ensuring materials/equipment brought into the area are Dieback free	Applicable	
				• Managing access to bushland areas	Applicable	
				• Communication to visitors and surrounding residents	Applicable	
				• Regular monitoring of vegetation	Partially adopted	
				• Hygiene measures to be implemented for ground works	Applicable	

Year	Focus area	Title	Author	Recommendations made	Status	Viability
1998	Water quality	Bibra Lake Management Study	Martinick McNulty	Reduce nutrient loading into lake by:		
				• Planting trees on landfill site to lower water table	Applicable	Viable
				• Restoring fringing lake vegetation	Applicable	Viable
				• Treating groundwater from landfill site	Applicable	Expensive, cost effectiveness needs to be determined
1998	Fire	Bibra Lake Fire Management Plan	Ecoscape (Australia) Pty Ltd	The current systems of fire buffers provided by firebreaks (internal paths), roads and the water body is sufficient (if maintained) for fire management purposes	Applicable Adopted	
				Mowing and weed control recommended for controlling fuel loads	Applicable	Viable
				Signage advising that rubbish dumping and fire lighting is prohibited	Applicable Adopted	Viable
				Fire fighting methods which minimise potential environmental harm are to be used in the event of a fire		
				A fire management map should be maintained by the City of Cockburn		

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4. CURRENT STATUS

4.1 EXISTING PROPERTY TENURES

The Planning Area largely comprises reserves or freehold land vested in the City of Cockburn, however several properties on the west side of the lake are privately owned including Adventure World, Bibra Lake Gallery Function Centre, Perth Waldorf School and Lot 21. An area of approximately 14.2 ha of bushland in the northwest part of the Planning Area is owned by the Western Australian Planning Commission (WAPC) and managed by the City (Table 1, Figure 2).

4.2 GEOLOGY / GEOMORPHOLOGY

Bibra Lake is part of the eastern chain of the Beeliar wetlands, which runs approximately north to south in an interdunal depression at the junction between the Bassendean Dune System to the east and the Spearwood Dune System to the west. Both dune systems are aeolian in origin, however they differ in age and soil profile characteristics. The Bassendean system comprises acidic, highly leached and nutrient poor, deep pale grey sands and is older than the Spearwood system by between 75,000 and 185,000 years. The younger, overlying Spearwood unit comprises yellow sand derived from Tamala Limestone, over limestone that is acidic at the surface and alkaline below the surface where the limestone outcrops (Bright 2001; DEP 2000).

4.3 HYDROLOGY

4.3.1 Groundwater

Bibra Lake is the surface expression of the superficial aquifer in the underlying Spearwood Dune system. Groundwater originating from the Jandakot mound, approximately 3 km to the east of the lake, flows from east to west through the lake; as indicated by groundwater surface contours (DoW 2004).

Seasonal changes in lake water levels reflect fluctuations in the groundwater level. Maximum water levels are usually observed in September and October, while minimum levels are observed in April and May (Bright 2001).

Fresh water springs are reported to have been utilised in the past by market gardeners on the south east side of Bibra Lake (Drake and Kennealy 1998). Anecdotal evidence suggests that the operation of the landfill at the south end of the lake may have adversely affected the springs. It is not known whether any springs still occur in the area.

4.3.2 Surface water

Water enters Bibra Lake via direct rainfall recharge onto the lake surface or from surface runoff from the surrounding catchment. The lake has a mean depth of 1.1 m and an open water area of approximately 135 ha (Sinclair Knight Merz (SKM) 2002). The lake's catchment comprises approximately 250 ha, of which 57% is urban and 43% is vegetated (SKM 2002).

Average rainfall in the vicinity of Bibra Lake is estimated to be 870 mm/yr with an estimated evaporation rate of 2040 mm/yr. There are six stormwater catchments on the eastern side of the lake served by a stormwater drainage system and outlet that directs stormwater into Bibra Lake (Figure 7). These catchments contain a high level of hard standing surfaces that generally have a low retention of water (Bright 2001). There are other smaller catchments on the west side of the lake that also discharge indirectly into the lake (SKM 2002).

Stormwater from the eastern side of the lake discharges into either dry swales or seasonally wet areas around the Bibra Lake foreshore. There are currently dense beds of *Typha orientalis* and other sedges and rushes around the drains outlets discharging into these areas. This vegetation is likely to perform a significant nutrient-attenuation function and any plans to control *Typha orientalis* in these areas would need to take the potential for nutrient release into account (SKM 2002).

Bond Swamp is an existing small wet depression on the east side of Bibra Lake approximately 350 m northeast of the Bibra Drive – Parkway Road intersection. This basin is used as a nutrient stripping basin with a gross pollutant trap at the point of stormwater discharge. It had formerly been fully vegetated with Typha but recent control measures have significantly reduced the cover. The volume of stormwater discharge is limited due to the high usage of soak wells in the nearby residential area (SKM, 2002).

4.3.3 Water levels

Data provided by the DoW shows that the level in Bibra Lake has fluctuated between 12.5 m AHD and 16.1 m AHD since the late 1950s up to 2008 (Figure 8). Prior to this time, the lake is reported to have dried out periodically and experienced greater fluctuations in water level (Drake and Kennealy, 1998).

The lowest level since regular monitoring began occurred in 1978, after a decade-long trend of declining water levels. Since 1992, there has been a similar trend of decreasing water levels. Long-term groundwater levels and subsequently, the water regime at Bibra Lake, are controlled by long term climatic conditions. An increasingly drier climate has resulted in a progressive decline in groundwater levels over the Jandakot Mound, resulting in seasonal drying of the lake. The major factor affecting water levels are winter rainfall and drainage (DoE, 2001). In wetter years, the lake consequently tends to remain permanent over the summer months.

Figure 7 Lake bathymetry, stormwater catchments and entry points to Bibra Lake (source: City of Cockburn 2014)

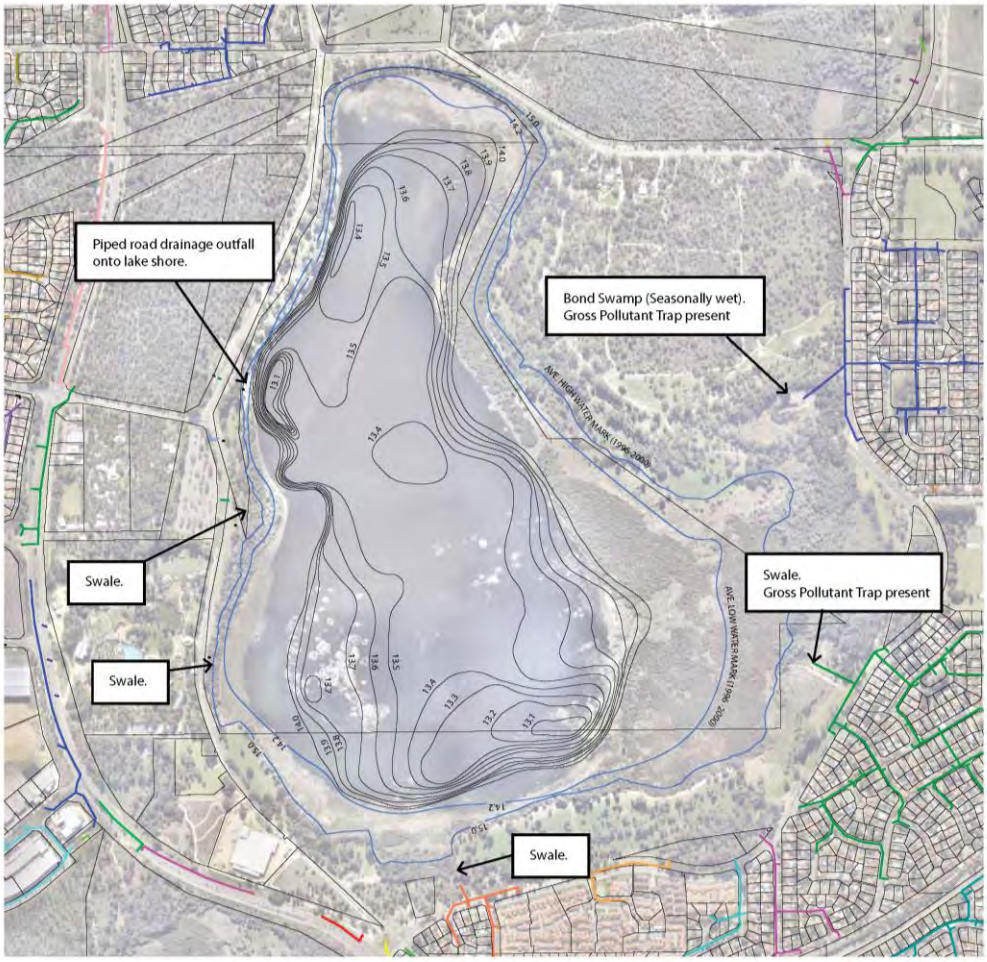
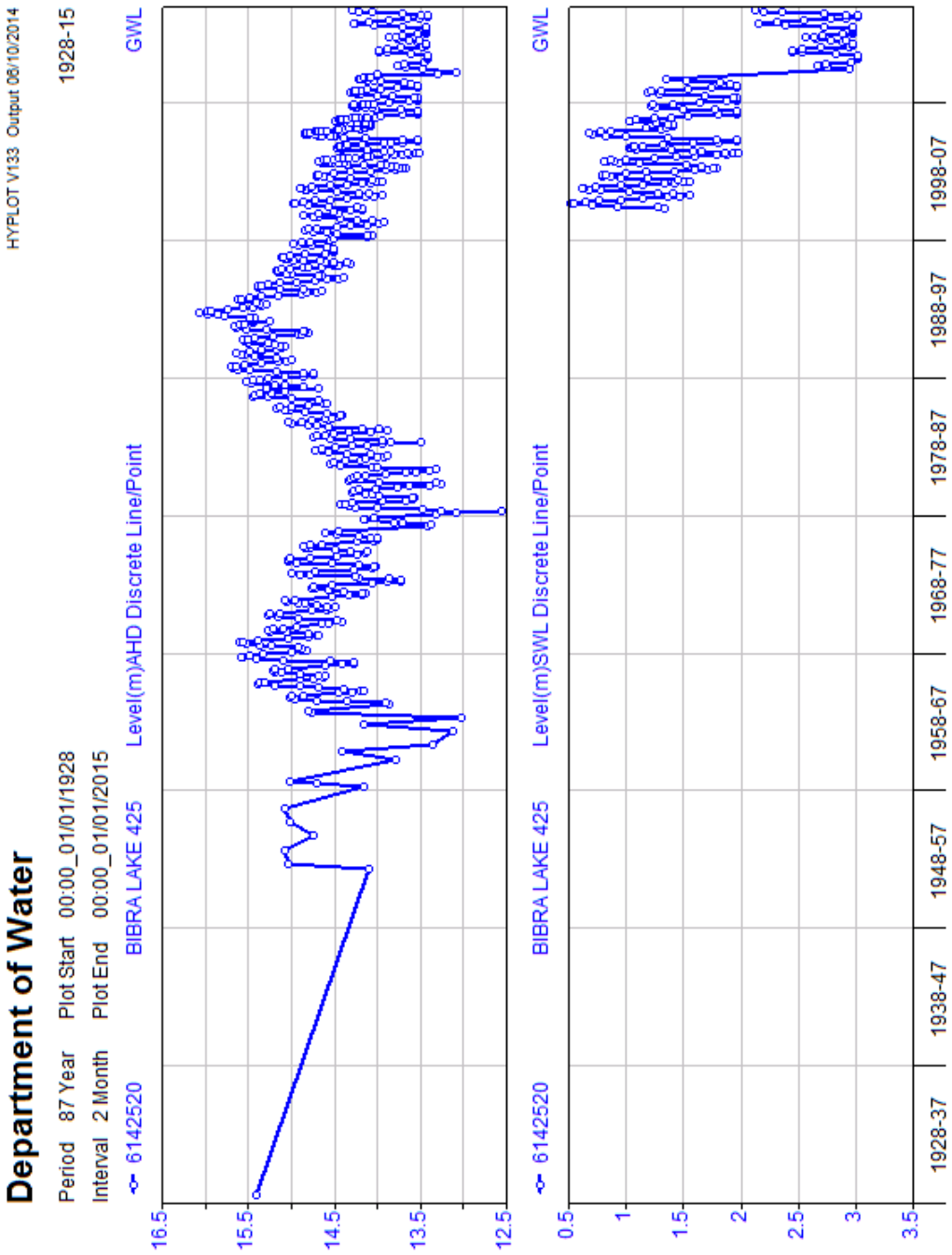


Figure 8 Water level fluctuation in Bibra Lake through time (figure provided by the Department of Water, October 2014)



4.3.4 Water Quality

The water quality of Bibra Lake has been considerably affected by the increase in development around the lake in recent decades. Factors that have been most influential include landfill sites (now decommissioned), stormwater drainage from urban areas and clearing of native vegetation around the lake. The nutrient loadings into the lake have increased as a consequence of these activities (Giles and Davis 2005).

Bibra Lake is recognised as being a moderately to highly altered wetland and was classified as hypertrophic (nutrient enriched) in a study of wetland invertebrate sampling methods on the Swan Coastal Plain (Davis et al. 2006). Phosphorus is the principal nutrient that limits biological activity in the lake (SKM 2002). The main sources of phosphorus entry into the water column of the lake are:

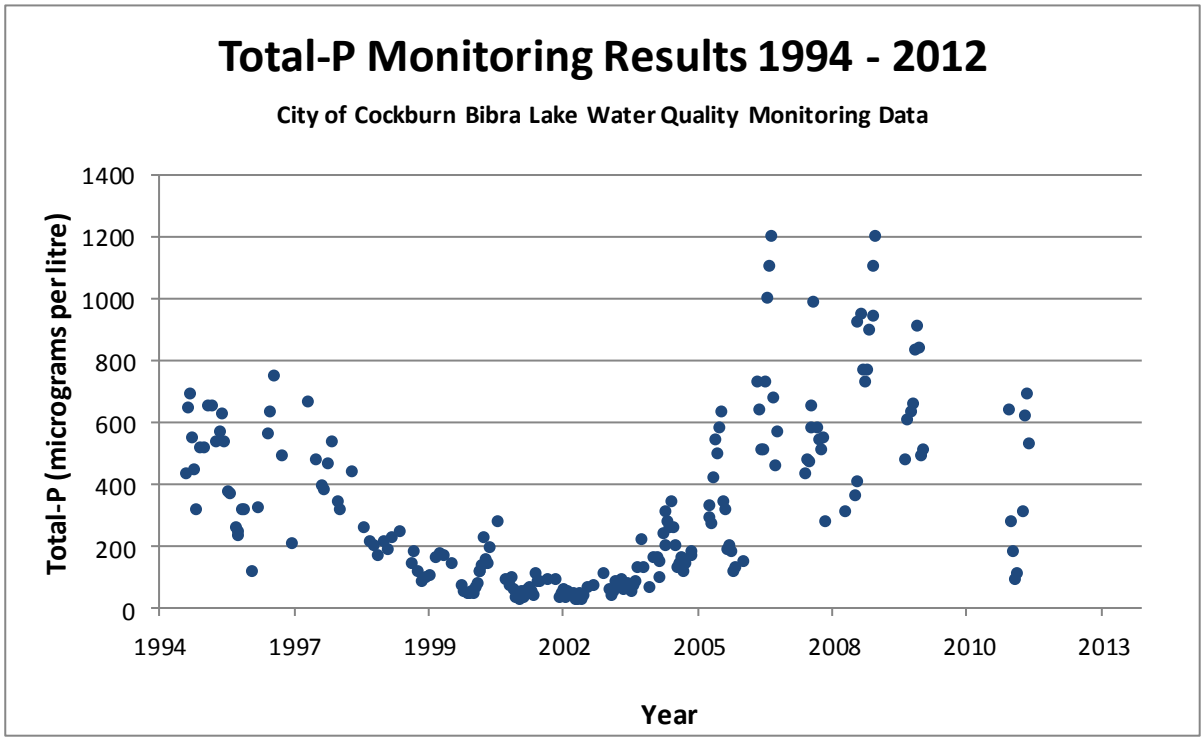
- sediment: Bibra Lake has a 400 mm light floc sediment layer over a detritus layer that can extend to 1 m -2 m deep - this sediment contributes an estimated 59% of the phosphorus load into the lake
- groundwater: the groundwater contributes approximately 27.3% of phosphorus in the water column
- landfill: the confirmed landfill site on the south east edge of the lake and possibly four other unconfirmed landfill sites contribute approximately 11.5% of phosphorus load
- stormwater: the storm water outlets that allow stormwater to run into the lake contributes approximately 1.4% of the phosphorus load (SKM 2002).

The 2002 study by SKM concluded that to reduce nutrient loads into Bibra Lake to a point where the lake is classed as healthy, phosphorus loads would need to be reduced by approximately 80%. Therefore, water quality remediation strategies need to address the major sources of phosphorus listed above.

Bibra Lake exhibited improved water quality in the period 2000-2005, with lower phosphorus concentrations and less algal blooms. This improvement has been attributed to a decrease in the average annual rainfall over the last decade, resulting in lower runoff volumes and therefore lower nutrient loads into the lake (Giles and Davis 2005). However, analysis of more recent water quality data shows a trend of increasing phosphorus levels, and increasing soluble phosphorous as a proportion of total P (Figure 9). Soluble phosphorous is the biologically active component able to be utilised by algae, potentially leading to algal blooms. Therefore, it is possible water quality will deteriorate in the future without the implementation of actions to reduce phosphorous loads entering the lake.

The nutrient enrichment of Bibra Lake is associated with a corresponding increase in midge numbers. There is a strong correlation between lake water phosphorus concentrations and midge larvae (chironomid) counts (Figure 10). Algal blooms caused by high phosphorous loads eventually die and sink, providing a nutrient rich food source for larval midges living in the sediment of the wetland. As midges have a short life cycle, they can take advantage of algal blooms and quickly build up to very large numbers. Natural predation on midges can be limited at this time due to decreased visibility from the algal blooms. Other factors such as low oxygen levels and reduced habitat diversity, associated with lack of aquatic vegetation, may also contribute to low predator numbers (Midge Research Group 2005b). Midges and mosquitoes are discussed further in Section 4.4.3.

Figure 9 Phosphorus Levels in Bibra Lake



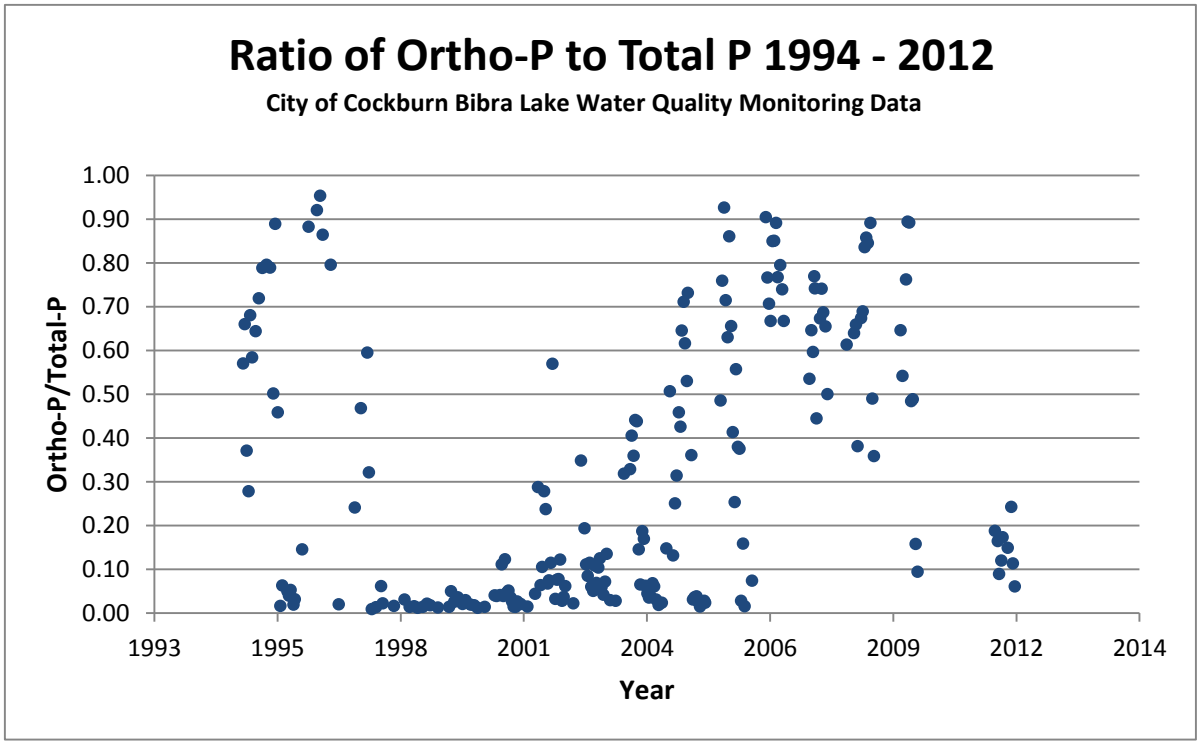
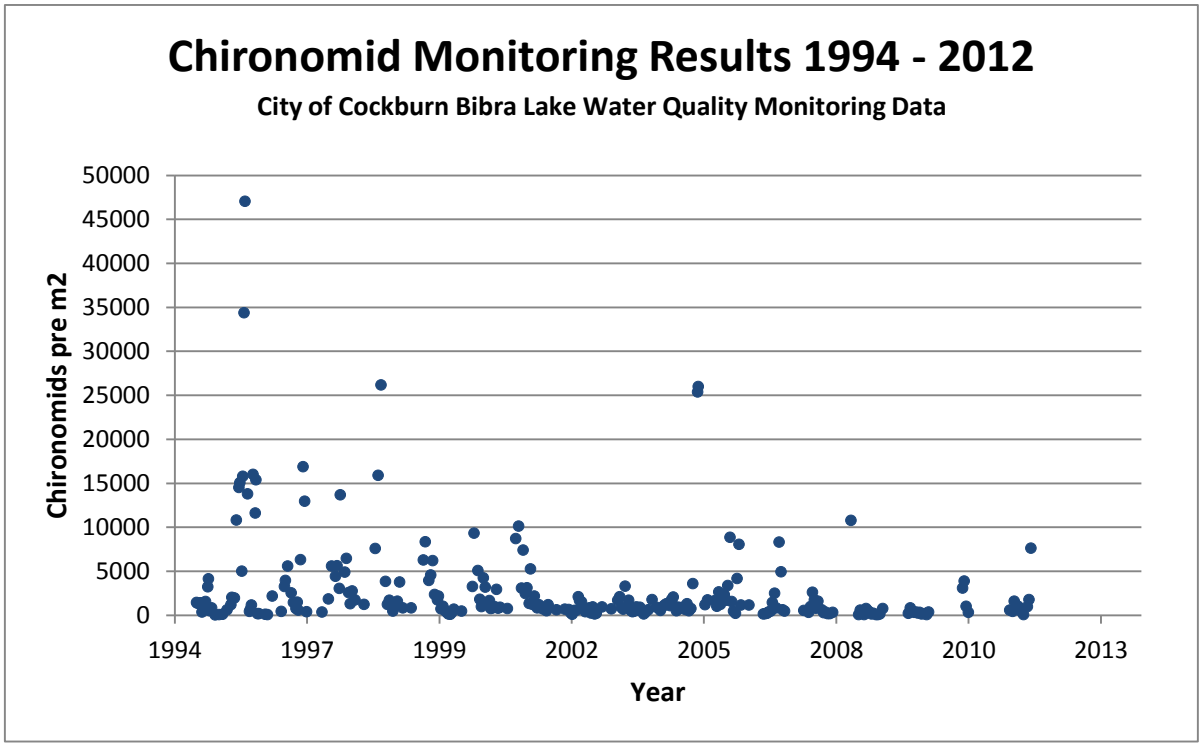


Figure 10 Midge chironomid counts in Bibra Lake through time



4.4 ECOLOGY

4.4.1 Flora and vegetation

The Planning Area contains areas of remnant vegetation in varying condition. A large area of dampland vegetation dominated by *Melaleuca teretifolia* occurs on the south east side of the lake. Upland Banksia woodland vegetation on the eastern side is more variable in condition, interspersed with cleared areas and containing a number of introduced tree species. The area to the north west of the lake on the west side of Progress Drive consists mainly of Banksia – Eucalypt woodland in moderate to good condition.

The western and southern sides of the lake are predominantly cleared and turfed, with scattered parkland trees. Some pockets of fringing native vegetation occur in these areas.

Vegetation Complexes and Structural Units

The remnant native vegetation present around Bibra Lake is representative of the Central and South Bassendean Complex, associated with the Bassendean Dune System, Central and South Karrakatta Complex, associated with the Spearwood Dune System, as per Heddle *et al.* (1980). Vegetation within the wetland is representative of the Herdsman Complex.

The vegetation at Bibra Lake has also been classified into different structural units based on the vegetation types (DEP 2000). These include:

- **upland areas**: low open forest, dominated by *Banksia attenuata, B. menziesii, Allocasuarina fraseriana* and *Eucalyptus marginata*

- **Wetland areas**: Fringing woodland including *Melaleuca raphiophylla, M. preissiana* and *Eucalyptus rudis*, thickets of *Melaleuca teritfolia* and sedgeland areas including *Baumea articulata, Schoenoplectus validusi* and the invasive *Typha orientalis.*

Floristic Community Types

Four floristic community types have been identified at Bibra Lake and reported in various studies of the lake vegetation (Table 9, Figure 11) (DEP 2000, Bright 2001, Gibson *et al*. 1994). It should be noted that vegetation mapping of the Planning Area has not been undertaken since 2001, however, revegetation activities have been ongoing since that time but not reflected in Figure 11.

Table 9 Floristic Community Types at Bibra Lake (adapted from Bright 2001)

Community Type	Description	Associated vegetation complex	Typical Species at Bibra Lake	Reservation status (Gibson *et al*. 1994)	Conservation status (Gibson *et al*. 1994)
11	Wet forests and woodlands	Herdsman Complex	*Eucalyptus rudis, Melaleuca raphiophylla* and *M. teretifolia* around most of the lake Native reeds: *Baumea articulata, Schoenoplectus validusi* in patched around lake	Well reserved	Low risk
12	*Melaleuca teretifolia* and/or *Astartea* aff *fascicularis*	Herdsman Complex	Dense thickets of *Melaleuca teritifolia* dominate on eastern side of lake	Well reserved	Low risk
23a	Central *Banksia attenuata – B. menziesii* woodlands	Bassendean Central Complex	Diverse assemblage of plants dominated by *B. attenuata* and *B. menziesii. Xanthorrhoea preissii* occur in mid stratum	Well reserved	Low risk

Community Type	Description	Associated vegetation complex	Typical Species at Bibra Lake	Reservation status (Gibson *et al*. 1994)	Conservation status (Gibson *et al*. 1994)
28	Spearwood *Banksia attenuata* or mixed *B. attenuata/* Eucalypt woodlands	Spearwood Complex	Diverse assemblage of plants dominated by the overstorey species *B. attenuata, Eucalyptus marginata* and *E. gomphocephala* Common understorey species include *Xanthorrhoea preissii* and *Macrozamia riedlei*	Well reserved	Low risk

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Figure 11 Native vegetation types in the Planning Area (source Bright, 2001)

LEGEND

- DODONAEA HACKETTIANNA (PRIORITY SPECIES)
- 11 WET FORESTS AND WOODLAND
- 12 MELALEUCA TERETIFOLIA SHRUB
- 23A BASSENDEAN CENTRAL BANKSIA ATTENUATA - B. MENZIESII WOODLAND
- 28 SPEARWOOD BANKSIA ATTENUATA - EUCALYPTUS WOODLAND
- NATIVE RUSHES

Refer to Table 9 for Floristic Community Type descriptions.

Date of photography June, 2014.

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Vegetation condition

Bush Forever (DEP 2000) describes Bibra Lake has having greater than 20% of vegetation in a good to very good condition. The remaining vegetation (Less than 80%) is classified as being degraded, with areas of severe localised disturbance.

The condition of vegetation around the lake was more recently assessed by Bright 2001 (Figure 12), using criteria developed by Ecoscape and summarised in Table 10. A large proportion of the remnant vegetation surrounding Bibra Lake was classified as being in poor to very poor condition. The *Melaleuca teretifolia* thicket on the eastern side of the lake was classified as being in very good to excellent condition. The majority of the Spearwood *Banksia attenuata* - *Eucalyptus* woodland on the north west side of lake was classified as being in fair to good condition. On the eastern side of the lake, the Bassendean Central *Banksia attenuata – B. menziesii* woodland included some pockets in fair to good condition including a substantial area south east of the Cockburn Wetlands Education Centre (Bright 2001).

Visual observations made recently suggest that the findings of Bright (2001) remain broadly indicative of the current condition of the vegetation. However, it should be noted that rehabilitation activities have occurred since 2001 and Figure 12 does not reflect the results of rehabilitation within the Planning Area.

Priority and Declared Rare Plants

The only reported 'Priority or Declared Rare' plant in the Bibra Lake reserve is Hackett's Hop Bush, *Dodonaea hackettiana*. This species is currently assigned a Priority 4 (P4) conservation status by DPaW. It only occurs at the southern end of the lake in an area of severely degraded bushland (Bright 2001).

Table 10 Criteria used to assess vegetation condition in study of Bright 2001

Vegetation condition rating	Criteria
Very Good – Excellent	80-100% native flora Vegetation structure intact Cover/abundance of weeds <5% Minor signs of disturbance
Fair - Good	50- 80% native flora Vegetation structure with some modification Cover/abundance of weeds 5-20% Moderate signs of disturbance

Vegetation condition rating	Criteria
Poor	20-50% native flora Vegetation structure completely modified Cover/abundance of weeds 20-60% Disturbance incidence high
Very Poor	0-20% native flora Vegetation structure disappeared Cover/abundance of weeds 60-100% Disturbance incidence very high

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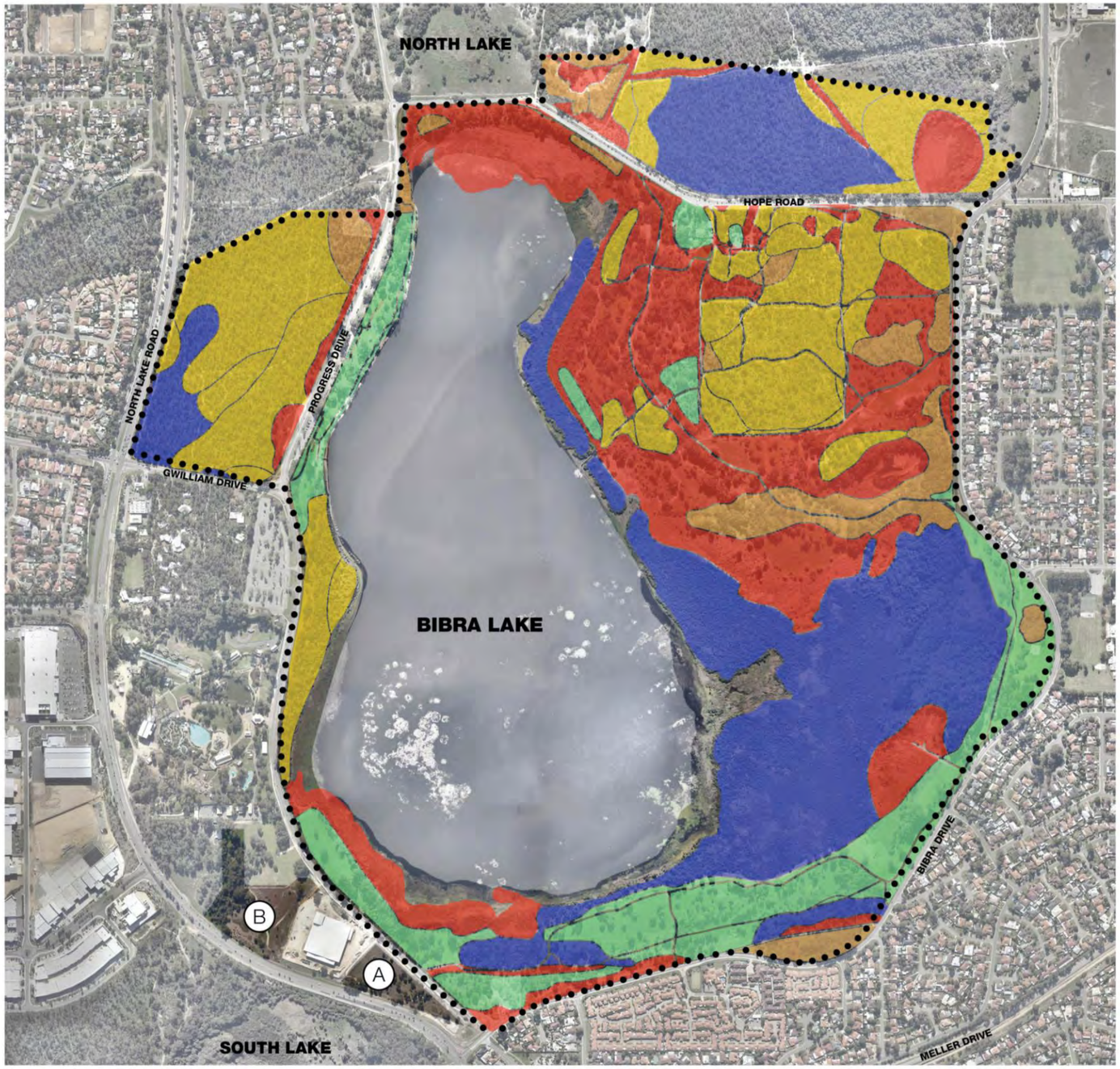
Figure 12 Vegetation condition in the Planning Area (source City of Cockburn, 2014)



VEGETATION CONDITION

- VERY GOOD
- GOOD
- DEGRADED
- COMPLETELY DEGRADED
- PARKLAND
- (A) REVEGETATED IN 2014
- (B) REVEGETATION COMMENCING IN 2014

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Revegetation

Since the 1990s, a significant amount of revegetation at Bibra Lake has been undertaken by the City of Cockburn and the Cockburn Wetlands Education Centre. The aspiration goal of revegetation is to reinstate vegetation communities and species originally occurring at Bibra Lake. Within the limits of available budgets, the City of Cockburn revegetation resources at Bibra Lake are directed to areas of a manageable size, in order to achieve:

- effective displacement of weeds and localised elimination of priority weed species
- high seedling establishment success
- a high level of vegetation persistence following establishment.

Revegetation methods have been improved and customised to different vegetation types and landscape positions. The process of revegetation involves the following steps:

- several years of weed control (as dictated by site) in order to eliminate weed competition and substantially reduce the weed seed bank
- tubestock planting using local native species matched to site conditions. Tree guards are routinely used to protect young seedlings from pests and spray drift from post-planting weed control
- post-planting weed control until revegetation has effectively displaced weeds through site occupancy (shading, competition for moisture and nutrients etc).

The City of Cockburn generally sources seedlings from commercial nursery suppliers, which do not necessary use locally collected seed (D. Bright, pers. comm., July 11 2008).

Revegetation by the Wetlands Education Centre has focussed mainly on a zone between the lake and the Centre. The long-term aspirational goal has been to create a continuous vegetation link within the zone. The use of nursery-grown seedlings has been more successful than direct seeding methods. The Wetlands Education Centre operates an onsite nursery facility to propagate seedlings with locally sourced seed. Upland sites require watering during the summer following planting. Watering is not required at more moist sites closer to the lake; however, in these areas, highly dense plantings are necessary to counteract weed competition. The Wetlands Education Centre maintains ongoing consultation with the City of Cockburn with respect to its revegetation activities.

Weeds

There are a large number of weed species within the Bibra Lake area and those with high management importance have been identified by Bright (2001) (Table 11).

Table 11 Significant weed species and their status at Bibra Lake

Weed Species	Current status and control
Fig *Ficus carica*	Original mature specimens removed, however ongoing germination of seeds
Geraldton Carnation (*Euphorbia terracina)*	
Castor Oil *Ricinis communis*	Original mature specimens removed, however ongoing germination of seeds
Japanese Pepper *Schinus terebinthifolus*	Original mature specimens removed, however ongoing germination of seeds
Coastal or Victorian Tea Tree *Leptospermum laevigatum*	Original mature specimens removed, however ongoing germination of seeds
Bamboo	One occurrence in area. Has been slashed and sprayed, now additional regrowth
Bulrush *Typha orientalis*	Extremely vigorous and highly invasive, out-competes native reeds and rushes.
African Love Grass *Eragrostis curvula*	In dryland areas
Perennial Veldt Grass *Ehrhata calycina*	In dryland areas. Have been slashed through revegetation sites.
Kikuyu *Pennisetum clandestinum*	In wetter areas
Paspalum or Vasey Grass *Paspalum urvillei*	In wetter areas
Bracken fern *Pteridium esculentum*	Sizeable thickets present as monocultures
Bulbous weeds (several species)	Scattered throughout area, difficult to control, often unaffected by herbicides

Current Weed Management

The City of Cockburn undertakes weed control activities at Bibra Lake as a component of the annual environmental works program. Weed management activities are usually undertaken in connection with revegetation projects or mowing/slashing to reduce fuel loads. Other weed control actions are dependent on resource prioritisation for the overall management of the Bibra Lake reserve.

The City of Cockburn has developed a weed priority list based on local site conditions, which assists with the prioritisation of resources for weed control (Appendix 2). Currently, there is no guiding weed management plan for Bibra Lake.

Typha orientalis

A problematic weed affecting the water body is *Typha orientalis* (Typha), which is highly invasive and has the potential to establish across most of the water body. In the years between 2003 and 2007, Typha began to spread beyond the 1 hectare patch at the northern end of the lake. By 2010, approximately 20 hectares of the lake had been colonised by Typha, with dense areas establishing along the north, south and eastern edges, as well as Bond Swamp and Roe Swamp. The open water area of the latter had been totally colonised by Typha.

Typha will aggressively colonise bare areas around the lake edge. Effective control of Typha requires a combination of weed control actions and intensive revegetation to prevent its re-establishment. Ongoing displacement with native species revegetation using locally occurring sedge species is the only way to prevent reinfestation from occurring.

Although identified as a problem weed, Typha performs a number of ecological functions at Bibra Lake. It provides a nutrient-stripping function (SKM 2002) in the vicinity of storm water outlets. It also provides food, shelter and nesting sites for a range of native fauna (Bright 2001). Preservation of these functions provides an additional rationale for native vegetation replacement following Typha removal.

The City of Cockburn and the Cockburn Wetlands Centre have developed an effective partnership for controlling Typha, using a process that spans several years. After selecting an infested area, the City of Cockburn plans and conducts the initial weed control program for two years using glyphosate-based herbicides. The Wetlands Centre then revegetates the area using dense plantings of native species. The City of Cockburn conducts follow-up weed control for two or more years following the revegetation, using spot spraying methods in the summer months as water levels fall and expose bare areas vulnerable to Typha re-establishment.

The City of Cockburn has trialled the use of black plastic as a Typha suppressant, in conjunction with dense revegetation using seedlings planted through the black plastic. The method has been very successful in affected areas on the eastern side of the lake and is to be utilised in additional areas.

The City of Cockburn uses a number of methods of reducing the extent of Typha:

- aerial spraying of glyphosate from helicopters
- spray from a MAX buggy
- hand spraying
- cut and paint
- cut and spray regrowth
- cut and remove below water level

No single method is appropriate for use in all areas and hence, the City will continue to apply various means to bring Typha under effective control while re-establishing appropriate native vegetation.

Terrestrial Fauna

Bamford and Wilcox (2005) conducted a terrestrial fauna survey that mostly focused on the north-east corner of the reserve which is the largest tract of native vegetation. The survey report indicated vertebrate species that were known or expected to occur in the area based on the survey observations and other information (Table 12).

A total of 138 vertebrate species have been recorded at Bibra Lake; 136 of which are native and two of which are introduced. Some additional species have been recorded in regional surveys that have included Bibra Lake, while casual observations identified the WA Carpet Python (*Morelia spilota imbricata*) along the northern end of the lake in 2007.

Table 12 Number of vertebrate fauna species expected to occur at Bibra Lake

Fauna group	Total number of species
Avian fauna	112
Native Mammals	1
Introduced Mammals	2[1]
Reptiles	14
Amphibians	2
Total	**138**

Source: Adapted from Bamford and Wilcox 2005, CALM, 2006

1. An additional 4 introduced mammal species are considered highly likely to occur at Bibra Lake but have not been recorded in surveys

Fauna species of conservation significance

In terms of fauna of conservation significance, Bamford and Wilcox (2005) found that no Threatened Fauna, as listed under Schedule 1 of the Wildlife Conservation Act 1950 or the *Environmental Protection and Biodiversity Act 1999* (EPBC Act), were known or expected to utilise Bibra Lake (Table 13). Although not listed by Bamford and Wilcox (2005), it is possible that Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), listed as Threatened under both the above Acts, frequents the Bibra Lake area to feed on Banksia seeds in areas of remnant Banksia-Eucalypt woodland and Banksia woodland.

Six Priority fauna species listed by DPaW for special attention are either known or expected to occur at Bibra Lake, including two mammals, the Southern Brown

Bandicoot or Quenda (*Isoodon obesulus fusciventer*) and the Native Water Rat or Rakali (*Hydromys chrysogaster*) (Table 13).

Five other species, consisting of one frog and four reptile species are likely to occur at Bibra Lake and are of local conservation significance because of reasons relating to their current distribution (Table 13).

Table 13 Fauna species of conservation significance known or potentially occurring and the likelihood of occurrence within the project study area

Species	EPBC Act status	Wildlife Conservation Act status	DEC Priority Fauna list status	Other reasons for significance	Likelihood of occurrence
Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)	(Statutory) Schedule 1 Threatened species	Listed Threatened species under EPBC Act	None		Possibly occurs
Bold-striped Lerista (*Lerista lineate)*	None	None	Priority 3		Recorded by Western Australia Museum (WAM)
Black-striped snake (*Neelaps calonotos)*	None	None	Priority 3		Recorded by WAM
Quenda or Southern Brown Bandicoot *(Isoodon obesulus fusciventer)*	None	None	Priority 5		Recorded by WAM
Western False Pipistrelle (*Falsistrellus mackenzei)*	None	None	Priority 3		Likely to occur
Rakali or Water Rat (*Hydromys chrysogaster)*	None	None	Priority 3		Likely to occur
Western Australian Carpet Python (*Morelia spilota imbricata*)	None	None	Priority 4		Recorded by City of Cockburn staff
Quacking Frog (*Crinia Georgiana*)	None	None	None	Locally significant due to its scattered	Likely to occur

Species	EPBC Act status	Wildlife Conservation Act status	DEC Priority Fauna list status	Other reasons for significance	Likelihood of occurrence
				distribution on the Coastal Plain	
Keeled Legless Lizard (*Pletholax gracilis*)	None	None	None	Locally significant because they are close to the limit of their distribution	Likely to occur
Rosenberg's Goanna (*Varunus rosenbergi*)	None	None	None	Locally significant because they are close to the limit of their distribution	Likely to occur
Glossy Swamp Egernia (*Egernia luctuosa*)	None	None	None	Locally significant because they are close to the limit of their distribution	Likely to occur
Worm Lerista (*Lerista praepedita*)	None	None	None	Locally significant because they are close to the limit of their distribution	Likely to occur

Source: Adapted from Bamford and Wilcox 2005

Avian Fauna

Bibra Lake supports a large diversity (112 species) and abundance of bird species (CALM 2006a). Bibra Lake is considered to be of regional to international significance as a wetland because of its size and the variety of habitats in and around the lake. An appraisal of the value of Bibra Lake for bird habitat was made as part of a larger study of the Cockburn wetlands in 1976 (Anon 1976). In this study, Bibra Lake was found to have the following characteristics:

- large numbers of swans and ducks utilise the lake
- the extensive shallow water thicket on the south east side of the lake provides valuable habitat for water birds and bush birds
- the *Melaleuca raphiophylla* stands on the south west side of the lake are also important for local bird life
- Roe Swamp has a rich and diverse flora of heaths, sedges and a mix of other dense vegetation which provides refuge and nesting sites for waterfowl.

Aquatic Fauna

Fish

The only fish species recorded in the latest aquatic survey (Giles and Davis 2005) was the introduced mosquito fish, *Gambusia holbrooki*.

Aquatic Invertebrates

A total of 54 species of aquatic invertebrates were recorded at Bibra Lake in spring 2005 (Giles and Davis 2005). The most dominant fauna were the calanoid copepods, but other abundant species included the amphipods and ostracods. The most abundant insect was the water boatman, *Micronecta robusta* with backswimmers *Anisops sp.* also present in high numbers.

4.4.2 Midges and Mosquitos

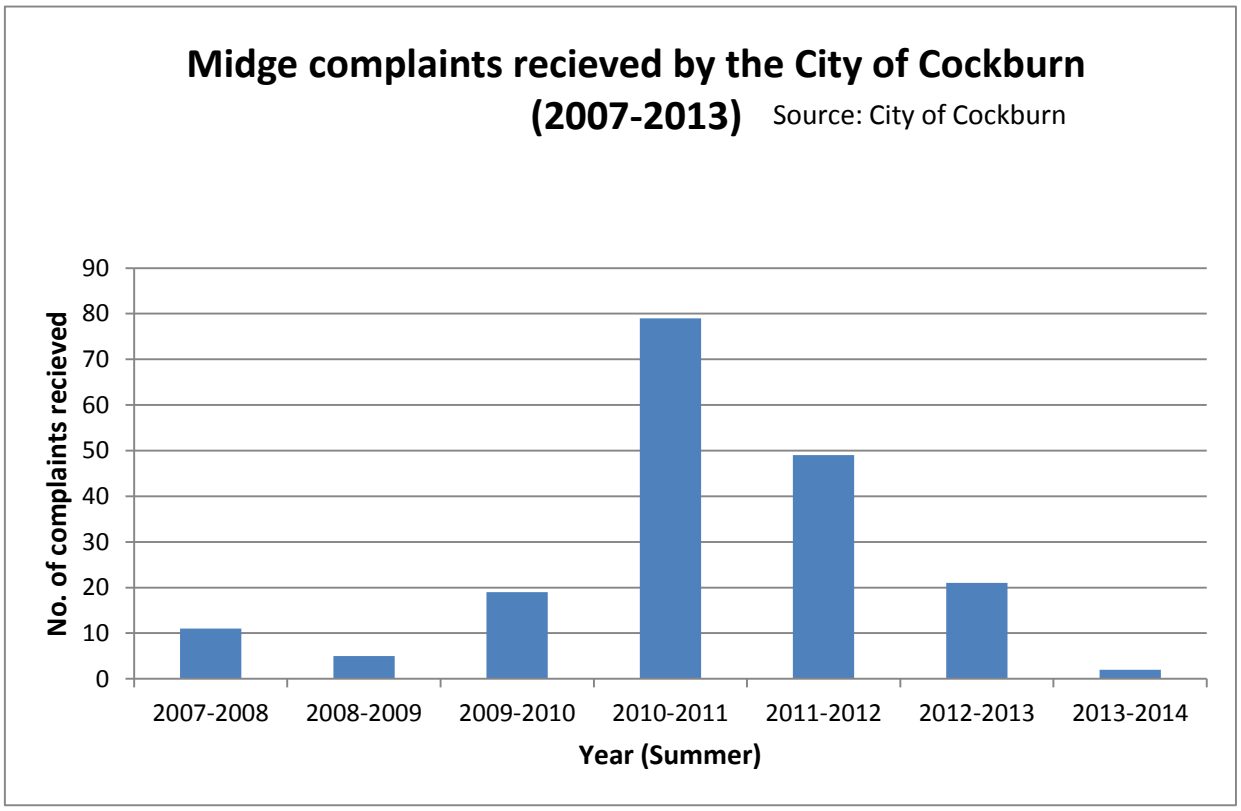
There is a history of midge populations being a nuisance at Bibra Lake in the summer months (Figure 13). Midges detract from outdoor activities for residents surrounding the lake and can greatly compromise the recreational values for visitors within the Planning Area.

Midge numbers appear to have reduced since 2002, correlating with increased seasonal drying of the lake and fewer algal blooms. However, factors predisposing the lake to a rapid build-up of midge numbers have not been eliminated. Refilling of the water body, which may occur in a wetter than average winter-spring, could produce a flush of midges responding to algal growth after the wetting of nutrient-rich sediments. Also, predator populations will be eliminated each time the water body dries (Midge Research Group 2005a). A build-up of mosquito populations would also

be favoured by a return to wetter conditions, as a result of the hatching of desiccation-resistant eggs.

To address the midge problem, the City of Cockburn has implemented an Integrated Midge Control Strategy. The purpose of this Strategy is to provide a framework to achieve the long-term goal of effectively controlling midge populations whilst reducing the level of nuisance to residents from midges in the short to medium-term.

Figure 13 Midge complaint data for Bibra Lake



Intensive monitoring is undertaken by the City as part of the strategy to determine the frequency of midge control treatments required and the effectiveness of these treatments. The determination of whether to undertake a treatment is based on several factors including: whether the number of midges exceeds the threshold of 5000/m2, the number of complaints by surrounding residents or an increase in water temperature of Bibra Lake. Regular monitoring of the water quality of the lake over summer months is conducted as part of the midge control program (Section 3.1.4).

Short-term control measures outlined in the Integrated Midge Control Strategy include:

- reducing midge larvae using larvicides.
- reducing flying adult midges using insecticides and light traps.

No chemical treatment of Bibra Lake has been undertaken since February 2006. The City no longer intends to use larvicides to control midge and instead, a growth inhibitor known as S - Methaprene is being applied as it is target specific and affects both midge and mosquitoes. This has been used at Yangebup Lake with excellent results.

Abate® larvicide has previously been used in granular form to stop the midge larvae from maturing. Effectiveness of the above treatment has varied in the past depending on whether the spraying has been done before the adult emergent stage of the midges. In addition, if chlorophyll levels are high in the lake, then Abate® can bind to the algae reducing effectiveness of the treatment.

The City of Cockburn has also established light traps near the recreation area on the west side of the lake and at the south end of the lake as a strategy to control midge and mosquito populations. Light traps are no longer located within the lake. The light traps work by using artificial light to attract midge and other flying insects and lure them into electric insect killers. The effect of these light traps on midge populations has not been monitored, however, in trials at Lake Monger, between 7 – 11% of emerging adult midges were estimated to have been captured per night (Midge Research Group, 2005a).

The City of Cockburn has been installing Bat boxes at Bibra Lake to assist in the control of midge. A single bat can consume more than 1000 midge in a single evening. Results of the programme are encouraging with large numbers of bats colonising many of the boxes.

Long-term control strategies outlined in the Integrated Midge Control Strategy include:

- preventing nutrients from entering the wetland by minimising fertiliser use on parkland surrounding Bibra Lake

- pursuing implementation of other nutrient reduction strategies being developed by State Government agencies

- the distribution of pamphlets detailing strategies residents can employ, including minimising fertiliser use and nutrient runoff from their properties through

- re-establishing fringing vegetation around Bibra Lake to reduce the number of midges and mosquitoes attracted to the light from residents in close proximity to the lake

- participating in ongoing midge control and ecology research through a midge research group.

Introduced fauna

Competition and predation by pets and introduced problem animals is considered one of the main threats to the natural fauna in the Beeliar Regional Park. Six introduced mammals are considered highly likely to occur in the Planning Area (Bamford and Wilcox 2005). These are:

- House mouse, *Mus musculus*
- Brown rat, *Rattus norvegicus*
- Black Rat, *Rattus rattus*
- Rabbit, *Oryctolagus cuniculus*
- European Red Fox, *Vulpes vulpes*
- Feral Cat, *Felis catus.*

Feral cats and foxes prey on waterbirds and other native fauna and therefore have particular management importance. The control and removal of these animals is outlined in the "Regional Parks Pest and Problem Animal Control Plan prepared by CALM in 2006 (CCWA, 2006).

The City undertakes feral animal control in and around Bibra Lake. A contractor is engaged to trap foxes and feral cats, while baits, warren destruction, fumigation and the release of viruses are means used to control rabbits. The City intends to work in conjunction with DPaW at North Lake and South Lake and with Murdoch University grounds maintenance to co-ordinate feral animal control to maximise results.

4.4.3 Dieback

Dieback is the name used to describe the plant disease caused by the water mould – *Phytophthora cinnamomi*. Dieback attacks plants roots, compromising the ability of the roots to absorb water and nutrients, ultimately resulting in plant death. Over 40% of Western Australian native plant species are susceptible to the disease (Dieback Working Group 2005).

Dieback can be spread through surface and subsurface water flows, movement of contaminated soil or contact between the roots of infected and uninfected plants (Dieback Working Group, 2005). Contaminated vehicles, tools and soil material (including nursery seedlings) have the potential to spread dieback to the Planning Area.

Management strategies are directed primarily at preventing the spread of the disease through the implementation of excellent hygiene protocols, controlling access and correcting drainage problems (Dieback Working Group 2005). Plants in infected areas can also be treated with phosphite to stop the progression of the disease; however, this form of treatment will contain, but not eradicate dieback as *P. cinnamomi* will remain present in the soil. Phosphite can be applied through either stem injection or foliar spray.

Several dieback assessments have been made in the east of Bibra Lake. A survey undertaken in 1999 found no evidence of the disease in the Bibra Lake reserve at that time (Kilgour 2000). The alkalinity of the soil types present at Bibra Lake may account for the absence of *P. cinnamomi* (Kilgour 2000). A more recent assessment was made in late 2007 by the City of Cockburn. Soil and plant root sampling did not detect *P. cinnamomi*, A small area to the east of the lake has been suspected to contain dieback and will continue to be monitored by the City of Cockburn and any future deaths of trees at the site will be tested for the presence of dieback.

The Lot 800 bushland to the west was tested in June 2013. The majority of the assessed area was observed as uninfested, with the remainder being uninterpretable due to inadequate biomass and indicator species (Glevan Consulting 2013). Two 'Phytofighter' bootwashing stations and informative signage have been installed in the area. It is hoped that the combination of these features may reduce the spread of dieback in this and other areas of the reserve.

4.5 RECREATIONAL FACILITIES AND USE

4.5.1 Recreational facilities within the Bibra Lake Planning Area

A large number of recreational facilities are already present within the Bibra Lake Planning Area, including:

- a recreation area with lawns, children's playgrounds, BBQ and ablution facilities on the west side of the lake (Pioneers' Park)
- a cycle/walk paths circuit around the lake
- a bird hide and boardwalk on the north-east side of the lake (new structures built since the 2009 plan was implemented)
- a renovated boardwalk on the north-east side of the lake (renovated since the 2009 plan was implemented)

- several car parks on the west and south west side of lake
- Bibra Lake Reserve and Café van
- golf/putting range on south west side of lake
- the Native ARC Wildlife Rehabilitation Centre in the north east region of the Planning Area (leased)
- the Cockburn Wetlands Education Centre in the north east region of the Planning Area (leased)
- a Scouts Australia Hall (1st Bibra Lake Group) in the north east region of the Planning Area
- Adventure World Theme Park on the west side of lake
- Bungee West Facility to the west of the lake (not currently active)
- Gallery and Function Centre to the west of the lake
- Cockburn Ice Arena (not yet opened as of April 2015)
- a skateboard park on the east side of the lake
- a children's playground with adjacent ablution facilities on the east side of the park.

Other facilities and land uses within the Planning Area include:

- Waldorf Steiner School to the west of the lake
- Council owned car park to the west of the lake, adjacent to Adventure World and Bungee West (no longer in operation).

These existing facilities are shown in Figure 2.

The City of Cockburn supports the Cockburn Wetlands Education Centre and the Native ARC Wildlife Rehabilitation Centre through funding from its Grants and Donations Fund. The Council also provides in-kind support by providing staff to assist develop and implement programs.

Cockburn Wetlands Education Centre

The Cockburn Wetlands Education Centre was commissioned and opened by the City of Cockburn in 1993. The Centre is operated by a not for profit group which delivers environmental education, landcare and youth programmes. Many volunteers from member groups and the wider community participate in the activities of the Centre. The local community, government and professional groups also utilise the Centre's resources and facilities.

The objectives of the Centre are to:

- develop an appropriate range of facilities to carry out its mission;
- attract sponsorship
- develop and maintain a 'Friends Group' to support the work of the Centre
- promote the centre for community activities
- offer environmental education and information services
- participate in landcare and job training schemes within the local area
- offer recreational and scouting activities for youth
- manage the operations of the Centre
- maintain the centre in accordance with the agreement with the City of Cockburn.

Obtaining funds to operate the Cockburn Wetlands Education Centre is an ongoing challenge. Considerable resources are required to seek and obtain funds, thereby limiting resources available for implementing landcare and educational activities. Funding sources targeted in the past include corporate sponsors, government and industry grants. Community groups and government agencies also pay fees to hire the Centre.

Native ARC Wildlife Rehabilitation Centre

Native ARC is a not-for-profit organization formed by those concerned for the rescue, treatment and care of sick, orphaned and displaced wildlife. The Centre specializes in the care of native sea birds and water birds.

The objectives of the Centre include the:

- rescue, treatment or care for wildlife for rehabilitation and eventual release into their natural environment
- improvement and expansion of existing facilities to achieve the highest possible standard of care
- improvement of habitat for native wildlife within the boundaries of Native ARC
- encouragement of pre-release facilities for rehabilitated wildlife
- fostering of awareness of requirements and problems confronting native animals
- collection of information and or undertake research to benefit wildlife
- provision where possible and assistance with the production of educational material
- engagement and liaison with other organizations
- consideration of the long-term needs of wildlife unsuitable for release.

Obtaining funds to operate Native ARC is an ongoing challenge. Considerable resources are required to seek and obtain funds, thereby limiting resources available for implementing wildlife rescue and rehabilitation programmes.

4.5.2 Visitor Characteristics

Bibra Lake Reserve

A previous visitor survey (Patterson Market Research 2004) has estimated that approximately 3000 people visit Bibra Lake Reserve per week to utilise some of the previously described facilities. Two thirds of these visitors come from within the City of Cockburn, while the majority of the remainder come from other southern regional areas. Other surveys of Beeliar Regional Park (of which Bibra Lake is part), have identified that while surrounding local residents regularly use the park on a daily basis, visitors from at least 36 Perth Metropolitan suburbs, as well as from interstate and overseas, visit Beeliar Regional Park. The park, therefore, should be viewed as a regional community resource (CALM 2006a). While the impact of the southern rail line has not been assessed, greater accessibility to Bibra Lake could be expected from this facility.

The most common uses of the reserve were walking (including dog walking) and engaging in children's play activities. Cycling, picnicking, bird watching and passive activities such as reading were other common activities reported by Patterson Market Research (2004). Visitor use can be attributed to the range of facilities and amenities available, aesthetics, safety for small children, accessible car parking and the 'central' location of Bibra Lake within the metropolitan area (CALM 2006a).

In 2004, almost twice the number of visitors frequented the western side of the lake compared with the eastern side and most visits occurred on weekends.

A study was undertaken in January 2013 on behalf of the City of Cockburn "to establish a profile and pattern for the pedestrian and vehicular use of these areas on non-raining fine-weather days" (Ecoscape 2013). The patterns established by the pedestrian and vehicle surveys indicated:

- a very distinct pattern of evening use of the foreshore by pedestrians on both the weekend evening and weekday evening, though the study did note that the temperature reached 36 degrees on the weekend survey day. This may also have been due to patrons of Adventure World returning to their vehicles.
- Vehicles parked during the day for Adventure World stayed into the evening and were likely to be affecting the car parking areas north of Gwilliam Drive.

The Cockburn Wetlands Education Centre receives in excess of 12 000 visitors per annum, including school groups, conference attendees and volunteers (Denise Crosbie pers. comm. May 2009).

Adventure World

Adventure World is a regionally significant theme park that attracts a large number of visitors, particularly over the summer school holidays. The major user groups are youth (10–15 year olds) and families. Although drawing from the greater Perth Metropolitan Area, visitor surveys conducted prior to the 2009 Management Plan indicated that the majority of Adventure World customers were from the surrounding southern suburbs. An Adventure World trial of direct bus services from Joondalup to attract visitors from the northern suburbs was reasonably successful (Grant Laidlaw, pers. comm., 30 April 2008).

Adventure World is accessible by bus from both Cockburn Central and Fremantle on the same connecting bus route. The impact of increased accessibility resulting from train and bus access is not known, however, the route is advertised on the Adventure World website.

4.5.3 Illegal / Undesirable uses

A number of undesirable or illegal activities are known to occur at Bibra Lake including:

1. **Walking dogs off their lead**: this is the most common illegal activity in Bibra Lake and it occurs mostly to the west and north of the lake. Dogs off leads are undesirable due to their potential to cause harm to other visitors to the lake and disturb native fauna such as water birds. City of Cockburn Rangers undertake regular surveillance of the Bibra Lake reserve to police and deter this activity (Rob Lever, pers. comm, 6 Feb 2008).

2. **Trail bikes**: this is a relatively infrequent problem in the Planning Area, but incidences of people riding trail bikes have been recorded in the north east and north west of the lake reserve (Rob Lever, pers. comm, 6 Feb 2008). Trail bike activity can damage native vegetation, spread weeds and dieback and detract from desirable community uses of the area (including community safety).

3. **Four wheel drive vehicles**: very occasionally, vehicles have been sighted entering the bushland areas in the north west and north east (Rob Lever, pers. comm, 6 Feb 2008). Off road vehicles can damage native vegetation, spread weeds and dieback and detract from desirable community uses of the area (including community safety)

4. **Rubbish dumping**: incidences of vehicles entering bushland areas surrounding the lake and discarding rubbish have been recorded; however, this activity is relatively uncommon (Rob Lever, pers. comm, 6 Feb 2008).

4.5.4 Surrounding land uses

Facilities and land uses surrounding the Planning Area include:

- residential areas to the east and south of the Planning Area
- North Lake Reserve to the north of the Planning Area
- South Lake Reserve to the south west of the Planning Area
- a retirement village to the south of the Planning Area
- Murdoch University to the north of the planning area, north of North Lake
- Lakeside Recreation Centre to the north east of the Planning Area
- Bibra Lake Primary School to the east of the Planning Area
- Murdoch Pines Golf Club to the north east of the Planning Area
- Spanish Club to the north east of the Planning Area.

These land uses are shown in Figure 15, on page 102.

4.6 FIRE MANAGEMENT

The Planning Area includes large areas of remnant vegetation in varying condition. Fire response planning is necessary to ensure people and property are protected from the risk of fire. The important environmental and recreation values of the area also require protection from the impacts of fire.

The City of Cockburn maintains a Fire Response Plan (FRP) for Bibra Lake that is updated on an approximately three-yearly basis (Figure 19). Other stakeholders included in the plan include Department of Fire and Emergency Services (DFES), DPAW and the Cockburn Wetlands Education Centre. In the event of a fire, DFES is the lead combat authority for fire suppression. The local Fire and Emergency Service Station is approximately 5 km south of the Planning Area, at 365 Hammond Road, Success.

The City of Cockburn recently began work on a Bushfire Risk Mitigation Plan which will identify bushfire risk areas within the City and outline mitigation measures. The City currently undertakes an extensive weed control program at Bibra Lake to help reduce bush fire risk.

The FRP was last updated in November 2012. It identifies a range of special considerations for implementing fire control actions and protecting environmental values at Bibra Lake, including:

- applying the Incident Control System to the management of all fires occurring in the Bibra Lake reserve

- ensuring the safety of public and fire fighters is given first priority. Consider early protection of public utilising the recreation facilities, including the dual use path and other trails
- utilising existing low fuel areas to assist in controlling the fire
- utilising water bombers for initial fire attack in Banksia Woodland. Note: avoid major power-line north of Hope Rd
- minimising construction of new fire access tracks. Construction of new fire access tracks should only be undertaken following consideration of sensitive areas (including Aboriginal sites). Where possible, consultation should be undertaken with onsite environmental advisors
- aiming to prevent the entire reserve being burnt out in a single fire event
- foam or other additives are not recommended for:
    - water bomber drops over areas adjacent to open water or wetlands
    - fire fighting vehicles working in swampy areas or close to open water, wetlands, rivers or creek lines
    - minor fires in conservation reserves unless there is a real and imminent risk of the fire increasing in magnitude without their use
- considering early involvement of Police to assist in traffic control on major roads
- considering impact of long distance fire spotting. Aim to prevent fire escaping into other adjoining reserves e.g. North Lake and South Lake
- ensuring areas of thick Rush and Kikuyu are fully mopped up
- ensure all fires, particularly peat fires, are adequately extinguished to prevent fire escape.

5. CONSTRAINTS, THREATS AND OPPORTUNITIES

5.1 CONSTRAINTS AND THREATS

There are a number of constraints to the expansion of recreation and other activities within the Planning Area. Related to this, a range of threats to the values of the Planning Area has been identified. These are discussed in the following sections.

The management initiatives outlined in Section 7.3 consider and provide a response to the identified constraints and threats.

5.1.1 Beeliar Regional Park Management Plan 2006

Bibra Lake is part of Beeliar Regional Park and subject to management strategies and policies contained in the Beeliar Regional Park Management Plan. This plan has been endorsed by the City of Cockburn.

The Beeliar Regional Park Management Plan partitions publicly owned land within the Planning Area into three management zones (Figure 3). The majority of land around Bibra Lake is zoned for 'Conservation and Protection', in which development options for human use activities are highly limited and controlled. Acceptable uses for each of the management zones are described in Table 3 and have been adhered to in the development of this Management Plan.

5.1.2 Roe Highway extension

Between Bibra Lake and North Lake is a road reserve that has been nominally allocated to the Stage 8 extension of Roe Highway between the Kwinana Freeway and Stock Road. The extension of the Roe Highway may potentially affect the values of the Planning Area. Potential impacts include:

- loss of native vegetation within the new road reserve
- disruption to the movement of fauna between Bibra Lake and North Lake
- the creation of an additional vector for weeds
- disruption to areas of cultural heritage significance
- reduced visitor amenity due to increased noise and the visual impact of a major road
- reduced accessibility to the Planning Area.

The conservation values of the North Lake Reserve including Roe Swamp (also part of the BRP), would be similarly affected. The EPA concluded in Bulletin 1108 that "any proposal for the construction of the alignment of Roe Highway Stage 8 through the Beeliar Regional Park would be extremely difficult to be made environmentally acceptable" (EPA 2003).

At the time of writing this management plan the EPA decision to allow Roe 8 had been appealed. The Office of EPA Appeals Convenor is currently assessing the appeal.

5.1.3 Landfill sites

The southern end of Bibra Lake was historically used as a sanitary landfill site until the 1980s. The area was previously identified as a significant source of nutrient contamination entering the lake (SKM 2002). The site was evaluated by the Department of Environment Regulation (formerly DEC) in accordance with the *Contaminated Sites Act 2003* and in May 2008 the entire Bibra Lake Reserve was classified as "suspected of contamination – further investigation required". A memorial stating the site classification has been placed on the Certificate of Title and will trigger the need for further investigation and risk assessment should the site be proposed for more sensitive land use.

The results of a Preliminary Site Investigation in 2009 and the subsequent 3 rounds of groundwater monitoring were inconclusive regarding impacts on the lake water quality. As a result, no further monitoring is planned though it should be considered should environmental conditions change at or around the site, or if significant rain falls.

Two other sites are reported to have been used for landfill activities – beneath the area used for golf chip and putt and the western parklands (Pioneers' Park). The latter has been studied to inform the design and planning of new recreation facilities in the area.

It is recommended that the outcomes of the City's investigations be taken into account within the scope of the suggested expert review of the 2002 SKM report (see Recommendation 2F in Table 14).

5.1.4 Climate Change

Observation data from the Australian Bureau of Meteorology indicates an upward trend in average temperatures across most of W.A. since 1910, with a more distinct trend since the 1950s. In this same period there has been a decrease in late Autumn and early Winter rainfall, with a distinct drop off in the 1970s.

Predictions across the south west of the state indicate ongoing declines in the mean average winter rainfall and increases in average temperature across the remainder of this century. The specific modelling scenarios can be viewed at the Indian Ocean Climate Initiative's website:

http://ioci.org.au/pdf/Fact%20Sheet%202.pdf

It is possible and likely that the water level of Bibra Lake will continue to lower as a consequence of the combination of further declines in rainfall (decreased inflows from rain and runoff), decreased groundwater levels resulting from reduced rainfall and increases in temperature (higher rates of evaporation).

An ongoing reduction in lake water levels threatens the current ecological values of the lake, including fringing vegetation health and habitat value for water birds. Reduced lake levels may expose larger areas of the existing water body to the threat of infestation by *Typha orientalis,* increasing the resources required to control this weed. Reduced lake levels would also detract from the visual amenity and appeal of the lake for community activities.

5.1.5 Wetland Health

Bibra Lake is threatened by a further decline in water quality and weed infestations. Maintaining or improving the health of the wetland is important for preserving its ecological functions and its appeal for recreational activities.

Midges have been a historical nuisance at Bibra Lake and could become problematic in the future if favourable conditions re-emerge. In the short to medium-term, ongoing midge control will be required to ensure that new and existing public facilities remain well used and viable. Further investigation into factors underlying midge population dynamics, and treatment options for these factors, is warranted in the longer term. The threat of midges is an important consideration for any proposed commercial developments or activities near the water body.

High nutrient levels in the lake appears to be linked to increases in midge and mosquito populations, which have periodically reached public nuisance levels over the past several decades. Midge swarms can significantly detract from community enjoyment of the lake, rendering public use facilities unusable.

Eutrophication (nutrient enrichment) of Bibra Lake has already reduced its suitability as a water source, food source and habitat for native fauna. Toxic algal blooms caused by elevated nutrient levels have resulted in fauna deaths at the lake in the past (SKM 2002). The major sources of nutrients into Bibra Lake are the lake sediment and underlying groundwater system, which enters the lake from the east (the nutrient inputs from the former landfill sites suggested in the 2002 SKM report are separate to the west-flowing groundwater) Substantive improvements in lake water quality will only be achievable if these sources are contained and reduced. A technical appraisal of the 2002 SKM study, in light of new technologies and implementation costs, is recommended (Section 6).

The feeding of water birds especially on the western edge of Bibra Lake has localised effects on water quality. Birds congregate in large numbers, uneaten food and faeces sink to the bottom of the lake and nutrient loading in the local area increases. Artificial feeding also has adverse effects on bird health and populations.

The introduced mosquito fish *Gambusia holbrooki* occurs in Bibra Lake and is associated with detrimental impacts on invertebrates and native fish species (SKM 2002). There are no known management strategies for controlling this species.

5.1.6 Fire

Fire poses a threat to the following values of the Planning Area:

- human life (including recreational users, local residents and business operators)
- property and infrastructure
- remnant vegetation values
- newly vegetated areas
- fauna, including avian nests and nestlings.

A Fire Management Plan was developed for Bibra Lake by Ecoscape Pty Ltd in 1998. The key findings and recommendations made in the Ecoscape plan have been reviewed and remain valid. These are summarised and augmented as follows:

Fire Risk

The risk of accidental or deliberate fire ignition at Bibra Lake is high due to the high level of public use of the area. However, the risk of fires entering or escaping from adjoining land is relatively low given the extensive road network within the Planning Area. Dry, hot weather and strong winds are important risk factors for the likelihood and severity of a fire in the Planning Area.

Fire Hazard

The relatively flat topography of the Planning Area presents a minimal hazard. The water body provides a substantive barrier against fire spread through the north-south axis of the Planning Area. Major hazard areas include the large tracts of remnant vegetation east of the water body, north of Gwilliam Drive and north of Hope Road.

The City recently commenced work on a Bushfire Risk Mitigation Plan. This plan will identify bushfire risk areas within the City and outline mitigation measures.

5.1.7 Management Resources

The City of Cockburn has finite resources to underpin management activities at Bibra Lake. The delivery of effective, ongoing management at Bibra Lake requires a long-term commitment to underwrite management initiatives.

A Master Plan has been developed to provide a long-term management blueprint for the Planning Area (Section 7). Cost estimates for enhancing the surrounds of Bibra Lake and constructing new visitor facilities are displayed in Appendix 3 (Capital Works: Opinion of Probable Cost 2015/2016 – 2019/2020).

There is scope to augment traditional funding sources with external grant monies and revenue generating developments within the Planning Area. The requirement for external funding requires determination by the City of Cockburn and will be regularly reviewed during the implementation of the plan. The involvement of community groups in projects would further enhance potential for external funding.

5.2 OPPORTUNITIES

The Planning Area is characterised by landscape diversity and a long history of public use and community activity. These attributes provide a broad range of management opportunities, which are discussed in the following sections. The management recommendations described in Section 6 consider, and respond to these opportunities.

5.2.1 Wetland Precinct

The north east end of Bibra Lake houses several community based organisations, including:

- the Native ARC Animal Rehabilitation Centre (refer to Section 4.5.1 for description)
- Cockburn Wetlands Education Centre (refer to Section 4.5.1 for description)
- 1st Bibra Lake Scouts Group

For the purpose of this report and future management, the area these organisations are located in shall be known as The Wetland Precinct. The organisations collectively perform a range of valuable community service, including: education and awareness raising, volunteer involvement, training, revegetation, fauna rehabilitation and applied research. The most important factor limiting the capacity of the organisations is a lack of reliable funding to enable long-term strategic planning, program development and service provision.

In the past, these organisations have operated relatively independently and without coordination in planning. At times, this has caused conflict over boundaries of operation and activities being undertaken. However, the organisations have sufficient commonality of purpose to work together for mutual advantage with respect to administration, resourcing and promotion.

The currently active organisations share a common philosophy with respect to preserving the environmental values of the planning area; and a common objective of raising community awareness of conservation and sustainability principles. All are supportive of a Wetlands Precinct concept: including formal arrangements for planning, collaboration and communication.

There is scope to consolidate the identity of the Wetlands Precinct and increase the capacity of the member organisations to undertake activities that contribute to the Management Plan objectives. Actions to achieve this could include:

- upgrading and extending buildings and facilities
- long-term funding assistance, allowing current difficulties in planning and delivering services to be overcome
- support for developing other sources of funding
- administrative and technical support for specific activities or projects.

The Cockburn Wetlands Education Centre and Native ARC are independently exploring opportunities, such as venue hire and environmental and cultural tours, to provide additional financial resources to support their activities. It is important that these initiatives be integrated with the wider management of the Planning Area by the City of Cockburn.

5.2.2 Former Lots 14 and 22

Since the 2009 Management Plan was adopted, action has been taken on the former Lots 14 and 22 at the lake's southern end. A new private landholding was created (now occupied by the soon to open Cockburn Ice Arena) with City of Cockburn reserves to either side of it. This arrangement has facilitated revegetation on the City's lands, thereby fulfilling the intent of the 2009 plan which was to create vegetated areas and habitat linkages between Bibra and South Lakes. The installation of fauna underpasses beneath North Lake Road has increased connectivity.

The revenue raised from this outcome is being used to enhance the recreational and environmental values of Bibra Lake.

5.2.3 Commercial ventures

There is potential for a range of new commercial activities to be developed within the Planning Area, that are compatible with the protection of environmental and heritage values. A proportion of the proceeds from commercial activity could be used for the ongoing management of the Planning Area. The following potential commercial opportunities are an updated list of those identified in the 2009 plan:

- an Aboriginal Cultural Heritage Centre with café, art gallery, souvenir sales and hiring of café for functions
- environmental and cultural heritage tours (from the Aboriginal Cultural Heritage Centre and/or the Wetlands Education Precinct)
- advertisement space within the Wetlands Precinct (this will be unobtrusive e.g. acknowledgment of sponsorship as footnotes on signage)
- hire of equipment for "Chip and Putt"
- operation of a "tram" service to transport visitors to different attractions around Bibra Lake.

Any new commercial ventures will require in-depth feasibility analysis to confirm their viability. Joint venture arrangements with the City of Cockburn and/or other partners may overcome start-up cost and risk barriers. For example, the City of Cockburn could establish facility hire ventures and then on-sell these to private operators at a future time. This would allow operating parameters to be established which prevent any conflict with adjacent activities and management.

The challenge of developing new commercial facilities is demonstrated by a failed attempt to develop a café on the west side of Bibra Lake. The proposal reached the design stage but was ultimately rejected on commercial grounds.

Any proposed venture needs to take into account the potential impacts of nuisance midge. While ongoing control measures applied by the City are generally successful, there remains a risk of outbreaks in any given year.

5.2.4 Dog Exercising

The issue of dogs being required to be on leads when walked in the Planning Area is identified in the Beeliar Regional Park Management Plan, which recommends ensuring that recreation uses (including dog exercising) are consistent with the protection and management of native fauna and their habitat (DEC 2006a). Dogs walked off their lead around the lake in proximity to wildlife are a potentially serious issue for ecological protection at Bibra Lake. Dogs off leads also present a potential safety hazard to other visitors. Dogs off their leads are also at risk of being bitten by snakes and being caught in soft leg traps used in fox control.

The size of the adjacent suburban population and lack of an exclusive, dog exercise-only area may provide the basis for establishing a fenced (and therefore contained) dog exercise facility in the Planning Area. At present, a gazetted off-lead dog exercise area exists on the eastern side of the Planning Area, in the same location as the skate park. Neither feature is fenced and therefore they co-exist, though the gazetted status of the off-lead area is not advertised on site.

A decision regarding development of a fenced dog exercise park in the Planning Area needs to be based on current information. To this end, the City needs to map demand and spatial opportunities for development of a dog exercise park across the Local Government Area and adjoining suburbs outside of the City boundaries.

The facility would allow leash-free dog exercise and could potentially provide:

- a venue for dog owner groups to meet and interact
- a forum for educating dog users about responsible dog ownership, to protect the values of the Planning Area and the greater Beeliar Regional Park
- dog training fee for service activities
- dog washing fee for service activities.

The facility could include a range of novel structures and activity areas for exercising dogs. Incorporation of environmental and cultural themes into the facility design would provide a unique and distinctive appeal for users.

5.2.5 Improving Accessibility

The volume and speed of traffic on roads that surround Bibra Lake has the potential to affect the utility of the Planning Area. Parking space is already insufficient for peak visitor periods. Public safety considerations need to be incorporated into traffic management controls. An additional consideration is the protection of native fauna from traffic.

The 2008/09 Project Working Group identified that downgrading or closing sections of Hope Road would improve the linkage between Roe Swamp, Bibra Lake and the North Lake reserve whilst also reducing traffic along Hope Road. However, road modifications would also affect the activities of the Wetlands Precinct member groups and local residents.

The redesign of the western foreshore, Progress Drive and the future location of the Aboriginal Cultural Heritage Centre provides an opportunity to integrate traffic controls with improved pedestrian facilities, increased parking and the creation of a distinctive entry statement for the Planning Area on Progress Drive.

There are also opportunities for improving walking and bicycle access throughout the park to enable visitors to gain a fuller experience of the natural environment of the lake and its surrounds. This includes the creation of additional viewing nodes at points around the lake; the redevelopment of the bird hide/boardwalk on the north east side of the lake and the repair of the degraded jetty further to the south were undertaken to this end.

Bibra Lake is already serviced by buses from Fremantle, Cockburn Central Train Station and Murdoch Train Station on routes 514 and 520 (Transperth 2008). However, there is scope to explore rapid transit bus options from these and other locations (such as Perth City), to service Adventure World and other activities occurring in the Planning Area in times of peak demand.

5.2.6 Education awareness raising

The Planning Area has potential to provide educational opportunities with respect to the natural environment, Aboriginal history and European history. Based on stakeholder consultation and recommendations from several previous reports and surveys, a range of educational interpretive materials and programmes would be suitable at Bibra Lake, including:

- additional signage addressing natural and cultural heritage themes; including naming of facilities after people with an historical association with the Planning Area
- sculptures and other structures depicting the values of the Planning Area; such as Aboriginal symbols associated with the spiritual values of the lake

- brochures providing information on key themes of interest and self-guided tour options
- managed tours, packaged and targeted to a range audiences, addressing environmental and cultural themes
- special functions and public events related to particular values of the Planning Area (e.g. World Environment Day).

The local Indigenous community has indicated support for providing Aboriginal heritage tours at Bibra Lake. The Cockburn Wetlands Education Centre already delivers a range of environmental education and training program with potential to be further developed and expanded. The Native ARC facilities could also be further developed to allow a greater interface with the wider community. The local Scout Group operating at Bibra Lake has indicated an interest in focussing on conservation and environmental themes.

5.2.7 New recreational opportunities

Parkland on the west and cleared areas on the south and south east provide space for new low impact recreational activities to be developed to increase local and regional visitors to the area, without compromising the natural heritage values of the lake. There is scope to provide a range of novel exercise and leisure facilities targeting a diversity of ages and interests.

5.2.8 Bushland restoration

The restoration of degraded areas to a condition resembling the natural environment is a stated objective of the Beeliar Regional Park Management Plan (DEC 2006a).

Much of the bushland on the eastern side of Bibra Lake is in relatively poor condition. However, the area of remnant vegetation is substantial in a regional context, with value as fauna habitat and connectivity between other vegetation to the north and south of the Planning Area. Improving the quality of the existing vegetation, through a sustained program of weed control and revegetation, would improve the utility of the area for native fauna, including rare and endangered species such the Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) and for those which are more common but nevertheless important.

The City of Cockburn is implementing the Natural Area Management Strategy 2012-20. The aim of this strategy is to restore all bushland within the City of Cockburn to a vegetation condition rating of 'Good' as defined within the Strategy. Bibra Lake is identified as a high priority reserve within this strategy. Priority ranking is based on a number of factors which are outlined with the strategy.

5.2.9 Research

The Project Area has a diverse range of vegetation and habitat types that are subject to a variety of external pressures and management inputs. Proximity to Murdoch University and Challenger TAFE makes the Planning Area well suited to student research projects targeting issues of management interest such as dieback, water quality, revegetation methods and fauna conservation.

The extensive rehabilitation works undertaken by the Wetlands Education Centre has involved the progressive development of methods targeted to specific revegetation challenges. There is value in further extending the experiences of the Wetland Centre to other groups involved in land restoration projects across the Metropolitan Region.

6. MANAGEMENT RECOMMENDATIONS

Management Recommendations have been developed addressing each of the Management Plan Objectives (Table 14). The recommendations are based on:

- information previously provided by the Project Working Group and other stakeholders during preparation of the 2009 management plan
- previous Bibra Lake studies and reports (Section 3.2)
- consideration of multi-faceted history of the Planning Area (Section 3)
- the existing status of the Planning Area (Section 4)
- identified management constraints (Section 5.1)
- identified threats to the values and assets of the Planning Area (Section 5.1)
- identified management opportunities (Section 5.2).

Collectively, the recommendations provide the basis for protecting and enhancing the identified values of the Planning Area.

The framework for implementing the management recommendations is provided in the Bibra Lake Master Plan (Section 7).

Table 14 Management Plan Recommendations

Recommendation	Timing / Application	Description / Rationale
Objective 1: Mitigate the impacts of the drying climate on the natural environmental values of Bibra Lake.		
1A: Maintain all inflows to the lake via stormwater runoff and groundwater recharge.	Ongoing	In the context of a drying climate, it is important that all available runoff is captured and enters the lake as surface water or via groundwater recharge. All planning processes and opportunities that may impact in either positive or negative ways upon the available runoff must be utilised to facilitate the objective. An example is the planning and design of the proposed Roe Highway extension; no water that would otherwise make its way into Bibra Lake via surface runoff, or recharge the groundwater that expresses as the surface water of Bibra Lake, can be allowed to be directed elsewhere.
1B: Liaise with the Department of Water regarding investigations into possibilities for groundwater recharge and for decreased groundwater abstraction in the Bibra Lake area that can benefit the lake's water levels.	2015 and ongoing	The lake is fed by surface runoff after rain and by the superficial aquifer of the Jandakot Mound. In light of decreasing rainfall, management of the groundwater is critical to all of Perth's wetlands.
Objective 2: Protect, enhance and foster the natural environmental values of Bibra Lake to the extent possible in the context of a drying climate.		
2A: Protect all remaining native vegetation and fauna in the Planning Area	In perpetuity	In accordance with the Beeliar Regional Park Management Plan and in line with the City of Cockburn (COC) Natural Area Management Strategy 2012-2022 (NAMS)
2B: Regularly assess the condition of remnant vegetation on both the East and Southwest sides of Bibra Lake, and North of Gwilliam Drive.	Spring 2014 then every 4 years	Assess vegetation using the assessment methods recommended in the Biodiversity Planning Guidelines published by the Western Australian Local Government Association (WALGA 2004). Repeated assessments through time will enable vegetation condition to be monitored and effectiveness of vegetation management to be evaluated. Should be in line with the COC Natural Area Management Strategy (NAMS)

Recommendation	Timing / Application	Description / Rationale
2C: Implement and maintain an ongoing terrestrial weed programme	Ongoing	Control weeds to minimise fuel loads (and hence fire risk), maintain and where possible, improve the condition of native vegetation. Priorities for weed control will be: 1. Protect vegetation area until weed suppression is achieved. 2. Protect remnant vegetation classified as fair-good or better. 3. Create a series of land compartments separated by low fuel buffers (using existing features and landscape barriers to fire, where they occur).
2D: Implement and maintain an ongoing *Typha orientalis* control programme.	Annually	*Typha orientalis* is capable of spreading rapidly under favourable conditions and threatens the ecological and aesthetic values of Bibra Lake and Roe Swamp (the seasonal waterbody of which is 100% covered in T. orientalis as of July 2014). The priority is to control Typha infestations around the lake, Bond Swamp and Roe Swamp. The level of management intervention required each year will be affected by the ecological conditions which control the ability of Typha to spread; this includes the lake water levels.
2E: Undertake progressive revegetation using native species and utilising locally collected seed where practical.	In accordance with the masterplan and in areas which build upon previous seasons' work.	Revegetation with local native species will improve the ecological value of the planning area and, over time, may also improve the aesthetic value through restoration and consolidation of the Western Australian flora. The management plan specifies areas to be revegetated in the period 2014-2020 (fringing wetland and terrestrial zones). The goal for all revegetation is to reinstate vegetation of which the composition and structure resembles as much as practicable the vegetation communities and species that naturally and originally occurred at Bibra Lake. The use of local provenance seed is generally considered as desirable as it benefits the preservation of biodiversity (WALGA, 2004). The City of Cockburn has applied effective revegetation methods for the different environments at Bibra Lake. However, with regard to the use of local provenance seed, the scope exists for incorporating a greater percentage of seed collected within and adjacent to the Planning Area.
2F: Develop a new water quality improvement	2015 pending funding	The lake water body is the centrepiece of the Planning Area, many of the values of which are dependent upon its health and amenity.

Recommendation	Timing / Application	Description / Rationale
and management strategy.		The 2002 SKM report quantified the sources of nutrients entering Bibra Lake and described options for improving the lake water quality. These options remain to be implemented, likely due to their scale, complexity, resource requirements and associated costs. A new study should include an expert review of the 2002 SKM report, include advances in knowledge and technology and result in a list of prioritised actions which take into account the limitations of the City's funding. Practical and achievable projects may include stormwater management to reduce nutrients, solids and other pollutants entering the lake. Regular monitoring of former landfill sites should be undertaken to best inform future actions: tests for leachates at the southern landfill site were inconclusive, however the site's history warrants ongoing monitoring. The implementation of a water quality improvement and manage strategy will likely require substantial funding over an extended period to ensure it is effectively implemented.
2G: Develop bio-swales to capture and pre-treat all runoff from constructed impervious surfaces generated by up to the 1-year, 1-hour average recurrence interval (ARI) events.	2015	Nutrient enrichment of the lake is an ongoing issue which will continue to impact upon the health of the water body and some surrounding features such as Bond Swamp. Construction of treatment swales along Progress Drive are proposed to capture and treat runoff from the road and from the Adventure World and western parkland zone carparks. The redevelopment of the parkland can feature the swales as attractive features of the redesign. The stormwater outlets along the lake's eastern shore should be redesigned and rebuilt to improve the pre-treatment of runoff before it enters the swamp. At both of the outfalls, potential exists to combine the stormwater from Bibra Drive and from the adjoining residential areas into 1 year, 1 hour ARI bio swales closer to Bibra Drive. These vegetated features would provide nutrient stripping before the water enters

Recommendation	Timing / Application	Description / Rationale
		the lake fringe or Bond Swamp proper. At Bond Swamp, management of the area could then focus on Typha control, revegetation and aesthetic improvements. At the outlet further south, the treatment zone could become an accessible, attractive feature. Both locations would provide opportunities for environmental interpretation and education.
2H: Investigate opportunities with the Western Australian Planning Commission to reserve vegetated areas of Lot 14 and 22.	2014	***This item needs the City's input as Lots 14 and 22 no longer exist, having been replaced with Lots 25 and 27 resulting from the sale of land to the Cockburn Ice Arena.***
2I: Update the Bibra Lake Fire Response Plan	2015	The previous revision was in 2012.
2J: Undertake a biennial dieback survey in all remnant vegetation areas (using qualified dieback interpreters) and develop a new Dieback Management Plan if warranted.	2015	As of 2014, dieback has not been positively identified within the Planning Area. Ongoing surveys are needed to enable management controls to be implemented or modified if dieback infestations are identified. The City has installed 'Phytofighters' (boot scrubbing stations) in the Lot 800 Bushland and is commencing a programme of surfacing the tracks in the area with compacted limestone, both aimed at minimising the risk of introducing and spreading dieback. The Phytofighters are also education tools and may be more effective than simple signage.
2K: Undertake biological surveys of Bibra Lake and surrounding bushland on a 5-yearly basis.	Ongoing	Vegetation and flora, fauna and macroinvertebrate surveys should be undertaken every 5 years to quantify and qualify the biodiversity value of Bibra Lake and its surrounding bushland which in turn will be used to gauge the success of restoration and other management activities.
2L: Implement and expand the strategies outlined in the Integrated Midge Control Strategy.	Ongoing	The Integrated Midge Control Strategy provides a framework to achieve the long-term goal of effectively controlling midge populations whilst reducing the level of nuisance to residents from midges in the short to medium term. It outlines both short-term and long-term control measures which will help ensure that human use of the Planning Area is not compromised. In the 2013 season, midge levels in Bibra Lake did not reach the trigger levels for treatment, indicating success at this location in managing the conditions.

Recommendation	Timing / Application	Description / Rationale
2M: Continue to develop habitat connections between Bibra Lake and surrounding sections of the Beeliar Regional Park.	2015/2016	The movement of fauna between habitats such as South and Bibra Lakes is important for maintaining genetic diversity and for limiting the impacts associated with isolated populations, e.g., local extinctions.
Objective 3: Protect and enhance the cultural and heritage values of Bibra Lake		
3A: Consult with Aboriginal stakeholders prior to implementing the Management Plan.	Completed	In accordance with the Aboriginal Heritage Act 1972.
3B: Develop an Aboriginal Cultural Awareness Plan for Bibra Lake, in consultation with the indigenous community and other stakeholders.	2015/2016	The indigenous community, including past members of the Waalitij Corporation, should be consulted to develop a plan to enhance the Aboriginal cultural values of the Planning Area. The past success of the Waalitij Corporation indicates that there is a demand for cultural activities at Bibra Lake.
3C: Develop a Bibra Lake Aboriginal Cultural Heritage Centre on the western side of the lake.	2018 - 2019	An Aboriginal Culture Centre combined with a Visitors Centre will be constructed on the Western Side of Progress drive. The possible impacts of nuisance midge upon the use of the centre should be considered carefully when developing the design.
3D: Maintain and enhance European heritage sites.	In accordance with the Implementation Plan.	Informative interpretive signage can be used to bring features and places of interest to the attention of the public. Sites on the Municipal Inventory such as the Norfolk Island Pines and Moreton Bay Fig trees should be maintained and their significance as historical features be interpreted.
Objective 4: Create a distinctive identity for Bibra Lake as a community destination and place of connection to the natural environment.		
4A: Maintain existing recreation facilities in the Planning Area.	In accordance with the Parks and Environment Asset Management Plan 2014-2017	Existing recreation facilities such as park furniture, BBQs, playgrounds, the bird hide and jetty, exercise equipment and toilets around the lake should continue to be maintained until such times as they need to be replaced or upgraded.
4B: Upgrade selected recreation facilities.	2015/16 - 2017/18	Selected existing facilities require upgrading to improve amenity and safety. Facilities to be upgraded include the fitness circuit, the associated carpark, the Eliza Cave

Recommendation	Timing / Application	Description / Rationale
		Playground and skate park. **Note: since 2009, the boardwalk and bird hide have been upgraded / redeveloped and existing ablutions upgraded.**
4C: Establish new facilities.	In accordance with the Implementation Plan	New recreation and support facilities are being considered, including a regionally significant adventure playground (western parklands) and an Aboriginal Cultural Heritage Centre on Progress Drive. Treatments that address current stormwater inputs to the lake in a more contemporary and environmentally sensitive way are proposed.
4D: Establish entry statements reflecting indigenous heritage at key access points to Bibra Lake park.	In accordance with the Implementation Plan	Feature signage and sculpture should include the Aboriginal name for the lake – Walliabup – at the entrance to the park near Gwilliam Drive and at the intersection of Hope Road and Bibra Drive. The installation would feature animals (the tortoise and the eagle) with special Aboriginal spiritual significance at Bibra Lake. This will be developed in consultation and in agreement with the local indigenous community.
4E: Create a Bibra Lake Visitors Centre, to be located on the western side of the lake.	*Superseded*	**Note: An Aboriginal Cultural Heritage Centre will be developed.**
4F: Establish an outdoor function area immediately south of Bond Swamp.	*No further consideration*	The area is to be managed and enhanced for conservation.
4G: Integrate proposed new recreation facilities south of Adventure World into the Planning Area	*Ongoing*	Subdivision of former Lot 14 Progress Drive took place and the Ice Arena built. Revegetation is continuing to enhance ecological linkages - 18,000 plants were planted into Lot 25 in 2014.
4H: Reduce the visual intrusiveness of the City-owned carpark used predominantly for Adventure World.	2016-2018	When preparing plans for redesign of the carpark, include features which can better integrate the space into the local character. Incorporate: • Native planting along the Progress Drive verge, in place of turf. • Groups of trees within the carpark. Designs in accordance with the "Commercial Lot Design Guidelines"
4I: Develop a series of vegetated stormwater treatment swales along Progress Drive opposite	2019- 2020	The swales would replace the open turf between the road and the lakeshore and provide improved treatment of stormwater from the carpark and road before it enters the lake.

Recommendation	Timing / Application	Description / Rationale
the City-owned Adventure World carpark.		Replacing the turf would increase the cover of native vegetation and fauna habitat and reinforce the bushland character of the area.
4J: Investigate options for improved bus services to Bibra Lake during peak visitor periods.	Completed	Modified or additional bus services to Bibra Lake during peak activity periods could bring benefits including increased visitors to the park and Adventure World without increased private motor vehicle use and greater freedom to visit by certain sectors of the community. Direct bus transfers from Murdoch and Cockburn Central train stations are suggestions which could be investigated with Transperth.
Objective 5: Provide and maintain a network of access around Bibra Lake and its connections to the Beeliar Regional Park; enabling the values of the lake and surrounds to be explored and appreciated by the wider community while still protecting the natural environment.		
5A: Construct new boardwalk out to waterbody from birdhide on north east side of Bibra Lake.	*Completed*	
5B: Upgrade jetty on eastern side of Bibra Lake	*Completed*	
5C: Develop a feature promenade on the western side of Bibra Lake.	*Completed*	In tandem with the development of the regional playground, develop a feature promenade along the lake shore to cater for increased visitor numbers and provide a more distinctive feature.
5D: Investigate options for the redesign of the path intersection closest to Bond Swamp on the outer edge of the park.	2015	The intersection does not function as well as possible, requiring users of the eastern-most path to undertake a minor detour to continue travelling around the park's perimeter. Obstacles to realignment of the intersection are a stand of trees and some electricity infrastructure. The trees should be retained if possible, while the infrastructure may be relocatable.
5E: Develop a running circuit as part of development of a greater range of fitness and exercise opportunities at the southern end of the lake.	2015	Introducing a measured and marked running course with 1 kilometre and 2 kilometre circuits would further add to the diversity of exercise opportunities at the fitness zone. The circuits would utilise the path network to the East which already provides these opportunities though they are unmarked.

Recommendation	Timing / Application	Description / Rationale
5F: Maintain the existing path network around and within the Planning Area.	Ongoing	Ensuring that the paths and the edges immediately along them are well maintained will encourage visitors to continue using the park and reduce the need for major path replacement works.
5G: Improve access to the Lot 800 bushland west of Progress Drive.	2015/2016	Compacted limestone is to be installed progressively to improve accessibility and to reduce the risk of dieback disease spread. Minor tracks will be closed and revegetated to reduce edge effects and the potential spread of dieback disease. The east-west trail and a portion of the north-south track are to be resurfaced in latter 2014.
5H: Include adequate parking and traffic controls in appropriate areas around Bibra Lake.	Ongoing	Parking and traffic controls will need to be investigated and detailed plans prepared and implemented to manage parking demand and the effects of traffic movements on visitors and wildlife. The designs for the western parklands and Progress Drive need to incorporate adequate parking for the regionally significant playground, Adventure World overflow plus capacity for the proposed Aboriginal Cultural Heritage Centre. Traffic controls and warning signs need to be installed to minimise ongoing losses to the breeding population of Oblong Turtles along the western and northern edges of the lake.
5I: Encourage appropriate use of the existing gazetted off-leash dog exercise area (located opposite the Bibra Lake Primary School).	2015	The skate park is located within an area gazetted by the City as an off-leash dog exercise area. To reduce the likelihood of conflicts between dogs and other park users, it is recommended that the skate park is fenced. The City should review the management of the area annually to determine the suitability of the location for off-leash dog exercise.
Objective 6: Provide environmental education and interpretation opportunities at Bibra Lake which are contemporary and reflect the changing natural and built environments.		
6A: Support the Wetlands Precinct to implement its five year Strategic Plan, through the development of an agreed long-term support package.	Ongoing	Identify opportunities to provide funding and/or in-kind support for the Wetlands Precinct group member programmes that contribute to Management Plan objectives. The City should provide administrative and technical support for specific activities or projects and for developing other sources of funding. Ongoing support should be regularly reviewed and linked to performance by group members.
6B: Install new informative signage addressing	In accordance with the	Signage may include, but not be limited to, information on changes in the park's habitats

Recommendation	Timing / Application	Description / Rationale
environmental values and environmental management programmes in accordance with the Masterplan.	Implementation Schedule	through time as land uses have changed, significant species, vegetation types, habitats, rehabilitation areas, benefits of and issues with habitat connectivity throughout the Beeliar Regional Park, introduced species, water quality issues and opportunities for improvements and the means by which visitors can help improve the environmental values of the park. See Recommendation 2G for suggested locations of interpretation and educational materials.
6C: Work with local stakeholders to assist in furthering environmental awareness strategies.	Ongoing	One issue of significance is the death of breeding turtles while crossing the roads surrounding the lake to lay their eggs or while returning to the water. Distributing pamphlets and installing signage at the car park and exit from Adventure World may assist in reducing traffic speed and in increasing driver awareness of the fact animals can be encountered. Information on the impact of the loss of breeding females may foster concern, more so if this information programme is developed in tandem with feature signage that displays the turtle as an emblem of the park. The programme could be developed and run via the Turtle Watch partnership.
Objective 7: Enhance and diversify cultural and heritage education and interpretation opportunities at Bibra Lake.		
7A: Develop an Aboriginal Cultural Heritage Centre on the western side of Progress Drive.	2015 - 2016	The development of this facility has been endorsed by the City of Cockburn. Other Indigenous heritage education and interpretation recommendations should be put on hold until the design and interpretive features of the Centre are known; it is probable that interpretation and education activities associated with the Centre would involve the development of materials, signage and educative tours around the lake. Construction of this facility should be considered carefully in light of possible impacts from nuisance midge.
7B: Investigate opportunities for displaying Aboriginal Artwork.	In accordance with the Master Plan	Display and sale of artwork will be considered in the development of the Aboriginal Cultural Heritage Centre. Incorporation of Aboriginal art into the landscape surrounds of the Centre and western parklands will be considered. The Reference Groups for each project should facilitate contact with and access for artists.

Recommendation	Timing / Application	Description / Rationale
7C: Install new informative signage addressing Indigenous cultural values in accordance with the Masterplan, developed in consultation with the Indigenous community.	2018 - 2019	Signage may include, but not be limited to, information on the Aboriginal historical significance of Bibra Lake, Aboriginal spiritual significance of Bibra Lake, other significant Aboriginal sites within the Planning Area, Aboriginal uses of native plants and animals in the area.
7D: Install new informative signage addressing European cultural heritage values in accordance with the Masterplan.	In accordance with the Implementation Schedule	Signage may include, but not be limited to, information on the location of significant European cultural heritage areas, the history of the Bibra Lake area, significant landowners and past land uses.
7E: Support the activities of the Wetlands Precinct.	Ongoing	Identify opportunities to provide funding and/or in-kind support for the Wetlands Precinct group member programmes that contribute to the Management Plan objectives. Ongoing support would be regularly reviewed and linked to performance by the group members.
Objective 8: Support and expand community involvement in environmental protection and restoration activities and environmentally sensitive recreation.		
8A: Support the activities of the Wetlands Precinct	Ongoing	As above: Item 7E.
8B: Facilitate community involvement in revegetation programmes.	Ongoing	Continue the partnership with the Cockburn Wetlands Centre to maintain weed control and replanting programmes in the Planning Area. This will facilitate community 'ownership' and care of Bibra Lake and its surrounds.
8C: Work with the Wetlands Education Centre to raise the profile of the Friends of Cockburn Wetlands Centre and undertake a membership drive.	2014/2015 and then ongoing as required.	As the key community stakeholder and 'caretaker' of Bibra Lake, the profile of the Friends of Cockburn Wetlands Centre should be raised and its activities promoted. The aim is to increase membership and involvement in group activities such as planting, bird watching, weeding, walking etc. This can facilitate greater community 'ownership' and care of Bibra Lake and its surrounds, increase the number of people in the Planning Area recreating in an environmentally sensitive manner and potentially decrease dependency on and/or value add to Council environmental management resources.

Recommendation	Timing / Application	Description / Rationale
Objective 9: Develop a revenue stream for the ongoing management of Bibra Lake and surrounds, based on commercial land use options that are compatible with other Management Plan objectives.		
9A: Obtain Council support for implementing the Management Plan.	*Completed*	
9B: Develop commercial activities	2015 onwards	Potential exists to develop a variety of new commercial activities within the Planning Area that are compatible with the protection of environmental and heritage values. A proportion of the proceeds from commercial activity could be used for the ongoing management of the Planning Area, providing a potential secure income stream for funding improvements. Commercial activities could include but are not limited to: • An Aboriginal Cultural Visitor Centre with café, art gallery and space for hire for functions. • Environmental and heritage tours from the Wetlands Education Precinct Development of any new commercial activities should be considered carefully in light of the possible impacts from nuisance midge.
9C: Investigate further opportunities to gain revenue from property lease or sales in the Planning Area.	2014/2015	Since the 2009 Management Plan was adopted by Council, the agreement to subdivide Lot 14 Progress Drive (which facilitated private development of the new ice skating facility) occurred, providing funding for management actions.
9D: Pursue funding from the Western Australian Planning Commission for the active management of Lot 800 by the City of Cockburn.	Continuing	The BRPMP recommends vesting tenure with the City Of Cockburn though as of 2014, there is no indication that the WAPC has active intentions in this regard. The City will need to formally accept a transfer of tenure, which will incur a liability to maintain the property.

Recommendation	Timing / Application	Description / Rationale
9E: Investigate the potential for external funding sources to assist the implementation of the plan.	Ongoing	There is scope to augment traditional funding sources with external grant monies. The requirement for external funding requires determination by the City and will be regularly reviewed during the implementation of the plan. The involvement of community groups in projects would further enhance potential for successful grant applications.
Objective 10: Develop and maintain a body of applied research knowledge which can be used in the management of the natural environmental values of Bibra Lake.		
10A: Support the research activities of the Wetlands Precinct members.	Ongoing.	Identify opportunities to provide funding and/or in-kind support for Wetlands Precinct group member research programmes. Identify opportunities to work collaboratively on research projects with other educational organisations such as universities (particularly the nearby Murdoch University) and schools. Findings of research projects should be made available for use by other interested parties.
10B: Appoint and maintain a repository of data for the Planning Area.	2014	Seek an agreement with Cockburn Wetlands Education Centre for their library and database to be an official repository for all management plans, reports, monitoring records, research papers and other data on the Bibra Lake environment. This will ensure there is a 'one stop shop' for information on the Planning Area and reinforce the relevance of the centre. Environmental divisions of tertiary institutions such as Murdoch University and Challenger Institute Murdoch, who undertake investigations in the Beeliar Wetlands, should be informed of the status of the centre as a focus of research for Bibra Lake. They should be encouraged to consult with the Centre whenever undertaking work within or relevant to the Planning Area and provide copies of any new data, reports etc. as they arise. Copies of all files should also be kept on a City of Cockburn database in the event that the Wetlands Centre moves or ceases to operate.

7. BIBRA LAKE MASTER PLAN

7.1 OVERVIEW

The Master Plan has been developed to provide a planning framework for implementing the management recommendations described in Section 6. The Master Plan defines management zones around the lake and describes a series of management actions for each zone. This includes maintenance activities, facility upgrades and proposed new facilities (Figure 14).

7.2 LAND USE THEMES AND RELATIONSHIPS

During preparation of the 2009 plan, an assessment of surrounding land use, traffic and access was made to aid in the formulation of the Master Plan. This enabled complementarities with existing land uses to be identified and built upon. It also enabled areas of potential land use conflict to be identified. The assessment resulted in a diagrammatic representation of the surrounding land use context of the Planning Area (Figure 15).

The above information and recommendations outlined in Section 6 has been used in the development of management zones within the Planning Area and management actions for these zones, as described in Section 7.3.

7.3 MANAGEMENT ZONES

The Planning Area is divided into management zones (Figure 16) to guide implementation of the Master Plan. The management zones have been demarcated based on land use themes and relationships, extent of existing landscape modification and compatibility with zones defined in the Beeliar Regional Park Management Plan. Initiatives, described here as management actions, for each of the management zones were developed by the Project Working Group. A number of management actions relevant to the entire Planning Area were also identified during this process. The management actions outlined in Sections 7.3.1 to 7.3.7 have been related back to the objectives contained in Section 2.3.

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Figure 14 Bibra Lake Master Plan

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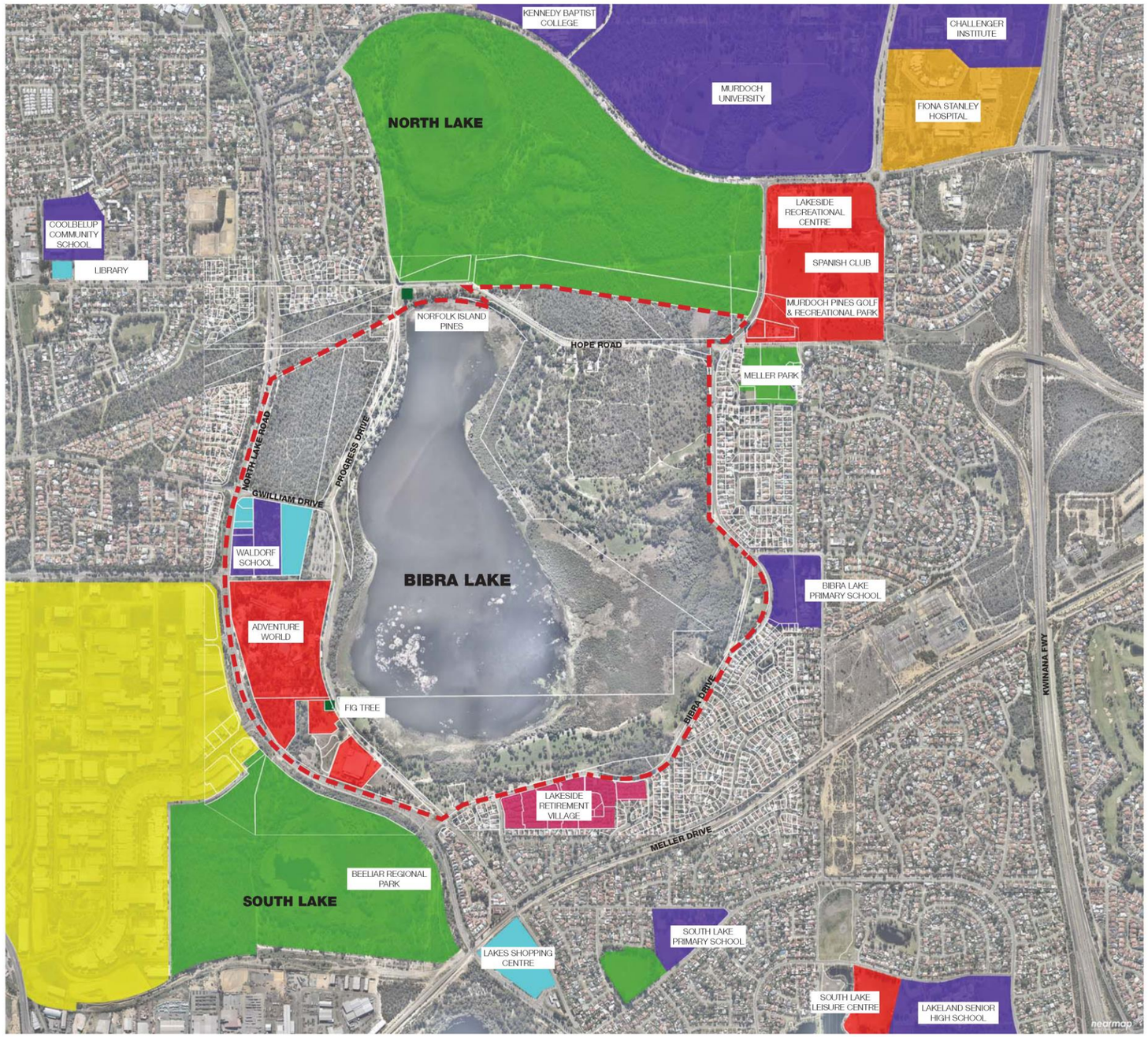
Figure 15 Bibra Lake surrounding land use context



LEGEND

- EDUCATION
- RETIREMENT VILLAGE
- RECREATION (COMMERCIAL)
- MEDICAL PRECINCT
- LIGHT INDUSTRY
- PUBLIC OPEN SPACE / RESERVE
- HERITAGE VALUE
- COMMERCIAL

ENTIRE SITE OF GREAT ABORIGINAL HISTORICAL SIGNIFICANCE. RELEVANCE TO HERITAGE, EDUCATION AND COMMERCIAL CONTEXT

Figure 16 Bibra Lake Management Zones

LEGEND

- ENVIRONMENTAL EDUCATION ZONE
- CITY OF COCKBURN CARPARK
- CONSERVATION ZONE
- RECREATION ZONE - PROGRESS DRIVE
  - BIBRA DRIVE

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7.3.1 Conservation Zone

The purpose of the Conservation Zone is to protect, enhance and re-establish remnant bushland while providing access for the public to enjoy a predominantly natural setting. Proposed management initiatives reflect the zoning status under the BRPMP, with a focus on maintaining the natural state of the precinct with minimal disturbance or visible evidence of management (Table 15). Priority activities include the repair and upgrading of existing visitor facilities, weed control and native vegetation regeneration.

Table 15 Conservation Zone management actions

Management Objective (s) (refer to Section 2.3)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
1,2,8,	2E,2G, 2M, 4I, 8A, 8B, 8C	Revegetate degraded areas in accordance with a staged implementation plan using local native species (Appendix 4). This includes establishing three native vegetation linkages on the eastern side of the lake, following a wetland to upland gradient, providing connections between better quality upland vegetation and the fringing lake vegetation. Establish vegetated habitat links at the southern end of the lake to foster connectivity between Bibra Lake and South Lake for terrestrial fauna and birds: • Establish shrubs and groundcovers in an area 30 metres wide beneath trees at the eastern end of the golf 'chip and putt' area. • Increase vegetation cover and diversity in the area surrounding the pump station at the intersection of Progress and Bibra Drives. Involve the community in revegetation activities through liaison and organisation with Wetlands Precinct member groups and other community groups.	2014 - 2019	City of Cockburn - Parks and Environment Wetlands Precinct members

Management Objective (s) (refer to Section 2.3)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2	2C, 2D	Control weeds to minimise fuel loads (and hence fire risk) and maintain, and where possible, improve the condition of native vegetation. Prioritise weed control to: • protect vegetation classified as fair-good or better • create a series of land compartments separated by low fuel buffers (using existing landscape barriers to fire where they occur). • Prepare areas for revegetation and maintain these areas after planting.	Annually	City of Cockburn - Parks and Environment
3,4,6,7	3D, 4D, 5H, 6B, 6C, 7C, 7D	Upgrade and add to existing signage within the Conservation Zone, including a series of themed trails with new signs providing information on the environmental and heritage values of Bibra Lake. New entry statement signs are proposed for the Wetlands Precinct and at the corner of Bibra Drive and Hope Road. All signage shall be compatible with BRP signage and comply with the Style Guide (Appendix 4).	2014 - 2019	
4,5,6	4A, 5D, 5F, 5G,	Upgrade existing pathways within the Conservation Zone, including resurfacing tracks in Lot 800 with limestone.	2014 - 2019	City of Cockburn - Parks and Environment
5,6,9	4F	Review community demand for an outdoor function area at Bond Swamp and consider the potential cost versus benefit in relation to income potential and the land management and human resource implications.	2014	City of Cockburn - Parks and Environment

Management Objective (s) (refer to Section 2.3)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2,6	1A, 2D, 2F	Reconstruct the stormwater outlet and gross pollutant trap presently within Bond Swamp in a location closer to Bibra Drive, combining it with treatment of 1 hour, 1 year ARI stormwater. The aim is to reduce nutrients, solids and other pollutants entering Bond Swamp to facilitate rehabilitation of the swamp. Reconstruct the stormwater outfall on the eastern side of the lake (closest to Walliabup Way) to detain and treat 1 hour, 1 year ARI stormwater and other low flow runoff to prevent nutrients and sediments from entering the lake's fringing vegetation zone. Undertake revegetation of the zone to achieve a more natural appearance.	2015	City of Cockburn - Engineering
2	1A, 2F, 2G, 4I,	Develop 1 hour, 1 year ARI bio swales along Progress Drive (to the South of Gwilliam Drive) in existing lawn areas. The swales are to pre-treat runoff from the road and the large car park and capture litter.	2015 - 2016	City of Cockburn - Parks and Environment
2,3,10	2A	Make changes and improvements wherever possible to improve nesting success and decrease turtle deaths: • Implement changes to existing fences and construct new fences along the northern and western perimeters as per the recommendations made in the report by Dr J. Giles (2012). • Implement habitat modifications and management to create turtle nesting habitat areas as per the recommendations made in the report by Dr J. Giles (2012).	2014	City of Cockburn - Parks and Environment

7.3.2 Wetlands/Education Zone

The purpose of the Wetlands/Education Zone is to help integrate and amplify the activities of the Wetlands Precinct members (current and future members). A Strategic Plan for this precinct is being developed concurrently and will reflect the vision and objectives for Bibra Lake (Section 2). Building the capacity of these groups will result in greater delivery against the Management Plan objectives. The Wetlands/Education Zone will provide a focal point for involving the community in the participatory management of Bibra Lake through the provision of multi-faceted rehabilitation, educational, research and general community activities, with a focus on practical outcomes. It will also serve as the principal conduit for promoting the values of Bibra Lake to the wider public.

The City of Cockburn is continuing to investigate options for supporting the Wetlands Precinct to implement their draft strategic plan (Table 16). This could involve contributing funds for the upgrading and extension of facilities within the Wetlands/Education Zone, including upgrades/extensions to the Cockburn Wetlands Education Centre and Native ARC buildings. Funding may also be made available to assist the activities of group members where relevant to meeting the Bibra Lake Management Plan objectives. This will be negotiated with the group members on an ongoing basis and connected to specific programs being managed by these groups. In-kind support to assist group members, such as the provision of administration resources and staff expertise, could also be provided.

Table 16 Wetlands/Education Zone management actions

Management Objective (s) (refer to Section 2.3)	Recomm-endations (refer to section 6)	Management action	Timing	Responsibility
6,7,8,9,10	6A, 6C,7E, 8A, 8B, 8C, 10A, 10B	Support the Wetlands Education Centre to develop and maintain: • frog ponds • additional classroom, hall, office and display facilities • formal native show gardens • enhanced delivery of education and community involvement programs • repository of environmental data for Bibra Lake and surrounds • methods of knowledge transfer to other areas.	Ongoing	Wetlands Precinct members City of Cockburn

Management Objective (s) (refer to Section 2.3)	Recomm-endations (refer to section 6)	Management action	Timing	Responsibility
4,6,8,9,10	6A, 7E,8A, 10A	Support Native ARC to develop and maintain: • greater administrative capacity • improved buildings and office facilities • improved animal rehabilitation facilities • enhanced delivery of education and community involvement programs • methods of knowledge transfer to other areas.	Ongoing	City of Cockburn Native ARC
4,6,7,8	6A, 6C, 8A	• Support the 1st Bibra Lake Scouts to: • upgrade the Scout hall and storage facilities • designate a camping area near the Wetlands Precinct. • provide personal development opportunities for young people, with a focus on sustainability and environmental custodianship.	Ongoing	City of Cockburn 1st Bibra Lake Scouts
3,4,7	3B, 7E,	Develop an Aboriginal Cultural Awareness Plan, to support the involvement of Aboriginal people in delivering cultural education and awareness-raising activities as part of the Wetlands Precinct. The Aboriginal Cultural Awareness Plan will provide a framework for explaining the historical use, cultural and spiritual values of Bibra Lake to the wider community.	2015	City of Cockburn Depart of Parks and Wildlife Aboriginal Stakeholders

Management Objective (s) (refer to Section 2.3)	Recomm-endations (refer to section 6)	Management action	Timing	Responsibility
4,5,6,7	6A, 6B, 8C	Support the Precinct as a whole by: • upgrading the existing amphitheatre • upgrading parking facilities • providing shade and feature trees • upgrading and adding new signage • weed control and revegetation with local native species	Ongoing	Wetlands Precinct members City of Cockburn
8	6A	Develop a long-term Wetlands Precinct support package.	2014	Wetlands Precinct members City of Cockburn

7.3.3 Recreation Zone – Bibra Drive

The purpose of the Bibra Drive section of the Recreation Zone is to provide space and accessibility for active recreation by all members of the community. This zone is designed to cater for a suite of activities including dog exercise, fitness circuits, children's play, chip and putt golf and the skate park. Walking, running and cycling are also facilitated by maintenance of the pathways. The City presently has a gazetted off-leash dog exercise area in the parcel of land opposite the Bibra Lake Primary School where the skate park is. It is proposed that a fence be built around the North, East and South sides of the skate park to reduce the chance of conflicts between skaters and dogs. It is also proposed that shade trees be planted outside the fence to provide shade for skaters and dog owners. Trees previously planted around the skate park perimeter did not survive - replanting outside the fence may reduce the casual vandalism of the trees. Seating is also recommended within the skate park.

It is proposed that the fitness circuit be expanded and improved through the installation of additional and more diverse equipment. It is also proposed that measured and marked 1 and 2 kilometre running circuits be added so that people using the fitness circuit can include these laps in their exercise. Signage and maps are suggested means of improving the amenity of the area, as are improvements to the car park opposite the fitness circuit; sealing and setting out parking bays, establishing shade trees and improvements to the general appearance of the area (associated with the proposed revegetation adjacent to the car park).

The Eliza Cave play area is well-sited and includes some popular equipment, but the area would be improved and use increased through the introduction of nature-play features. The area has good shade, plenty of open space and path connections; by diversifying the play features, the potential of the site would be more developed to the benefit of local residents and visitors. Local environmental and heritage themes could also be introduced to reinforce the local character.

Table 17 Recreation Zone – Bibra Drive management actions

Management Objective(s)	Recomm-endations (refer to section 6)	Management action	Timing	Responsibility
5	4A, 4B, 5I	Establish a fence to three sides of the skate park with adequate space within the fenced area for skate activities and seating. Establish large shade trees around the outside of the fence.	2015	City of Cockburn Parks and Environment

Management Objective(s)	Recomm-endations (refer to section 6)	Management action	Timing	Responsibility
5	5I	Increase signage indicating the existence of the gazetted off-leash dog exercise area and its extent.	2015	City of Cockburn Parks
5	4A, 5E, 5F,5H	Review the exercise circuit on the South side of the lake to increase the range of exercise opportunities offered.	2015	City of Cockburn Parks and Environment
5	5E, 5F	Establish measured and marked 1 and 2 kilometre running circuits that start and finish at the exercise circuit carpark.	2015	City of Cockburn Parks and Environment
5	4B, 5H	Redesign and surface the car park opposite the fitness park.	2016	City of Cockburn Engineering
5	4A, 4B, 5I	Maintain and where required, upgrade the Skate Park facility to ensure it provides an appropriate level of safety and challenge for the facility's users.	Ongoing	City of Cockburn Parks and Environment
4,5	4A, 4B	Design and construct additional play features at Eliza Cave play area.	2015-2016	City of Cockburn Parks and Environment
2,4,	2C, 2E	Undertake weed control and targeted revegetation with local native species where indicated on the Master Plan.	Ongoing	City of Cockburn Parks and Environment

7.3.4 Recreation Zone – Progress Drive Parklands

The purpose of the Progress Drive Recreation Zone is to provide a range of distinctive recreational facilities and space for groups and community events to take place. Facilities such as BBQs, tables and chairs, shelters, grassed open spaces, shady trees, playgrounds and rest rooms are proposed to make this space suitable for a wider range of public functions than is currently catered for (Table 18).

A keystone component of the Progress Drive Parklands will be the development of a regionally significant playground. Vehicle traffic is expected to increase with the attractions of the playground, improved and more diverse visitor facilities and ongoing developments at Adventure World. To cater for this, new car parks will be constructed, with designated overflow parking areas in the design.

In addition to the above, the feasibility of building an Aboriginal Cultural Heritage Centre is being explored. The site being considered for the Centre is on the western side of Progress Drive, approximately 150 metres to the North of Gwilliam Drive. A café is envisaged within the Centre, a feature which itself may attract a substantial increase in visitor numbers to the zone.

Table 18 Recreation Zone – Progress Drive Parklands management actions

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
3,7	4D	Construct feature signage which includes the Aboriginal name for Bibra Lake ("Walliabup") at entrance to the park near Gwilliam Drive	2015	City of Cockburn Parks and Environment
5	4C	Construct a regionally significant playground within the parklands.	2015-2016	City of Cockburn Parks and Environment
4,6,7	4C	Construct new facilities including BBQ and picnic table facilities, signage, bike racks, shade structures and ancillary features on the existing parkland.	2015-2016	City of Cockburn Engineering
5	5H	Construct new car parking along Progress Drive and upgrade existing car parks.	2015-2016	City of Cockburn Engineering
5	5H	Reconstruct Progress Drive, including a central median	2015-2016	City of Cockburn Engineering

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
1,2,	4I	Construct 1 hour, 1 year ARI stormwater treatment features along Progress Drive and within the parklands as required to capture and treat stormwater from the road and carparks.	2015-2016	City of Cockburn Engineering
2,5	5C	Upgrade the retaining wall along the lake edge as required.		City of Cockburn Engineering
4	5H	Underground the powerlines along Progress Drive in association with the road reconstruction.	2016	City of Cockburn Engineering
3,4,6,7,9	4C, 4E	Develop an Aboriginal Cultural Heritage Centre to the west of Progress Drive	2015-2016	City of Cockburn Parks and Environment in partnership with the indigenous community

7.3.5 City of Cockburn car park

The City of Cockburn owns the land on which the large 'Adventure World' car park is located. The car park is used under agreement with the City, though not for sole use. The City has given consideration to options for redesigning the car park, with the aim of improving the function of the car park and replacing the ageing asset. It is important that the management of stormwater is considered during the redesign, with onsite detention and treatment the preferred option for the 1 year, 1 hour ARI rainfall. If this is not practical for reasons associated with maximising the parking yield from the site, then treatment should be undertaken in bioswales in the verge below the carpark and in the parkland across the road.

Further to this, the car park redesign is to accommodate improved pedestrian connectivity with the Parkland Zone to the North, facilitating easier and safer crossing between all areas. As the car park is not for the sole use of Adventure World, but given that the proposed car parks along Progress Drive in the Parkland Zone may be used for overflow parking by patrons of the facility, creating clear and safe pedestrian paths and road crossing features will be important. Increased shade trees and the possible introduction of shade structures should be considered.

Table 19 City of Cockburn car park management actions

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
1,2	2G, 4I	Incorporate on-site stormwater management in the redesign of the car park. If this is not possible, treatment swales should be constructed in adjacent verges and parkland.	2016	City of Cockburn Engineering, Parks and Environment
5	5F	Include pedestrian connections with parkland areas to the East and North in the car park design.	2016	City of Cockburn Engineering
5	4C, 4H	Include increased provision of shade throughout the car park and at pedestrian crossings to and from the site.	2016	City of Cockburn Engineering

7.3.6 The Water Body

Proposed management actions reflect the necessity of a sustained effort to achieve improvements in wetland health.

Table 20 The water body management actions

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2	2F	Review the 2002 Sinclair Knight Merz study in light of technological advances and present day costs in order to formulate a new strategy for the long-term management of lake water quality. The strategy is to be developed in consultation with other key stakeholders (such as DPaW and the DoW)	2015	City of Cockburn Environment
2	2E	Increase area of fringing wetland vegetation (including sedges/rushes in shallow water) around the lake to improve water quality and habitat value for fauna such as water birds. Priority revegetation areas are adjacent to turf areas and lake sections of high habitat value on the western side.	Annually	City of Cockburn Environment Wetlands Precinct
2	2L	Implement and the Integrated Midge Control Strategy to ensure that human use of the Planning Area is not compromised.	Annually	City of Cockburn Environment

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2	2D	Continue to control *Typha orientalis* infestations through slashing, aerial spraying and removal and replacement with local sedge species. Priorities are to contain and progressively reduce infestations at the north, south-west and southern areas of the lake. The Roe Swamp infestation will continue to be addressed in order to clear the presently 100% coverage of water body. The level of management effort required annually will be influenced by ecological conditions affecting the ability of *Typha* to spread, including lake water levels.	Annually	City of Cockburn Environment
2,6	6B	Prevent the feeding of water birds through placement of educational signs and policing of policy by rangers.	Ongoing	City of Cockburn Rangers
2	2E	Continue revegetation of the southern landfill site to minimise the leaching of nutrients into the lake from this source, with more dense plantings nearest to the lake's waterline.	2014-2015	City of Cockburn Parks
2	2F	Categorise turf areas according to high, medium and low use and irrigate and apply fertiliser accordingly. Continue to replace all low use areas of turf with native vegetation – this should be considered in tandem with the development of bioswales for the treatment of stormwater.	Ongoing	City of Cockburn Parks
2,6	2F	Encourage reduced groundwater extraction and fertiliser use within Bibra Lake catchment through community education programs.	Ongoing	City of Cockburn Environment Wetlands Precinct members

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2,10	2F, 10B	Share knowledge and maintain working relationships with relevant State Government agencies (DPaW, DoW and Water Corporation) and community groups with respect to wetland health.	Ongoing	City of Cockburn

7.3.7 Overall management initiatives

Some management issues are relevant to the entire Planning Area or multiple management zones and are not suited to being assigned to a particular management zone. These include traffic and access considerations, fire management, dieback management, policing and overall monitoring and maintenance requirements.

Traffic and access management

The actions outlined in Table 21 are aimed at reducing the speed of traffic, improving traffic flow, meeting the predicted demands for parking and access to the lake. Proposed traffic and pedestrian circulation and access are illustrated in Figure 17 and Figure 18.

Table 21 Management actions for traffic and access

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
5,6	5C, 5F	Deter antisocial behaviour within the Planning Area through maintaining a Ranger presence and applying Crime Prevention Through Environmental Design principles in all maintenance and new works.	Ongoing	City of Cockburn Rangers
2,6	2A, 6B,	Prevent dogs off leads outside of designated areas through appropriate signage informing public and policing of policy.	Ongoing	City of Cockburn Rangers

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2,5	2A, 4C, 5H	Undertake comprehensive traffic and parking modifications to Progress Drive to manage anticipated increases in traffic volumes. Include a review of provisions for preventing the passage of turtles across the roadway to ensure that traffic management does not further impact upon fauna. Continue investigations and negotiations into the realignment of the southern end of Progress Drive to improve traffic flow and safety.	2014-2016	City of Cockburn Engineering
2,6	2A, 5H	Install traffic controls along Hope Road to reduce vehicle speed.		City of Cockburn Engineering
2	2A	Investigate the feasibility of Installing fauna underpass structures on Hope Road, to provide for the safe movement of fauna.	2016	City of Cockburn Engineering
5	5H	Investigate options to realign the southern end of Progress Drive to improve traffic flow and safety.	2009	CoC Engineering
5	5H	Better define kerbside and entry parking zones around the perimeter of the Bibra Lake Reserve.	2014-2016	CoC Engineering
2,5	5F	All main pathways will be trafficable asphalt and will allow access to maintenance vehicles (for weeding, planting, spraying etc) and fire trucks. Pathways will also act as a barricade between grass and vegetation to minimise nutrient leaching and spread of grass to vegetated areas.	2014 and then ongoing	City of Cockburn Engineering

Figure 17 Traffic Circulation and Access

Figure 18 Pedestrian Circulation and Access Plan

Fire Management

Table 22 presents fire management actions that can be considered as complementary to the existing City of Cockburn Fire Response Plan (October 2012). Low fuel levels should be maintained at the north and south ends of the lake by regular weed control and mowing, creating a fire buffer on this axis.

Table 22 Management actions for fire hazard reduction and response

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2,6	2I, 6B	Erect signs advising that fire lighting and rubbish dumping are prohibited. Ensure an emphasis on the East side of the lake (near the informal car park near Bond Swamp) and in any areas of recurrent problems in the West.	2014	City of Cockburn Rangers
2,5	2I, 5F	Maintenance of strategic, fuel reduced, hazard reduction zones (> 20 metres wide) in the following areas: • The surrounds of the Wetland Precinct • Hope Road (road reserve) east of the Wetland Precinct. • The northern side of Gwilliam Drive • The internal pedestrian path from Bibra Drive to Hope Road (that runs south of Bond Swamp) • The north end of the lake • The south end of the lake (existing fire exclusion zone on Figure 19).	Annually	City of Cockburn Environment

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2,5	2I, 5F	The hard surface walk/cycle path encircling the water body provides good access for fire control and a firebreak opportunity. Maintain a 6 metre wide effective firebreak by mowing and spraying weeds either side of the path. Grassed areas to be maintained at less than 50 mm height during the months from October to April.	Annually	City of Cockburn Environment
2	2I, 2C	Strategic control of grassy weeds in remnant vegetation on the eastern side of the water body to create a mosaic of low fuel zones. Weed control to be prioritised to better quality remnant vegetation.	Annually (or as required)	City of Cockburn Environment
2	2I	Continuation of mowing programme on grassed areas within Planning Area.	Annually	City of Cockburn Parks

Figure 19 Fire Response Plan (City of Cockburn 2012)

Dieback Management

A Dieback Management Plan for Bibra Lake was developed in 2000 by Sharon Kilgour from the Dieback Working Group. The plan details strategies to reduce the risk of introducing dieback to Bibra Lake bushland. These strategies remain valid and are included in Table 23.

Good hygiene is essential for effective dieback management. Groups completing ground works shall ensure that footwear, vehicles, tools and machinery used are free of all soil when entering Bibra Lake bushland areas. Detailed dieback management guidelines are provided in Appendix 5.

Table 23 Management Actions for Dieback Prevention and Management

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2,5	2J	Maintain access paths and tracks regularly to ensure they are well drained and free of mud. Maintenance activities (such as track maintenance, fencing etc.) shall be carried out in dry soil conditions where practicable.	Annually	City of Cockburn Environment
2,5	4B, 5G	Continue to surface walking tracks throughout the Planning Area with compacted limestone to prevent ponding and poor drainage.	2014 and ongoing	City of Cockburn Environment
2	2J	Any soil, mulch, gravel or plants brought into Bibra Lake must be tested to determine if free from Dieback, or purchased from a supplier accredited by the Nursery Industry Association.	As required	City of Cockburn Environment
2,6	2J, 6B	Erect signs at entry points to bushland areas to inform visitors that the areas are free from Dieback and how they can assist in maintaining the status.	2015	City of Cockburn Environment
2,6	2J, 6B	Erect signs along paths that highlight plant species that are susceptible to dieback.	2015	City of Cockburn Environment

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2,6	2J	Distribute advice to surrounding residential areas outlining the status of dieback at Bibra Lake and how visitors can reduce the risk of introducing it.	2015-2016	City of Cockburn Environment
2	2J	Dieback surveys shall be undertaken in bushland areas that are yet to be surveyed for the presence of *Phytophthora cinnamomi* e.g., bushland to the North of Hope Road.	2014	City of Cockburn Environment
2	2B, 2J	Vegetation health in the Planning Area is to be monitored biennially by visual inspection and score sheet.	2014 then bi-ennially	City of Cockburn Environment
2	2J	If death of susceptible species occurs, the area shall be assessed by qualified dieback interpreters to determine if *P. cinnamomi* is present.	As required	City of Cockburn Environment

Monitoring

A monitoring programme is needed to enable the effectiveness of ongoing management initiatives to be evaluated and future management adapted as required to ensure continuing protection of the values of the Planning Area (Table 24).

Table 24 Management actions for monitoring

Management Objective (s)	Recomm-endations (refer to Section 6)	Management action	Timing	Responsibility
2,4,6,7	1A, 1B, 2A, 2B, 2C, 2F, 2I, 2J, 2K, 4B, 4C, 4D, 4E, 4I, 5E, 5F, 5G, 5H, 5I, 6B, 6C, 7E, 8A, 8C, 10A, 10B	Develop and implement a Bibra Lake Monitoring Programme. This plan should include monitoring methods, frequency and responsibilities with respect to: • Water levels and water quality (quarterly sampling) • Vegetation condition (biennial condition assessment including identification of plant deaths that may be caused by dieback) • Success of weed control and revegetation (annual) • Fauna diversity and abundance (annual sampling in Spring) • Adequacy of fire control through assessment of fuel loads and condition of firebreaks (including paths, car parks and naturally bare areas) • Visitation to the planning area • Compliance of new structures with the Style Guide (Appendix 4) Efforts to involve the community in monitoring activities should be made where appropriate.	2014 then ongoing	City of Cockburn
N/A	N/A	Include all new and existing assets in the City's Asset Management System for tracking the condition of facilities in the Planning Area and setting maintenance and replacement schedules.	2014 then annually	City of Cockburn Planning

7.4 LANDSCAPE STYLE GUIDE

A Landscape Style Guide (Appendix 4) has been developed to provide design guidelines for community facilities within the Planning Area. The Style Guide emphasises quality built form and a distinctive style for Bibra Lake.

All relevant management initiatives are to be implemented in accordance with the Style Guide.

8. PROGRAMME OF WORKS

An Opinion of Probable Costs (Appendix 3) has been prepared for Capital Works, covering the financial period 2015/2016 through 2019/2020.

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10. ACRONYMS

Short title	Long title
BRP	Beeliar Regional Park
BRPMP	Beeliar Regional Park Management Plan
CALM	Department of Conservation and Land Management
DEC	Department of Environment and Conservation
DEP	Department of Environmental Protection
DIA	Department of Indigenous Affairs
DoW	Department of Water
EPA	Environmental Protection Authority
EWP	Environmental Water Provisions
MRWA	Main Roads Western Australia
NLRA	North Lake Residents Association
PWG	Project Working Group
WALGA	Western Australian Local Government Authority
WAPC	Western Australian Planning Commission

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Appendix 1
DIA Aboriginal Sites Search

Search Criteria

4 Registered Aboriginal Sites in Custom search area; 388144.85mE, 6447306.99mN z50 (MGA94) : 390680.54mE, 6449925.54mN z50 (MGA94)

Disclaimer

The *Aboriginal Heritage Act 1972* preserves all Aboriginal sites in Western Australia whether or not they are registered. Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Aboriginal Affairs by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you email the details to the Department at HeritageEnquiries@daa.wa.gov.au and we will make every effort to rectify it as soon as possible.

Copyright

Coordinate Accuracy

Accuracy is shown as a code in brackets following the coordinates. Map coordinates (Latitude/Longitude and Easting/Northing) are based on the GDA 94 Datum. The Easting/Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '500000mE:Z50' means Easting=500000, Zone=50.

Terminology (NB that some terminology has varied over the life of the legislation)

Place ID/Site ID: This a unique ID assigned by the Department of Aboriginal Affairs to the place

Status:

- **Registered Site**: The place has been assessed as meeting Section 5 of the *Aboriginal Heritage Act 1972*
- **Other Heritage Place which includes:**
  - **Stored Data / Not a Site:** The place has been assessed as not meeting Section 5 of the *Aboriginal Heritage Act 1972*
  - **Lodged:** Information has been received in relation to the place, but an assessment has not been completed at this stage to determine if it meets Section 5 of the *Aboriginal Heritage Act 1972*

Access and Restrictions:

- **File Restricted = No:** Availability of information (other than boundary) that the Department of Aboriginal Affairs holds in relation to the place is not restricted in any way.
- **File Restricted = Yes:** Some of the information that the Department of Aboriginal Affairs holds in relation to the place is restricted if it is considered culturally sensitive. This information will only be made available if the Department of Aboriginal Affairs receives written approval from the informants who provided the information. Download the Request to Access Restricted Information letter and form.
- **Boundary Restricted = No:** place location is shown as accurately as the information lodged with the Registrar allows.
- **Boundary Restricted = Yes:** To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the place is located. If you are a landowner and wish to find out more about the exact location of the place, please contact DAA.
- **Restrictions:**
  - **No Restrictions:** Anyone can view the information.
  - **Male Access Only:** Only males can view restricted information.
  - **Female Access Only:** Only females can view restricted information

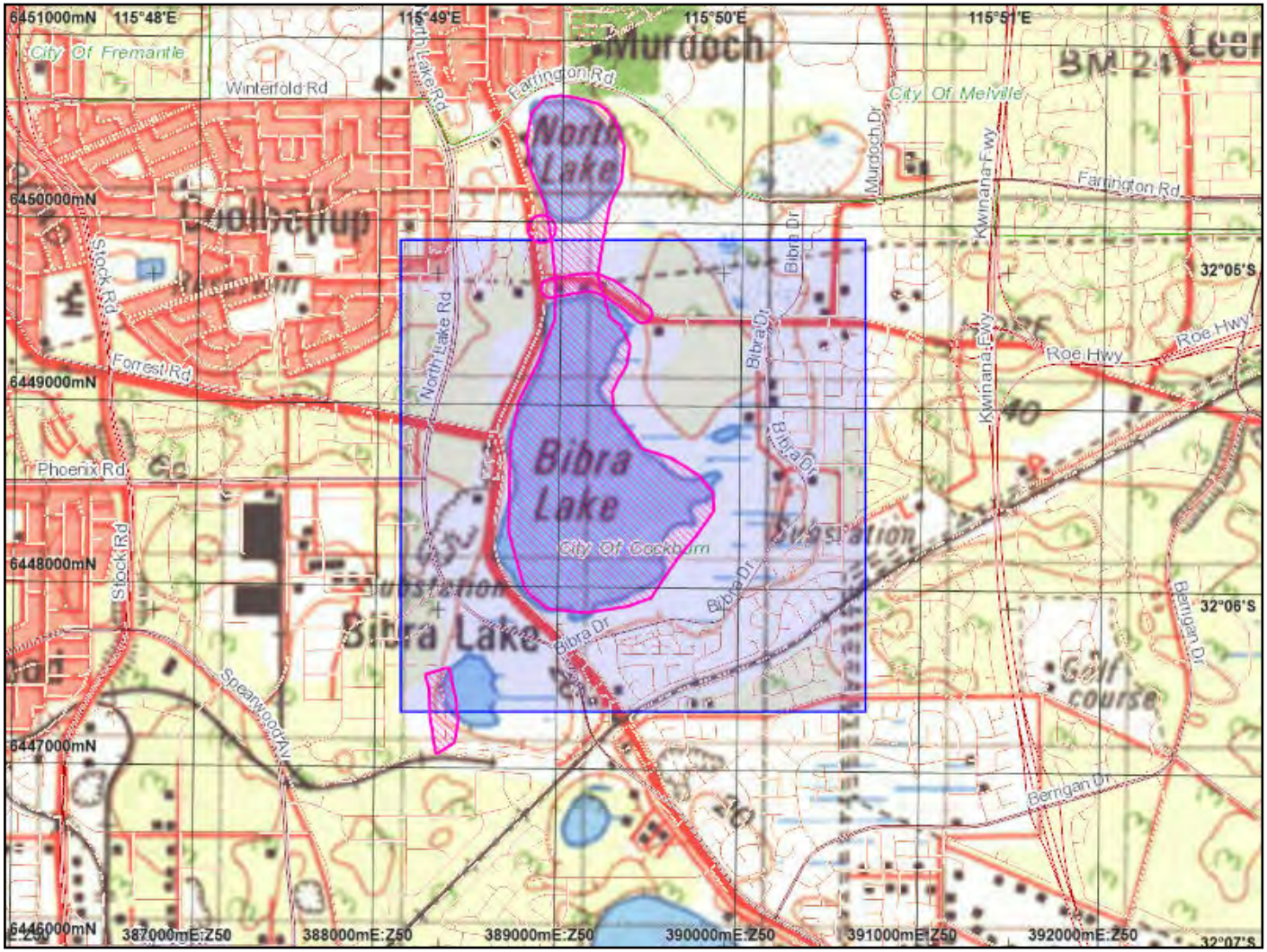
Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place. This has been replaced by the Place ID / Site ID.

List of Registered Aboriginal Sites with Map

Site ID	Site Name	File Restricted	Boundary Restricted	Restrictions	Status	Site Type	Knowledge Holders	Coordinates	Legacy ID
3709	NORTH LAKE AND BIBRA LAKE.	No	No	No Gender Restrictions	Registered Site	Mythological	*Registered Knowledge Holder names available from DAA	389282mE 6449283mN Zone 50 [Reliable]	S02209
4103	SWAMP 81	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter	*Registered Knowledge Holder names available from DAA	388375mE 6447322mN Zone 50 [Reliable]	S01289
4106	NORTH LAKE SW	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter	*Registered Knowledge Holder names available from DAA	388894mE 6449964mN Zone 50 [Reliable]	S01292
4107	BIBRA LAKE NORTH	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter	*Registered Knowledge Holder names available from DAA	389198mE 6449589mN Zone 50 [Reliable]	S01293

Aboriginal Heritage Inquiry System

Aboriginal Sites Database



Legend

Selected Heritage Sites

- Registered Sites
- Aboriginal Community Occupied
- Aboriginal Community Unoccupied
- Town
- Search Area

Search Criteria

3 Other Heritage Places in Custom search area; 388208.30mE, 6447258.72mN z50 (MGA94) : 390649.50mE, 6449980.96mN z50 (MGA94)

Disclaimer

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- **Boundary Restricted = Yes:** To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the place is located. If you are a landowner and wish to find out more about the exact location of the place, please contact DAA.
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  - **No Restrictions:** Anyone can view the information.
  - **Male Access Only:** Only males can view restricted information.
  - **Female Access Only:** Only females can view restricted information

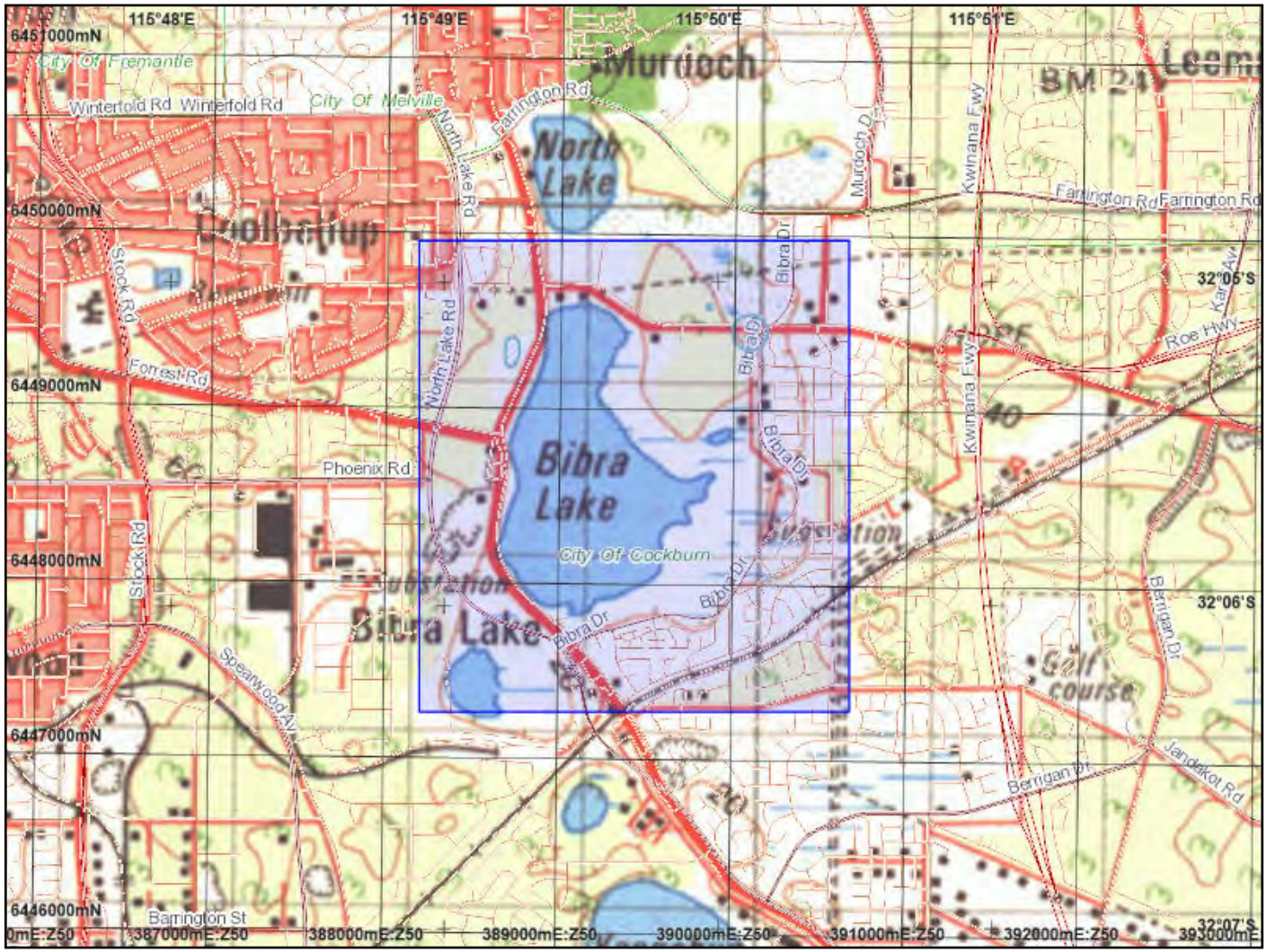
Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place. This has been replaced by the Place ID / Site ID.

List of Other Heritage Places with Map

ID	Place Name	File Restricted	Boundary Restricted	Restrictions	Status	Type	Knowledge Holders	Coordinates	Legacy ID
3196	LAKE BIBRA: FORREST ROAD	No	No	No Gender Restrictions	Stored Data / Not a Site	Quarry	*Registered Knowledge Holder names available from DAA	388721mE 6449319mN Zone 50 [Unreliable]	S00660
3296	HOPE ROAD SWAMP/BIBRA LAKE.	No	No	No Gender Restrictions	Lodged	Artefacts / Scatter	*Registered Knowledge Holder names available from DAA	390089mE 6449449mN Zone 50 [Reliable]	S00192
30574	NOON10_SMS_001	No	No	No Gender Restrictions	Stored Data / Not a Site	Modified Tree	*Registered Knowledge Holder names available from DAA	389855mE 6449588mN Zone 50 [Reliable]	

Aboriginal Heritage Inquiry System

Aboriginal Sites Database



Legend

Selected Heritage Places

- Other Heritage Places
- Aboriginal Community Occupied
- Aboriginal Community Unoccupied
- Town
- Search Area

Appendix 2
City of Cockburn Weed Priority List

City of Cockburn

Weed Management Strategy

TABLE OF CONTENTS

SUMMARY OF RECOMENDATIONS

Recommendation 1 : Revise and update the Priority Weed list every 5 years.

Recommendation 2 : Review/re-map Natural Area Condition every 4 years.

Recommendation 3 : Review/re-map Weed Mapping every 4 years

Recommendation 4 : Focus primary weeding efforts in high priority areas

Recommendation 5 : Prioritise grass weed control where there is a threat to adjacent areas of high conservation value.

Recommendation 6 : ONLY control grass weeds if the bushland has the ability to naturally regenerate and out-compete the weeds OR in conjunction with revegetation.

Recommendation 7 : Prioritise weed control within recently burnt areas, particularly during the first year after fire.

Recommendation 8 : Do not attempt direct seeding without at least one year, and preferably two years, of prior weed control.

Recommendation 9 : Commence weed control in proposed revegetation sites two years prior to planting.

Recommendation 10 : Control feral pests to reduce the spread of weeds

Recommendation 11 : Undertake a community education campaign to inform residents of the harm caused by weed invasion

1 EXECUTIVE SUMMARY

Environmental weed invasion has been identified as one of the major threats to biodiversity conservation across Western Australia and on a national scale. Competition from weeds is a major factor affecting biodiversity and ecological communities. In 1999 the State Government developed the Environmental Weed Strategy for Western Australia to give direction in management of environmental weeds. In addition a National Weeds Strategy has also been developed.

One of the most significant environmental challenges facing Western Australia is minimising the impact from environmental weeds. In the relatively short history of Western Australia since European settlement, some 1155 exotic plant species have established as weeds in our diverse and generally fragile ecosystems (Dept of Agriculture 2001).

In response to this acknowledged threat the City of Cockburn has devised its own environmental weed management strategy to help guide management programs and assist in allocation of resources to protect natural areas vested within the City.

In developing this management strategy standard methodologies for ranking weed species was used to determine weeds that fell into high, medium or low priority categories for control. The level of weed control that can be achieved in each reserve is limited and based on resource allocation. Reserves which are ranked highly in terms of conservation values will receive greater focus in regards to weed control.

Strategic Objectives:

To provide a strategic direction for the management of weeds in the City of Cockburn;

To develop a list of weed species and rank them according to their level of invasiveness, distribution and environmental impact; and

To determine and apply best practice integrated methodology for control of these species.

A list of 35 high priority weeds for the City of Cockburn has been developed and monitoring of weed invasion, distribution and control outcomes is achieved through regular mapping of these priority weeds within City of Cockburn reserves.

2 INTRODUCTION

Environmental weeds are considered one of the most serious threats to biodiversity and natural ecosystems (CALM 1999). They adversely affect the regeneration of indigenous flora and thus survival of its associated fauna. Weeds can affect both ecosystem function and structure through:

Displacement of native species

Prevention of recruitment of native species

Reduction in species diversity

Competition for resources

Alteration of fire regimes

Alteration of nutrient cycling

Acceleration of soil erosion rates

Alteration of soil pH

Alteration of hydrological cycles

Acceleration of local, regional and global extinction rates

The City's Weed Management Strategy is based on the following principles:

- Weed control is an essential component of sustainable natural resource management but is much more than simply the elimination of weeds. The underlying objective is always the protection and restoration of naturally diverse ecosystems (Brown et al 2002).

- Prevention, early detection and early intervention are the most cost-effective means of weed management.

- Effective weed control requires a long-term commitment.

- Effective weed management requires a coordinated approach.

A simple and effective priority setting and planning process is needed to best utilise available weed management resources and to ensure the long-term implementation of the weed strategy.

Environmental weeds and management of them have been identified at three levels:

Local;

State; and

National

The Australian Government has established a list of Weeds of National Significance (WONS), which may include plants of concern in natural areas, waterways or agricultural land. Several weeds found in Western Australia are among recent additions to the Weeds of National Significance (WONS) list. Species are selected based on their ranking for invasiveness, potential to spread, and impact on socioeconomic and environmental assets (Commonwealth of Australia 2007).

'Declared Plants', as defined under the Agriculture and Related Resources Act 1976, are high priority weeds that are or may become a problem to agriculture or the environment and are formally 'declared'. When a plant becomes declared, specific control strategies are required. Declared Plants (DP) when found on property, either privately owned or on crown land, must be controlled by landowners or managers.

The Local Government Act allows a local authority to declare plants as "pest plants". Declaration requires the control of that weed species on all lands within the local authority boundary. When this legislation is applied there is no requirement for consistency between adjacent local authorities, which may result in uncoordinated and less effective control.

In addition to other drivers, climate change may alter the potential range of some weeds. In Australia, the generally warming climate could allow tropical weed species to extend further south, temperate species to retreat to the south, and summer growing species to become more prevalent in the southern regions. This is a prevailing issue that will need consideration into the future. Additional resources may be required to identify and react to perceived threats.

2.1 WHAT IS A WEED?

There are a number of different definitions of weeds:

Bradley (1988) defines a weed as 'a plant out of place'

Dixon & Keighery, in Scheltema & Harris Ed. (1995), define weeds as 'plants growing where they are not wanted'

The National Weeds Strategy defines a weed as "a plant that has, or has the potential to have, a detrimental effect on economic, social or conservation values" (ARMCANZ, ANZECC and Forestry Ministers, 1997).

According to the Environmental Weed Strategy for Western Australia (1999) environmental weeds are plants that establish themselves in natural ecosystems (marine, aquatic and terrestrial) and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade.

Some native species can also become environmental weeds and require management. It is therefore perhaps useful to define weeds for the purpose of this document as comprising ALL non-indigenous plants PLUS any indigenous plant that has increased its distribution as a result of disturbance and is threatening the integrity of the local ecosystem.

Weed management in bushland is an important component of the City's overall program of managing its reserves. The primary objective is: *To control and manage weeds in all conservation reserves within the City of Cockburn in order to protect biodiversity, the natural ecosystems and, where possible, to restore them to a natural state.*

Bridal Creeper (*Asparagus asparagoides*) a WONS found in the City of Cockburn

3 WEED RANKING

To set priorities for weed control, it is necessary to firstly rank weeds with regard to their impact or potential impact on natural areas.

3.1 WEED RANKING METHODOLOGY

Weed-ranking methodologies are used to determine level of threat of a weed species.

The Environmental Weed Strategy for WA (EWSWA) ranks weeds according to:

Invasiveness: ability to invade bushland in good to excellent condition, or ability to invade waterways. (Score as yes or no).

Distribution: wide current or potential distribution including consideration of a known history of widespread distribution elsewhere in the world. (Score as yes or no).

Environmental Impacts: ability to change the structure, composition and function of an ecosystem. In particular an ability to form a monoculture in a vegetation community. (Score as yes or no).

The ranking of each weed was determined using the following scoring system:

High - a weed species would have to score yes for all three criteria. Rating a weed species as high would indicate prioritizing this weed for control i.e. prioritizing funding for it.

Moderate - a weed species would have to score yes for two of the above criteria. Rating a weed species as moderate would indicate that control should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).

Mild - a weed species scoring one of the criteria. A mild rating would indicate monitoring of the weed and control where appropriate.

Low - a weed species would score none of the criteria. A low ranking would mean that this species would require a low level of monitoring.

The City of Cockburn Weed Strategy uses rankings based primarily on the Environmental Weed Strategy for WA as a basis for determining the priority ranking of weed species.

Table 1: Target weed species that were found in selected COC reserves based on mapping 2012(Ecoscape)

WEED SPECIES	**EWSWA RATING**
ASPARAGUS ASPARAGOIDES (BRIDAL CREEPER)	HIGH
LUPINUS COSENTINII (SANDPLAIN LUPIN)	HIGH
TYPHA ORIENTALIS (TYPHA)	HIGH
ZANTEDESCHIA AETHIOPICA (ARUM LILY)	HIGH
ACACIA LONGIFOLIA (SYDNEY GOLDEN WATTLE)	MODERATE
CARPOBROTUS EDULIS (PIGFACE)	MODERATE
CYNODON DACTYLON (COUCH)	MODERATE
FICUS CARICA (EDIBLE FIG)	MODERATE
PENNISETUM CLANDESTINUM (KIKUYU)	MODERATE
TRACHYANDRA DIVARICATA (DUNE ONION WEED)	MODERATE
ASPHODELUS FISTULOSUS (ONION WEED)	MILD
FUMARIA CAPREOLATA (FUMARIA)	MILD
PENNISETUM SETACEUM (FOUNTAIN GRASS)	MILD
MELALEUCA NESOPHILA (MINDIYED)	LOW
RICINUS COMMUNIS (CASTOR OIL PLANT)	LOW
FOENICULUM VULGARE (FENNEL)	UNRATED

3.2 City of Cockburn Priority Weed List

The City has developed its own priority weed list based on the state and national strategic documents and using local knowledge and information. The City of Cockburn Priority Weed List can be found in Appendix 1. Priority ranking of a weed species can change with time as weeds become more established and widespread, adapt to different growing conditions, or are brought under control.

These rankings give a current indication of the seriousness of the threat posed by each weed species within the City of Cockburn. In addition the City must be aware of other state or national weed species which may impact on the priority ranking within the City.

Recommendation 1 : Revise and update the City of Cockburn Priority Weed List every 5 years.

4 RESERVE RANKING

The City has limited resources to manage natural areas. It is therefore necessary for reserves to be prioritized according to the criteria outlined below, to ensure that resources are being used effectively in areas where the most benefit can be gained.

Each reserve has been ranked based on the following criteria:

Vegetation condition
Reserve size
Reserve shape
Perimeter to area ratio
Connectivity
Rarity
Regional and local representation
Education, community or passive recreation

Social values such as education and community involvement have also been considered when assessing each reserve. Generally reserves with higher visibility have a higher community involvement. A greater community involvement means that a reserve is valued by the community and that expectations in relation to funding and management are higher. It can be argued that the greater the community involvement the better the outcomes as funding from alternative sources such as grants are more likely to be forthcoming.

A viability estimate (VE score) is determined for each reserve and this in turn determines its ranking.

4.1 RESERVE RANKING CRITERIA

Vegetation Condition

All reserves within Cockburn have been mapped for vegetation condition and vegetation complexes.

Excellent/good condition bushland areas are more resilient to weed invasion and thus are more ecologically sustainable. Reserves with a majority of their bushland in excellent condition are rated higher than those with a lesser condition. Reserves have been prioritised into *three* management categories; High, Medium and Low.

Prioritising weed control helps facilitate the self-regenerating process inherent in such bushland and reduces the need for long-term (and ongoing) follow-up weed control work.

Bushland condition is unlikely to change *significantly* in the short term but the weed control program should be reviewed regularly.

Recommendation 2 : Re-map vegetation condition every 4 years.

Reserve Size

Large reserves have greater integrity through intact vegetation and resistance to weed invasion, so hence are more ecologically sustainable. Larger reserves are rated higher than smaller reserves.

Shape and Perimeter to Area Ratio

The size and shape of a piece of bushland is critical to its health - the smaller the area, the greater the proportion of the bushland that is exposed to degradation and the invasion of weeds. Edge effects increase as remnant size decreases and generally, narrow linear remnants experience higher edge effects due to a higher edge-to-area ratio. A low ratio has a 'high' ranking and a high ratio has a 'low' ranking.

In addition to the perimeter of the reserve, all paths, tracks, firebreaks, etc, act as 'edges'.

Connectivity

The viability of any natural area depends on its proximity to other natural areas and the quality of the linkage between them. These two factors influence the movement of individual living organisms and the flow of genetic material between natural areas. In turn this determines the long term survival of species, their genetic variation, their ability to adapt to changes in the environment and the maintenance of ecosystem processes. Hence reserves which form part of an ecological linkage or form contiguous links with other natural areas will be ranked higher.

Rarity

This represents whether a reserve has been identified as containing either a Threatened Ecological Community (TEC) and /or a species of plant or animal that are listed as declared rare or threatened under either state legislation or under the EPBC (Environmental Protection and Biodiversity Conservation) Act 1999. This category also indicates if the reserve contains vegetation that may be significant in supporting a listed fauna species.

Regional and local representation

In addition to a ranking based on local parameters, many City of Cockburn reserves are part of the regional conservation estate and as such require a higher level of priority. The following factors are taken into consideration:

- Local and regional significance of vegetation types and the remaining pre-European extent of those specific vegetation complexes
- Whether it is a regional park

- Whether it is a Bush Forever site
- Whether it is an EPP or Conservation Category Wetland
- Reserves are ranked higher based on meeting any of these criteria.

Education, community and passive recreation

Social values such as visibility, access and community involvement have also been considered when assessing each reserve. Greater community involvement can result in better conservation outcomes as funding from alternative sources such as grants are more likely to be forthcoming and volunteers, in the form of groups such as friends of groups, are willing to contribute labor hours to reserve management.

5 WEED MAPPING

Maps that clearly show where weeds occur in bushland are excellent management tools. In conjunction with bushland condition maps, they provide the information needed for strategic weed management. They assist with determining appropriate use of limited resources and provide information on the spread of weeds over time plus the effectiveness of control programs. Not all weeds require mapping – only those that have a serious impact on bushland such as high or medium ranked species. Weed maps are produced at regular intervals based on the high priority weed list developed by the City.

Mapping of weed species varies depending on the nature of the weeds being mapped. The mapping techniques used consist of:

• Point Mapping - scattered individuals in a small area or clumps of bulbous weeds

• Density (polygon) Mapping – scattered individuals in a large area mapped at densities of:

<5%, 6-30%, 31-60 and >60%.

Maps produced will be loaded onto the City's Geographical Information System (GIS) and shall provide a record of priority weeds and their distribution throughout selected high value conservation reserves. This mapping is undertaken annually with each reserve having a four year rotation.

Recommendation 3 : Review/re-map weed mapping every 4 years

Figure 1 Distribution of Geraldton Carnation Weed (*Euphorbia terracina*) at Coogee beach

6 PRIORITISATION OF WEED CONTROL

To achieve the best outcomes in weed management an integrated approach is desirable. Integrated weed management is the combination of social, economic and technical approaches that lead to successful outcomes at all scales (CALM 1999). Integrated weed management involves the planned use of all control options available. Approaches to environmental weed management include:

Weed led control-strategy to prevent introduction, establishment, survival and dispersal of an emerging environmental weed.

Site led control-focus on identifying areas that require weed control to maintain their ecological values.

Human resources led control- will identify weeds and particular circumstances best suited to volunteer control and those managed by professionals.

Threatened species and communities led control-this approach places the protection of threatened species and threatened communities as the highest priority.

Cause led control-approach focuses on controlling, reducing or eliminating disturbance factors that increase ecosystem vulnerability.

All approaches will consider the national, state and local strategies and priorities.

To achieve the best use of resources and to enable them to be allocated to the overall program in a structured manner, it is imperative to prioritise weed control.

Prioritisation takes into consideration:

- Weed ranking - determination of both major weeds and lesser weeds
- The condition of the reserve, its urban or rural context and biological values.
- Fire hazard: the risk of high fuel loads, for example, Veldt Grass in degraded areas or weedy perimeters that are prone to arson.
- Aesthetic values: particularly along urban edges to encourage and engender an attitude of care.
- Revegetation sites: control of weeds prior to planting and reduction of competition during the establishment stage.

In general, high-priority weeds in areas of good quality bushland are those to be controlled first. However thought should be given to medium priority weeds that may occur in small populations in a reserve and without too much effort or expense can easily be controlled. Balancing the reserve size, reserve condition, weed flora, and the budget is crucial to the process of effectively determining weed control priorities.

Patersons Curse (WONS) found in the City of Cockburn

6.1 Within Reserve Prioritization-Site led control

Site led control focuses on identifying areas that require weed control to maintain their ecological values (CALM 1999). The condition of bushland within each reserve can vary from excellent to completely degraded. The perimeters of bushland are generally in poorer condition than the rest of a reserve due to edge effects, e.g. fire breaks, other land uses. Based on the Bradley principles of bush regeneration (Bradley, 1998), it is important to work from good condition bush first to consolidate the resilience of these areas. Once these core areas have been addressed, the Bradley method recommends moving onto bushland in poorer condition.

This method is practiced whereby primary weeding efforts are focused on good bushland first.

Recommendation 4 : Focus primary weeding efforts in areas of good bushland.

6.2 Fire Hazard

Fire is an important issue in bushland management. Grass weeds contribute to increased fire risk in bushland areas and thus in order to minimize this risk, it is important to control these weeds. Grass weeds are generally prevalent on disturbed edges. While it is important to prioritize weed control efforts in good condition bushland it is also important to also diminish the fire risk. Unfortunately, if only grass weeds are controlled, it is highly likely that more aggressive and difficult-to-control weeds will invade and thus result in more costly long-term control. Fire also stimulates germination of native seeds which may be difficult to distinguish from weed germinant, as such care must be taken to ensure off target damage is reduced.

Recommendation 5 : Prioritise grass weed control where there is a threat to adjacent areas of high conservation value.

Recommendation 6 : Only control grass weeds if the bushland has the ability to naturally regenerate and out-compete the weeds or in conjunction with revegetation.

Fire episodes encourage the proliferation of weeds, often at the expense of native plants. However, during the succeeding one- to two-year period, access to the site is likely to be relatively easy with consequent easier targeting of weeds.

Recommendation 7 : Prioritise weed control within recently burnt areas, particularly during the first year after fire.

6.3 Aesthetic Values

The public interface with bushland is generally at the edges. If a bushland looks weed infested and untidy, and therefore appears uncared for, it promotes a negative public attitude. In order to engender a more positive, caring attitude to bushland reserves it is important to manage the edges, particularly for weeds.

6.4 Revegetation Sites

Due to the large soil weed seed banks in degraded areas of bushland, the success of any revegetation program through either direct seeding or tubestock installation is directly related to the effectiveness of associated weed control. Without several years of weed control prior to revegetation taking place, the results are likely to be poor due to competition.

Recommendation 8 : Do not attempt revegetation without at least one year, and preferably two years weed control.

Recommendation 9 : Commence weed control in proposed revegetation sites two years prior to tubestock planting.

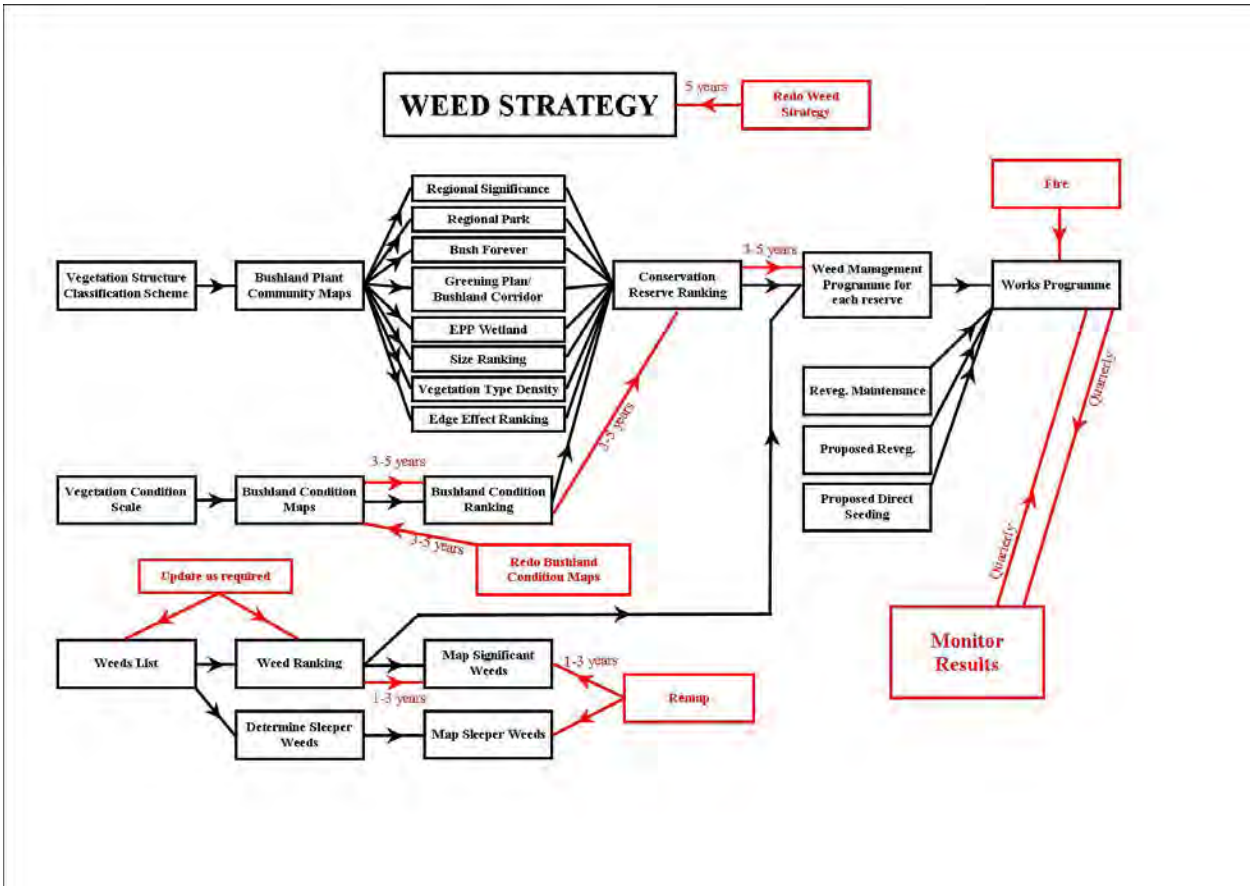


Table 2 Weed Organizational Strategy Flowchart

7 WEED CONTROL METHODS

Direct methods such as biological control, manual control, use of herbicides or indirect methods through effective land and water management can be used to control weeds. In several cases a combination of both direct and indirect methods are required for effective control. The selection of the best and most effective method depends largely on the biology of the weed species, for example, woody weeds may respond differently to bulbous weeds for a particular approach. As such it is vital that correct identification of the weed and its growth form is established prior to treatment. Controlling degrading influences that increase ecosystem vulnerability to weed invasion is in of itself a very effective method of reducing weed impact.

7.1 IDENTIFYING WEED SPECIES

It is important that before removal of weeds occurs, species are positively identified first. Some native species look very similar to introduced plants. In addition some native plants may become weeds and adequate care to minimize any off target damage to surrounding vegetation is required.

7.2 MECHANICAL/MANUAL WEEDING METHODOLOGIES

Manual and mechanical techniques such as pulling, cutting, stripping, ring barking, and stem injection may be useful to control some woody weeds, particularly if the population is relatively small.

Seedlings and small shrubs can be carefully pulled by hand, ensuring removal of the taproot. Seedlings can be distinguished by the presence of a long taproot while suckers have a hockey stick shaped end, where they have broken off the parent root.

Saplings and mature trees should not be removed using this method. The disturbance of soil structure and damage to native vegetation is counter-productive and may lead to invasion by other weeds. In addition, such disturbance of suckering species may stimulate growth from root fragments left in the soil.

Photo courtesy Bluemountains Bushcare

7.2.1 Felling and ring barking

These two techniques are suitable for trees and shrubs that do not re-sprout. The methods are labour intensive and may not be suitable for large infestations. Ring barking can be time consuming and the felling approach requires removal of branches from the site. However, on small infestations both techniques provide a simple, target specific, control option.

Ring barking involves cutting away a strip of bark, usually at least 20 mm wide, all the way around the trunk. The strip must be cut deep enough to completely severe the phloem and vascular cambium and stop the flow of plant food between the growing points of the tree. To be successful the cut MUST be around the complete circumference of the tree. (Felling the tree at the base has effectively the same result, cutting the flow of food between roots and crown.) The strip removed must be wide enough to prevent 'bridging'. A simple method is to use a chain saw to cut a continuous ring perhaps twice around the trunk. A SINGLE WIDTH cut in most species is NOT wide enough to prevent bridging.

Seedlings can be quickly slashed at ground level if not growing closely among native vegetation.

Non-sprouting shrubs, saplings and mature trees can be cut off at, or very near, ground level below any branches or dormant buds. Many non-sprouting plants have epicormal buds higher up the trunk so it is important to cut off the trunk as close to the ground as possible.

Keep in mind that surrounding vegetation can be damaged when trees and large shrubs are felled, and as branches are carried out.

7.2.2 Cut and paint

Cut and paint is a target-specific method, suitable for any small trees and shrubs that re-sprout. Successful control requires careful application - it is essential to apply the herbicide such a Glyphosate IMMEDIATELY to cut stumps. If delayed, the tree seals the wounded stump, preventing absorption of the herbicide. Large trees and shrubs may need to be cut down sequentially to avoid injury to workers and damage to the surrounding bush (or left standing and treated by stem injection.) Cut down the plant until one metre of trunk remains above the ground. With herbicide ready, cut the remaining trunk off close to ground level (+-100mm), apply herbicide immediately to the stump.

Shrubs and small trees can be treated by felling the plant close to ground level (+-100mm) and immediately painting the exposed stump with a systemic herbicide. The entire surface of small stems can be painted using a paintbrush or sponge applicator. On larger stems, focus on the outer ring of wood containing the phloem, xylem and vascular cambium.

7.2.3 Stem Injection

One of the easiest ways to kill trees and large shrubs is to drill holes into the trunk and inject herbicide.

8-10mm diameter holes should be drilled around the circumference of the tree or shrub at a spacing of no greater than 100mm, at an angle of between 45^0 and 60^0 down into the sapwood, to a depth of 40-50mm. Immediately fill the hole with undiluted herbicide. The more herbicide that is injected, the greater the chance of success. If the plant is actively transpiring, it may be possible to refill the hole(s) with herbicide several times within a half-hour period. Multi-stemmed shrubs or trees will usually require at least one hole per stem. Some plants (e.g. *Acacia longifolia*) do not seem to be able to translocate the herbicide sideways and sometimes only half the plant dies. With such plants, the problem can be overcome by DECREASING the spacing between holes to 50-75mm.

7.2.4 Weed Disposal

There is some debate as to the merit of removing or not removing weeds from site. Decomposition of weeds adds to the nutrient load in soils that are naturally nutrient-poor thus assisting the growth of weeds to the detriment of native plants. However in wetlands, where there are naturally higher levels of nutrients, it may be more productive to leave in situ.

ALWAYS remove weeds with seeds e.g. Victorian Tea tree, Inkweed, Castor Oil.

Remove all other weeds if practicable.

Do NOT pile weeds in heaps

Piling weeds into neat, easy-to-carry heaps makes sense in a conventional garden, but it is bad practice in the bush. Heaps of soft weeds rot down into a nutrient-rich mess that is quite the wrong environment for natives, and there is a very good chance that some weeds will re-root and flourish.

Woody weeds in piles are tedious to untangle when, as they often do, some of their seedlings grow up through the heaps.

So, disperse what you uproot. The soft weeds will quickly dry out and the woody ones will not get in your way during follow-up.

Some weeds can be mulched but this should not be done were it is likely that seeds will remain viable and germinate.

When working in areas infested with Caltrop (*Tribulus terrestris*) during the summer months, check and clean all tyres of seeds before leaving the site, or before moving to another portion of the site. NB. Do not forget to roll the vehicle forwards a few inches to check the underneath portion of the tyres.

7.3 HERBICIDES

A number of important principles affect the performance of herbicide on weeds and on the surrounding environment.

The type of herbicide used is also important. Try to identify the most appropriate herbicide for a specific task. The Department of Agriculture and Food and other local authorities can be a good source of information. There are also a number of books that also provide advice. These include Bushland weeds (Brown et al) and Western Weeds (Hussey et al).

Make sure you apply the correct rate of herbicide. Regularly calibrate the spray equipment, and check the output of the nozzles particularly after using abrasive chemicals. Nozzles wear out, and should be replaced regularly if their output is more than 5 per cent above or below the correct output. It is also important to check at regular intervals that each nozzle is distributing spray evenly.

Spray as evenly as possible at all times. This is particularly important when spot spraying.

Spray in light wind conditions if possible. This ensures that as much herbicide as possible reaches the target plants, and minimises the danger of drift on to non-target vegetation.

Spray weeds at the correct size or stage of growth

Spray weeds when they are actively growing. This will ensure maximum uptake and translocation of the herbicide. Weeds should not be sprayed when they are under stress, either through lack of water (drought), too much water (water logging), disease, insect or mechanical damage.

Avoid spraying when it's raining or likely to rain. Herbicide may be washed off the leaves before it can be absorbed. A 'rule of thumb' is that at least 30 minutes is required after spraying for the herbicide to be absorbed.

Do not apply a higher volume than necessary. Contact herbicides need to thoroughly wet the weed, to the point of run-off. Translocated herbicides such as Glyphosate, Metsulfuron Methyl,

and Fluazifop do not need such thorough coverage. Desirable coverage for translocated herbicides is between 50% and 80% of leaf area.

Do not use more surfactant (wetting agent) than is recommended, otherwise too much spray mix may run off from the leaf surface. Moreover, it may cause the spray to form large amounts of foam in the spray tank, leading to difficulties in application.

Do not apply at a higher pressure than you need to obtain good coverage of the plant. High pressure may generate excessive numbers of small droplets in the spray, which increases the danger of mist drifting on to non-target plants, and increases the hazard to the operator.

The City in 2009 trialed an innovative approach to *Typha orientalis* control using an aerial herbicide application. This process appeared very successful but requires resourcing and planning, including follow up treatment.

7.4 Weed Introduction and Dieback Control

Weeds may be introduced into a natural area through the movement of soil. All construction material must be inspected before bringing on to site, particularly limestone, for weed seed and only acquire from accredited clean sources. Black Flag (*Ferraria crispa*), Geraldton Carnation Weed (*Euphorbia terracina*) have been introduced to various bushland sites around Perth in construction materials.

Avoid bringing soil or mulch from elsewhere into bushland. This can be the greatest potential source, not only of weed seeds, but also pathogens such as *Phytophthora cinnamomi* (Dieback).

Always practice correct Dieback hygiene procedures when working in bushland.

7.5 FAUNA AND WEEDS

Some weeds can provide habitat or an opportunistic food source for native animals. A list of the known fauna in a bushland can help determine this at a particular site. Removal of such weeds should be staged in conjunction with a complimentary revegetation program.

Examples of weeds being used by native fauna include Bandicoots using Kikuyu, *Pennisetum clandestinum*, at Little Rush Lake and water birds using *Typha orientalis*, at Bibra Lake (CALM 2001).

7.5.1 Weed Spread by Fauna

Weeds may continue to be introduced into a natural area even though control is occurring through fauna. Weeds as discussed previously do provide some habitat and foraging value for a variety of fauna species. Birds and other animals will continue to reintroduce seed of plants with fleshy fruits from surrounding areas, such as Olive, Fig, Japanese Pepper and Bridal creeper. Rabbits also can encourage the spread of weeds through eating seed of non-native plants and dispersing them through their scats.

Recommendation 10 : Control feral pests to reduce the spread of weeds

8 THE ROLE OF COMMUNITY IN WEED CONTROL

Part of the solution to managing weeds in Western Australia is raising public awareness of the causes and appropriate responses to the problem.
Often people are not aware of the impact that weeds have on the natural environment and primary production or that they may be contributing to the problem through their own actions, for example, dumping weed-infested garden refuse in bushland or by distributing weed seeds by vehicles, animals and produce.

Community involvement can greatly contribute to the successful management of weeds in natural areas (CALM 2001). A growing number of community members are contributing to awareness and control of weeds through on ground action such as being part of a “Friends of” group or providing resources such as grants which can be otherwise limited. The City of Cockburn is developing a weed brochure to help inform community members about significant weeds within the City and to provide information on how to control them. In addition the City works with volunteer and “Friends of” groups to implement weed management strategies.

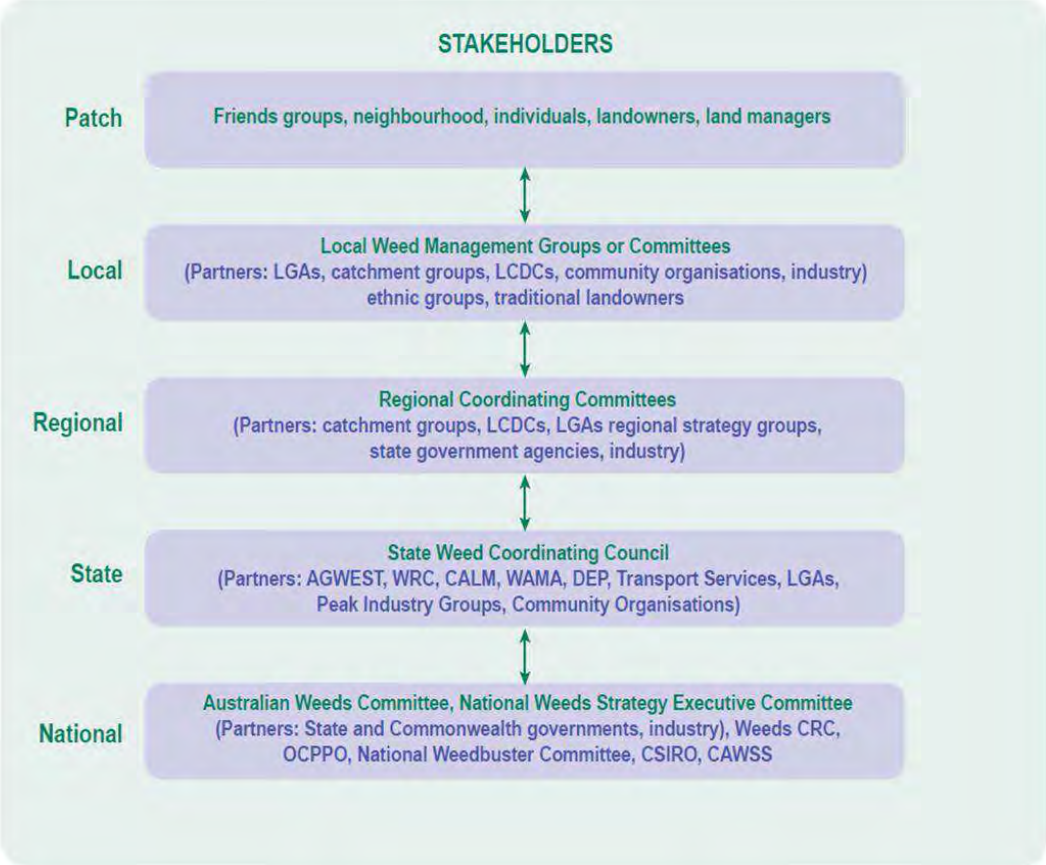


Table 3. Stakeholder flowchart (Dept Agriculture 2001)

Recommendation 11 : Undertake a community education campaign to inform residents of the harm caused by weed invasion

Community groups do require training or supervision when undertaking methods of weed control to ensure safe work practices are adhered to and no off target damage is incurred. Largely herbicide use by community volunteers should be limited and professional expertise in addition to community involvement is often required.

9 MONITORING

Monitoring of the success of weed control will be achieved through regular weed mapping within the City's reserves (e.g every 4-5 years). Where weeds are shown to have increased their distribution assessment and revision of current control methods will occur.

Where new populations or individuals of weeds ranked as high or medium priority have been recorded steps will be taken to ensure outbreaks are eliminated as soon as possible.

Monitoring quadrats will be established within specific locations where outbreaks of particularly invasive species have occurred to ensure that these populations are controlled effectively. In addition visual observations undertaken opportunistically can also inform management responses.

As part of the vegetation mapping that occurs regularly the loss of condition within a bushland will be closely linked to weed invasion and as such threatening process which may reduce the integrity and condition of vegetation within reserves will be assessed and mitigated where possible.

Photo monitoring of reserves also occurs on a regular basis (annually).

9.1 Revegetation Sites

It is important to maintain ongoing weed control in revegetation sites post planting.

As soil has been disturbed from the planting process and there is good moisture available large amounts of weed germination tends to accompany planting. Where tree guards have been used maintenance of tree guards including hand weeding within the guard will require additional resources.

7 – 10 days after the first spray, check for effectiveness of initial work. Re-spray if necessary. The effect of the herbicide should start to appear within a few days so revisiting a site after 7 days means that previously sprayed weeds are quite obvious and it becomes easier to target those missed previously.

During winter and spring, inspect sites every 3-5 weeks for ongoing germinants. Spray if necessary. Control of weed germinants is easiest when plants are small, however, spraying too soon is inefficient as weed seeds may continue to germinate after spraying. However, it is imperative that spraying occurs before seed set.

During summer and autumn, inspect every 4-8 weeks for summer germinating weeds.

9.2 Woody weeds

Inspection of most woody weed sites is best done during flowering when it's easier to recognise plants. It also allows sufficient time to effect removal before seed set.

For Broad-leaved Paperbark (*Melaleuca quinquinerva*), Mindiyed (*Melaleuca nesophila*), Sydney Golden Wattle (*Acacia longifolia*) and Victorian Teatree (*Leptospermum lavegatum*), inspect all mapped locations biennially, and record observations on a weed map. For Sydney Golden Wattle, continue for ten years after the last seed set.

Inspect mapped locations of Edible Fig and Japanese/Brazilian Pepper within one year of removal to identify and treat suckers.

Inspect mapped locations of Castor Oil Plant twice during the year; once in Aug/Sep and once in Jan/Feb to ensure prevention of seed set. Continue site inspections for four years after the last seed set.

9.3 VELDT GRASS

Timing for Veldt Grass spraying is crucial; too early, and ongoing rains will result in late germination and these plants will flower and set seed. Too late and, whilst seed set is prevented, dormant buds in the crown are not killed. Consider undertaking two controls during the season. The first the first germinates are developing seed heads and the second 4- 6 weeks later.

In April compile plans for veldt grass spraying that include:

Blanket spray of previous areas that have been blanket sprayed once. (2^{nd} year of a 2-year blanket spraying program)

Spot spray of previous areas that have been blanket sprayed twice. (To pick up individual plants germinating from the soil seed bank)

Spraying of new areas based on mapping of current occurrences of veldt grass.

Undertake checks from late June to mid August to identify 'boot' stage. Then request spraying to commence.

Inspect spraying within 24 hrs to ensure complete cover. Request additional spraying if areas have been missed.

Inspect one to two weeks after spraying to ensure kill has been achieved. Request follow-up spraying if areas have been missed. However sometimes this can be a pointless exercise as seeds have already developed.

Assess areas for a second spray in late August.

9 GLOSSARY

Boot Stage: Growth stage when a grass inflorescence is enclosed by the sheath of the uppermost leaf.

Declared Plant: (DP) means a plant 'declared' by the Agriculture Protection Board under the Agriculture and Related Resources Protection Act 1976. If a plant is declared, all landholders are obliged to control that plant on their properties. Declarations specify a category, or categories, for each plant according to the control strategies or objectives that the Agriculture Protection Board believes are appropriate in a particular place. e.g. Salvinia, *Salvinia molesta* and Water Hyacinth, *Eichhornia crassipes* are both declared plants, category P2, which requires the landowner to complete eradicate infestations. One Leaf Cape Tulip (*Moraea flaccida*) is declared category P1, which requires the landholder to prevent infestation spreading beyond existing boundaries of infestation.

Edge Effect: When an edge is created to any natural ecosystem, and the area outside the boundary is a disturbed or unnatural system, the natural ecosystem is seriously affected for some distance in from the edge. In the case of a forest where the adjacent land has been cut, creating an openland/forest boundary, sunlight and wind penetrate to a much greater extent, drying out the interior of the forest close to the edge and encouraging rampant growth of opportunistic weedy species at the edge.

Endemic: Native to and restricted to a particular geographical region e.g. Mindiyed, *Melaleuca nesophila*, is endemic to the south coast of WA near Bremer Bay.

Indigenous: Originating and living or occurring naturally in an area or environment, not exotic; not imported. E.g. Broad-leaved Paperbark, *Melaleuca quinquenervia*, is indigenous to eastern Australia.

Pest Plant: (PP) means a plant declared to be a pest plant, in relation to a district, prescribed by local laws made by a local government in that district. Caltrop, *Tribulus terrestris*, is a prescribed Pest Plant in the City of Cockburn.

Seed set: the formation of mature fruits with viable seeds. To produce seeds after flowering.

Sleeper Weeds: 'Sleeper weeds' are plants that are just waiting to go feral. They possibly have not yet invaded the environment but have the potential to do so. Plants that have had a limited distribution for years may suddenly become environmental weeds. This can be caused by: changing climatic conditions; presence of a pollinator; presence of a vector (spreader); changes in horticultural or agricultural practices. E.g. Bridal Creeper – became feral recently after having been cultivated in the Wheatbelt for years, and Freesia – recently recognised as a serious weed after years of apparently limited distribution.

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APPENDIX 1: PRIORITY WEEDS WITHIN THE CITY OF COCKBURN

High Priority	
Scientific Name	Common Name
Acacia longifolia	Sydney Golden Wattle
Asparagus asparagoides (DP,WONS)	Bridal Creeper
Asphodelus fistulosus	Onion Weed
Chasmanthe floribunda	African Cornflag
Cortaderia selloana	Pampas Grass
Cynodon dactylon	Couch grass
Echium plantagineum (DP)	Paterson's Curse
Ehrharta calycina	Perenial Veldt Grass
Ehrharta villosa	Pyp Grass
Eragrostis curvula	African Lovegrass
Euphorbia paralias	Sea Spurge
Euphorbia terracina	Geraldton Carnation
Ferraria crispa	Black Flag
Freesia hybrid	Freesia
Fumaria bastardii	
Fumaria capreolata	Climbing Fumitory
Fumaria muralis	Wall Fumitory
Hyparrhenia hirta	Tambookie Grass
Juncus acutus	Spiny Rush
Lachenalia reflexa	Yellow Soldiers
Leptospermum laevigatum	Victorian Tea Tree
Moraea flaccida (DP)	One-Leaf Cape Tulip
Oxalis pes-caprae	Soursob
Pelargonium capitatum	Rose Pelargonium
Pennisetum clandestinum	Kikuyu
Pennisetum setaceum	Fountain Grass
Rubus discolour (DP, WONS)	Blackberry
Stenotraphum secundatum	Buffalo
Tetragonia decumbens	Sea Spinach
Thinopyrum distichum	Sea Wheat
Trachyandra divaricata	Dune Onion Weed
Tribulus terrestris	Caltrop
Typha orientalis	Typha, Bulrush
Watsonia bulbilifera	Watsonia
Zantedeschia aethiopica (DP)	Arum Lily

Medium Priority	
Scientific Name	Common Name
Arundo donax	False Bamboo
Brassica tournefortii	Mediterranean Turnip
Carpobrotus edulis	Pigface
Cirsium vulgare	Spear Thistle
Cyperus spp	Nutgrass/ Dense Flat Sedge/ Umbrella Sedge
Ehrharta longflora	Annual Veldt Grass
Ehrharta villosa	Pyp Grass
Ficus carica	Edible Fig
Foeniculum vulgare	Fennel
Gazania linearis	Gazania
Gomphocarpus fruticosus (DP)	Narrow Leaf Cotton Bush
Lupinus cosentinii	Sandplain Lupin
Nicotiana glauca	Tree Tobacco
Olea europea	Olive
Opuntia stricta (DP)	Prickly Pear
Phytolacca octandra	Inkweed
Raphanus raphanistrum	Wild Radish
Ricinus communis	Castor Oil
Schinus terebinthifolia	Japanese/Brazilian Pepper
Solanum linnaeanum	Apple of Sodom
Symphyotrichum subulatum	Bushy Starwort
Tagasaste	

Low Priority	
Scientific Name	Common Name
Agave americana	Agave or Century plant
Conyza bonariensis	Flaxleaf Fleabane
Dittrichia graveolens	Stinkwort
Malva parviflora	Marshmallow
Melaleuca nesophila	Mindiyed
Melaleuca quinquenervia	Broad-leaved paperbark
Narcissus tazetta	Jonquil (Narcissus)
Pteridium esculentum	Bracken

APPENDIX 2: WEED RANKING WITHIN CITY OF COCKBURN

		Weed Ranking			
Weeds species	Common Name	Dixon/ Keighery 1995	Ecoscape 1998	Proposed new	Comments
Acacia longifolia	Sydney Golden Wattle	Minor	Mod	High	Has 8 to 10-year seed viability, can produce a monoculture after fire
Asparagus asparagoides	Bridal Creeper	Major	High	High	
Cortaderia selloana	Pampas Grass	Major	High	High	
Cynodon dactylon	Couch grass	Major	Mod	High	
Ehrharta calycina	Perenial Veldt Grass	Major	High	High	
Eragrostis curvula	African Lovegrass	Major	High	High	
Euphorbia terracina	Geraldton Carnation	Major	High	High	A serious weed but control is difficult and very labour intensive
Freesia hybrid	Freesia	Major	High	High	
Hyparrhenia hirta	Tambookie Grass	Major		High	Currently has limited distribution. Worth attempting to eradicate before it spreads more
Juncus acutus	Spiny Rush	Nuisance		High	Totally replaces Baumea juncea and Juncus kraussii sedgelands
Leptospermum laevigatum	Victorian Tea Tree	Major	High	High	
Melaleuca nesophila	Mindiyed			High	Forms dense thickets after fire
Moraea flaccida	One-Leaf Cape Tulip	Major	High	High	Declared Plant' category P1. A serious weed but control is very labour intensive
Opuntia stricta	Prickly Pear			High	Not a serious weed in CoC but difficult to control once established
Pelargonium capitatum	Rose Pelargonium	Major	High	High	A serious weed but control is very labour intensive
Pennisetum clandestinum	Kikuyu	Major	Mod	High	
Pteridium esculentum	Bracken		Mod	High	Limited distribution but is slowly spreading. Allelopathic affect 'kills' many natives.
Rubus discolor	Blackberry	Major		High	eradicated?
Stenotraphum secundatum	Buffalo	Major	Mild	High	
Tetragonia decumbens	Sea Spinach	Minor	Mod	High	Totally smothers natives
Tribulus terrestris	Caltrop			High	"Pest Plant" - occurs on disturbed edges
Typha orientalis	Typha, Bulrush	Major	High	High	
Watsonia spp	Watsonia	Major		High	
Zantedeschia aethiopica	Arum Lily	Major	High	High	
Arundo donax	False Bamboo	Nuisance	Low	Med	Suckers, and can produce dense thickets in damp areas
Brassica tournefortii	Mediterranean Turnip	Minor	High	Med	A serious weed but mostly of disturbed sites. Suggest control along path edges
Carpobrotus edulis	Pigface	Nuisance	Mod	Med	
Chasmanthe floribunda	African Cornflag	Minor	Mod	Med	
Cirsium vulgare	Spear Thistle	Minor	Mod	Med	
Cyperus spp	Nutgrass/ Dense Flat Sedge/ Umbrella	Nuisance	Mod	Med	Difficult to control.
Ehrharta longflora	Annual Veldt Grass	Minor	Mod	Med	
Ehrharta villosa	Pyp Grass	Minor	Mod	Med	Currently only at CY O'Connor Reserve
Ferraria crispa	Black Flag	Nuisance	Mod	Med	Difficult to control. Currently has limited distribution. Worth attempting to eradicate before it spreads more
Ficus carica	Edible Fig	Major	Mod	Med	
Foeniculum vulgare	Fennel	Nuisance	Mod	Med	
Gomphocarpus fruticosus	Narrow Leaf Cotton Bush	Minor	Mod	Med	
Lupinus cosentinii	Sandplain Lupin	Major	Mild	Med	A serious weed of disturbed sites
Olea europea	Olive	Minor	Mod	Med	
Pennisetum setaceum	Fountain Grass	Minor	Mild	Med	
Phytolacca octandra	Inkweed	Minor	Mild	Med	
Raphanus raphanistrum	Wild Radish	Minor	Mild	Med	A serious weed but mostly of disturbed sites. Suggest control along path edges
Ricinus communis	Castor Oil	Minor	Low	Med	Long seed viability
Schinus terebinthifolius	Japanese/Brazilian Pepper	Minor	Mod	Med	Forms dense growth that shades out natives
Solanum linnaeanum	Apple of Sodom	Minor	Mod	Med	"Declared Plant"
Symphyotrichum subulatum	Bushy Starwort	Minor	Mod	Med	
Agave americana	Agave or Century plant	Minor	Low	Low	
Conyza bonariensis	Flaxleaf Fleabane	Minor	Low	Low	
Dittrichia graveolens	Stinkwort	Minor	Mild	Low	
Echium plantagineum	Paterson's Curse	Minor		Low	Declared Plant' category P1. Currently has limited distribution. Worth attempting to eradicate before it spreads more
Malva parviflora	Marshmallow	Minor	Low	Low	
Melaleuca quinquenervia	Broad-leaved paperbark			Low	
Narcissus tazetta	Jonquil (Narcissus)		Low	Low	
Nicotiana glauca	Tree Tobacco	Minor	Mild	Low	

APPENDIX 3: LIST OF WEEDS OF NATIONAL SIGNIFICANCE

Appendix 3. Inaugural List of Weeds of National Significance

Common Name	Scientific Name
alligator weed	*Alternanthera philoxeroides*
athel pine	*Tamarix aphylla*
bitou bush / boneseed	*Chrysanthemoides monilifera*
blackberry	*Rubus fruticosus* agg.
calomba	*Calomba carolinana*
Chilean needle grass	*Nassella neesiana*
gorse	*Ulex europaeus*
hymenachne	*Hymenachne amplexicaulis*
lantana	*Lantana camara*
mesquite	*Prosopis* spp.
mimosa	*Mimosa pigra*
Parkinsonia	*Parkinsonia aculeata*
parthenium weed	*Parthenium hysterophorus*
pond apple	*Annona glabra*
prickly acacia	*Acacia nilotica* spp. *indica*
rubber vine	*Cryptostegia grandiflora*
salvinia	*Salvinia molesta*
serrated tussock	*Nassella trichotoma*
Willows except weeping willows, pussy willow and sterile pussy willow	*Salix* spp. except *S. babylonica* *S. x calodendron* and *S. x reichardtii*

Additional List of Weeds of National Significance – April 2012

Common Name	Scientific Name
African boxthorn	*Lycium ferocissimum*
Sagittaria	*Sagittaria platyphylla*
Asparagus weeds	*Asparagus aethiopicus, A. africanus, A. asparagoides Western Cape form, A. declinatus, A. plumosus* and *A. scandens.* Includes *original WoNS Asparagus asparagoides* Excludes *A. officinalis* and *A. Racemosis*
Bellyache bush	*Jatropha gossypiifolia*
Brooms	
Scotch	*Cytisus scoparius*
Montpellier	*Genista monspessulana*
Flax Leaf	*Genista linifolia*
Cat's claw creeper	*Macfadyena unguis-cati*
Fireweed	*Senecio madagascariensis*
Gamba grass	*Andropogon gayanus*
Madeira vine	*Anredera cordifolia*
Opuntioid cacti	*Opuntia* spp. (excludes *O. ficus-indica*), *Cylindropuntia* spp., *Austrocylindropuntia* spp.
Silverleaf nightshade	*Solanum elaeagnifolium*
Water hyacinth	*Eichhornia crassipes*

Appendix 3
Capital Works: Opinion of Probable Cost 2015/2016 – 2019/2020

BIBRA LAKE LANDSCAPE, RECREATIONAL AND ENVIRONMENTAL REDEVELOPMENT OPC

RECOMM	ZONE	CAPITAL WORKS ITEMS	2015/16	2016/17	2017/18	2018/19	2019/20	COST
1.0		**RETAIN AND ENHANCE NATURAL ENVIRONMENT**						
	A9	Revegetation - South Education Zone						$ -
	A6	Revegetation - west Education zone		120,000				$ 120,000.00
	A11	Revegetation - central conservation zone		300,000				$ 300,000.00
	A17	Rehabilitation - Progress Drive west			120,000	10,000		$ 130,000.00
	A8	Revegetation - east Education zone			100,000			$ 100,000.00
	A11	Revegetation - central conservation zone			150,000			$ 150,000.00
	A10	Revegetation - north east Conservation zone				250,000	200,000	$ 450,000.00
	A1	Rehabilitation - Hope Road North				150,000		$ 150,000.00
	A2	Rehabilitation - Hope Road North					150,000	$ 150,000.00
3.0		**RECREATIONAL FACILTITIES**						
	C2	New adventure playgroun						$ -
	C2	Lake edge treatmen						$ -
	C2	Parkland lake edge promenade - Progress Driv			300,000			$ 300,000.00
	C2	BBQ facilities x 12		60,000				$ 60,000.00
	C2	Signage x 6		30,000				$ 30,000.00
	C2	Bike Racks x 20		20,000				$ 20,000.00
	C2	Rubbish Bin surround and wheelie bin x		30,000				$ 30,000.00
	C2	Artwork x 6		120,000				$ 120,000.00
	C2	Themed arbours x 4		200,000				$ 200,000.00
	C2	Feature Lighting x 2					130,000	$ 130,000.00
	A11	Bond Swamp - Gazebo in open outdoor function area					60,000	$ 60,000.00
	B1	Adventure playground - opposite Primary Schoo					100,000	$ 100,000.00
	B1	BBQ facilities x 3 opposite Primary School					15,000	$ 15,000.00
	B1	Table settings x 3 opposite Primary Schoo					24,000	$ 24,000.00
	B1	Upgrade WC facility opposite Primary School					50,000	$ 50,000.00
	B1	Shade trees x 300 opposite Primary Schoo					15,000	$ 15,000.00
	B1	Irrigated lawn areas opposite Primary Schoo					75,000	$ 75,000.00
	C2	New WC facility		300,000				$ 300,000.00
	A17	Gazebo - Progress Dr west		50,000				$ 50,000.00
	A17	Lookout Ave - Progress Dr west		50,000				$ 50,000.00
	B2	Dog Park - Toilet Facilitties					300000	$ 300,000.00
	B3	Exercise Circuit - Dogs			100000			$ 100,000.00
	B2	Dog Park development			300000			$ 300,000.00
	B2	Adoloscent play node/skate park					300,000	$ 300,000.00
	C2	New visitors centre / Aboriginal CC - Parkland zon				4,000,000		$ 4,000,000.00
	C2	Entry statements - parkland zon				400,000		$ 400,000.00
4.0		**ACCESS NETWORK**						
	C1 & A16	Progress Drive upgrade	750,000					$ 750,000.00
	A8	Stabilised limestone paths - east Education zon					12,000	$ 12,000.00
	A11	Lookout - central Conservation zone					20,000	$ 20,000.00
	A11	Artists node - south central Conservation zon					50,000	$ 50,000.00
	C2	Boardwalk steel - Parkland zon					75,000	$ 75,000.00
	A17	Stabilised limestone paths - Progress Dr wes					60,000	$ 60,000.00
5&6		**EDUCATIONAL & CULTURAL INTERPRETATION**						
	A11	Interpretative signage - central Education zon			5,000			$ 5,000.00
	A1 & A2	Signage - Hope Road north			20,000			$ 20,000.00
	A3	Entry Statements			70,000			$ 70,000.00
	A17	Interpretative signage - Progress Dr wes			20,000			$ 20,000.00
	A16	Interpretative signage - Aboriginal Heritag			30,000			$ 30,000.00
	A9	Interpretive signage along pathway					30,000	$ 30,000.00
	A12	Interpretive signage - west Conservation zon					5,000	$ 5,000.00
	A13	Interpretive signage - central Conservation zon					10,000	$ 10,000.00
	A14	Interpretive signage - south east Conservation zon					10,000	$ 10,000.00
		SUB-TOTAL (all items)	$ 750,000.00	$ 1,280,000.00	$ 1,215,000.00	$ 4,810,000.00	$ 1,691,000.00	$ 9,746,000.00
		Contingency (3%)	$ 22,500.00	$ 38,400.00	$ 36,450.00	$ 144,300.00	$ 50,730.00	$ 241,650.00

	WORKS TOTAL (inc. Contingency	**$ 772,500.00**	**$ 1,318,400.00**	**$ 1,251,450.00**	**$ 4,954,300.00**	**$ 1,741,730.00**	**$ 8,296,650.00**

Appendix 4
Landscape Style Guide

BIBRA LAKE REDEVELOPMENT
STYLE MANUAL

Created By

PLAN E

CONTENTS

Front Cover Image: Bibra Lake Redevelopment - Masterplan rev A

1.1 Pavement

- Materials will reflect the hierarchy of each Pathway.
- Pavement Type A: Red Asphalt with Timber edging.
- Pavement Type B: Crushed Limestone with Timber edging.
- Pathways are to be a minimum of 2000mm and maximum of 3000mm.
- Distance indicators will be placed at 500m intervals along the path, to allow measured running tracks around the lake. Indicators are to take form as insets into pavement and can form part of the integrated artworks brief.(See 6.1)

Pavement Type A

Pavement Type B

Materials selected in reference to the City of Cockburn Landscape Guidelines.

1.2 Decking

- Combination of Jarrah wood and galvanised steel.
- Materials to be of high quality, durable and sourced from sustainable sources.
- Height and length of boardwalks and decking to take into account the varying levels of water in Bibra Lake. Opportunity to incorporate floating elements to allow access to the water regardless of depth variation throughout the year.

Decks enhance the wetland character by providing pedestrian access that is complementary to the ecologies of the site.

2.1 Seating / Tables

- Furniture is to be durable, reflect the theme, material and colour palette of the precinct and provide sufficient amenity.
- The base range will be off the shelf products that suits the style and environment of Bibra Lake.

Furniture is to be a combination of aluminium and Duraslat. Duraslat is a wood/ plastic composite product which offers a more sustainable, resilient and comfortable product then more traditional timber or aluminium slats.

Botton and Gardiner: Bench Seat Curved Radial Duraslat
BS1CR.20.DS.PL
For use in Pedestrian Promenade

Botton and Gardiner: Bench Seat 4.5 Duraslat with Armrests : BS4.5a DS
For use in individual seating nodes.

Botton and Gardiner: Alfresco Dining Setting
AT.18.MR.U.PL with Duraslat.

Botton and Gardiner:
Urban Seat 5.5 DuraSlat US5.5aDS
For use in individual seating nodes where back support is required.

Nb. All Duraslat is to be Redwood colour.

The natural materials and robust forms of the furniture in the public realm are complementary to the ecological and cultural heritage of the site.

2.2 Other

- Furniture is to be durable, reflect the theme, material and colour palette of the precinct and provide sufficient amenity.
- Products such as bins, bike racks and water fountains are to be chosen to compliment the overall theme without making the site too busy of cluttered.

  Furniture is to be a combination of aluminium and Duraslat. Duraslat is a wood/ plastic composite product which offers a more sustainable, resilient and comfortable product then more traditional timber or aluminium slats.

Botton and Gardiner: Mobile Garbage Bin Housing in Aluminium - Recyclable MGBHHAL REC
This version has the capacity to hold two Wheelie-bins and incorporates signage for recycling facilities. For use in highly populated areas. A single bin enclosure is recommended for lesser used areas. .

Street Furniture Australia: Fountain Head fountain powder coated silver.
For use in all areas, opportunity to attach water collecting bowl at bottom of fountain to allow run off water to be collected for dogs. This application would be used near the dog park.

Street Furniture Australia: Semi-hope bike stand, Stainless Steel.

2.3 Custom Furniture

- Custom furniture provides the opportunity to create a series of furniture that will highlight the themes and material palette of the precinct. Like artwork, custom furniture will create a unique style for the Bibra Lake Precinct.
- Custom furniture can be designed with the combined skills of a landscape architect, furniture designer and artist and should be considered after the theme and layout of a specific area has been finalised. This ensures the custom furniture will compliment and enhance a space rather then confuse or fragment an area.

Some examples of custom furniture from other projects.

3.1 Parkland Lighting

- Custom lighting will be required in some areas to allow use of facilities at all hours as well as to provide passive security..
- The range chosen provides effective lighting,, that is vandal resistant, designed for it's intended purpose and built with high quality fixtures. The range will also aesthetically compliment other features of the site.

We-ef Wall luminaire - DLB259/359
For use on facilities such as toilet blocks, buildings and walls. To highlight pathways, entry points and provide passive security from vandals.

We-ef Inground luminaire.ESC-130-140
Used to highlight art works, trees and features.

Bega Pole Top luminaire - 9587
For use to light pathways, parklands, play grounds and areas requiring passive security.

Lighting is to enhance significant natural and cultural features within public open space areas and provide a safe pedestrian environment at night throughout all areas of the public realm.

4.1 Shelters and Arbors

- Materials to reflect those used in the rest of the site.
- Incorporate theming of site with the use of integrated artworks.
- Use of high quality materials that are both durable and sustainable.
- Structures will reflect unique styling of Bibra Lake and form landmarks for the Cockburn community.

Examples of Shelters and Arbors

5.1 Retaining Walls and Fences

- Retaining walls will be constructed of limestone blocks, reflecting the existing and proposed colour palette.
- Fences will function to separate some activities such as at the dog park and the flood mitigation site as well as restricting access to areas for reasons such as safety and to preserve high quality bushland.
- Fencing Type A, for use around the dog park - 1.2m high Black chainlink fence.
- Fencing Type B, for use around Water mitigation Site - 1.6m high colorbond fencing in cool ridge.

  Fencing Type C, for use in directing pedestrian traffic and restricting access to conservation areas - Timber Structure with steel cable running throughout.

Limestone Retaining Wall

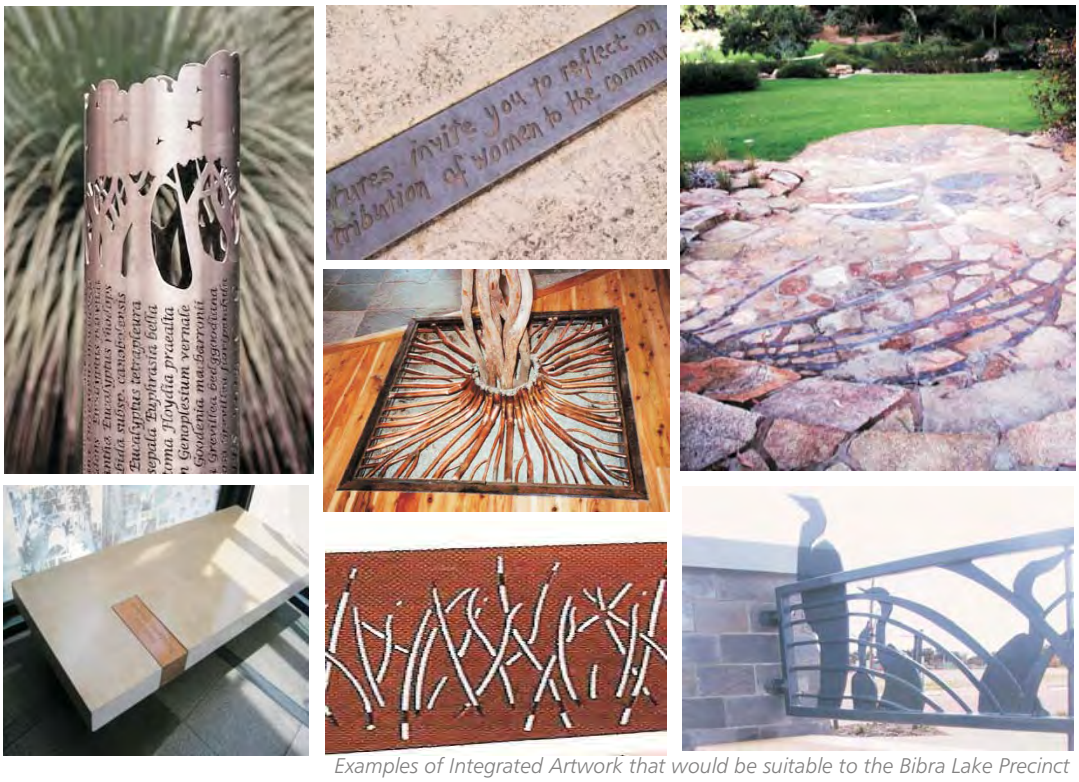
Fencing Type B

Fencing Type A

Fencing Type C

61 Integrated Artworks

- Opportunity to be integrated with the built forms and structures.
- Integrated artworks are important in creating a unique 'sense of place'.
- Artworks are to follow the design philosophy, colour and materials palette nominated for the development.
- An artist co-ordinator is to be engaged to manage all artworks in the Bibra Lake precinct to ensure a cohesive theme is maintained.



Examples of Integrated Artwork that would be suitable to the Bibra Lake Precinct

Integrated artworks are to enhance the site character and use locally occurring materials to integrate significant natural and cultural features into the public realm.

6.2 Sculptures / Feature Works

- Artworks will be a key tool in creating a pedestrian scale within the site.
- Artworks are key to creating a 'sense of place' in the site which reflects the values and ideologies of the development.
- Artworks are to follow the design philosophy, colour and materials palette nominated for the development.
- An artist co-ordinator is to be engaged to manage all artworks in the Bibra Lake precinct to ensure a cohesive theme is maintained.






Feature artworks are incorporated to add life and scale to public areas. Artworks aid in giving the site character and will help to orientate visitors.

7.1 Information and Interpretive Signage

- Informative and interpretive signs to be located at sites of significance.
- Signs are to complement park furniture, walls and built forms and comprise materials identified in the materials and colour palette.
- Signage will be a mix of written and symbolic elements combined with a simple colour palette to create a holistic scheme that allows for easy navigation of significant sites within the development; such as educational walks, sites of historical significance and areas where instructional information is required.
- Signage is to reflect the Department Environment and Conservation (DEC) design recommendations for signage. Signage style to be confirmed on release of DEC signage style guide.
- There will be four styles of signage in the Bibra Lake precinct that will address all aspects and requirements of directing visitors around the lake. The four styles will incorporate Informational/Instructional, Educational, Directinal and Identification. Each type of sign will have an individual style that shall remain consistent throughout the precinct.

Informational / Instructional
Will combine images with text and will be used in situations such as giving instruction on using recreational equipment, providing information on enviromental projects and giving times and dates for tours or events.

Directional
Providing clear and concise directions around the precinct these signs will use a combination of symbols and text.

Identification
Using bold texts in easy to read fonts these signs will clearly identify buildings, zones and ecological features for visitors.

Educational
Using a combination of sculpture, text, imagery and interactive components educational signage will encourage visitors to learn more about the Bibra Lake sites history, eco-systems and recreational opportunities.

7.2 Entry Signage

- Signage to main entry points are to be cohesive in design across the Bibra Lake precinct. They are to combine signage, artworks and feature planting.
- Entry Signage will be the first point of interaction for visitors and should be informative, welcoming, eye catching and form a symbol of the values and style of the entire site.

8.1 Formal Garden Beds

- Formal Garden Beds will be used in parkland areas and will exhibit how species endemic to Bibra Lake can be used in a garden setting, providing inspiration to visitors who are interested in using native in their own garden.

Examples of Native Formal Garden Beds





Species List A - Flowering

Gompholobium tomentosum
Hibbertia hypericoides
Anigozanthos humilis
Conostylis aculeata
Dianella revoluta
Kennedia prostrata
Hardenbergia comptoniana
Thysanothus manglesianus

Species List B - Strappy

Patersonia occidentalis
Juncus pallidus
Dasypogon bromeliifolius

Species List C - Low Feature

Acacia saligna
Macrozamia riedlei
Anigozanthos humilis
Kennedia prostrata
Patersonia occidentalis
Eremaea pauciflora
Jacksonia furcellata
Pimelea rosea
Rhagodia baccata ssp baccata

9.1 Adventure Play

- Adventure Play encourages children to develop their curiosity with the natural world, as well as encouraging imagination and physical exercise . The playground will be based on unstructured play equipment, themed on the Bibra Lake eco-system and where possible will provide interaction with the natural environment.
- Adventure Playgrounds are to have input from both a landscape architect and artist.








9.2 Fitness Circuit

- The fitness circuit is to be fitted with informational signage and activity nodes to encourage the community to get involved in physical activities.
- Each node will be fitted with fitness equipment for use by the public with emphasis on the elderly and their abilities.
- Outdoor fitness equipment can be purchased from Family Fitness and Playground Equipment. Elderly focused fitness equipment can be sourced from Miracle through their Lifetrail range.

10.1 Toilet Block

- Retrofitting of the existing toilet block (on East side of lake near proposed children's play node) - colours and materials updated to complement the aesthetic of the new site design. Dependent on state of facilities at scheduled time of works retrofitting may include painting, applying a cladding to walls, replacing floor tiles, replacing fixtures and incorporating artworks and signage.
- New toilet block to be designed with the colours and materials used throughout the site. Materials to be durable and sustainable.
- Consultation with architect/s and structural engineer/s throughout the design and construction process is necessary.

Simple Integrated Artworks add Interest and Context to Buildings.

Example of Toilet Block designed as a feature within the site.

Colours and Materials suitable for use in proposed toilet blocks.

Detailing such as different materials and textures will integrate the design of the toilet block with facilities throughout the park.

Appendix 5
Dieback Management Guidelines

Dieback Management Procedures

Phytophthora cinnamomi, or more commonly known as Die back, is a type of water mould that attacks the roots of the plant and causes them to rot. This kills the plant by preventing the uptake of water and nutrients. It spreads naturally by the movement of spores in water or by root-to-root contact. Dieback can spread at the rate of one metre each year on flat ground, though this is increased considerably by human activity.

There are simple precautions that can be undertaken to prevent the spread of Dieback. These include:

- Reduce activities to fine weather, as this will reduce the risk of contaminated soil being transported from infected to non-infected areas on shoes or other means.
- Stay on designated driving tracks and walking trails
- Do not remove plants or soil from the reserve to other areas. Also do not dump soil or plants into the reserve.

Cleaning and Sterilising the Vehicle, Footwear and other Equipment

1. When entering a Dieback free site make sure the vehicle is clean on entry.
2. When exiting a Dieback infested site make sure the vehicle is cleaned down before departing.
3. If unsure if Dieback is present then clean vehicles on entry and exit
4. If you have to move between infested and uninfested sites, once again cleaning is needed between each area.

Hygiene practices for vehicles and footwear

- Removing all mud and soil from vehicles and footwear is imperative to reduce the spread.
- When cleaning down in the field select a hard, well drained surface, close to where you have been working.
- Try to remove the mud when it is dry, using a brush or stick. Pay attention to the tyres, mudflaps and soles of shoes.
- Spray with Methylated Spirits or bleach to sterilise tyres, underneath of vehicle and the soles of footwear.

Cleaning Footwear

- Remove as much mud and soil with steel bristled brush.
- Use Methylated Spirits or bleach (1 part bleach to 10 parts water) for sterilising footwear and hand tools. Allow to soak into soil on footwear.