

Chittering Lakes Nature Reserve (A29538)

Management Plan 2017 - 2027



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INTRODUCTION

This Management Plan provides background information and direction for the management of Chittering Lakes Nature Reserve (the reserve). This plan provides the basis for management of necessary operations for the preservation of the biodiversity values of the reserve.

Chittering Lakes Nature Reserve is an A class crown reserve covering an area of 230.5 hectares. The reserve is vested in the Conservation Commission of Western Australia for the purpose of conservation of flora and fauna.

Located in the Shire of Chittering, within the Brockman River Catchment, the reserve is located approximately 5km south of the township of Bindoon. The reserve includes the large, mostly still water body known as Lake Chittering. Lake Chittering is in fact part of the Brockman River, receiving water from the river at the northern end of the Lake, along with additional surface runoff, and flowing out into the Brockman River again at the southern end of the lake (Judd *et al*, 2017).

Regional Context

Chittering Lake is a semi-permanent brackish lake which is important for the conservation of wildlife in the wheatbelt. The wetland system provides valuable habitat and breeding grounds for water birds, including species listed on international migratory treaties. Surrounding the lake are natural stands of remnant vegetation, including a dense 20m wide belt of paperbark (*Melaleuca raphiophylla*). The water levels in the lake are artificially controlled by a gauging station to avoid excessive flooding in neighbouring agricultural properties, while still providing adequate water for wildlife (Australian Heritage Council 2007). The weir and a flooding event recorded in October of 2013 are depicted in the photos included below this section.

Chittering Lakes lies within the Jarrah Forest bioregion of the Interim Biogeographic Regionalisation of Australia (IBRA).

The management issues of the reserve are similar to those faced by most wheatbelt wetlands with both salinity and siltation being problems. The close proximity of Bindoon townsite and the agricultural land surrounding the site also mean that weeds, introduced animals, grazing, erosion, fire and inappropriate recreational activities are ongoing issues that need to be managed.



Above: the Weir overflowing Below: Flooding October 2013 © Bob Huston



Ecological Linkages

Maintenance of the biodiversity of a fragmented landscape is dependant on the distribution of its remaining natural areas. The level of 'ecological linkage' between fragments affects the long term sustainability of the remanant areas. Sufficient linkages which include vegetated natural areas of a suitable size can maintain some ecological functions and counter the effects of habitat fragmentation (EPA, 2008). In Southwest Australia, Regional Ecological Linkages have been identified and mapped using a standard methodology outlined in The Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region (Del Marco et. al., 2004). Chittering Lakes Nature Reserve forms part of a Regional Ecological Linkage running north-south along the Brockman River. The reserve also forms part of two Local Ecological Linkages. Appendix A depicts these ecological linkages.

Aboriginal Heritage

A search of the Western Australian Government's Aboriginal Heritage Inquiry System revealed no registered Aboriginal sites or other heritage places recorded as occurring within the nature reserve.

MANAGEMENT DIRECTIONS AND PURPOSE

The Department of Parks and Wildlife (the Department) manages nature reserves according to the legislative specifications of the Conservation and Land Management Act 1984, the Wildlife Conservation Act 1950 and the policies of the Department and the Conservation Commission of Western Australia (Conservation Commission).

The Conservation and Land Management Act 1984 (section 56) specifies that nature reserves are established 'to maintain and restore the natural environment, and to protect, care for, and promote the study of, indigenous flora and fauna, and to preserve any feature of archaeological, historic or scientific interest'.

General Management Objectives

The Department's Strategic Directions 2014-17 prioritises the departments goals and outlines strategies for fulfilling them. The theme of this strategy is is to focus investment and resources on those programs that result in tangible improvements to on-ground management outcomes.

Working towards achieving the goals laid out in the Departments Strategy, the following general management objectives have been developed for Chittering Lakes Nature Reserve:

- To protect and manage the wetland area
- Protect and manage the threatened Freckled Duck (*Stictonetta naevosa* – listed under EPBC as Vulnerable) and the bird species listed in international migratory treaties.
- Continue managing lake water levels to provide adequate water levels for water birds while preventing excessive flooding in surrounding private lands

- To protect and manage the other flora and fauna, landscape, and conservation values of the reserve

Management of the Wetland

Together Chittering and Needonga Lakes constitute a nationally important wetland that is listed in the Australian Governments' Directory of Important Wetlands in Australia. The wetland meets five of a possible seven criteria for inclusion in the Directory:

- “1. It is a good example of a wetland type occurring within a biogeographic region in Australia
 2. It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex
 3. It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail
 4. The wetland supports 1% or more of the national populations of any native plant or animal taxa.
 6. The wetland is of outstanding historical or cultural significance”
- (Department of Environment and Energy, 2017).

The wetland is divided into a northern lake, Needonga Lake, and a southern lake, Chittering Lake, and both are part of the Chittering Lakes Nature Reserve. The winding lakes are connected to the Brockman River system with the water entering the northern tip of Needonga Lake and leaving the wetland at the southern tip of Chittering Lake. Chittering Lake is the larger of the two lakes at 148 ha while Needonga Lake is 100 ha (Department of Environment and Energy, 2017). The lakes have been classified as the inland wetland types B7 and B14, “permanent saline/brackish lakes” and “freshwater swamp forest; seasonally flooded forest, wooded swamps; on inorganic soils” (Department of Environment and Energy, 2017).

The protection of Chittering and Needonga Lakes was recommended by the Environmental Protection Agency (EPA) as part of the System 6 conservation project. The recommendation was made because the lakes support a large number of water birds and contribute to the conservation values of the region (EPA 1983).

The southern end of Chittering Lake has a levee and sluice gate that was erected in 1975 by the Department of Fisheries and Wildlife to artificially control the water level (EPA 1983). The levee is closed in early spring to retain water in the lake during summer as habitat for the water birds, while in winter the levee is controlled to prevent flooding of neighbouring pastures (Department of Environment and Water Resources 2007a).

The wetland is important as a habitat for water birds and provides a major breeding ground for twenty bird species.

There are several threats to the wetland including siltation, salinisation, weeds and grazing. The lake has become shallower over the last few decades because of silting from the catchment and this problem is likely to continue.

Objectives

- To protect and manage the wetland and its values, particularly as a habitat and breeding grounds for waterbirds
- To prevent excess flooding on neighbouring agricultural properties

Actions/Strategies

- Monitor water levels in the lakes to ensure there is sufficient water to provide habitat for birds

LAND TENURE

Chittering Lakes Nature Reserve is an A class reserve (Reserve No.29538) in the Shire of Chittering. The reserve is vested with the Conservation Commission for the purpose of conservation of flora and fauna.

THE NATURAL ENVIRONMENT

Geology and Soils

Chittering Lakes NR is located east of the Darling Fault on the Yilgarn Block, which consists of Archaean crystalline rocks. This area of Archaean rocks is relatively stable with granite and metamorphic belts of sedimentary and volcanic rocks. Chittering Lakes is on the Chittering metamorphic belt that has a composition of aluminous schist with sections of quartzofeldspathic gneiss. The belt is approximately 10 km wide with the Darling Fault to its west and granite to its east (Biggs *et al.* 1980).

The geomorphic province of the reserve is the Darling Plateau of Precambrian crystalline rocks. The Darling Plateau has experienced deep weathering as well as natural erosion and the lateritic profile of the soil reflects this. Chittering Lakes is on a valley floor and the landform-soil unit is the Noonung unit. The valley floor of the upper Brockman River has red earth soils and some sandy deposits that originate from the basic rocks of the terraces that surround it. The landform that surrounds the swampy valley floor is the Bindoon unit which consists of steep irregular slopes, containing little laterite, and rock outcrops (Churchward & McArthur 1980).

Water Quality

Water quality sampling of the lake and riparian habitats was undertaken in 2017. Subsequently it was described as well mixed, with the water chemistry being consistent throughout the different habitat types. Judd *et al* (2017) also describe it as slightly coloured, slightly turbid and subsaline, with little sign of excessive nutrients. Although it was noted that it was sampled in a relatively wet year and the lake was expected to have been well flushed.

Flora and Vegetation

The reserve is located within the Northern Jarrah Forest IBRA subregion. The pre-european vegetation complex Nooning is mapped by Heddle *et al* (1980) over the majority of the reserve. This vegetation complex is confined mostly to the riparian area of the Brockman River in the Shire of Chittering. This vegetation is described as; Low open forest of *Casuarina obesa* and open shrubland of *Casuarina obesa*-*Acacia* spp.-*Melaleuca* spp. With localised patches of *Eucalyptus rudis* and *Melaleuca raphiophylla* on the fringe of the watercourse.

Lake Chittering has been most recently surveyed, by Connell in 2017. The lake is surrounded by 79 ha of vegetation which has been described as being in mostly good ecological condition (Connell, 2017). Four local vegetation community types have been recorded within the reserve. The lake is fringed by a woodland/forest of *Melaleuca raphiophylla*, *Casuarina obesa* and *Eucalyptus rudis*. *Eucalyptus wandoo* Woodlands occur at higher elevations in the north of the reserve. *Eucalyptus marginata*-*Corymbia calophylla* Woodlands occur on the western margins of the reserve on rocky lateritic slopes (Connell, 2017). These local plant communities are represented in Appendix B.

The flora recorded at Lake Chittering is comprised of 93 native and 64 exotic species. The majority of these species represent the Proteaceae, Myrtaceae and Fabaceae families. All species recorded here are considered to be widespread and none are considered to be of conservation significance (Connell, 2017). A list of species recorded from Lake Chittering is included as Appendix D.

Native Animals

Chittering Lakes Nature Reserve provides important habitat and breeding grounds for many water birds. In a survey of 602 wetlands in south-west Western Australia, Chittering Lakes was in the top 4% for the number of individual birds and the top 1% for the number of breeding species that use the wetland (Australian Heritage Council 2007).

There are rare and protected birds that use the lake area as habitat. The rare freckled duck (*Stictonetta naevosa*) is listed as a threatened species under the state's Wildlife Conservation Act, Schedule 1. The Freckled Duck frequents the wetland and probably uses it as a breeding ground. There are four species of migratory birds that also use the wetland, which are listed on international migratory treaties. The great egret (*Egretta alba*) is listed on both the Japan Australia Migratory Bird Agreement and the China Australia Migratory Bird Agreement, and Chittering Lakes supports its second biggest breeding colony in Western Australia (Australian Heritage Council 2007).

While the wetland is particularly important for water birds, it also supports other native animals. Tortoises (*Chelodina oblonga*) use the lake during autumn and winter and leave in spring to find dry breeding sites.

Surveys of the aquatic environments of Lake Chittering identified 36 species of macroinvertebrates from a variety of habitat niches. These include seasonally flooded woodland habitat, submerged beds of green Alga and *Ruppia* seagrass in open water

habitats. The endemic freshwater shrimp (*Palamonetes australis*) also resides in the lake (Judd *et al.*, 2017).

Surveys by the Chittering Bird Group volunteers have recorded 39 species of birds in the reserve. Bird species recorded include a wide variety, including wetland dependent species such as the Swamp Harrier (*Circus approximans*) as well as woodland species such as the Endangered Carnaby's Cockatoo (*Calyptorhynchus latirostris*). A comprehensive list of the latest available bird data is included as Appendix J and K at the end of this document.

THREATS

A number of threats have been recorded for the reserve, including weed invasion, salinisation, inappropriate fire regimes, Phytophthora dieback and feral animals.

Environmental Weeds and Disease

Weeds threaten the reserve's purpose of conservation of flora and fauna and have already led to some degradation in the area. Weeds can displace native plant species, prevent native seedlings from establishing, affect nutrient cycling, replace fauna habitat, and alter the fire regime in the area (Hussey *et al.* 1997). The weeds in the reserve are interfering with the general management objectives listed above, in particular to protect the wetland area and to protect and manage other flora and fauna.

During a field survey of Lake Chittering in 2017, 64 different species of weeds were recorded. A comprehensive list of these weed species is included as Appendix C. All weed species recorded are considered to be common weeds associated with agriculture and disturbance. As such, weeds in this reserve are most common in highly disturbed areas such as firebreaks, tracks and road verges, as well as in the gully (Connell, 2017).

Watsonia (*Watsonia bulbilifera*) is a key threat to the biodiversity of the reserve. It forms dense stands in seasonally wet areas of the reserve. Watsonia is a serious environmental weed in Western Australia with a wide distribution and an ability to form dense monocultures. Plants use corms as their underground storage organs and they die back to these over summer. These corms allow Watsonia to reproduce vegetatively and they are persistent in the soil. *Watsonia bulbilifera* also produce cormels on above ground stems. These cormels can remain viable in the soil for several years, so follow up control is needed for years after the initial herbicide spraying. Watsonia flowers profusely in post-fire conditions with mass seed production (Brown & Brooks 2002).

There has been previous weed control carried out at the site over a number of years. Weed species considered to be significant threats have also been mapped. The latest information recorded on the location of significant weed species within the reserve is included as Appendix E, F, G and H.

Recently, Chittering LCDC received a State NRM grant to undertake a flora and vegetation survey and a water quality monitoring survey in the southern section of the

reserve (Lake Chittering). Weed control and weed mapping was also undertaken through this grant funded project, with a focus on controlling the re-emergents of *Watsonia*, Arum Lily and woody weeds within the reserve. This work was also supported by the Department of Parks and Wildlife, Perth Hills District, Nature Conservation Program.

Dieback (*Phytophthora cinnamomi*) is not evident within the reserve. Currently there are no Disease Risk Area or Road Closure signs, indicating that the disease has not been identified in the area.

Objectives

To minimise the impact of environmental weeds and disease on the values of the reserve.

Actions/Strategies

- Implement the weed management plan for Chittering Lakes Nature Reserve, including follow up weed control, monitoring and rehabilitation of previously infested areas
- Amend annual works plans based on results of monitoring and adaptive management principles
- Liaise with adjoining property owners to control weeds in their properties to prevent spread of weeds into the reserve from private property
- Monitor for the occurrence of dieback and adopt appropriate hygiene practices

Feral Animals, Domestic Animals and Stock

Feral animals pose a threat to the reserve, particularly to the native animals that use the area as habitat. Feral animals are a threat because they can be predators, provide competition for resources and spread weeds and diseases. Foxes and cats pose the biggest threat to the waterbirds while rabbits can alter native vegetation.

There is evidence that foxes have been preying on native animals and diminishing their numbers. In October 2006 while spraying for weeds, Dean Perry noticed hundreds of turtle shells that appeared to have been recently killed. This is likely to be the result of foxes and may pose a serious threat to the turtle population around the wetland.

A study of the predation pressure and its effects on the population dynamics of Oblong Turtles in the reserve was subsequently undertaken. This study was undertaken as a collaborative project between Murdoch University, the Department of Parks and Wildlife's Perth Hills Nature Conservation Program and TRONOX. The study by Dawson *et al* in 2012 found that the Red Fox was the primary predator of the Oblong Turtle in the reserve, preying on both adult females which leave the safety of the water to lay their eggs, as well as the eggs and hatchlings. The study used a range of methods, including camera traps, artificial nests, scat analysis and DNA swabs of turtle remains. The study found that as a result of this predation pressure, the population was missing a high proportion of large breeding females and juvenile turtles. The figure included as Appendix I shows the location of artificial nests used in the study and the level of predation recorded.

The reserve is in close proximity to Bindoon township and therefore there may be problems with domestic animals entering the reserve. It also means that 1080 fox baiting is not currently used and is unlikely to occur because of the risk of domestic dogs taking bait. However, some efforts have been made by the Chittering LCDC to engage with local landholders to undertake control of foxes on nearby private property (Bob Huston pers comm.)

Objectives

Minimise the impact of feral animals on the conservation values of Chittering Lakes NR by controlling, and where possible eradicating, the species or ameliorating their impact.

Actions/Strategies

- Liaise with neighbours to ensure boundary fences are maintained and stock do not gain access to the reserve
- Monitor the presence and extent of feral species within the reserve
- If feral animal populations are at a high level then measures for eradication should occur
- Keep neighbours informed of any feral animal control on the reserve

Fire

Chittering Lakes Nature Reserve is mostly wetland that will not burn easily although the surrounding closed forest of paperbark *Melaleuca raphiophylla* may burn. If the nature reserve was burnt then the loss of habitat for waterbirds would be a major problem. The surrounding land is private property and mostly cleared, therefore there is no adequate substitute for habitat in the nearby vicinity. There has been no recorded burns in the nature reserve in recent years (<14 years), although in 1997/98 small areas to the east and north of the lakes were burnt.

Any fire management program of the Department aims to balance maintaining biodiversity with protecting life, property and communities. The fire management strategies the Department uses include prescribed burning, fire exclusion and suppression, and community education (DEC 2007). Fire can have a profound impact on vegetation communities and fauna habitats, and therefore the conservation values of the reserve. The disturbance can increase the spread of environmental weeds or introduce new weed infestations. Fire management will be in accordance with Departmental objectives and implemented through the District Fire Plan.

It would be difficult to construct firebreaks in the reserve because its boundaries are very close to the high water mark. The access routes to the reserve are through private property except along Great Northern Highway (CALM 2002).

Objectives

To protect the conservation values of Chittering Lakes Nature Reserve from wildfire.

Actions/Strategies

- Any prescribed burns to reduce fuel loads must consider the conservation values of the reserve including the priority listed species and be in accordance with the District Fire Plan. Prescribed burns are not recommended
- Maintain fire breaks along the boundaries of the reserve
- Rehabilitate fire-affected areas when necessary

Access and Signage

There is public access to the reserve along Great Northern Highway with no fences along this boundary, and it is unlikely to be feasible to fence this boundary. There are signs along the highway to inform people the area is a nature reserve and they are in relatively good condition.

Objectives

To provide suitable access while minimising the adverse effects on the reserve's values. To ensure that the reserve is adequately signed so that the public are aware of the reserve's presence and purpose.

Strategies/Actions

- Ensure signage is maintained along the Great Northern Highway

Fencing

The reserve is surrounded mostly by agricultural private properties and adequate fencing is important to prevent stock entering the site. Fencing around the reserve has improved as a result of the Crown Reserve Programme (CRP) in 2002 and cooperation with some neighbours. CALM supplied fencing to the landowners under the scheme and in 2003 two landowners, Kay and Lefroy, fenced their boundaries. The fencing was erected to allow a buffer area around the reserve boundary and therefore the fences are on private property (CALM 2002).

There are still some boundaries that are not adequately fenced and this is a problem with stock getting into the reserve. Along some boundaries there is no fence while in other places the fence is in disrepair (CALM 2002). A good relationship with DEC's neighbours is necessary to encourage them to fence their properties.

Objectives

To maintain good quality fence lines along the boundaries of the reserve.

Strategies/Actions

- Work with neighbours to ensure fences are maintained and repairs are made promptly in line with DEC's Good Neighbour Policy 2007
- Inform neighbours of their responsibilities under the Good Neighbour Policy 2007
- Conduct regular inspections of fence lines around the reserve and report any maintenance that is required

Liaison with Neighbours

A good working relationship between DEC and its neighbours is important and fosters the cooperation needed to manage the reserve. Neighbours should be consulted or informed on cross boundary issues including fencing, fire management, weed control issues and feral animal control.

Properties neighbouring the reserve were approached in 2002 under the Crown Reserve Programme to work with the Department to fence their boundaries. The Department supplied the fencing material while the farmers erected the fence. Two landowners accepted the offer and fenced their boundaries while several others agreed not to run stock through the wetland (CALM 2002).

Objectives

To maintain a good working relationship with neighbours to improve management of the reserve.

Strategies/Actions

- Keep an up-to-date contact list of neighbours of the reserve

Rehabilitation

Environmental degradation in the reserve is an important issue, particularly with Bindoon township close by. Some of the actions that contribute to degradation include rubbish dumping, firewood removal, deliberately lit fires and uncontrolled access. These damaging human activities need to be controlled to allow for natural regeneration of disturbed sites and successful establishment of revegetated sites.

Objectives

Restore degraded areas in the reserve and prevent further degradation by controlling damaging activities.

Strategies/Actions

- Control inappropriate vehicle use through signage, or fencing if necessary
- Ensure there is adequate signage informing people of forbidden activities eg no firewood collecting or rubbish dumping
- Remove rubbish promptly from the reserve
- Prosecute illegal actions in accordance with *CALM Act 1984*

Recreational Use

The large number of bird species and close proximity to Bindoon allows for good quality recreation opportunities for both residents and naturalists. Bush walking and bird watching are passive recreational activities that can be compatible with the conservation purpose of the reserve. Much of the reserve is wetland and vehicle use or horse riding is not appropriate as they may damage the area.

Objectives

Ensure recreational activities do not interfere with the conservation values of the reserve.

Strategies/Actions

- Maintain adequate signage regarding appropriate recreational activities eg no four-wheel drives and no horse riding

MONITORING AND IMPLEMENTING THE PLAN

The Department and the Conservation Commission will conduct assessments of the effectiveness of this Management Plans using audits. These audits assess the Department's success in achieving the relevant strategies from the Department's Strategic Directions.

The strategies outlined in this Management Plan will be built into the annual works program of the Department's Perth Hills District, which is responsible for the daily management of the reserve. Progress against the management strategies will form the basis of an annual status report of the reserve by the Department's Perth Hills District to the Department's Corporate Executive and the Conservation Commission.

This Management Plan is considered current for a period of 10 years from the date of approval by the Conservation Commission, or until amended or superseded. The Conservation Commission will be required to approve the amendments to this Management Plan.

REFERENCES

Australian Heritage Council (2007) *Register of the National Estate*, Australian Heritage Council. Available from: <<http://www.ahc.gov.au/register/index.html>> [5 June 2007].

Biggs, E.R., Wilde, S.A. & Leech, R.E.J. (1980) 'Geology, mineral resources and hydrogeology of the Darling System, Western Australia', in *Atlas of Natural Resources Darling System Western Australia*, Department of Conservation and Environment, Perth, pp.3-24.

Brown, K. & Brooks, K. (2002) *Bushland weeds: a practical guide to their management*, Environmental Weeds Action Network, Perth.

CALM (2002) Reserve File 29538 Chittering Lakes Reserve (PHD2004F285V01), Department of Conservation and Land Management, Perth Hills District.

Churchward, H.M. & McArthur, W.M. (1980) 'Landforms and soils of the Darling System Western Australia', in *Atlas of Natural Resources Darling System Western Australia*, Department of Conservation and Environment, Perth, pp.25-33.

Connell Dr S. (2017) *Vegetation and Flora Assessment Lake Chittering Nature Reserve*, Kallaroo, 6025.

Dawson S., Fleming P., Huston R. and Adams P. (2012) *Predation pressure on oblong turtles (Chelodina colliei) by the introduced predator; the red fox (Vulpes vulpes)*. Tronox, Department of Environment and Conservation & Murdoch University.

DEC (2007) *NatureBase*, Department of Environment and Conservation. Available from: <<http://www.naturebase.net/>> [9 July 2007].

Del Marco, A., Taylor, R., Clarke, K., Savage, K., Cullity, J. and Miles, C. (2004). *Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region*. Perth Biodiversity Project, Western Australian Local Government Association. West Perth, Western Australia

Department of Environment and Energy (2017) *Australian Wetlands Database*. Available from: <http://www.environment.gov.au/cgi-bin/wetlands/report.pl> [10 June 2017].

Department of the Environment and Water Resources 2007b, *IBRA*. Available from: <<http://www.environment.gov.au/parks/nrs/ibra/index.html>> [9 July 2007].

DIA (2007) *Sites and Surveys*, Department of Indigenous Affairs. Available from: <<http://www.dia.wa.gov.au/Heritage/SitesSurveys.aspx>> [6 June 2007].

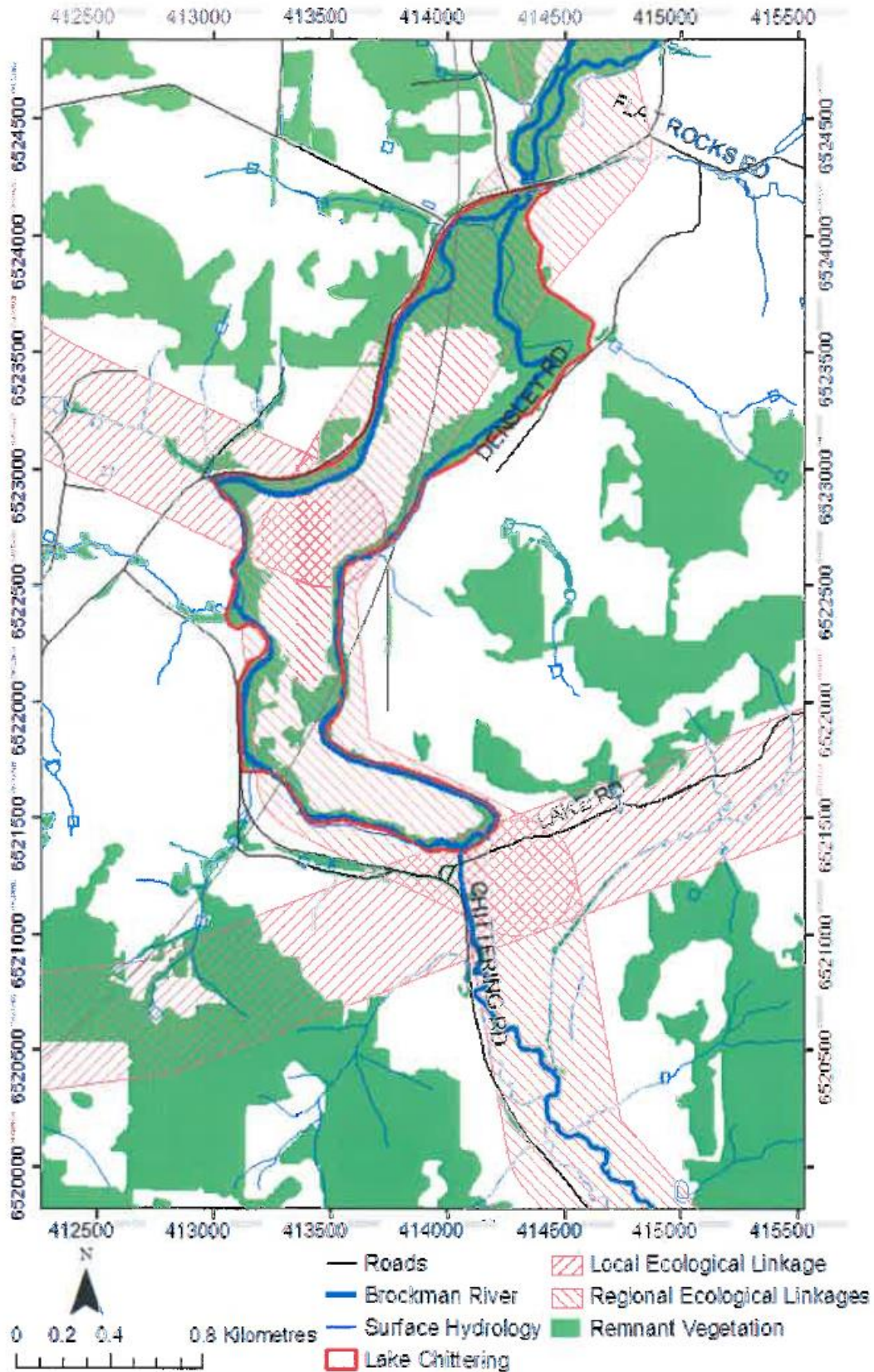
EPA (1983) *The Darling System, System 6: conservation reserves for Western Australia: part 2, recommendations for specific locations*, Department of Conservation and Environment, Perth.

Halse, S.A., Pearson, G.B. & Patrick, S. (1993) *Vegetation of deep-gauged wetlands in nature reserves of south-west Western Australia*, Technical Report No. 30, Department of Conservation and Land Management, Perth.

Hussey, B.M.J., Keighery, G.J., Cousens, R.D., Dodd, J. & Lloyd, S.G. (1997) *Western weeds: a guide to the weeds of Western Australia*, Plant Protection Society of Western Australia, Perth.

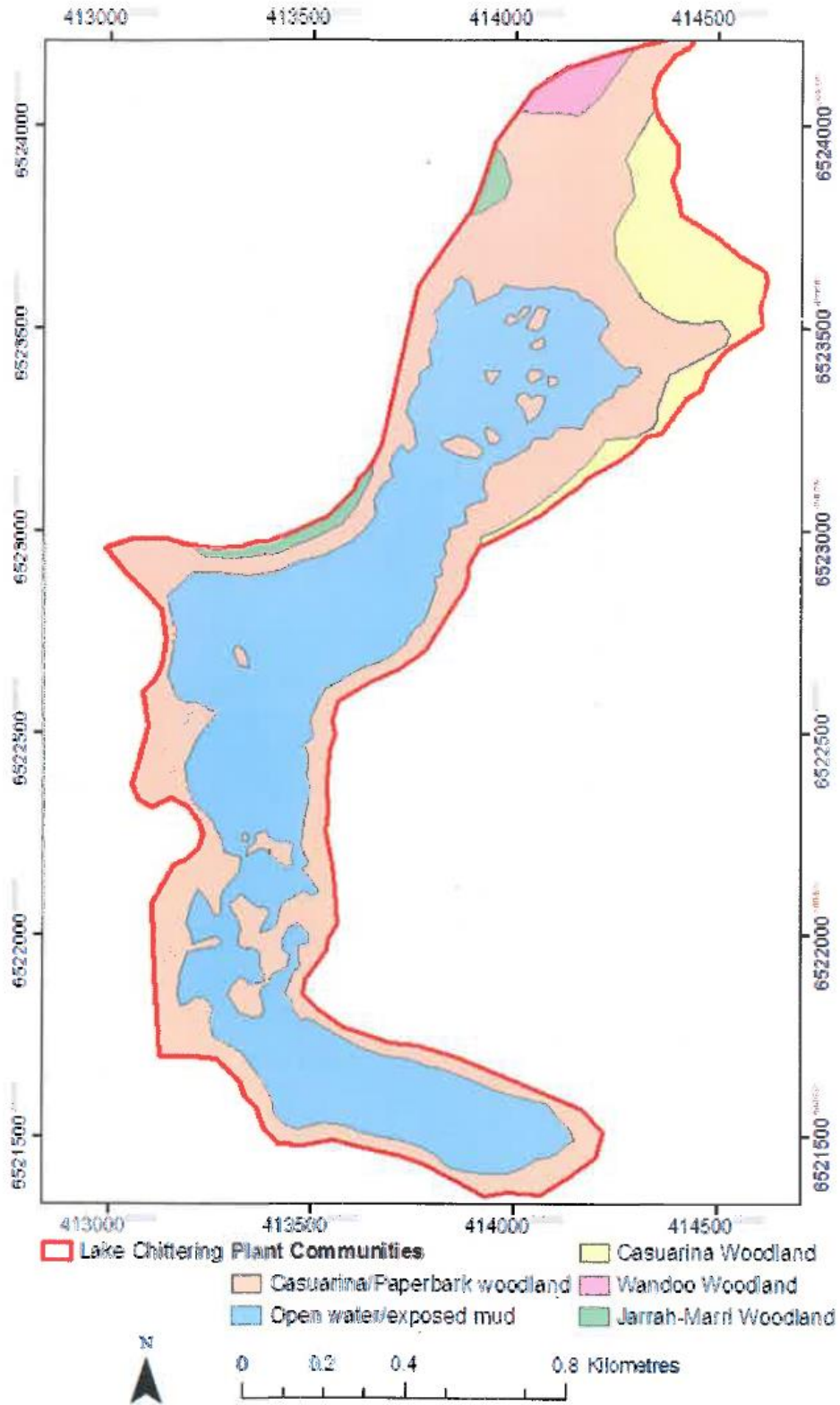
Judd S, Brown H & Horwitz P (2017) *Habitat, water quality and macroinvertebrate assessment of Lake Chittering, Western Australia*, Report No CEM2017-1 Edith Cown University, Centre for Ecosystem Management.

Appendix A: Ecological Linkages



Source: Connell, 2017

Appendix B: Local Plant Communities



Source: Connell, 2017

Appendix C: Weed Species Recorded from Chittering Lakes Nature Reserve

Species	Family
<i>Acacia iteaphylla</i>	Fabaceae
<i>Acacia longifolia</i> var <i>sophorae</i>	Fabaceae
<i>Acacia podalyriifolia</i>	Fabaceae
<i>Arctotheca calendula</i>	Asteraceae
<i>Avena barbata</i>	Poaceae
<i>Avena fatua</i>	Poaceae
<i>Avena sativa</i>	Poaceae
<i>Barista trixago</i>	Orobanchaceae
<i>Brachychiton populneus</i>	Malvaceae
<i>Brassica tournefortii</i>	Brassicaceae
<i>Briza maxima</i>	Poaceae
<i>Briza minor</i>	Poaceae
<i>Carpobrotus edulis</i>	Aizoaceae
<i>Cenchrus clandestinus</i>	Poaceae
<i>Cenchrus setaceus</i>	Poaceae
<i>Centaurium spicatum</i>	Gentianaceae
<i>Chamaecytisus palmensis</i>	Fabaceae
<i>Conzya bonariensis</i>	Asteraceae
<i>Cotula coronopifolius</i>	Asteraceae
<i>Crassula glomerata</i>	Crassulaceae
<i>Cynodon dactylon</i>	Poaceae
<i>Cyperus congestus</i>	Cyperaceae
<i>Cyperus polystachyos</i>	Cyperaceae
<i>Disa bracteata</i>	Orchidaceae
<i>Echium plantagineum</i>	Boraginaceae
<i>Erharta calycina</i>	Poaceae
<i>Eragrostis curvula</i>	Poaceae
<i>Ficus carica</i>	Moraceae
<i>Fumaria capreolata</i>	Papaveraceae
<i>Gladiolus caryophyllaceus</i>	Iridaceae
<i>Holcus lanatus</i>	Poaceae
<i>Homeria flaccida</i>	Iridaceae
<i>Hordeum leporinum</i>	Poaceae
<i>Hypochaeris glabra</i>	Asteraceae
<i>Juncus articulatus</i>	Juncaceae
<i>Lagurus ovatus</i>	Poaceae
<i>Lathyrus tingitanus</i>	Fabaceae
<i>Lolium perenne</i>	Poaceae
<i>Lotus angustissimus</i>	Fabaceae
<i>Lupinus consentinii</i>	Fabaceae
<i>Lysimachia minima</i>	Primulaceae
<i>Olea europaea</i>	Oleaceae
<i>Orobanche minor</i>	Orobanchaceae

<i>Oxalis pres-caprae</i>	Oxalidaceae
<i>Papaver rhoeas</i>	Papaveraceae
<i>Paspalum dilatatum</i>	Poaceae
<i>Pelargonium capitatum</i>	Geraniaceae
<i>Petrorhagia velutina</i>	Caryophyllaceae
<i>Phalaris paradoxa</i>	Poaceae
<i>Polygonum arenastrum</i>	Polygonaceae
<i>Polypogon monspeliensis</i>	Poaceae
<i>Raphanus raphanistrum</i>	Brassicaceae
<i>Romulea rosea</i>	Iridaceae
<i>Rumex crispus</i>	Polygonaceae
<i>Schinus terebinthifolia</i>	Anacardiaceae
<i>Solanum nigrum</i>	Solanaceae
<i>Sonchus asper</i>	Asteraceae
<i>Sonchus oleraceus</i>	Asteraceae
<i>Trifolium arvense</i>	Fabaceae
<i>Trifolium hirtum</i>	Fabaceae
<i>Ursinia anthemoides</i>	Asteraceae
<i>Washingtonia filifera</i>	Arecaceae
<i>Watsonia bulbilifera</i>	Iridaceae
<i>Zantedeschia aethiopica</i>	Araceae

Adapted from Connell, 2017

Appendix D: Native plant species recorded at Lake Chittering.

Species	Family
<i>Acacia accuminata</i>	Fabaceae
<i>Acacia pulchella</i>	Fabaceae
<i>Acacia saligna</i>	Fabaceae
<i>Adenanthos cygnorum</i> var <i>cygnorum</i>	Proteaceae
<i>Allocasuarina humilis</i>	Casuarinaceae
<i>Anigozanthos bicolor</i>	Haemodoraceae
<i>Apium prostratum</i>	Apiaceae
<i>Banksia grandis</i>	Proteaceae
<i>Banksia nivea</i>	Proteaceae
<i>Banksia sessilis</i>	Proteaceae
<i>Banksia squarrosa</i>	Proteaceae
<i>Beaumea articulata</i>	Cyperaceae
<i>Beaumea juncea</i>	Cyperaceae
<i>Billardiera heterophylla</i>	Pittosporaceae
<i>Bolboschoenus caldwellii</i>	Cyperaceae
<i>Bossiaea eriocarpa</i>	Fabaceae
<i>Brachychiton populneus</i>	Malvaceae
<i>Callistemon glaucus</i>	Myrtaceae
<i>Callitris columellaris</i>	Cupressaceae
<i>Calothamnus hirsutus</i>	Myrtaceae
<i>Cassytha</i> sp.	Lauraceae
<i>Casuarina obesa</i>	Casuarinaceae
<i>Cenchrus setaceus</i>	Poaceae
<i>Centella asiatica</i>	Apiaceae
<i>Chamelaucium uncinatum</i>	Myrtaceae
<i>Clematis pubescens</i>	Ranunculaceae
<i>Conostylis setosa</i>	Haemodoraceae
<i>Corymbia calophylla</i>	Myrtaceae
<i>Cotula australis</i>	Asteraceae
<i>Crassula colorata</i>	Crassulaceae
<i>Daucus glochidiatus</i>	Apiaceae
<i>Dianella divariata</i>	Hemerocallidaceae
<i>Drosera erythrorhiza</i>	Droseraceae
<i>Drosera menziesii</i> subsp. <i>menziesii</i>	Droseraceae
<i>Eucalyptus marginata</i>	Myrtaceae

<i>Eucalyptus rudis</i>	Myrtaceae
<i>Eucalyptus wandoo</i>	Myrtaceae
<i>Gastrolobium calycinum</i>	Fabaceae
<i>Gastrolobium spathulatum</i>	Fabaceae
<i>Grevillea</i> spp.	Proteaceae
<i>Grevillea synaphea</i>	Proteaceae
<i>Haemodorum paniculatum</i>	Haemodoraceae
<i>Haemodorum spicatum</i>	Haemodoraceae
<i>Hakea prostrata</i>	Proteaceae
<i>Hardenbergia comptoniana</i>	Fabaceae
<i>Hibbertia huegelii</i>	Dilleniaceae
<i>Hibbertia hypericoides</i>	Dilleniaceae
<i>Hypocalymma angustifolium</i>	Myrtaceae
<i>Hypoxis occidentalis</i>	Hypoxidaceae
<i>Jacksonia sternbergiana</i>	Fabaceae
<i>Juncus pallidus</i>	Juncaceae
<i>Kennedia prostrata</i>	Fabaceae
<i>Kunzea glabrescens</i>	Myrtaceae
<i>Lagenophora huegelii</i>	Asteraceae
<i>Lechenaultia biloba</i>	Goodeniaceae
<i>Macrozamia riedlei</i>	Zamiaceae
<i>Marianthus coeruleopunctatus</i>	Pittosporaceae
<i>Melaleuca lateritia</i>	Myrtaceae
<i>Melaleuca radula</i>	Myrtaceae
<i>Melaleuca raphiophylla</i>	Myrtaceae
<i>Melaleuca teretifolia</i>	Myrtaceae
<i>Melaleuca uncinata</i>	Myrtaceae
<i>Mesomelaena pseudostygia</i>	Cyperaceae
<i>Millotia myosotidifolia</i>	Asteraceae
<i>Nitella</i> sp.	Charophyta
<i>Olearia axillaris</i>	Asteraceae
<i>Opercularia vaginata</i>	Rubiaceae
<i>Ornduffia albiflora</i>	Menyanthaceae
<i>Orthrosanthos laxus</i>	Iridaceae
<i>Patersonia occidentalis</i>	Iridaceae
<i>Phyllanthus calycinus</i>	Phyllanthaceae
<i>Phyllothea spicatus</i>	Rutaceae
<i>Pimelea imbricata</i>	Thymeleaceae

<i>Podotheca gnaphalioides</i>	Asteraceae
<i>Ptilotus manglesii</i>	Amaranthaceae
<i>Ptilotus polystachyus</i>	Amaranthaceae
<i>Schoenolaena juncea</i>	Apiaceae
<i>Solanum hoplopetalum</i>	Solanaceae
<i>Sowerbaea laxiflora</i>	Asparagaceae
<i>Sporobolus virginicus</i>	Poaceae
<i>Stackhousia monogyna</i>	Celastraceae
<i>Stylidium amoenum</i>	Stylidiaceae
<i>Stylidium brunonianum</i>	Stylidiaceae
<i>Stypandra glauca</i>	Hemerocallidaceae
<i>Taxandria linearifolia</i>	Myrtaceae
<i>Thysanotus manglesii</i>	Asparagaceae
<i>Trachymene pilosa</i>	Araliaceae
<i>Triglochin centrocarpa</i>	Juncaginaceae
<i>Triglochin procera</i>	Juncaginaceae
<i>Trymalium ledifolium</i>	Rhamnaceae
<i>Viminaria juncea</i>	Fabaceae
<i>Xanthorrhoea preisii</i>	Xanthorrhoeaceae
<i>Xanthosia huegelii</i>	Apiaceae

Adapted from Connell, 2017

Appendix E: Location information for significant weed species at Chittering Lakes Nature Reserve.

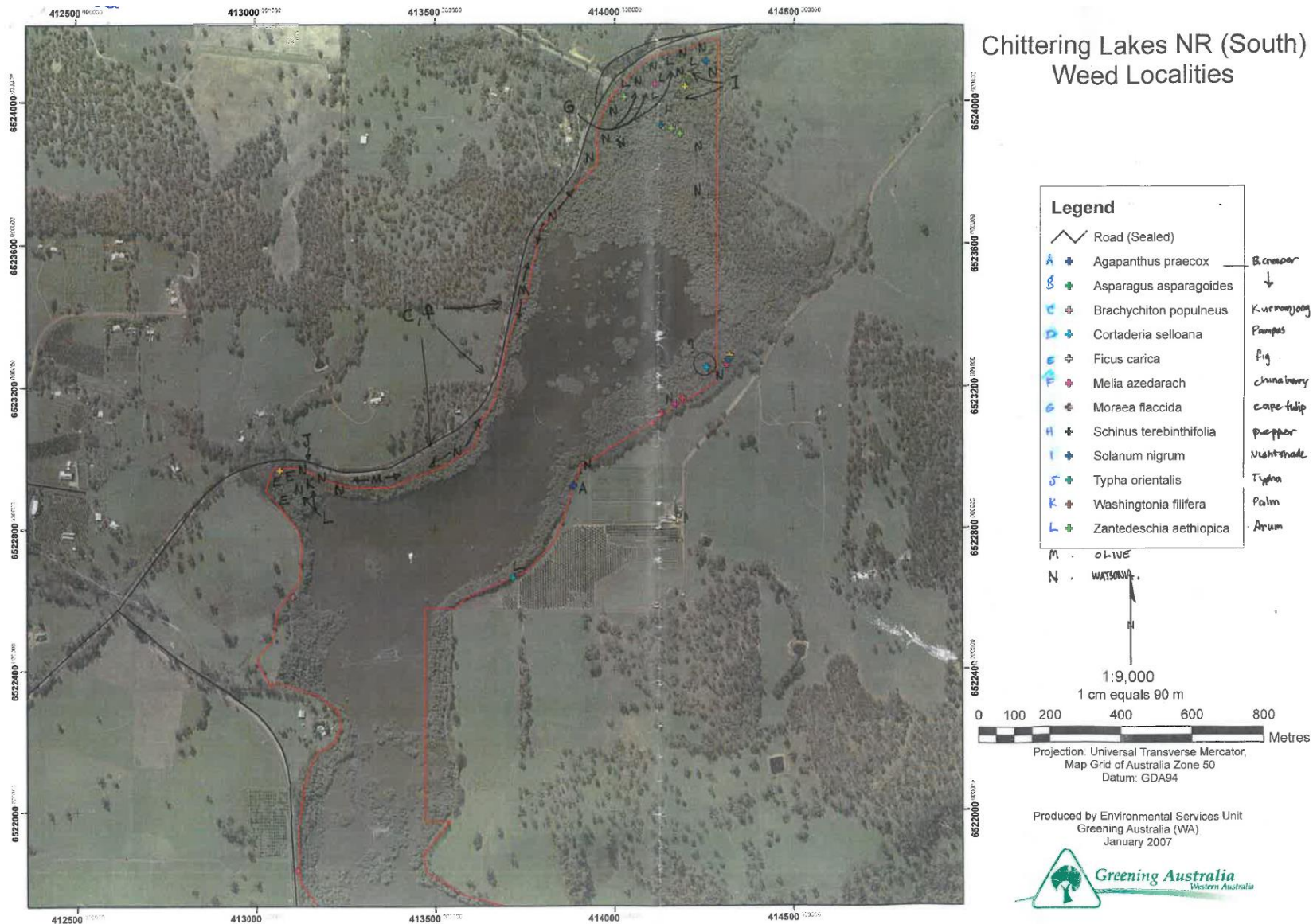
Species	Easting	Northing
<i>Acacia iteaphylla</i>	413709	6523387
<i>Acacia podalyriifolia</i>	413622	6523131
<i>Chamaecytisus palmensis</i>	413813	6523700
<i>Chamaecytisus palmensis</i>	414175	6524162
<i>Ficus carica</i>	413120	6522801
<i>Ficus carica</i>	413084	6522852
<i>Ficus carica</i>	413085	6522966
<i>Olea europaea</i>	414102	6524072
<i>Schinus terebinthifolia</i>	414059	6523924
<i>Schinus terebinthifolia</i>	414291	6523303
<i>Schinus terebinthifolia</i>	414323	6523352
<i>Solanum hoplopetalum</i>	413527	6523044
<i>Washingtonia filifera</i>	413103	6522618
<i>Washingtonia filifera</i>	413060	6522915
<i>Watsonia bulbilifera</i>	413709	6523387
<i>Watsonia bulbilifera</i>	413578	6523080
<i>Watsonia bulbilifera</i>	413270	6522957
<i>Watsonia bulbilifera</i>	414005	6524056
<i>Watsonia bulbilifera</i>	414196	6523985
<i>Watsonia bulbilifera</i>	414437	6523423
<i>Watsonia bulbilifera</i>	414361	6523340
<i>Watsonia bulbilifera</i>	413084	6522852
<i>Watsonia bulbilifera</i>	413057	6522939
<i>Watsonia bulbilifera</i>	413085	6522966
<i>Zantedeschia aethiopica</i>	414074	6524013
<i>Zantedeschia aethiopica</i>	414246	6524177

Adapted from Connell, 2017

Appendix F: Weed mapping for Chittering Lakes Nature Reserve – South.

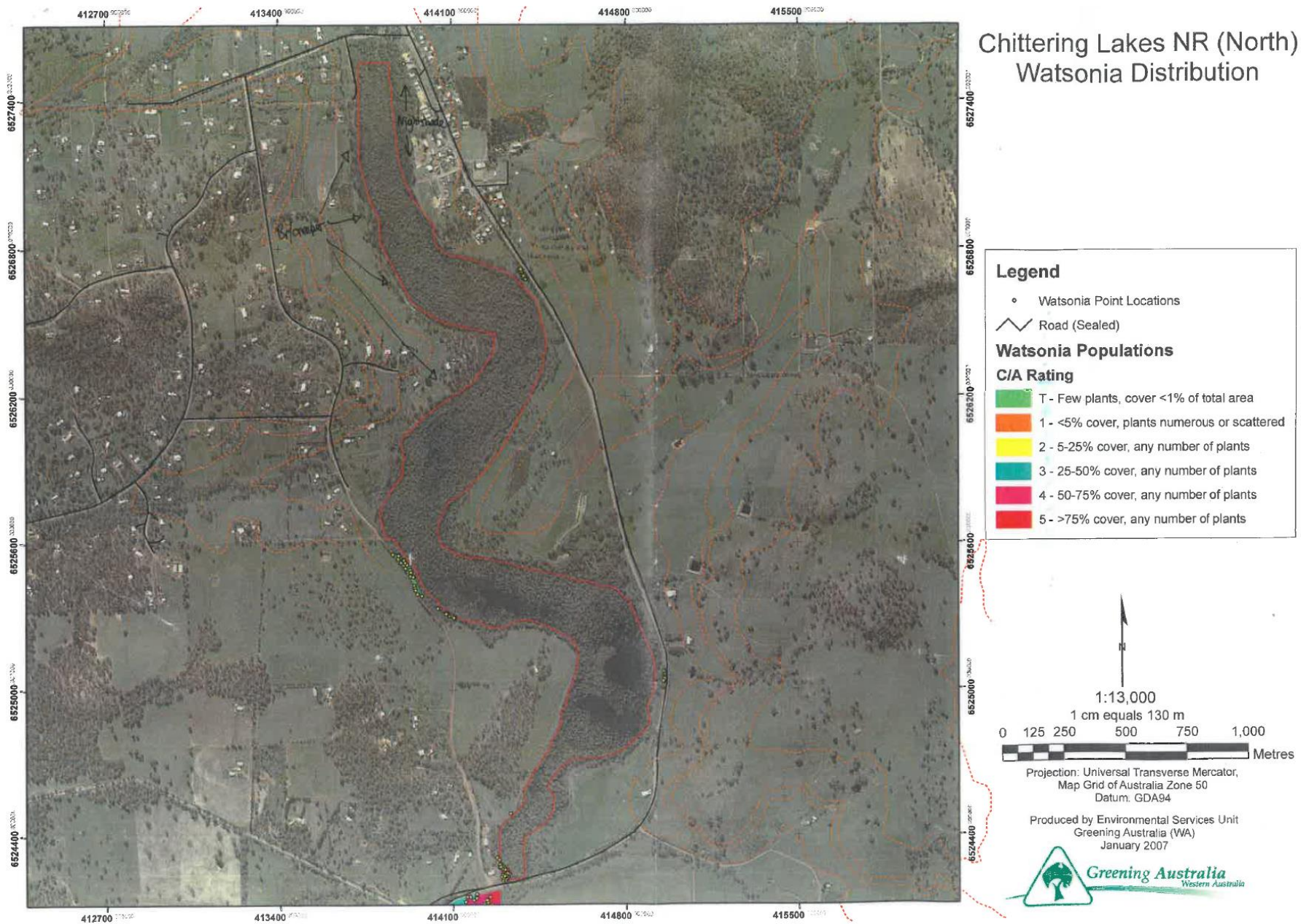
This map shows weed location information from 2017 overlaid on 2007 mapping information.

Chittering Lakes NR (South) Weed Localities

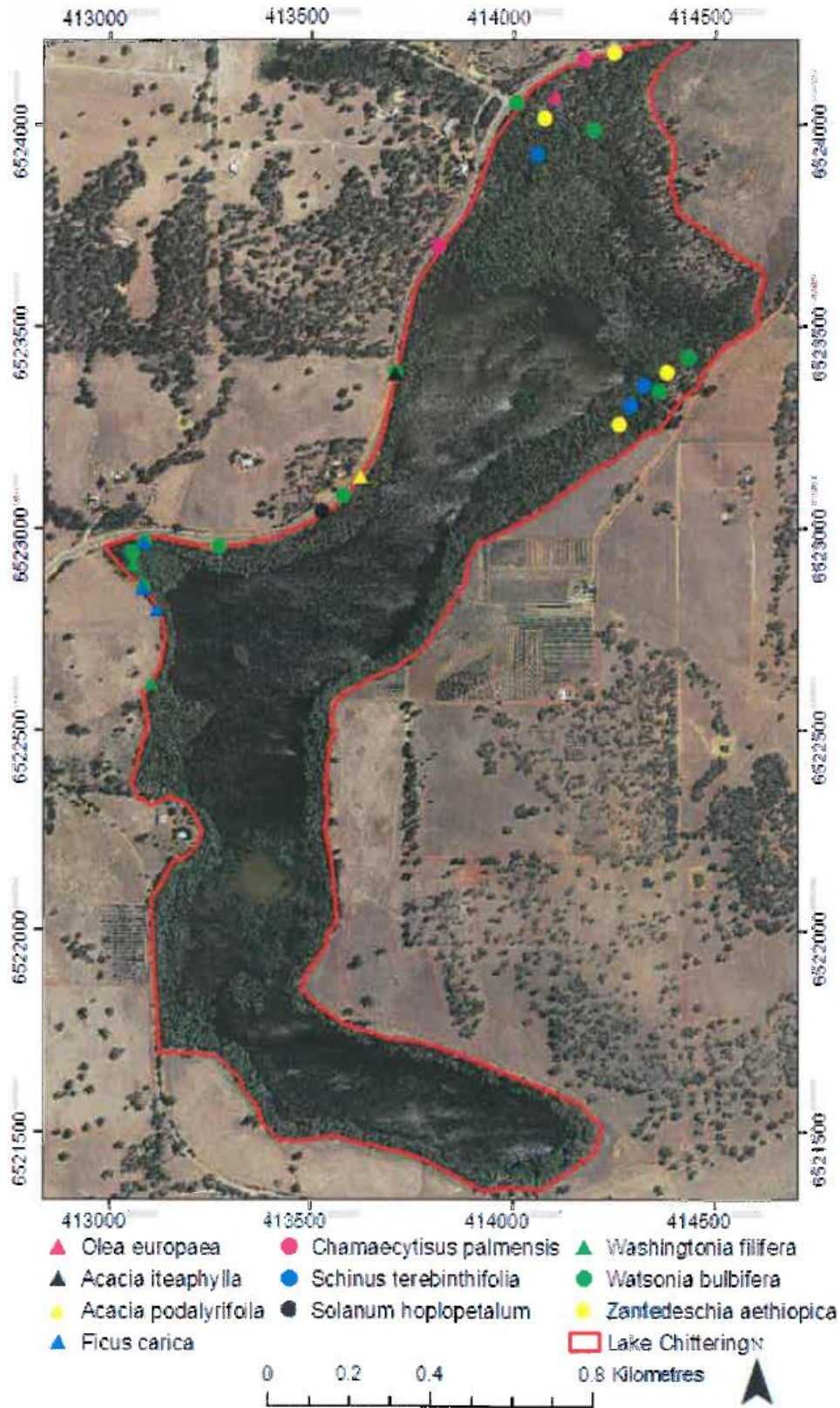


Appendix G: Weed mapping for Chittering Lakes Nature Reserve – North.

This map shows weed location information from 2017 overlaid on 2007 mapping information.

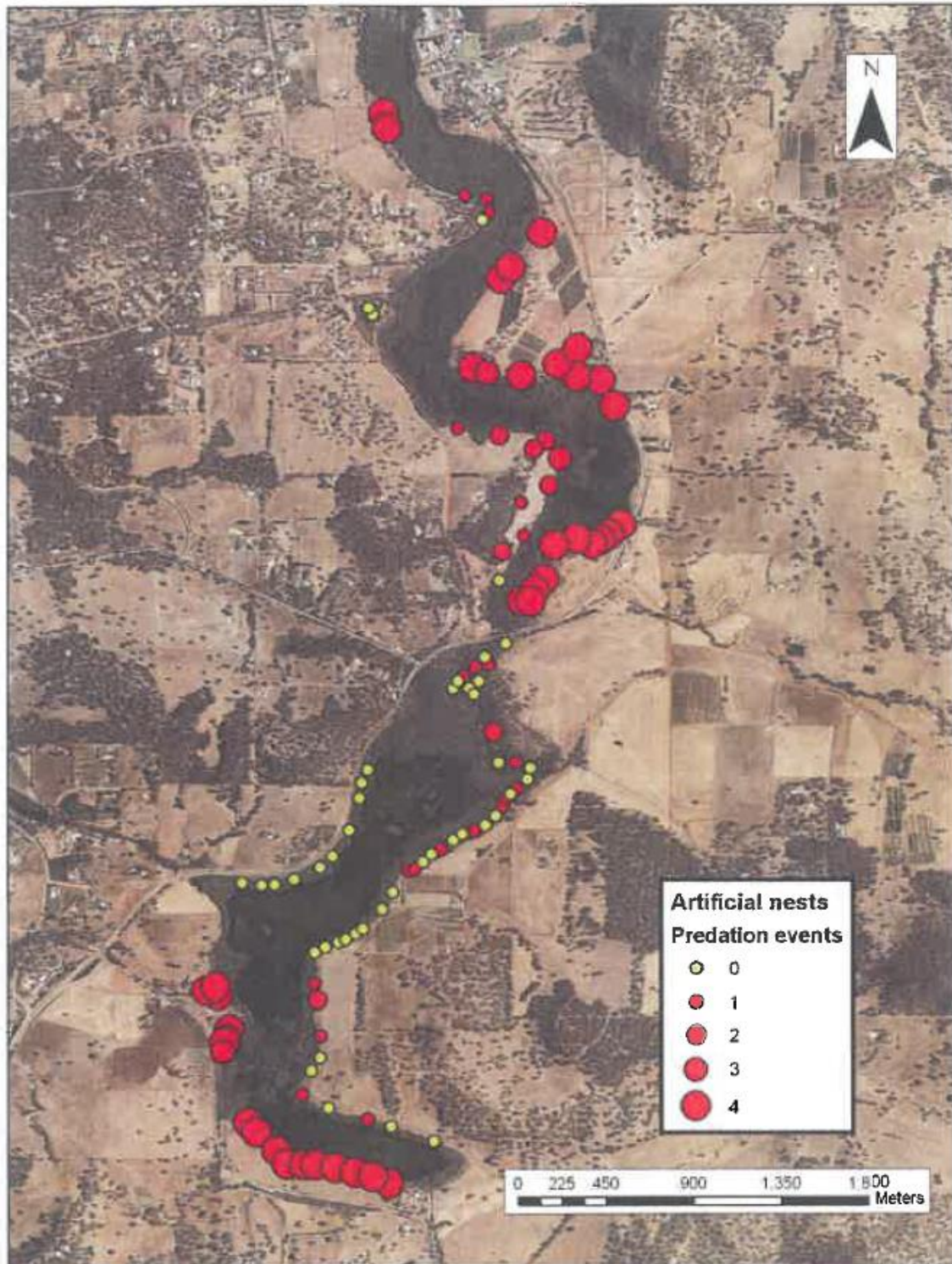


Appendix H: Weed mapping for Chittering Lakes Nature Reserve – South



Source: Connell, 2017

Appendix I: Map of the artificial nest locations and the level of predation recorded by Dawson *et al* (2012)



Source: Dawson et al, 2012

Appendix J: Birds recorded from Lake Needoonga in 2016 by the Chittering Bird Group.

Scientific Name	Common Name
<i>Biziura lobata</i>	Musk Duck
<i>Anas superciliosa</i>	Pacific Black Duck
<i>Microcarbo melanoleucos</i>	Little Pied cormorant
<i>Phalacrocorax sulcirostris</i>	Little Black cormorant
<i>Ardea modesta</i>	Great Egret
<i>Threskiornis molucca</i>	Australian White Ibis
<i>Threskiornis spinicollis</i>	Straw-necked Ibis
<i>Platalea flavipes</i>	Yellow-billed Spoonbill
<i>Circus approximans</i>	Swamp Harrier
<i>Falco cenchroides</i>	Nankeen Kestrel
<i>Fulica atra</i>	Eurasian Coot
<i>Ocyphaps lophotes</i>	Crested Pigeon
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo
<i>Calyptorhynchus banksii</i>	Red-tailed Black-Cockatoo
<i>Eolophus roseicapillus</i>	Galah
<i>Cacatua sanguinea</i>	Little Corella
<i>Barnardius zonarius</i>	Australian Ringneck
<i>Purpureicephalus spurius</i>	Red-capped Parrot
<i>Chalcites basalis</i>	Horsfield's Bronze Cuckoo
<i>Chalcites lucidus</i>	Shining Bronze-Cuckoo
<i>Dacelo novaeguineae</i>	Laughing Kookaburra
<i>Todiramphus sanctus</i>	Sacred kingfisher
<i>Malurus splendens</i>	Splendid Fairy-wren
<i>Pardalotus striatus</i>	Striated Pardalote
<i>Smicrornis brevirostris</i>	Weebill
<i>Gerygone fusca</i>	Western Gerygone
<i>Acanthiza apicalis</i>	Inland Thornbill

<i>Anthochaera carunculata</i>	Red Wattlebird
<i>Lichmera indistincta</i>	Brown Honeyeater
<i>Pachycephala rufiventris</i>	Rufous Whistler
<i>Colluricincla harmonica</i>	Grey Shrike-thrush
<i>Rhipidura fuliginosa</i>	Grey Fantail
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike
<i>Cracticus torquatus</i>	Grey Butcherbird
<i>Cracticus tibicen</i>	Australian Magpie
<i>Corvus coronoides</i>	Australian Raven
<i>Hirundo neoxena</i>	Welcome Swallow
<i>Petrochelidon nigricans</i>	Tree Martin
<i>Zosterops lateralis</i>	Silvereye

Appendix K: Birds recorded from Chittering Lake in 2016 by the Chittering Bird Group.

Scientific Name	Common Name
<i>Oxyura australis</i>	Blue-billed Duck
<i>Biziura lobata</i>	Musk Duck
<i>Cygnus atratus</i>	Black Swan
<i>Tadorna tadornoides</i>	Australian Shelduck
<i>Anas superciliosa</i>	Pacific Black Duck
<i>Anas gracilis</i>	Grey Teal
<i>Aythya australis</i>	Hardhead
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe
<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe
<i>Microcarbo melanoleucos</i>	Little Pied cormorant
<i>Phalacrocorax sulcirostris</i>	Little Black cormorant
<i>Pelecanus conspicillatus</i>	Australian Pelican
<i>Ardea modesta</i>	Great Egret
<i>Nycticorax caledonicus</i>	Nankeen Night Heron
<i>Threskiornis molucca</i>	Australian White Ibis
<i>Threskiornis spinicollis</i>	Straw-necked Ibis
<i>Circus approximans</i>	Swamp Harrier
<i>Falco longipennis</i>	Australian Hobby
<i>Fulica atra</i>	Eurasian Coot
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo
<i>Eolophus roseicapillus</i>	Galah
<i>Cacatua sanguinea</i>	Little Corella
<i>Barnardius zonarius</i>	Australian Ringneck
<i>Purpureicephalus spurius</i>	Red-capped Parrot
<i>Malurus splendens</i>	Splendid Fairy-wren
<i>Pardalotus striatus</i>	Striated Pardalote
<i>Gerygone fusca</i>	Western Gerygone
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill
<i>Lichmera indistincta</i>	Brown Honeyeater
<i>Pachycephala rufiventris</i>	Rufous Whistler
<i>Rhipidura fuliginosa</i>	Grey Fantail
<i>Rhipidura leucophrys</i>	Willy Wagtail
<i>Cracticus torquatus</i>	Grey Butcherbird
<i>Cracticus tibicen</i>	Australian Magpie
<i>Corvus coronoides</i>	Australian Raven
<i>Hirundo neoxena</i>	Welcome Swallow