Kareela Flying Fox Camp

Plan of Management – Final

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Abbreviations

Abbreviation	Description
AAH	Australian Animal Health
ABLV	Australian Bat Lyssavirus
AHA	Animal Health Australia
ARCUE	Australian Research Centre For Urban Ecology
ASVC	After School Vocational Care
AWHN	Australian Wildlife Health Network

Abbreviation	Description
BFF	Black Flying-fox
CAMBA	China and Australia Migratory Bird Agreement
CBD	Central Business District
cm	Centimetre
Council	Sutherland Shire Council
HDCV	Human Diploid Cell Vaccine
DECC	Department of Conservation and Climate Change
DECCW	Department of Conservation, Climate Change and Water
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
DotE	Department of the Environment
DoHA	Department of Health and Aging
EEC	Endangered Ecological Community
ELA	Eco Logical Australia
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FFCMP	Flying-fox Camp Management Plan
GHFF	Grey-headed Flying-fox
GHFFACTF	Grey-headed Flying-fox Alternative Campsite Task Force
ha	Hectare
HCC	Hurstville City Council
HRIG	Human Rabies Immunoglobulin
IUCN	International Union for Conservation of Nature
JAMBA	Japan and Australia Migratory Bird Agreement
DDCV	Human Diploid Cell Vaccine
IUCN	International Union for Conservation of Nature
KBCS	Ku-ring-gai Bat Conservation Society
LGA	Local Government Area
LRFF	Little-red Flying-fox
MNES	Matters of National Environmental Significance
OEH	Office of Environment and Heritage
NPW Act	*National Parks and Wildlife Act 1974*
NP&WR	*National Parks and Wildlife Regulation Act (2002)*

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Abbreviation	Description
NSW	New South Wales
PEP	Post-exposure prophylaxis
PreP	Pre-exposure prophylaxis
POCTA Act	*Prevention of Cruelty to Animals Act 1979*
PoM	Plan of Management
RBGM	Royal Botanical Gardens Melbourne
ROKAMBA	Korea and Australia Migratory Bird Agreement
RSPCA	Royal Society for the Prevention of Cruelty to Animals
Schools	Bates Road Special School and Sylvanvale Foundation After School Vocational Care
SFF	Spectacled Flying-fox
SRBG	Sydney Royal Botanical Gardens
SSC	Sutherland Shire Council
TSC Act	*Threatened Species Conservation Act 1995*

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Executive summary

Eco Logical Australia (ELA) has been commissioned by Sutherland Shire Council to produce this Plan of Management (PoM) to identify and assess options for the management of a Grey-headed Flying-fox (GHFF) (*Pteropus poliocephalus*) camp. The camp comprises between 500 and 12,000 flying-foxes, depending on the time of year and seasonal food availability. It occupies habitat within a 2.2 ha bushland reserve at Bates Drive, Kareela.

The NSW Minister of Environment advised Council to prepare the PoM to address concerns raised by the community regarding the health, safety and amenity of nearby residents, schools, businesses and sporting groups. As well as addressing the community's concerns, the PoM is required to demonstrate consideration of the ecological values and need to conserve the GHFF population. The GHFF is listed as vulnerable to extinction under the both the NSW *Threatened Species Conservation Act 1995* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The Kareela camp provides roosting habitat critical to the survival of the species, as defined by the draft GHFF National Recovery Plan (DECCW 2009).

In order to develop the PoM, ELA reviewed the available scientific literature, reports, previously implemented management plans and results of dispersal attempts relating to flying-foxes. This included a review of the ecology and biology of the species, and a critical review of the effectiveness of previous attempts to manage flying-fox camps in situ and attempts to disperse them to other areas.

This PoM has been prepared in accordance with the Flying-Fox Camp Management Policy (DECC 2007). It aims to provide the framework for Council and the community to manage the camp through staged actions:

- in a manner consistent with the State and Commonwealth statutory obligations and policies
- so that the health, safety and wellbeing of the community and flying-foxes are not negatively impacted.

Analysis of possible management options according to factors such as risk, cost, likely effectiveness and community opinion found that establishing health and safety protocols, modifications to playgrounds, alterations of Council's operational activities, and implementation of an education program were preferred approaches in the short term including increasing the buffer between the camp and neighbouring properties. Monitoring will be required to inform future management decisions.

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1 Introduction

1.1 Study area

The Kareela Grey-headed Flying-fox (GHFF) (*Pteropus poliocephalus*) camp is located approximately 30 km from Sydney's Central Business District within a 2.2 ha bushland reserve. It comprises a north-facing gully with Bates Drive, Mikarie Place, Sylvanvale and Aspect Mikarie facilities to the north west; residential dwellings to the west and south west; sporting fields to the south east; and Bates Drive and Kareela Golf Course to the north east. **Figure 1** shows the boundaries of the reserve and its regional context.

The reserve is zoned Public Open Space (Bushland) under Council's Local Environmental Plan (LEP 2006) and managed by Sutherland Shire Council. The reserve lies within an urbanised environment and adjoins residential, educational and recreational facilities. These include the Bates Drive Public School, and Sylvanvale, Aspect and Mikarie facilities. Bates Drive Public School, Sylvanvale, Aspect and Mikarie facilities provide education and programs for children and adults with disabilities.

1.2 Need for plan

The camp comprises between 500 and 12,000 GHFF depending on seasonal conditions, and **Figure 2** illustrates its extent. The proximity of the camp to schools and residences has resulted in Council receiving complaints about the offensive odour of the camp, the noise of the flying-foxes (which can be considerable during the mating period and when the non-flying juveniles are present), the mess created and damage to property from faecal drop by defecating flying-foxes. However, the greatest source of concern stems from the potential health risks associated with the Hendra virus and the Australian Bat Lyssavirus (ABLV). The school staff and parents are especially concerned because many of the special needs students do not understand the risks associated with these diseases or the means of transmission, and the students may have difficulty communicating with others if they come into contact with a GHFF.

Council has already undertaken a range of works aimed at managing the camp to address the complaints. These works involved pruning and removal of vegetation from the north-western edge of the camp to create a 10-15 m wide buffer. These works provided some relief from the noise and odour emitted from the camp. However, ongoing concerns combined with the death of a boy from ABLV in Queensland, prompted Sylvanvale to request that Council disperse the Kareela GHFF camp.

Statutory and ecological matters also need consideration in relation to any proposal to manage the GHFF camp. The GHFF is listed as vulnerable to extinction under both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Council sought advice from the NSW Environment Minister, Robyn Parker, about possible dispersal of the camp. The Minister advised Council to prepare a Plan of Management (PoM) that presents options for management including dispersal. The community and government agencies were consulted prior to finalisation of this PoM. Council plans to establish a steering committee (**Appendix A**) to oversee implementation.

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Figure 1: Location of study area

Figure 2: Extent of Kareela GHFF camp

1.3 Study objectives

This PoM is a comprehensive document that provides the context for assessment of a range of options for management of the Kareela GHFF camp. It has the following major objectives:

- Identify relevant State and Commonwealth statutory requirements associated with the species and its conservation.
- Investigate the impacts of the GHFF camp on local residents, sporting groups, staff, students and parents associated with the schools and other work places that occur in close proximity to the camp.
- Identify a range of options and strategies to conserve and protect the camp in situ and options that encourage co-existence of the GHFF camp and the community, as set out in the Flying-Fox Camp Management Policy (FFCMP) (Department of Conservation and Climate Change 2007).
- Identify staged management options suitable for implementation in the short, medium and long term, including a dispersal strategy.

1.4 Document structure

This PoM comprises three main parts:

- The first part describes management issues and gives a history of previous management of the Kareela camp. It identifies and assesses management options according to risk factors, costs and expected effectiveness based on experience at other locations. A framework for staged implementation is included.
- The second part presents technical matters such as relevant legislation and policies, biology of the species, threats to flying-foxes and results of an ecological survey at Kareela.
- The third part comprises a dispersal strategy.

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Part A – Management

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2 Management issues

Conflicts arise when flying-foxes camp close to a sensitive area such as residential dwellings, schools or if there is a sudden and dramatic influx of individuals in an established but small urban camp (Robert 2006; ELA 2012). Neighbours generally tolerate camps of a small size (Eby and Lunney 2001). However, people living, working or attending an education facility near a flying-fox camp are often negatively impacted by noise levels (sleep loss and reduced concentration), faecal drop, damage and loss of amenity and the fear of disease (Eby and Lunney 2001, ELA 2012, Geolink 2012).

This chapter examines the main management issues associated with flying-fox camps, including concerns and conflicts with the Kareela camp. Similar issues have arisen at other sites, as explained in the case studies in **Appendix B**.

The community was consulted to help identify the key issues associated with the Kareela camp that require management. Responses to surveys from those who live, work or occupy properties adjacent the Kareela camp indicated the following issues as being of greatest concern:

- human health risks 45%
- faecal drop 27%
- noise 15%
- odour 9%
- damage to native vegetation 3%.

2.1 Human health risks from pathogens, viruses and diseases

Australian flying-foxes have potential to carry a number of viruses that can pose human health risks and if contracted can be fatal without the appropriate treatment (NSW Health 2012). This includes the ABLV, Hendra virus and Menangle virus (Field 2005, NSW Health 2012).

A fact sheet produced by NSW Health (2012) suggests that the occurrence and risk of transmission of these agents are very rare and the public health risk is negligible. Often these pathogens are only transmitted to humans via a third party (e.g. pigs and horses) or through directly handling or contact between an infected flying-fox and a human (DAFF 2007). The fact sheet below explains the transmission, disease symptoms and health implications for each virus.

http://www.health.nsw.gov.au/environment/factsheets/Pages/flying-foxes.aspx

2.1.1 Australian Bat Lyssavirus

The ABLV is closely related to the rabies virus and in Australia infects four species of flying-fox (including GHFF) and a number of microchiropteran bat species (NSW Health 2013).

There have been three recorded cases of ABLV since the virus was identified in Australia, all of which have resulted in the death of the infected person. The mode of transmission of ABLV is through virus-laden saliva from infected animals introduced via a scratch or a bite, contamination of mucous skin or broken skin (NSW Health 2013). Contact with infected flying-foxes through scratches or bites is thought to have been the cause of transmission in all three cases.

The virus may incubate for 3-8 weeks following contraction, after which it affects the central nervous system and can be fatal if left untreated. Early symptoms of ABLV in humans are flu-like and include headache, fever, aversion to fresh air and water, weakness and fatigue. The disease can progress

rapidly and malaise, delirium, convulsions, coma and death occur within a week or two (NSW Health 2013).

ABLV was first discovered in flying-foxes in northern NSW in 1996 (Fraser et al. 1996). The expression of disease among wild populations of bat species is thought to be very low, with the results of recent surveys suggesting that approximately 4% of 200 individuals that tested were found to contain antibodies for ABLV (DAFF 2007). Flying-foxes infected by ABLV have been recorded from the north and eastern coastal areas, as far inland as Narromine in NSW and near Mount Isa in Queensland (Garner and Bunn 1997, Field and Ross 1999, Animal Health Australia (AHA) 2009). Serological surveys for the viral antigens suggest that ABLV may have a broad geographic range in flying-foxes across much of Australia (Field 2005, AHA 2009).

According to AHA (2009), flying-foxes affected with ABLV show a range of clinical symptoms that may be difficult for members of the general public to determine, and would be more difficult among school children with disabilities. These symptoms include overt aggression, paresis and paralysis, seizures and tremors, weakness, respiratory difficulties and change of voice. These symptoms are not exclusive to ABLV infection and be caused by other factors (Australian Animal Health (AAH) 2009). Affected animals are often found on the ground or low in a tree, and are unwilling or able to fly. ABLV also occurs in dead or dying flying-foxes, or those that appear to be suffering from another disease such as lead poisoning or angiostrongylosis (AAH 2009). Therefore, it should always be assumed that all Australian bat species have the potential to carry and consequently transmit ABLV (DoHA 2012).

People at greater risk of becoming infected by ABLV are those whose occupation includes volunteering or recreation activities resulting in exposure to potential diseased flying-foxes (DoHA 2012). However, there is a vaccine that can be administered prior to and after being bitten or scratched that can prevent disease, illness and death among humans. According to NSW Health and AHA (2009), contact or exposure to bat faeces, urine or blood will not pose a risk of exposure to ABLV.

2.1.2 Hendra virus

The Hendra virus, which is also known as the equine morbillivirus or bat paramyxovirus no.1 was first discovered in Australia following an outbreak of illness among horses at a large racing stable near Brisbane, Queensland (NSW Health 2012). To date, the virus has resulted in seven known human infections, of which there have been four deaths (NSW Health 2012). All of these seven people had some form of contact with infected horses prior to becoming ill (Geolink 2012). It appears that all of the horses involved in these cases caught the virus from infected flying-foxes. The transmission of the virus appears to have occurred through horses consuming food that is contaminated by the faeces from infected flying-foxes. Despite not exhibiting any disease symptoms, flying-foxes are thought to be the natural host of the Hendra virus. Antibodies for this virus are present in all four flying-fox species across the Australian mainland.

Human symptoms include fever, cough, sore throat, headache and tiredness which can develop between 5-21 days following contact with infectious horses. Further symptoms associated with meningitis or encephalitis (inflammation of the brain) can also develop, resulting in headache, high fever, drowsiness and sometimes convulsions and coma (NSW Health 2012).

There is no evidence of Hendra being transmitted from bat to humans, or from human to human (NSW Health 2012). In addition, it also appears that the Hendra virus is not readily transmitted between infected and un-infected horses (NSW Health 2012).

2.1.3 Menangle virus

The Menangle virus (also known as bat paramyoxovirus no.2) was first isolated from stillborn piglets from a NSW piggery in 1997. Little is known about the epidemiology of this virus, except that it has been recorded in flying-foxes, pigs and humans (Australian Wildlife Health Network (AWHN) 2010). The virus caused reproductive failure in pigs and severe febrile illness in two piggery workers employed at the same Menangle piggery where the virus was recorded (AWHN 2010). The virus is thought to have been transmitted to the pigs from flying-foxes via an oral-faecal matter route (AWHN 2010). Flying-foxes had been recorded flying over the pig yards prior to the occurrence of disease symptoms.

The two infected piggery workers made a full recovery and this has been the only case of Menangle recorded in Australia.

2.1.4 Management of injured or dead flying-foxes

Juvenile, injured or dead flying-foxes may be on the ground, or entangled amongst power lines or barbed wire. Three GHFFs (two dead, one injured) have been found in the school grounds since the Kareela camp was established in 2006. In accordance with the schools' management plan, searches of the school grounds and surrounding areas are conducted by staff to confirm the absence of flying-foxes before the students arrive each morning and/or are allowed outside.

2.2 Faecal drop

Flying-foxes have a very efficient digestive system which allows food to pass through very quickly (12-30 minutes) and they will primarily defecate at their feed sites or as they travel back to their roost sites (Westcott et al. 2011). However, flying-foxes are also known to defecate immediately as they leave their roosts to fly to their nightly foraging habitats. If deposited in flight, faecal matter and urine can splatter and create mess, damage property as well as cause other inconveniences such as not being able to dry washing on warm nights (Hall and Richards 2000). Flying-fox droppings can permanently mark painted objects such as cars, houses and pathways (Hall and Richards 2000, ELA 2012).

All animal faeces and urine can contain bacteria, viruses and other microorganisms that can cause illness among humans (Geolink 2012). However, NSW Health (2009) and the Department of Sustainability and Environment (DSE 2009) advise that touching and/or coming in contact with flying-fox faecal matter or urine will not transmit ABLV, Hendra or any other pathogen that is currently known to cause significant disease among humans (Geolink 2011).

Faecal drop has affected the schools' amenities and cars that belong to staff. During a recent site visit by ELA, faecal drop was on demountable buildings that are located immediately adjacent to the camp (Error! Reference source not found.). However, there was little evidence of other faecal drop impacts elsewhere in and adjacent to the schools.

The general nightly foraging fly-out direction from Kareela, during which the flying-foxes appear to defecate the most, was observed in a south west and southerly direction, away from the school and across sporting fields.

2.3 Noise

Flying-foxes are highly social animals that vocalise to communicate with each other and have been recorded making over 30 different types calls (Westcott et al. 2011, Geolink 2012). Flying-foxes use calls to make warnings, contact, and during courtship, territorial disputes and for mother-infant recognition, especially when the mothers return from their nightly foraging activities (Roberts 2006). Daytime calls are made by squabbling juveniles, during courtship and in response to external

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disturbances, including dogs, people and the operation of machinery. The noise created from flying-fox camps, especially during peak periods of activity, such as fly-outs and as foraging individuals return to the camp in the early morning can adversely affect human sleep patterns, create annoyance, cause stress and impact on the wellbeing of local residents (Roberts 2006, ELA 2012, Geolink 2013).

Community consultation confirmed that daytime noise emitted from the Kareela GHFF camp is a significant problem at the schools and residential properties with noise ranked third after health risks and faecal drop. School managers indicated that noise levels during spring and summer, when the camp is densely populated with migrating adults and squabbling flightless young, can be particularly loud which is distracting to staff and can cause distress among the students.

Roosting GHFFs at Kareela are easily disturbed by roaming dogs, birds of prey, planes and people, as well as the use of machinery (chainsaws, lawnmowers, whipper snippers and excavators) (Roberts 2006).

2.4 Odour

Flying-foxes use odour for identification, including attractants during the reproductive period to enable mothers to find their young when they return to the camp following their nightly foraging activities (Ipswich City Council Date - Living with Flying-foxes: Fact Sheet 4).

The characteristic pungent odour emitted from flying-fox camps is a scent produced by a male scapular gland applied to tree branches to mark territories and attract females (Roberts 2006, Geolink 2011). Odour does not come from a build-up of faecal matter and urine underneath the roosting flying-foxes. The odour emitted from the Kareela camp is noticeably stronger and generally regarded as being more unpleasant during:

- periods of prolonged rainfall, which causes the males to have to remark their territories
- periods of hot and humid weather conditions
- periods when the camp is densely populated by flying-foxes.

During community consultation, the occupants of neighbouring properties indicated that some days the odour is so strong they cannot be outdoors or leave the windows open. This leads to a rise in the need for air-conditioning and loss of outdoor recreational opportunities.

2.5 Damage to native vegetation and proliferation of weeds

While landing and flying within their roosts, flying-foxes will often defoliate and break branches, and tree deaths are common in densely populated camps or during prolonged periods of camp occupation. Flying-foxes have seriously damaged the upper canopy vegetation at the Kareela camp, and several large Coral Trees (*Erythrina* X *sykesii*) and *Eucalyptus* spp. are dead (**Figure 4**). The loss of canopy vegetation allows for increased levels of sunlight to reach the lower vegetation strata levels. Greater sunlight combined with the additional nutrients from the defecating GHFFs as well as other urban impacts (e.g. stormwater, garden dumping) has led to a proliferation of exotic weeds.

2.6 Displacement of native fauna

Anecdotal accounts suggest that damage and weed invasion associated with GHFF camps can displace other native species. However, there are no studies available to indicate the extent to which the GHFF camp at Kareela has displaced native species. It is more likely that native species would

have been significantly affected by past habitat fragmentation and other impacts associated with urban activity (e.g. development, roads and domestic animals).

Figure 3: Faecal drop on demountable building within the school

Figure 4: Loss of canopy cover due to defoliated trees

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3 Management history

3.1 Australian context

Flying-foxes (*Pteropus* spp.) were once common and widespread across much of eastern Australia. Since European settlement, many flying-fox species have suffered considerable range and population declines (Westcott et al. 2011). Anecdotal evidence suggests that flying-foxes had already suffered a 50% reduction in abundance by the 1920s (Ratcliffe 1932, Tideman et al. 1999). Camp counts conducted between 1989 and the early 2000s indicate an additional 30% decline in the population (Tideman et al. 1999, Parry-Jones 2000, DECCW 2009). The reasons for these declines include the destruction of foraging and roosting habitats through forestry, agriculture and urbanisation, intra-species competition and persecution (Tidemann et al. 1999, DECCW 2009, Westcott et al. 2011).

In recognition of its significant decline and need for conservation, the GHFF is listed as vulnerable to extinction under the both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The species is also listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988* and Queensland *Nature Conservation Act 1992*.

3.2 Establishment of the Kareela camp

The history of the Kareela camp extends back to the summer of 2006-2007 when a small number of individuals were recorded roosting in the gully that the camp presently occupies (Council 2011). The establishment and gradual increase in GHFF numbers at the Kareela camp may be linked to the demise of the Kurnell GHFF camp (location shown in **Figure 5** and **Figure 6**). Council staff observed that about 8,000 GHFF abandoned the Kurnell camp following de-watering operations during the construction of the Sydney Desalination Plant and approximately the same number of GHFF established at the Kareela camp over a two-week period in 2008. This is typical as displaced flying-foxes tend to move short distances in their search for new roosts in order to maintain a close connection to their optimal or seasonally available food resources.

The size of the camp has fluctuated over time and between seasons from 500-12,000. Temporary abandonment of the Kareela camp in August 2012 (pers. comm. John Martin, Royal Botanical Gardens (RBG), Ian Drinnan SSC) coincided with other Sydney GHFF camps being deserted for short periods as many GHFFs flew to the south coast of NSW to take advantage of the prolific flowering of *Eucalyptus* species. The size, permanency and dynamics of most flying-fox camps are strongly tied to the availability of local and regional food resources and climatic extremes (Roberts et al. 2012).

3.3 Recent management

Since the Kareela GHFF colony became established, Council has undertaken a range of works in an attempt to mitigate the impacts and reduce conflicts. A section 95 certificate (no. 1118944) was issued by OEH on 14 October 2010 to allow removal of 28 native and exotic trees and saplings from a 0.12 ha area on the northern edge of the camp to create a 10-15 m wide buffer separating the camp from the school grounds and adjoining residential dwellings. In accordance with the section 95 certificate and to minimise direct impacts upon the flying-foxes, the works were conducted at night while the flying-foxes were absent from the camp between 20 and 28 October 2010.

Compensatory planting was provided on the opposite side of the camp where no conflicts exist. The access road and parking for the Bates Road Special School is adjacent to the buffer area and provides

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additional separation from the camp. The total buffer (including road and carpark) between the camp and the Sylvanvale buildings and grounds is at least 20 m. (**Figure 7** shows the buffer and compensatory planting locations.)

However, a small amount of faecal matter was on buildings closest to the camp and staff highlighted to ELA the need to wash buildings, cars and playground equipment at certain times of the year – probably from fly over of flying-foxes returning to the camp.

3.4 Summary of management history

The following table summarises the management history of the Kareela camp.

Table 1: Management history of the Kareela camp

Date	Event
Mid 1990s	A GHFF camp established at Kurnell. Counts estimated that it often comprised approximately 8,000 individual GHFFs.
November 2005	Sydney Water released an Environmental Assessment (EA) for the desalination plant at Kurnell (Veolia Water Australia Pty Ltd 2011). The EA identified the presence of a GHFF camp at Kurnell and concluded that the works at the desalination plant were unlikely to have a significant impact on the camp.
January 2006	Council made a submission to the Department of Planning objecting to the proposed construction of the desalination plant at Kurnell. Council raised a number of environmental matters that may be affected by works, including the potential impacts to the GHFF camp.
November 2006	Approval granted for the construction of the Kurnell desalination plant to begin.
Summer 2006 – 2007	A small GHFF camp consisting of approximately 20 individuals established at Kareela.
2007	Works associated with the construction of the Kurnell desalination plant commenced.
Summer 2007 – 2008	Large numbers of GHFF appeared at the Kareela site, which coincided with the abandonment of the Kurnell camp following works undertaken at the desalination plant.
October 2008	Residents from Mikarie Place Kirrawee presented a petition to Council concerning a range of issues.
November 2008	Council responded to the residents and staff from the schools with information explaining the ecological importance of GHFF, risks and requirements under state and federal legislation that are applicable to ensure the protection of the species.
Summer 2008 – 2009	The schools implemented specific measures aimed at reducing the risks to the children. This included ground patrols each morning before students arrive at the school to ensure that there are no dead or dying flying-foxes present within the grounds, additional cleaning of play areas and equipment, closing of windows to classrooms and buildings facing the camp, and the increased use of air conditioning to reduce the effects of the camp's odour.
March 2009	Council approached Sydney Water and requested assistance to deal with the GHFF issue at Kareela because it was supposed that the flying-foxes moved from Kurnell in response to the construction activities associated with the desalination plant. While Sydney Water did not accept responsibility, they did engage bat expert, Dr Peggy Eby to assist Council in their attempts to manage the camp in situ and reduce conflicts between the camp, schools and local residents.

Date	Event
October 2009	In an attempt to limit conflict/impacts from the camp, Council pruned all of the branches that overhung the schools. The aim was to prevent any GHFF from roosting in the vegetation that directly overhung the schools' grounds. This represented the maximum extent of works that Council felt could be undertaken without the need to apply for state and federal approvals and licences.
July 2009 – December 2009	Royal Botanical Gardens Flying-fox Team conducted counts at Kareela and estimated the camp contained between 1650 and 3000 individual GHFFs.
January 2010 – September 2010	Royal Botanical Gardens Flying-fox Team conducted regular counts at Kareela and estimated the camp numbers to fluctuate between a low of 570 to a July peak of 12,000 individual GHFFs.
September 2010	Council lodged an s.91 application to NPWS to clear the vegetation from the north-west boundary to create a buffer that would separate the camp from the schools. The works involved the removal of 0.15 ha of vegetation and compensatory plantings elsewhere in the reserve in attempt to re-create habitat for the camp away from the schools.
October 2010	The s.91 licence application was successful and a s.95 certificate was granted by OEH to clear vegetation and create the buffer (see **Figure 7**).
August 2011	Correspondence received from schools indicated that works undertaken to create a buffer (including on-site management measures, overhanging branch removal and vegetated buffer clearing) were unsuccessful in delivering the desired outcomes/results and consequently health concerns and amenity impacts resulting from the presence of GHFF at Kareela persist. Council received further requests from the school to disperse the GHFF camp.
September 2011	Council invited a representative from NSW Health to present the risks associated with disease transmission between flying-foxes and humans. The presentation was aimed at attempting to alleviate the concerns of the parents, staff and local residents.
October 2011	Council approached Sydney Water for a second time requesting assistance with the GHFF issues at Kareela. Sydney Water denied the request for assistance.
December 2011	Council engaged contractors to undertake vegetation management works at Kareela in compliance with s.95 conditions that include offsetting the lost vegetation that was cleared from the northern edge of the camp to create a habitat buffer separating the Sylvanvale and Bates Drive Special School from the camp.
February 2013	Council voted to allocate funds for the preparation of a Plan of Management that is required to support any applications made to the Office of Environment and Heritage (OEH) to disperse the Kareela GHFF camp.
April 2013	Council invited a number of consultants to tender for the opportunity to prepare the Plan of Management.
May 2013	Eco Logical Australia Pty Ltd (ELA) was engaged to prepare a Plan of Management for the Kareela GHFF camp.
October – November 2013	Council exhibited the draft Plan of Management. The public was encouraged to make written submissions via an on-line questionnaire, or by email or letter. The exhibition period included two general community information sessions, and one information session for the Sylvanvale, Bates Drive, Aspect schools and Mikarie Place childcare centre. Other councils and agencies were also consulted.

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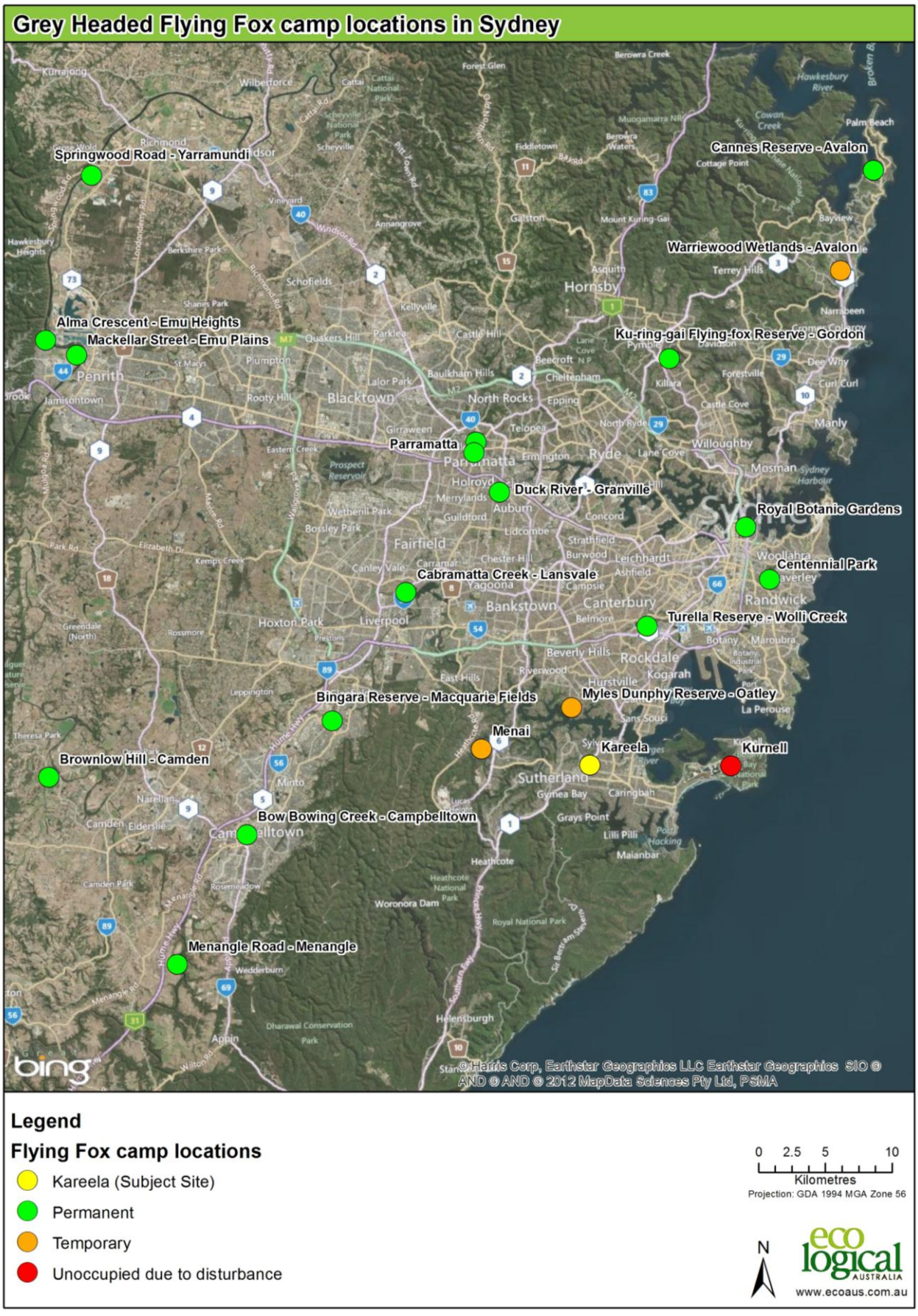

Figure 5: Current status of Sydney flying-fox camps

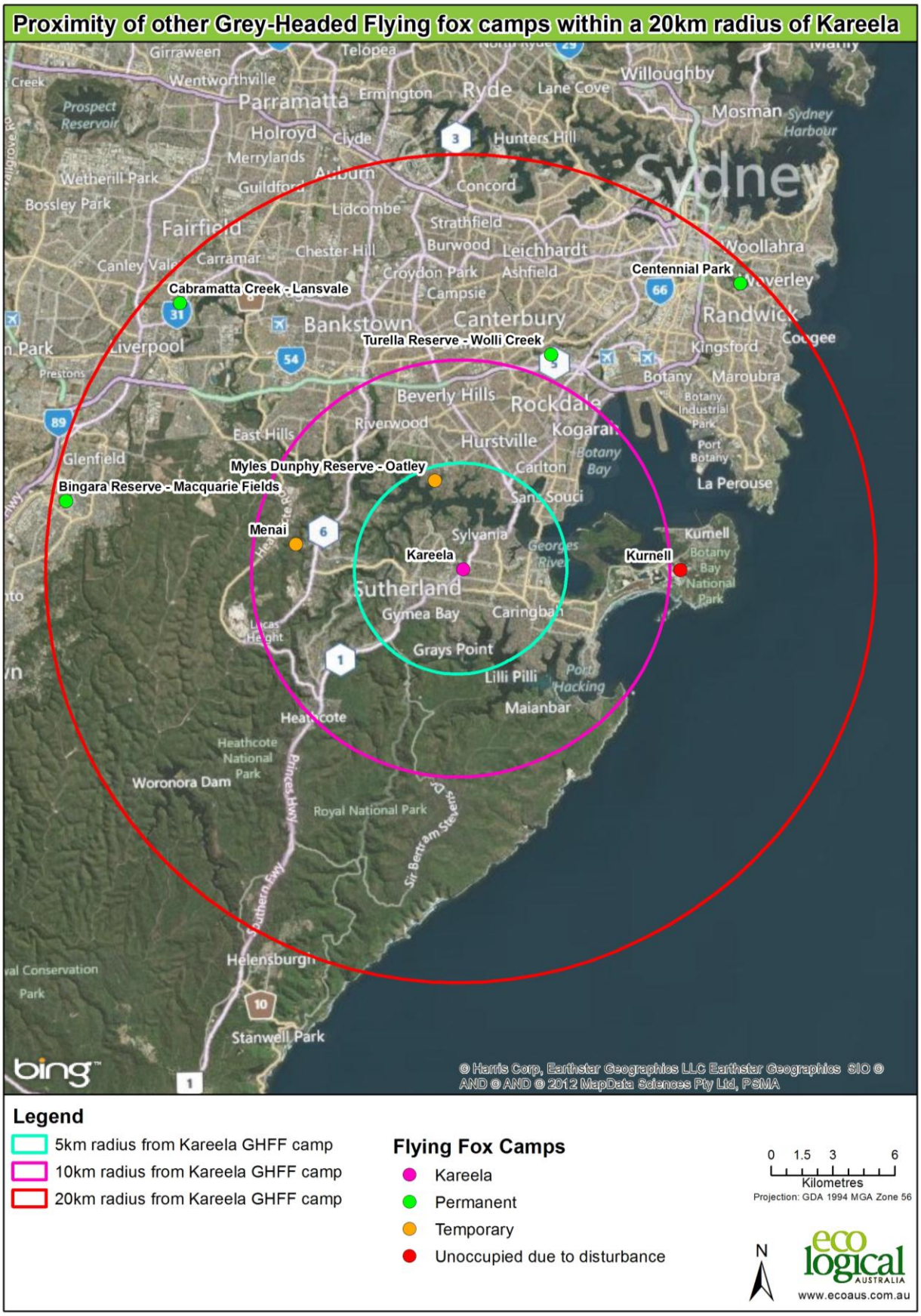

Figure 6: Locations of camps that are within 5, 10 and 20 km of the Kareela GHFF camp

Figure 7: Vegetation management within the Kareela reserve (SSC 2011)

Figure 8: Northern end of the buffer looking south to the open woodland

Figure 9: Core of GHFF camp in dense weed dominated vegetation near school fence

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Figure 10: The southernmost of end of buffer between the schools and camp, includes drainage

Figure 11: Lawn separating the residential dwellings from the camp

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Figure 12: Compensatory planting on the south-eastern edge of the reserve

Figure 13: Crown deaths in taller canopy tree species due to roosting flying-foxes

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4 Management options

This chapter describes and assesses options available to manage the GHFF camp at Kareela. In **Table** 2, the options have been ranked from most to least preferred based on PoM objectives, statutory matters, GHFF welfare, experience at other sites, scientific information, risks, potential impacts, expected costs and community feedback. The success of short term (Stage one) measures will inform decisions about the need for further action in the medium to long-term (stages two and three). Monitoring and performance measurement will be an essential part of any management option.

Table 2: Summary of stage one, two and three management actions

Stage 1 – Targeted response for people directly impacted	Stage 2 – Increasing the buffer	Stage 3 – Dispersal (last resort)
4.1.1 Alter Council operations adjacent camp to reduce flying-fox disturbance 4.1.2 Provide educational programs for surrounding residents and community 4.1.3 Research and monitoring 4.1.4 Prepare health and safety protocols for surrounding residents and community 4.1.5 Increase school 'bat watch' patrols 4.1.6 Modify school grounds 4.1.7 Modify directly affected residential properties 4.1.8 Provide input to master planning of adjacent facilities to move vulnerable activities away from Kareela camp	4.2.1 Enlarge vegetation buffers 4.2.2 Nudging the camp to another nearby location 4.2.3 Provision of alternative habitat	4.3.1 Dispersal by noise and other deterrence 4.3.2 Dispersal by selective habitat removal 4.3.3 Dispersal by total habitat removal

4.1 Stage one - options to manage the camp in situ

Stage one management options aim to improve the amenity and safety of those most directly affected by the camp while managing the camp in situ. These actions do not disturb the flying-foxes and therefore can be conducted without State or Federal approval. Regular approvals through Council will be required for car ports/pergolas and other modifications to buildings as per Council's development controls and Local Environment Plan.

4.1.1 Alter Council's operations adjacent the camp

Roosting GHFFs become more unsettled and noisy when disturbed by loud noises such as machinery and barking dogs. Rather than maintain the existing grassy buffer area, the buffers can be transformed by mulching and planting attractive and ecologically functional vegetated buffers using suitable low-growing vegetation (not flying-fox habitat). This will reduce the need for lawn mowing and reduce the suitability for dog exercise (i.e. potential sources of noise and disturbance).

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Regular maintenance of the vegetation within the buffer area using hand techniques will reduce the need for machinery for maintenance by preventing the weeds becoming large and abundant. If machinery is required for buffer management then controls on the timing should be implemented, such as times of the year when flying-foxes are less abundant and times to accommodate and prevent disturbance of school activities.

An operational procedure for Council staff should be prepared regarding required timing and methods for maintenance of buffer zones around the camp and activities within the Bates Drive depot. The procedure should also specify requirements for occupational health and hygiene relevant to the flying-foxes (see **Section 4.1.4**).

Table 3: Alter Council's operations adjacent the camp

Considerations	Details
Aim of the action	Reduce the disturbance of flying-foxes by maintenance and operational activities adjacent the camp
Statutory requirements	Nil
Previous experience	No previous experience identified in recent management of flying-fox camps
Community welfare	Reduced noise, reduced faecal drop outside of the camp footprint and improved amenity
Flying-fox welfare	Positive outcome for flying-foxes due to less disturbance
Monitoring	Observational monitoring of the impacts of GHFF adjacent the operational areas before and after operational changes Interview school staff to ascertain if the management of the area adjacent the camp has been effective in reducing flying fox disturbance
Success criteria	Low maintenance buffer established and amenity impacts reduced
Cost	Modification of grassy buffer to mulched/vegetated buffer – estimated cost $25,000 Ongoing maintenance costs – hand control of weeds by bush regenerators rather than regular mowing by Council

4.1.2 Education

Provision of clear, targeted and accurate information to the local community about flying-foxes is integral to management of the Kareela flying-fox camp. The program will identify and communicate community concerns and provide an up to date program of works (e.g. via Council's website) to ensure the community feels heard and that actions are being implemented. Various sectors in the community will respond to different education platforms and a variety of avenues should be pursued, such as:

- information on Council's website regarding the camp's management status
- interactive workshops to discuss the ecology of the species, perceived health risks, history of the Kareela camp, issues at the camp and management actions to be undertaken
- leaflet explaining the ecology of the species, perceived health risks, history of the Kareela camp, issues at the camp and management actions to be undertaken
- consider signage at key locations around the camp to explain ecological features and health risks associated with GHFFs.

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Table 4: Education program

Considerations	Details
Aim of the action	Reduce the fear and misinformation the community may have in relation to the flying-foxes
Statutory requirements	Nil
Previous experience	Maclean – since education material has been distributed, the PoM developed and some on ground actions have been undertaken, community concern about the project has dwindled (Rodney Wright, Clarence Council, pers. comm. 2013) Wolli Creek Preservation Society indicate that their efforts in providing education to the community and engaging a volunteer group to assist in observing the camp may have contributed to less conflict (pers com Deb Little, Wolli Creek Preservation Society 2013)
Community welfare	Raised community awareness of actual risk but no mitigation of amenity issues
Flying-fox welfare	May result in reduced intentional disturbance through better understanding
Monitoring	Monitor the number of 'hits' to Council's GHFF web page Pre- and post-education community surveys (e.g. by interviews or questionnaires) to evaluate changes in community attitudes as per Larson et al. (2002)
Success criteria	Use of Council's GHFF webpage Improved community awareness of ecological importance of GHFF and support for management Less formal complaints relating to health risks
Cost	Printed brochure for local area, dedicated page on council website plus yearly community workshop events with experts - estimated cost $5,000 Design and install educational signage – estimated cost $5,000 Monitoring – letter box surveys (pre and post education program)

4.1.3 Research and monitoring

Managing the Kareela flying-fox camp is complicated by gaps in local and regional ecological knowledge of GHFFs, their camps and their response to management. It is considered mandatory to undertake basic monitoring of all management actions to provide quantifiable and repeatable actions to help manage the species into the future as conflicts between humans and flying-foxes in the urban area are likely to increase into the future.

Research directions and opportunities are available that can benefit the management of urban flying-fox camps. Success criteria must be established prior to any monitoring program to effectively understand the outcomes of any research. Examples of these research directions are below:

- Monitor on-site management actions – are flying-fox key issues being alleviated?
- Monitor any actions at the site for their respective impacts.
- Community perception of management, what are the perceived issues and risks before and after actions implemented.

Table 5: Research and monitoring program

Considerations	Details
Aim of the action	To gain further understanding of flying-fox ecology that can inform future actions
Statutory issues	Scientific licence from OEH and potential animal ethics approval depending on techniques to be used. Requirement in Flying-fox Camp Management Policy (DECC 2007) to monitor outcomes of actions.
Previous experience & scientific information	Significant research currently exists on the species, although specific priority research questions on the management of human/flying-fox interactions is lacking. Research on the relocation of the Sydney RGB relocations is ongoing and Melbourne and Maclean findings have largely been published (Sydney RBG website 2013, ARCUE 2009, Roberts *et al* 2011). Significant findings of the research include: • Flying-foxes did not disperse to targeted locations, at least initially and many locations were inappropriate and required further action • At Sydney and Maclean, dispersal varied between individuals, the whole camp did not move to a single location • Monitoring of a dispersal is critical in understanding the outcomes and monitoring the welfare of the flying-foxes • Ongoing work was required to prevent re-establishment of camps Significant gaps are present in research in understanding changes in community attitudes from the implementation of various management actions.
Community welfare	Community can be more confident that management decisions are informed by scientific knowledge
Flying-fox welfare	Improved welfare based on increased knowledge
Success criteria	Provision of funds and expertise to ensure the development and ongoing research into managing urban GHFF camps
Cost	Costs associated with research / monitoring should be covered as part of other actions External funding and collaboration will be required

4.1.4 Health and safety protocol

A flying-fox health and safety protocol for the schools, local residents and the Council depot on Bates Drive would need integration with current workplace health and safety measures at places of employment. The protocol would focus on the management of any potential contact with flying-foxes to ensure that potential infection with the ABLV is handled appropriately. Protocols would be directed at staff and students at Sylvanvale, local residents and workers at the Council depot on Bates Drive. Other bat-borne viruses such as Hendra Virus are not directly transmittable to humans from flying-foxes.

Animal searches

Such a protocol would need to incorporate searches for animals on premises, what to do if a flying-fox is found and a clear course of action if an animal is discovered. Protocols would need to be developed for each risk sector (schools, private residences and Council depot) and include the following actions:

- Ground searches first thing in the morning.
- Ground searches prior to the students using outdoor areas (schools).
- If a flying-fox is discovered on the ground or in a location with potential for human contact, the area is clearly identified, access prohibited and a suitable wildlife agency contacted to undertake the removal of the animal.

It is understood that a protocol of this nature currently exists at Sylvanvale. This protocol would bring 'bat patrols' into line with an over-arching plan. Appropriate integration with other actions such as education will significantly mitigate risk of unwanted human-flying fox contact.

Animal handling

If a flying-fox is recorded within the school grounds, under no circumstance should it be handled unless the person has been previously vaccinated for the rabies virus and is trained to handle wildlife. However, if there is an urgent need to handle a dead or living flying-fox it should only be handled using the following techniques:

- Wear thick gloves (e.g. gardening gloves) and use garden shovel where possible.
- Wrap the carcass up in at least two plastic bags.
- Wash hands thoroughly with soap and water afterward.
- If you get scratched, a doctor should be consulted immediately.
- Store the carcass in a safe place and contact the Department of Health to remove and analyse it.

Vaccinations

Particular sectors of the community in proximity to the Kareela flying-fox camp have higher perceived risks from the ABLV (i.e. staff and students at the schools). The NSW Health advice states that contact or exposure to faces, urine or blood do not pose a risk of exposure to ABLV, nor does living, playing or walking near flying-fox camps.

A pre-exposure ABLV vaccine is administered through a series of three injections over the course of approximately one month, although it does not provide complete immunity to the virus. Following any potential exposure through a scratch or bite, further medical treatment will be required and boosters for the vaccine are potentially required every two years, based on an assessment of a person's immune response. A post-exposure vaccine is available as a series of five injections.

Vaccination would alleviate fears of perceived health risks for the community. staff, parents and students from schools. Council and other work places could consider vaccinating staff. This is a Workplace Health and Safety measure that may reduce potential liability on behalf of employers. Any implementation of this action should be undertaken under the supervision of a health care professional in conjunction with an education program and broader health and safety protocols.

More information about vaccination is in the Department of Health handbook http://www.health.gov.au/internet/immunise/publishing.nsf/Content/handbook10-4-16).

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Table 6: Health and safety protocol

Considerations	Details
Aim of the actions	To reduce the exposure of the community to potential health risks
Statutory issues	Appropriate integration with work site processes and protocols in line with the *Work Health and Safety Act 2011*
Previous experience	No previous experience identified in recent management of flying-fox camps
Community welfare	Improved management of health risks
Flying-fox welfare	No impact to flying-foxes
Monitoring	Record and report all health incidents and contact with flying-foxes
Success criteria	Protocol developed and implemented
Cost	The cost of the development of the protocol would be minimal, although some cost would be associated with training and increased workloads on staff as well as provision of suitable anti-viral antiseptics. In the event of an incident, NSW Health would cover the cost of the vaccine and the frequency of such events considered very low. Estimated <$5,000 for development of the protocol Approximately $500 per vaccination ($330 for vaccination cost and $170 for addition time charges) A two year booster is recommended to those people working closely and have continued exposure to bats

4.1.5 Increase 'bat watch' patrols

Sylvanvale staff began 'bat-watch' patrols of their grounds in the summer of 2008-09. The provision of an additional staff member would increase the schools' capacity to undertake these patrols and expand their scope and frequency. Increased surveillance of the school grounds during times when children are outdoors may reduce the likelihood of flying-fox and human contact. Patrols would be undertaken in the early morning before staff and students arrive, and prior to and during any outdoor activities.

Table 7: Increase 'bat-watch' patrols

Considerations	Details
Aim of the action	To reduce the exposure of the students to potential health risks
Statutory issues	Nil
Previous experience	No previous experience identified in recent management of flying-fox camps
Community welfare	Mitigation of perceived health risks. No mitigation of noise, faecal drop and odour issues
Flying-fox welfare	No impact to flying-foxes
Monitoring	Record and report all surveillance and contact with flying-foxes

Considerations	Details
Success criteria	Increased surveillance of school grounds
Cost	One additional staff member, minor qualifications = $50,000/year

4.1.6 Modify school grounds

Modifications to Sylvanvale, Aspect, Mikarie and Bates Drive grounds adjacent the Kareela GHFF camp could reduce the impact of noise, odour and faecal drop. Actions at schools around the Kareela camp in order of importance could include:

- 'bat safe' netting over play yards
- carports over vehicles
- increased shade cloth areas in areas affected by faecal drop
- selective removal of vegetation to prevent flying-fox roosting on adjacent grounds
- sound barriers
- double glazed or laminated windows
- coating surfaces to allow easier cleaning
- scheduled cleaning services or gurney purchase for regular cleaning
- air conditioning to allow temperature control in buildings when windows are closed to prevent odour entering buildings
- planting of suitable screening plants between the camp and schools.

These actions target concerns raised during the exhibition period by school staff and parents. 'Bat safe' netting over play yards would virtually eliminate the potential for staff and students in play yards to come into contact with flying-foxes. If implemented in conjunction with other actions such as a 'bat watch' patrols, health and safety protocols and education there is an opportunity to manage the flying-foxes in situ. Implementation could be quick, subject to available funding.

Table 8: Modify school grounds

Considerations	Details
Aim of the action	To reduce the exposure of the staff and students at the schools to potential health risks and reduce the amenity impacts such as faecal drop, odour and noise.
Statutory issues	Nil
Previous experience	The experience at Maclean has been that shade structures were effective in managing faecal drop in the school areas, along with ensuring doors and windows are closed during lesson times (Geolink 2011).
Community welfare	Prevents contact with flying foxes by occupants of play yards near camp. Reduces impacts of noise, faecal drop and odour.
Flying-fox welfare	No impact to flying-foxes
Monitoring	Record and report incidences of flying-fox faecal drop, noise and odour including conditions prior to and after modification of grounds
Success criteria	Improved protection of buildings and grounds from flying-fox faecal drop, noise and odour

Considerations	Details
Cost	Costs based on best estimates: • Double-glazing windows - $7,000 per building • Laminated windows - $3,000 per building • Covered carport - $3,500 single, $5,700 double • Acoustic/thermal batts - $2,000 per building • Vegetation removal - $5,000/day for 2 days = $10,000 • Bat safe netting for play yards - ~$50,000 • Planting of screening plants - $5,000

4.1.7 Modify directly affected residential properties

Properties within 50 m of the camp boundary (e.g Mikarie Pl and Kannan Pl Kirrawee) can be modified to reduce the impact of noise, odour, faecal drop. Council will need to develop a methodology for determining and ranking the most affected properties. Actions at these properties could include (but are not limited to):

- carports over vehicles
- shade cloth in areas affected by faecal drop
- double glazed or laminated windows
- coating surfaces to allow easier cleaning
- acoustic/thermal batts for sound proofing
- air conditioning for preventing odour entering buildings without overheating with closed windows
- planting of screening plants such as conifers or climbers between camp and residents
- pool covers to prevent faecal drop
- pergolas for covering outdoor areas
- purchase a gurney for regular cleaning.

These actions aim to reduce the impacts experienced by directly affected properties. It is acknowledged that each resident will have different circumstances.

Table 9: Modify directly affected residential properties

Considerations	Details
Aim of the action	To reduce the amenity impacts such as faecal drop, odour and noise for directly affected residential properties.
Statutory issues	Nil
Previous experience	The experience at Maclean has been that shade structures were effective in managing faecal drop in the school areas, along with ensuring doors and windows are closed during lesson times (Geolink 2011).
Community welfare	Reduces impacts of noise, faecal drop, odour and amenity
Flying-fox welfare	No impact to flying-foxes
Monitoring	Record and report incidences of flying-fox faecal drop, noise, odour and amenity including conditions prior to and after modification of properties (property survey)

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Considerations	Details
Success criteria	Improved protection of properties from flying-fox faecal drop, noise and odour
Cost	Costs based on best estimates: • Double-glazing windows - $7,000 per property • Laminated windows - $3,000 per property • Covered carport - $3,500 single, $5,700 double • Acoustic/thermal batts - $2,000 per property • Planting of screening plants - $1,000 per property • Pool cover - ~$1500 per property • Pergola - ~$8,000 per property • Gurney purchase - $500 per property

4.1.8 Provide input to adjacent facility master planning

Council must communicate with the schools during their current and future master planning to ensure that Council is supporting the creation of improved amenity and conditions for future facilities at the Sylvanvale, Aspect, Mikarie and Bates Drive School properties. Consideration should also be given to reducing the impact of any redevelopment on the GHFF camp.

Table 10: Master planning input

Considerations	Details
Aim of the action	To minimise impacts to the community and GHFFs by appropriate planning and redevelopment
Statutory issues	Nil
Previous experience	No previous experience identified in recent management of flying-fox camps
Community welfare	Reduces the proximity of vulnerable clients of the schools from flying-fox camp
Flying-fox welfare	No impact to flying-foxes
Monitoring	Following redevelopment of any of the adjacent schools, review the level of complaints regarding impacts and health risks, and health of GHFF camp
Success criteria	Reduced complaints and impacts experienced by schools staff and students
Cost	Nil

4.2 Stage two - options to increase the buffer

Stage two management options aim to improve the amenity and safety of those most directly affected by the camp by increasing the buffer between the camp and adjacent properties. These actions would result in disturbance of the camp, and therefore need State and Federal approval. The time needed to prepare for and obtain approvals means that these options cannot be implemented immediately.

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4.2.1 Enlarge vegetation buffers

Vegetation buffers are practical to reduce potential human/flying-fox interactions, particularly during the day. Buffers also help reduce the impact of odour, faecal drop and noise due to the increased distance between the camp and surrounding buildings and yards. Wider buffers on the north-west and western boundaries would further increase the extent between the most affected properties and the core roost trees within the camp. Vegetation removal would need to be offset by improving habitat closer to the soccer fields. As discussed in **Section 4.1.1**, buffers should comprise suitable low-growing vegetation and mulch rather than mown grass.

Table 9: Enlarging the existing buffer

Considerations	Details
Aim of the action	Reduce the impacts experienced living and working adjacent to the Kareela camp
Statutory issues	Depending on the extent of works being undertaken, a s.91 licence under the TSC Act may be needed, including an assessment of significance. However, if there appears that any works may result in a negative impact upon the GHFF or any other threatened species there may be a need for a Species Impact Statement and Referral to Department of the Environment under the EPBC Act.
Previous experience & scientific information	Buffer zones effectively implemented at the Coffs Creek flying-fox camp. These have included creating buffers and planting buffers with suitable shrub species along interfaces where conflicts existed which reduce flying-fox roosting whilst providing enhanced visual amenity for residents (CHCC 2007). At Gordon in Ku-ring-gai LGA in Sydney, the selective removal of roost trees to reduce issues at particularly high conflict locations around the boundary of the camp. This technique has not been implemented to disperse the flying-foxes, just to mitigate localised issues (Pallin 2000). This technique was used during an attempt to alleviate conflict associated with the Cannes Reserve flying-fox camp in Avalon. Several trees and shrubs have been removed from selected areas with the reserve and from residential backyards. The aim was to push the camp towards the centre of the reserve to limit conflict.
Community welfare	Improve amenity for neighbours (less noise, faecal drop and odour) Reduce likelihood of GHFF entering adjacent properties
Flying-fox welfare	Careful consideration should be given to which trees are removed to create a wider buffer and the process for vegetation removal/replanting The enhancement and better management of buffers will reduce disturbance to the flying-foxes, ultimately improving their welfare
Monitoring	Visual assessment of GHFF camp prior to, during and after expansion of the buffer to determine if GHFF are exhibiting signs of ill health then consider postponing the works or conducting further surveys such as live trapping and health checks before works (although this would involve additional costs) Interview local community to determine if the expanded buffer has been effective in reducing conflict
Success criteria	Reduced complaints concerning noise, faecal drop and odour

Considerations	Details
Cost	Bush regeneration of buffers $2,000/day (team of 4) for 30 days = $60,000 Ongoing maintenance $2,000/day (team of 4) for 10 days/year = $20,000/year Installation of fencing to prevent access that may disturb flying-foxes = ~$5,000 These costs are likely to be a minimum and do not include costs for assessment and approvals

4.2.2 Nudging the camp to a nearby location

Nudging involves a low intensity of stimuli to encourage or 'nudge' animals from non-suitable areas to preferred areas without scattering them. Nudging is a dispersal technique that incorporates various dispersal methods in a directed, targeted and low impact fashion. Gradually nudging the camp to a nearby location would progressively increase the size of the buffer between the camp and properties currently affected.

Nearby locations that may accommodate the GHFF during the nudging efforts could be directed at the Kareela golf course to Freya St Reserve and the creek area adjacent, approximately 1.4 km from the existing camp; or to the west through Joseph Banks Native Plants Reserve and Drysdale Park to Glendale Place Reserve, approximately 1 km away. On those days in January 2013 when temperatures rose above 45°, GHFFs from Kareela temporarily roosted at Joseph Banks Native Plant reserve (John Martin pers. comm. 2013). These sites still have the potential for negative conflicts although neither have the complicating issue of children with disabilities.

Techniques of nudging will be the same used in the dispersal of the flying-fox colony at the Melbourne RBG, where connected vegetation existed to the preferred site. Low levels of disturbance were carried out at or shortly after dawn when the flying-foxes were returning to camp causing them to roost a little closer to the preferred site (ARCUE 2009, van de Ree et al. 2006). Flying-foxes may be left at temporary locations 'on route' to the preferred site to allow any scattered flying-foxes to rejoin the main group.

Important in any undertaking of nudging activities is the necessity to liaise with and get agreement from potentially impacted landholders, such as the Kareela Golf Club.

The methodology for nudging should involve the following steps:

- Identify suitable target site and potential nudging 'routes'.
- Prepare a strategy for dispersal of animals from inappropriate locations.
- Identify the directions the flying-foxes are approaching the site from.
- Start disturbance action approximately one hour before dawn for approximately 10 min followed by a 5 min break to observe the direction of dispersal, numbers of flying-foxes present and their stress levels.
- Alternate this pattern until approximately 30 min before sunrise or cease activity if stress levels of animals is considered too high.
- In the half hour before sunrise attempt to determine where dispersed flying-foxes have roosted and ensure these are not undesirable locations.
- These subsequent locations should become new disturbance areas to continue nudging the flying-foxes onwards.
- Continued monitoring and disturbance actions are likely to be required for an extended period to ensure re-establishment does not occur.

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This is likely to be a temporary fix unless there are ongoing and complementary actions. The local community may be affected by noise during the dispersal action. There is a high likelihood of moving the conflict to multiple new unsuitable locations.

During the October 2014 exhibition period, the community overwhelmingly rejected the option to nudge the Kareela GHFF camp because of the risk of adverse impacts to potential recipient sites and due to concerns for the welfare of the flying-foxes.

Table 10: Nudging the camp to another site

Considerations	Details
Aim of the actions	To nudge the camp away from its current location
Statutory issues	Dispersal plan developed in accordance with the OEH Flying-fox Camp Management Policy. s.91 licence under the TSC Act including an assessment of significance. Depending on the outcome this may result in the need for a SIS. Need an EPBC Act referral to Department of the Environment.
Previous experience & scientific information	The most prominent example of nudging flying-foxes was at the Melbourne RBG where animals were methodically nudged along the Yarra River corridor from the RBG to their current location at Yarra Bend Park. Some dispersal attempts have succeeded although the majority have either failed or created conflicts in other unsuitable locations.
Community welfare	Loss of amenity during the nudging (e.g. increased noise at certain times) Risk of moving the conflict to multiple new unsuitable locations
Flying-fox welfare	Needs to be undertaken at an appropriate time of the year to avoid the impacts to pregnant females or dependent young. Areas that the flying-foxes disperse to may not offer the same important habitat components such as shelter from extreme weather and may result in increased mortality especially on high temperature days. Increased stress from being disturbed and increased fatigue from moving to other suitable roost sites. Potential to be less stressful than straight dispersal due to the 'softer' nature of the disturbance and no large scale scattering of individuals.
Monitoring	Visual assessment of GHFF camp prior to, during and after nudging to determine if GHFF are exhibiting signs of ill health then consider postponing the works or conducting further surveys such as live trapping and health checks before works (although this would involve additional costs) Interview local community, including landholders of new camp site, to determine if the nudging has been effective in reducing conflict

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Considerations	Details
Success criteria	Reduce conflict between flying-foxes and the community
Cost	Similar in scope to dispersal by disturbance although utilises more people to cover a wider area Equipment = $10,000 Initial disturbance = 6 people (5 noise/1 welfare), 3 hours/day, 120 days/year, 2 years @ $40/hr = $172,800 Continual disturbance to prevent return = 1 person, 2 hours/day, 365 days/year, 2 years @ $40/hr = $58,400 Total $241,200 These costs are likely to be a minimum and do not include costs for assessment and approvals

4.2.3 Provision of alternative habitat

It is possible to identify and revegetate suitable areas in the region to provide alternative habitat that may encourage at least some of the flying-foxes to move. However, there are no examples of where enhanced sites have been occupied by dispersed flying-foxes, either on their own accord or following dispersal (Roberts et al. 2011). For example, the use of artificial structures and attractants were unsuccessful at Melbourne where the largest passive dispersal attempts were made (GHFFACTF 2001; ARCUE 2009).

As shown in the maps provided in the dispersal strategy (**Part C**) there are few areas near Kareela that are considered appropriate for a proposed new camp site. Even using quick growing tall vegetation, it is estimated that new habitat would take 10-15 years to reach a suitable maturity for use by flying-foxes.

The Kareela camp is thought to have come from the old Kurnell camp approximately 13 km away which dispersed during construction of the desalination plant (ARCUE 2009). Much of the disturbance and landscape changes have ceased at Kurnell and the location has potential as suitable GHFF camp site, particularly as many of the flying-foxes at Kareela may remember the Kurnell camp. However, previous occupancy is not always a good indicator as to the suitability of a potential site. In the Maclean case study, the nearby camp in the Yaegl Nature Reserve was previously occupied by flying-foxes, but was not used until 12 months after the initial disturbance (Roberts 2006).

Prior to habitat restoration, modification or augmentation at potential sites, monitoring of these sites should be undertaken to understand if any flying-foxes are visiting these areas at any time during the year and in what numbers. An assessment may be required to determine why the flying-foxes are not currently utilising the site and what habitat features may be needed to encourage the flying-foxes to roost. The Kurnell site was not deemed suitable by the landowners Sydney Desalination Plant (pers. comm. G Ovens 2013). A suggested action plan should involve:

- monitoring of potential sites for signs of utilisation prior to any dispersal actions at Kareela
- assessment of potential conflict issues
- assessment of suitable habitat characteristics at likely relocation sites

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- detailed plan of works prepared for each site to be undertaken in conjunction with dispersal at Kareela.

This action requires long-term commitment but should have a long-term positive result. As flying-foxes have not been recorded relocating to enhanced areas without active dispersal, this action would have to be in conjunction with other dispersal and monitoring actions.

Table 11: Provision of alternative habitat

Considerations	Details
Aim of the actions	To improve habitat for GHFF away from the current camp in more suitable locations with less likelihood for conflict
Statutory issues	Providing suitable areas identified for habitat modification are not threatened ecological communities or contain habitat for threatened species then no considerations are required. If these elements exist at the site, requirements under both the TSC Act and EPBC Act may be triggered.
Previous experience & scientific information	Burdekin Park, Singleton – money has been obtained to enhance habitat in suitable locations but actions have not been implemented yet. Melbourne RBG – Unsuccessful attempts were made to attract GHFF to a target site through the provision of food, playback of recorded calls, establishment of artificial roosts, caged conspecifics and GHFF models, as well as the distribution of leaf litter and droppings from the RBGM camp to provide familiar smells (ARCUE 2009). Maclean – alternative habitat planted along with revegetation of the Maclean Rainforest Reserve. The alternative habitat is yet to mature to a stage suitable for use by flying-foxes.
Community welfare	Passive measure with no targeted mitigation of issues on site
Flying-fox welfare	This action has the potential to benefit the flying-foxes by enhancing habitat in suitable areas to help provide a long term roosting area for the species away from human conflict
Monitoring	Monitor establishment of vegetation at target site Monitor occupancy by flying-foxes
Success criteria	Establish habitat to attract GHFF from Kareela
Cost	Construction cost for artificial structures will be high, ~$100,000. Over $600,000 spent at Melbourne RBG but this included the housing of live individuals (Roberts et al. 2011). Cost of revegetation and ongoing maintenance likely to be similar to costs of bush regeneration at Kareela, approximately $60,000 up front and $20,000/year ongoing. These costs are likely to be a minimum and do not include costs for assessment and approvals

4.3 Stage three – dispersal options

Stage three management options are provided as a last resort and will not be implemented by Council unless all previous actions have been attempted and failed. Other local councils, government agencies

and conservation groups do not support dispersal. Dispersal had limited support from the community, although it was strongly supported by some people currently affected by the Kareela camp.

The term dispersal refers to the active relocation of a species through various mechanisms. The dispersal of the GHFF camp from Kareela aims to achieve a complete or substantial relocation of the colony to another location or locations. Techniques used to disperse a camp require some form of auditory or visual disturbance, through deterrents or via the selective or complete removal of the available roosting habitat. It is very likely that the successful dispersal of the camp would require a combination of actions.

There are numerous examples of attempts to disperse flying-fox camps. Roberts et al. (2011) provides a comprehensive review of selected cases and shows how many failed to achieve their initial aims. Briefly, the key findings of Roberts et al. (2011) include the following:

- Dispersal actions often require a consistent approach and a long-term undertaking. Many of the reviewed dispersal actions lasted over a 2-10 year period. Dispersal actions have required significant resources and considerable funding. For example, $120,000 spent unsuccessfully attempting to remove flying foxes from Singleton. $3,000,000 spent to successfully disperse the camp from the Melbourne RBG. However, this campsite still requires ongoing management.
- Pre-identified campsites, even those that have been actively managed to encourage flying-fox occupancy, have never been successfully colonised (GHFFACTF 2001; ARCUE 2009).
- The distances covered by flying-foxes during the initial actions aimed at dispersal have generally been very short, often less than 900 m.
- In the majority of cases, dispersal has resulted in moving the conflict to a new area.

Statutory matters also need to be addressed.

The GHFF is listed as vulnerable under both the TSC Act and the EPBC Act. Any proposed activity that has the potential to result in the harm of a threatened species is required to apply for a licence under section 91 of the TSC Act. In order to determine whether the action will have a significant negative impact, an assessment of significance (7-Part Test) is required as part of the licence application. A Species Impact Statement (SIS) may be required if the Director General of OEH deems the action likely to have a significant impact.

Further, in accordance with the Significant Impact Guidelines 1.1 (DEWHA 2009), a referral to Department of the Environment will be required if a proposed action is likely to have a significant impact on an EPBC Act listed species or habitat critical to its survival. The Kareela camp has had in excess of 10,000 individuals at least once within the previous ten years and contained reproductive females. It therefore meets two of the criteria of the Draft National Recovery Plan for GHFF (DECCW 2009) to constitute 'roosting habitat critical to the survival' of the species. Recent advice from Department of the Environment is that any action likely to impact on GHFF habitat, or to involve the dispersal of GHFF, should be referred under the EPBC Act.

4.3.1 Dispersal by noise and other disturbance

Disturbance techniques aimed at dispersing the flying-foxes are focused on the use of visual, physical, smell and auditory deterrents. Based on previous experience of other dispersal attempts, only some techniques have been successful. Poor success with these techniques may have been due to the high mobility of the species, the ability to constantly move between camps and migrate away from Sydney, as well as the seasonal limitations on disturbing GHFF camps when numbers are often peaking. When this is combined with the potential high turnover of individuals at flying-fox camps (Roberts et al. 2012),

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the result is that when a disturbance activity is used in isolation, the likelihood of success will be lower, short term and will require additional and potentially expensive works over an unknown number of years.

There have been a number of reviews in recent PoMs and reports on various disturbance techniques (ARCUE 2009, Geolink 2011, ELA 2012, GeoLINK 2012). The key findings of these reviews include:

- Pre-recorded and human generated industrial noise played randomly is the most successful technique employed, in successful and temporary dispersals.
- Pre-recorded noise played at a static location resulted in localised effects only and likely not suitable for an entire camp.
- Playing flying fox distress calls and various ultrasonic deterrents have been completely ineffective on their own.
- Visual deterrents such as plastic bags hung in trees and inflatable 'eventman' has only had very localised effects.
- Other high intensity visual deterrents such as lights, beacons, reflective items have been completely ineffective.
- Some physical deterrents have worked such as numerous canopy-mounted sprinklers, although a large amount of infrastructure is needed. Smoke has also been locally successful, but the issues of delivery make it difficult to target areas.
- Physical deterrents such as wrapping trees in plumbing piping or hanging rope/heavy fishing line has proved unsuccessful. Netting has proved to be logistically unfeasible for a whole camp.
- Deterrents based on smell have been effective in a very localised sense, including hanging items such as toilet deodorisers, spraying or application of 'D-ter', chilli paste or 'Envirospray Ultrawax'. Python excrement has been effective but the issue of obtaining the scent and reapplication reduces the applicability of the technique.

Planned and coordinated noise disturbance has proven to be the most successful technique in other dispersal attempts and is relatively easy to deploy. The most effective techniques utilise significant human labour (ARCUE 2009, GeoLINK 2012). Noise disturbance should be undertaken based on the following guidelines:

- Recorded CD with a range of noises. The greater the range of different noises will reduce the chances of any habituation. A CD of noise used during the activities to disperse flying foxes from the Sydney RBG is available.
- Disturbance should be limited to June to August and potentially supplemented in February and March if juveniles are sufficiently strong enough to relocate.
- Noise played at multiple and random locations at any one time.
- Noise disturbance at particular times through the day including:
    - Early morning, as individuals from the camp return from their night time foraging activities to roost for the day.
    - Randomly during the day for short periods. For example, create a disruptive noise for ten minutes followed by an hour's rest, then a further ten minutes.
    - Just prior to the individuals leaving the camp to fly to their foraging grounds.
- Acoustic stimuli should begin at the lowest intensity at the start of each dispersal event, so as to prevent flying-foxes from taking to flight in panic. The level of disturbance will be increased gradually, until flying-foxes begin to wake up and show signs of unease (e.g. flying to another roost tree, squabbling with conspecifics). If large numbers of flying-foxes

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take flight during daytime disturbance and begin circling above the camp, disturbance will cease to allow the flying-foxes to settle down.

- In addition to people undertaking the noise disturbance, persons dedicated to the monitoring of animal welfare need to be present to monitor progress and the welfare of the flying-foxes and to stop the disturbance if individuals are showing signs of stress such that injury or death may result.

Complementary action would be needed to avoid negative impacts to flying foxes, potential for re-establishment or further conflicts at undesirable locations**.** Impacts of noise to neighbouring areas (especially schools) also need consideration.

Table 12: Dispersing the camp through noise disturbances

Considerations	Details
Aim of the actions	To disperse the camp permanently from the current location
Statutory issues	Dispersal strategy developed in accordance with the OEH Flying-fox Camp Management Policy. A s.91 licence under the TSC Act including an assessment of significance will be required. Activity may require preparation and approval of an SIS. This activity will impact the foraging habitat critical to the species survival and consequently a referral under the EPBC Act to Department of the Environment will be required. Consideration given to the welfare of the GHFF under the POCTA Act. Noise management in accordance with Environment Protection Agency requirements.
Previous experience & scientific information	Some dispersal attempts have succeeded although the majority have either failed or created conflicts in other unsuitable locations.
Community welfare	Loss of amenity during dispersal (e.g. increased noise and possibly faecal drop at certain times) Risk of moving the conflict to multiple new unsuitable locations
Flying-fox welfare	Any disturbance of the GHFF need to be undertaken at an appropriate time of year to avoid impacts to pregnant females or dependent young. The majority of disturbance should be undertaken during the period between May and June. Outside of this time, pregnant females may be present and have been known to abort young during times of stress while dependant young that are unable to fly rarely survive if they fall out of the roost and onto the ground. Areas that the flying-foxes disperse to may not provide the same habitat components such as protection from predators, shelter from extreme weather events, access to food resources, and may increase levels of stress and increased mortality. Increased stress from being disturbed and increased fatigue from moving to other suitable roost sites can lead to heightened prevalence of disease and disease transmission.
Monitoring	Visual assessment of GHFF camp prior to, during and after dispersal to determine if GHFF are exhibiting signs of ill health then consider postponing the works or conducting further surveys such as live trapping and health checks before works (although this would involve additional costs)

Considerations	Details
	Interview local community, including landholders of and adjacent to new camp sites, to determine if dispersal has been effective in reducing conflict
Success criteria	Reduce conflict between flying-foxes and the community
Cost	Equipment = $10,000 Initial disturbance = 4 people (3 noise/1 welfare), 5 hours/day, 120 days/year, 2 years @ $40/hr = $192,000 Continual disturbance to prevent return = 1 person, 2 hours/day, 365 days/year, 2 years @ $40/hr = $58,400 Total $260,400 or Permanent installation of directional and high quality speakers = one off installation @ 2 x $10,000 = $20,000 plus installation. These costs are likely to be a minimum and do not include costs for assessment and approvals

4.3.2 Dispersal by selective habitat removal

The selective removal of roost and non-roost habitat has the potential to alter the micro-climate within the camp which may encourage the dispersal of flying-foxes. Examples of habitat features to target for removal would be the roosting resources such as the tall trees and dense mid-story vegetation (mainly *Ligustrum lucidum* and *Syzygium* sp.) that provides roosting and cover resources. By clearing the understorey or removing the lower limbs of selected trees, flying-foxes may be deterred from roosting (Hall and Richards 2000, Roberts 2005). This dense mid-story vegetation is also likely to be important in maintaining a suitable microclimate along the drainage line.

The removal of critical habitat features will deter subsequent re-colonisation whilst maintaining some of the environmental values and amenity of the site. As the site is heavily weed infested and much of the vegetation utilised for roosting is exotic, this action has the potential to provide the opportunity to undertake bush regeneration at the site using native species, enhancing environmental values whilst attending to the issues surrounding the flying-foxes. It is considered a critical component of this action that native bush regeneration is undertaken following the removal of the flying-fox roosting habitat, otherwise exotic species such as privet may re-establish along with the potential re-establishment of the camp.

The lower portion of the site is largely native vegetation and exists as a small area of open woodland, although the flying-foxes do not commonly roost there. Careful planning of suitable vegetation based on the components of the vegetation present in the lower portion of the site and those being utilised by the flying-foxes would be required. A comprehensive vegetation management plan to guide works with should include:

- removal of tall trees utilised by the flying-foxes
- removal of dense mid-story vegetation used by the flying-foxes, typically *L. lucidum* and *Syzygium* sp.
- removal or control of other exotic species and bush regeneration with suitable local native species that will not attract the flying-foxes, such as those in the lower portion of the site.

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The timing of any proposed habitat removal is critical to avoid any significant impacts upon the species. It is assumed that vegetation removal would be undertaken when animals were either not present in the area or present in low numbers. These circumstances may occur at night when the flying-foxes are out feeding; directly following a dispersal event and the flying-foxes are not attempting to recolonise; and/or when the camp has naturally been abandoned as the flying-foxes follow seasonal food resources.

This option is likely to result in the permanent abandonment of the camp as important habitat will be removed. Complementary action is needed to avoid negative impacts to flying foxes, potential for re-establishment or further conflicts at undesirable locations. This option has the advantage that amenity could be improved and habitat for other native species provided.

Table 13: Dispersing the camp through selective habitat removal

Considerations	Details
Aim of the action	To disperse the camp permanently to a more suitable location
Statutory issues	Dispersal strategy developed in accordance with the OEH Flying-fox Camp Management Policy s.91 licence under the TSC Act including an assessment of significance. Depending on the outcome this may result in the need for a SIS. Referral under the EPBC Act to Department of the Environment.
Previous experience & scientific information	The removal or modification of roost trees has been undertaken at the Lorn flying-fox camp in Maitland LGA. The vegetation works were part of two licence applications to OEH, granted with conditions for habitat removal to occur between June and August with monitoring of the camp for a week prior to any actions being undertaken. Under the first licence in 2012, monitoring identified pregnant females at the camp and no actions were undertaken. Under the second licence and following monitoring and abandonment of the camp by flying-foxes in May 2013, vegetation removal and modification was undertaken over five nights in early June. This has resulted in the flying-foxes not returning to the camp, although numbers of flying-foxes in nearby areas have increased (R. Gibson OEH pers com 30 January 2014.
Community welfare	Risk of moving the conflict to multiple new unsuitable locations
Flying-fox welfare	Needs to be undertaken at an appropriate time of the year to avoid the impacts to pregnant females or dependent young. Areas that the flying-foxes disperse to may not offer the same important habitat components such as shelter from extreme weather and may result in increased mortality. Increased stress from being disturbed and increased fatigue from moving to other suitable roost sites. As vegetation removal would occur during the day, any individuals present on the site and dispersed during the day would be at higher risk of predation by birds of prey.
Monitoring	Visual assessment of GHFF camp prior to, during and after dispersal to determine if GHFF are exhibiting signs of ill health then consider postponing the works or conducting further surveys such as live trapping and health checks before works (although this would involve additional costs) Interview local community, including landholders of new camp sites, to determine if

Considerations	Details
	dispersal has been effective in reducing conflict
Success criteria	Reduce conflict between flying-foxes and the community
Cost	Removal of vegetation by hand $5,000/day for 15 days = $75,000 Bush regeneration of site following vegetation removal $2,000/day (team of 4) for 40 days = $80,000 Ongoing maintenance $2,000/day (team of 4) for 10 days/year = $20,000/year Total $155,000 ($20,000 ongoing) Monitoring - $60,000 - $120,000 (depending on how GPS trackers are required) These costs are likely to be a minimum and do not include costs for assessment and approvals

4.3.3 Dispersal by total vegetation removal

The removal of all vegetation that presently occurs on the site will result in the complete dispersal of the Kareela colony. This is considered a permanent action as there is no potential to reverse the decision if undesirable conflicts or impacts occur in other locations. OEH have stated that this option would not be approved unless other dispersal options had been attempted. If the flying-foxes are dispersed to unsuitable locations, they would not be able to return to Kareela if no vegetation remains, which makes this option highly risky.

This action will have significant other undesirable impacts on the site from the reduced amenity of the land for local residents, loss of habitat for other fauna species, and exposure of and necessary controls for the drainage line.

The timing of any removal of vegetation would be critical. It is assumed that the removal of vegetation would be undertaken when animals were not present in the area being cleared. These circumstances may occur at night when the flying-foxes are out feeding; directly following a dispersal event and the flying-foxes are not attempting to recolonise; and/or when the camp has naturally been abandoned as the flying-foxes follow seasonal food resources.

The site is not considered to have significant ecological values besides the flying-fox camp, although the removal of the vegetation on the site would still require an environmental assessment. Council would need to consider requirements under Part 5 of the EP&A Act, Infrastructure SEPP 2007 and *Water Management Act 2000*.

This option is likely to result in the permanent dispersal of the camp as important habitat will be removed. Complementary actions would be needed to avoid negative impacts to flying foxes, potential for re-establishment or further conflicts at undesirable locations**.**

Table 14: Dispersing the camp through total vegetation removal

Considerations	Details
Aim of the action	To disperse the camp permanently to a more suitable location
Statutory issues	Dispersal strategy developed in accordance with the OEH Flying-fox Camp Management Policy (provided in Part C). Requirements under Part 5 of the EP&A Act, Infrastructure SEPP 2007 and

Considerations	Details
	exemptions within the WM Act to assess the vegetation removal and subsequent management of the area. s.91 licence under the TSC Act including an assessment of significance for impacts to the flying-foxes. Depending on the outcome this may result in the need for a SIS. Referral under the EPBC Act to Department of the Environment for impacts to flying-foxes.
Previous experience & scientific information	This type of action has rarely been undertaken, largely due to the additional impacts beyond the removal of the flying-foxes, loss of amenity to the area and in many cases the impacts to other environmental values of a site. In addition, where this has occurred the human/flying-fox conflicts have just been moved to a new location. In 2004, trees were illegally removed from the flying-fox camp at Dallis Park in Murwillumbah. The flying-foxes subsequently moved just 250 m to another area of parkland with further conflict with residents. Vegetation in the new area suddenly died and the flying-foxes vacated the area altogether. A similar situation occurred in nearby Dulguigan and now only one camp exists on the Tweed floodplain where human/flying-fox conflicts persist (Eby & Roberts 2010).
Community welfare	Risk of moving the conflict to multiple new unsuitable locations
Flying-fox welfare	Needs to be undertaken at an appropriate time of the year to avoid the impacts to pregnant females or dependent young. Areas that the flying-foxes disperse to may not offer the same habitat components such as shelter from extreme weather and may result in increased mortality. Increased stress from being disturbed and increased fatigue from moving to other suitable roost sites. As vegetation removal would occur during the day, any individuals present on the site and dispersed during the day would be at higher risk of predation by birds of prey.
Monitoring	Visual assessment of GHFF camp prior to, during and after dispersal to determine if GHFF are exhibiting signs of ill health then consider postponing the works or conducting further surveys such as live trapping and health checks before works (although this would involve additional costs) Interview local community, including landholders of new camp sites, to determine if dispersal has been effective in reducing conflict
Success criteria	Reduce conflict between flying-foxes and the community
Cost	Removal of vegetation $7000/day for 15 days = $105,000 Bush regeneration of site following vegetation removal $2000/day (team of 4) for 30 days = $60,000 Engineering remediation of the site (stormwater control, public safety) = $150,000 Costs for assessment and approvals Total $315,000 Monitoring - $60,000 - $120,000 (depending on how GPS trackers are required) These costs are likely to be a minimum due to the potential to undertake additional dispersal activities where flying-foxes relocate to inappropriate areas

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4.4 Other options

The 'do nothing' option and culling are considered here for completeness. Neither is realistic for the reasons discussed below.

4.4.1 Do nothing approach

The do nothing approach involves not undertaking any management actions and leaving the situation in its current state. However, the do nothing approach is considered an unrealistic alternative to managing the Kareela camp because it will not address any of the existing conflicts between the flying-foxes and the local community.

It is expected the current issues, concerns and conflicts will continue into the future and there is potential for it to escalate. This could result in the community 'taking the situation into their own hands' and engaging in illegal action that may be harmful and counter-productive. Detrimental impacts to flying-foxes may result from disturbance that takes place at an inappropriate time of year e.g. during the reproductive period or while the dependant young are present within the camp. Illegal activities would increase the stress levels among the roosting GHFF, which has the potential to:

- heighten the levels of disease among the GHFFs that are roosting at Kareela
- increase mortality levels among GHFF that roost at the site
- increase potential for the local community to have contact with GHFF
- increase risk of disease transmission.

Table 15: 'Do nothing' approach

Criteria	Comment
Aim of the action	This option does not help resolve any issues
Statutory issues	Nil
Previous experience & scientific information	Previous experience shows that flying-foxes can suddenly vacate a camp, whilst some camps have a long history of continuous occupation even with deteriorating vegetation. The camp may eventually move from the area once all the canopy and mid strata vegetation has been become degraded and no suitable roost locations for the flying-foxes remain or alternatively the suitable foraging resources within 20 km of the camp become diminished. However, the timeline for this, or whether it will occur, are unknown. This is mainly due to the long-term supply of planted and natural foraging resources in the region. It is very likely that the camp will remain occupied for the foreseeable future because many of the camps in Sydney are occupied continuously, numbers have been consistent or increasing over the last two years and most of the flying-foxes are likely to have come from those dispersed from the Kurnell and Royal Botanic Gardens.
Community welfare	Ongoing conflicts
Flying-fox welfare	No impacts on the welfare of the flying-foxes
Cost	Some costs may be incurred through the time and effort required to deal with community complaints.

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4.4.2 Reduce numbers by culling

A cull could result in a short-term reduction in GHFF numbers occupying the camp and consequently reduced associated impacts. However, this is not a viable option because it has never been proven successful in the long-term management of flying-foxes. Further, the activities associated with performing a cull may violate the objectives of the *Prevention of Cruelty to Animals Act* (POTAC Act).

Results of culling are unpredictable because flying-foxes move around the landscape, often over large distances and may occupy a variety camps over short periods of time (Roberts et al. 2012). Culling would only provide short-term relief to the conflicts and would need to be ongoing as other flying-foxes will continue to join the camp.

A variety of culling methods could be employed but these are not explored further within this PoM as this action is not considered a suitable solution to the conflicts and the licences/approvals required would not be granted by OEH. The risks associated with shooting or poisoning an animal in an urban environment such as Kareela would be considered dangerous and there is a direct threat to humans and other species (domestic dogs and cats), especially if dying and dead animals are found within the school.

Table 16: Reduce numbers by culling

Considerations	Details
Aim of the action	This option aims to reduce numbers of GHFF at Kareela. However, it is highly unlikely to be approved.
Statutory issues	This action would be harmful to a species listed as vulnerable under both the NSW TSC Act and EPBC Act. To conduct such an activity, approvals and licences under the TSC Act, EPBC Act and NPW Act would be required. This action is inconsistent with the objectives of the FFCMP (DECC 2007). Culling has the potential to result in unreasonable, unnecessary or unjustified abuse, torment, torture, or infliction of terror among the GHFF which may be deemed as being act of cruelty, offence under the POTAC Act.
Previous experience & scientific information	Culling flying-foxes as a management option was unsuccessful at Maclean. Because of this State and/or Federal approval was not granted for culling at the Burdekin Park camp, Singleton.
Community welfare	Potential risk to community from dead or dying flying-foxes Community concern about animal welfare issues
Flying-fox welfare	This action will result in the death and injury of potentially a large number of flying-foxes. Issues regarding the unethical and inhumane practice of culling are likely to be raised. This activity may result in flying-foxes being injured rather than killed outright, which may be perceived as being an act of cruelty.
Cost	This will depend on methods and length of time. Roberts et al. (2012) suggests culling has the potential to be long term activity and consequently could become very costly. Costs for assessment and approvals

5 Management recommendations

Management recommendations were developed following the public exhibition period in October 2013 and Council's Environment, Health and Regulation committee 9 December 2013 meeting (report reference EHR058-14). Actions recommended for implementation by Council are:

1. Stage One:
    a. Place 'bat safe' netting over play yards located within 50 m of the camp at Sylvanvale/Mikarie/Aspect/Bates Drive facilities.
    b. Provide procedures to the surrounding community regarding what should be done and who should be contacted if a flying-fox is encountered. Provide information on Council's website.
    c. Develop and administer yearly educational programs for Sylvanvale/Mikarie/Aspect/Bates Drive facilities and the local community in conjunction with WIRES, Sydney Wildlife volunteers and NSW Health. Provide information on Council's website.
    d. Provide up to $5,000 grants to each significantly affected property within 50 m of the camp boundary for implementing actions that will reduce their impacts e.g. pool cover, car port, pergola, air conditioning, double glazing, purchasing a gurney.
    e. Plant screening trees and/or vegetation between the camp and neighbouring properties.
    f. Encourage the adjacent facilities to re locate their play yards further away from the Kareela camp boundary through their master planning process.
2. Stage Two:
    a. Clear an area of vegetation on the north and north west boundaries of the camp between neighbouring properties and the camp boundary, and offset this with revegetation elsewhere.
    b. Install fencing where required to reduce disturbance of the camp which may occur due to increasing the thoroughfare via vegetation removal.

Throughout the process of managing the Kareela camp, Council will continue to monitor the impacts from the camp and the effectiveness of the stage one and two actions. This will enable Council to adapt strategies to meet changing circumstances.

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Part B – Technical aspects

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6 Legislation and policy

This chapter highlights statutory requirements relevant to protection and management of the GHFF. The species is on the International Union for Conservation of Nature (IUCN) Red List 2008. It is listed as a vulnerable species under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

6.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act aims to protect the environment, in particular Matters of National Environmental Significance (MNES). The GHFF is listed as a threatened species under the EPBC Act and is therefore a MNES.

Under the Act, any action which 'has, will have, or is likely to have a significant impact' on a MNES is defined as a 'controlled action'. An action includes a project, development, undertaking, activity or series of activities that may affect a MNES. Actions that may have a significant impact on one or more MNES need referral to the Department of the Environment.

The referrals process can produce one of three outcomes:

- Non-controlled action (NCA): The project may proceed without further approval under the EPBC Act.
- Non-controlled action – particular manner (NCA-PM): Assessment and approval under the EPBC Act is not required provided the action is undertaken in a specific way (similar to conditions).
- Controlled Action (CA): The project will, or is likely, to have a significant impact on one or more MNES. The project will require full assessment and approval by the Commonwealth Environment Minister before it can proceed.

Department of the Environment is responsible for administering the EPBC Act. This includes the provision of advice on impact assessment and approvals as well as coordinating recovery planning for threatened species.

6.2 National Parks and Wildlife Act 1974

All flying-foxes within NSW are protected under the *National Parks and Wildlife Act 1974* (NPW Act). Under Part 8A of the NPW Act it is an offence to harm an animal species that is part of a threatened species, an endangered population or an endangered ecological community without the appropriate approval. There are significant penalties for harming protected and/or threatened fauna, or damaging their habitat, without prior approval, consent and licences (DECC 2007).

A scientific licence under section 132C of the NPW Act may be issued to a person or organisation undertaking activities associated with scientific, educational or conservation purposes that are likely to result in one or more of the following:

- harm to any protected fauna, or animal that is a threatened species or is part of an endangered population or an endangered ecological community listed under the TSC Act
- picking of any plant listed under the TSC Act as protected, threatened, or part of an endangered population or endangered ecological community

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- damage to critical habitat
- damage to habitat of a threatened species, endangered population or an endangered ecological community.

The National Parks and Wildlife Regulation Act (2002) (NP&WR) exempts Aboriginal people from the restriction imposed under the NPW Act to hunt protected fauna species and gather certain flora species. Those species that are protected but not threatened under the NPW Act, may be hunted for domestic purposes in certain areas. The NP&WR Act does not allow GHFF hunting to occur because it listed as threatened under the TSC Act.

6.3 Environmental Planning and Assessment Act 1995

The EP&A Act is the principal piece of planning legislation for NSW and provides framework for the overall environmental planning and assessment of development proposals. The EP&A Act places a duty on the determining authority to adequately address a range of environmental matters including maintenance of biodiversity and the likely impact to threatened species, populations or ecological communities (under the TSC Act).

6.4 Threatened Species Conservation Act 1995

The TSC Act aims to:

- Conserve biological diversity and promote ecological sustainable development.
- Prevent the extinction and promote recovery of threated species, populations and endangered ecological communities (EECs).
- Protect the critical habitat of a threatened species, population or EEC.
- Eliminate or manage certain processes that threaten the survival or evolutionary development of a threatened species, population or EEC.
- Ensure that the impact of any action potentially affecting a threatened species, population or EEC is properly assessed.
- Encourage the conservation of a threatened species, population or EEC through co-operative management.

It is an offence to damage the habitat of a threatened species, endangered population or EEC. A person must not, by an act or an omission do anything that causes damage to any habitat of a threatened species, an endangered population or an EEC if the person knows that the land concerned is habitat of that kind.

A licence may be required under section 91 of the TSC Act if an action is likely to result in the harm to, or picking of, a threatened species, population or ecological community; damage to critical habitat, or damage to a habitat of a threatened species, population or ecological community.

6.5 Crown Lands Act 1989

The *Crown Land Act 1989* makes provision for the establishment and management of Crown owned reserves under the principles of the Crown land management. Furthermore, it provides guidance for the management of these reserves under a board of Trustees and the development of plans of management for Crown Reserves. The Crown owns Kareela reserve and Council manages it.

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6.6 Local Government Act 1993

The approvals provision of the *Local Government Act 1993* may be applicable for areas outside the Crown Reserve that may be affected by the proposed activities to disperse the GHFF camp. Requirements for activities relevant to the provision of infrastructure are in Section 68 of the Act. Any proposed activities or infrastructure that is created at the school or elsewhere (e.g. the Council depot) will require an assessment under the EP&A Act.

The bushland within the reserve is zoned as Zone 14 Public Space (Bushland) in accordance with the Sutherland Shire's Local Environmental Plan (2006).

6.7 Prevention of Cruelty to Animals Act 1979

The NSW *Prevention of Cruelty to Animals Act 1979* (POCTA Act) is the core legislation in protecting the general welfare of animals. The objectives of the Act are to:

- prevent cruelty to animals
- promote the welfare of animals by requiring a person in charge of an animal to:
    - provide care for the animal
    - treat the animal in a humane manner
    - ensure the welfare of the animal.

ARCUE (2009) while quoting from page 21 of the FFCMP (DECC 2009) stated, 'if there is evidence that a flying-fox camp relocation amounts to unreasonable, unnecessary or unjustified abuse, torment, torture, or infliction of terror, or if the animals become infuriated on relocation, or if some form of cruelty is involved, this be an offence under the Act'.

The Department of Primary Industries (DPI) is responsible for administering the Act, but officers from the DPI do not have enforcement powers. Therefore, complaints associated with acts of animal cruelty are directed to the Royal Society for the Prevention of Cruelty to Animals (RSPCA), Animal Welfare League of NSW or the NSW police (ARCUE 2009).

6.8 Draft National Recovery Plan for Grey-headed Flying-fox

DECCW (2009) prepared a Draft National Recovery Plan for the GHFF. Specific objectives of the plan aim to:

- Identify, protect and enhance key foraging and roosting habitat across the distribution of the species.
- Substantially reduce deliberate destruction associated with commercial fruit crops.
- Reduce negative public attitudes and conflict with humans.
- Involve the community in recovery actions where appropriate.
- Address the impact on the species from artificial structures such as powerlines, loose netting and barbed wire fences.
- Improve knowledge of demographics and population structure.

The draft National Recovery Plan (DECCW 2009) outlines criteria to identify areas of foraging and roosting habitat that is critical to the survival of GHFF**.** Foraging habitat critical to survival of the species meets one or more of the following criteria:

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- Productive during winter and spring, when food bottlenecks for the species have been identified (Parry-Jones and Augee 1991, Eby et al. 1999).
- Known to support populations of >30,000 individuals within an area of 50 km radius (the maximum foraging distance of an adult).
- Productive during the final weeks of gestation, and during the weeks of birth, lactation, and conception (September to May).
- Productive during the final stages of fruit development and ripening in commercial crops that may be affected by GHFF (months vary between regions; Hunter Valley grape picking season occurs February to March).
- Known to support a continuously occupied camp.

Roosting habitat that is critical to the survival of GHFF needs to meet one or more of the following criteria:

- The camp either continuously or seasonally occupied in >50% of years.
- The camp has been used as a camp at least once in the last 10 years and is known to have contained >10,000 individuals — unless such habitat has been used only as a temporary refuge and the use has been of limited duration (i.e. in the order of days rather than weeks or months); and / or has been used as a camp at least once in 10 years (beginning in 1995).
- Has been known to contained >2,500 individuals, including reproductive females during the final stages of pregnancy, during lactation, or during the period of conception (i.e. September to May).

Additional points regarding roosting habitat include:

- In order to reduce conflict, camps in remnant vegetation should be isolated from habitation by a management zone >300m wide. The extent of the management zone should be included in the definition of the camp and it should comprise of habitat that is considered unsuitable for roosting by flying-foxes (low, shrubs, or isolated trees). Any residential development, or the construction of schools and other structures that have the potential to cause conflict should be excluded from this from this zone.
- Where possible, the area of vegetation that defines the camp should be large enough to accommodate influxes of migratory animals and enable the colony to change location.
- Camps that are considered critical to the survival of the species may consist of introduced plants.

6.9 Flying-fox Camp Management Policy

The objectives of the Flying-fox Camp Management Policy (FFCMP) (DECC 2007) are to:

- Assist OEH and others in the management of flying-foxes and their camps in a manner that will ensure the maintenance of a network of flying-fox camps throughout their range, and the conservation of the flying-fox population.
- Provide a consistent approach when managing flying-fox camps so public health and safety is not compromised
- Provide guidelines for and information on conserving and managing flying-foxes and their camps.
- Provide advice on alleviating concerns about perceived negative impacts of flying-foxes and their camps.

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- Encourage constant reviews and updates to ensure that any new and relevant information become readily available.
- Applies to all flying-fox camps in NSW that are located within public and privately owned land and will replace all previous DECC policies relevant to the species.
- Not compromise the conservation on any native species.

Chapter 6 of DECC (2007) provides assistance to those wishing to attempt to disperse flying-camps camps. It sets requirements for assessment of the potential impacts of the proposed dispersal activities to ensure the best outcome for the (potentially) displaced GHFF and the community, and to increase our understanding of the issues associated with planning and procedures required to facilitate the dispersal. OEH do not generally support the dispersal of camps, unless adverse circumstances can be shown (DECC 2007).

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7 Flying-fox biology

There are 65 *Pteropus* (flying-fox) species that occur world-wide. The species that occur on mainland Australia include the GHFF, *P. alecto* (Black Flying-fox (BFF)), *P. conspicillatus* (Spectacled Flying-fox (SFF)) and *P. scapulatus* (Little-red Flying-fox (LRFF)). Only the BFF and LRFF commonly occur within NSW (DECC 2007). Only GHFFs have been recorded occupying the Kareela camp and consequently are the focus of this PoM (Council 2012).

The GHFF is Australia's largest bat and only endemic pteropidid (Westcott et al. 2011). It is a highly mobile species and regarded as being partially migratory. However, there is considerable variation in the migratory patterns of individual GHFFs in terms of distances travelled, time spent within and between different roosts and longitudinal regions (Geolink 2011, Roberts et al. 2012). For example, some individuals have been recorded taking long-distance movements that have covered thousands of kilometres in relatively short times whereas other individuals remain sedentary and exhibit strong fidelity to a single camp (Roberts et al. 2012, Geolink 2013).

The migratory patterns of GHFF are closely associated with reliance on food resources that have irregular seasonal and temporal patterns of production, mating opportunities and exchange of social information (Tidemann and Nelson 2004, Eby and Law 2008, DECCW 2009).

7.1 Distribution

GHFFs primarily occur in the wetter coastal regions of eastern Australia from Mackay in central Queensland to Warrnambool in south-western Victoria (Eby 2006, Churchill 2008, Tideman et al. 2008, Roberts et al. 2011). The historical distribution of the species has changed dramatically since European settlement with a 500-600 km reduction in the species' northern extent and a recent westerly range extension to Adelaide in South Australia. Further, the species has also recently begun establishing camps in areas where GHFF have been rarely recorded previously (Geolink 2013). For example, new, small and short duration camps have been recently been established in Orange, Bathurst, Albury in NSW as well as the central Victorian town of Bendigo (Tideman et al. 2008, Westcott et al. 2011).

Despite these statements alluding to a population increase among the species, it is more likely that these incursions provide evidence to suggest that the species is under considerable stress. This is possibly in response to a reduction in their food resources, roosting habitat and ongoing persecution, which is forcing the species to search across a broader geographic areas to search for new food resources.

7.2 Foraging activities and dietary requirements

The GHFF navigates and finds food principally using sight, smell and possibly spatial memories of previously used food resources (Parry-Jones and Augee 1991, Eby and Law 2008). Historical evidence suggests that GHFF will travel considerable distances, in some cases individuals travel upwards of 50 km from their camp to forage (Eby 1991, McDonald-Madden et al. 2005). However, more recent evidence provided from the use of satellite telemetry have shown individuals often travel as far as 250 km in a single night, which is much further than previously recognised or recorded (Roberts et al. 2012). Apart from being able to migrate over large distances, the species has no adaptive ability to withstand shortages of food resources (Eby 1991, Eby and Lunney 2002). Consequently, GHFF will move south annually in spring and summer and return to the coastal forests of

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north-east NSW and south-east Queensland in winter. This results in large fluctuations in camp numbers across NSW from as few as 20% of the total population in winter up to around 75% of the total population in summer (Eby et al. 1999).

The diet of GHFF comprises primarily nectar, pollen and the pulp of fleshy fruit from forest trees. They will also utilise leaves and exudates from leaf-mining insects, such as psyllids as secondary dietary components (Eby and Law 2008). Eby and Law (2008) conducted a review of published documents, unpublished reports and thesis, field records and observations to compile a preliminary list of diet plants used by the species and identified 59 blossom-bearing and 46 fruit-bearing plant species that contributed to the diet of the GHFF.

7.3 Life and reproductive history

GHFFs are a relatively long-lived species and have been recorded living up to 20 years of age in the wild and 30 years in captivity (Pierson and Rainey 1992, Roberts 2006). All Australian flying-foxes, including the GHFF are highly seasonal and synchronised breeders with relatively low reproductive rates (Pierson and Rainey 1992, Roberts 2006, DECCW 2009). Mating behaviour among GHFF commences in January with conception occurring in April and May, which is followed by a six month gestation period and the birth of a single pup in October or November (Eby 2006, Martin et al. 1996).

When the young are born they are highly dependent on their mother for food, care and thermo-regulation (Roberts 2006). The young remain dependant on the mother until they are six months of age and carried during her night foraging activities for the first three weeks of their lives (Roberts 2006). The young remain flightless and confined to the camp for the first three to four months. They are weaned at six months of age. GHFF do not become sexually mature until they are two to three years old and tend not to raise young until they are three to four years old, after which they generally raise one young per year (Roberts 2006).

7.4 Ecological functions and importance

Flying-foxes feed primarily on nectar, pollen and the fruit produced by a broad range of native and introduced plant species (Parry-Jones and Augee 1991, Eby and Law 1991). Despite being a destructive feeder, flying-foxes are recognised as important pollinators of a range of canopy flowering plant species (Parry-Jones and Augee 1991, Eby and Law 1991). Pollination is achieved when an individual GHFF collects hundreds of pollen grains within its fur while feeding, which is then transferred when it moves and begins foraging on the flowers of same trees or shrubs species (Hall and Richards 2000).

Flying-foxes are also recognised as having a crucial role in the dispersal of the forest plant species seeds through defecation. The defecation of seeds whilst flying, allows for the broad scale dispersal of seeds from a variety of forest plants across vast distances by flying-foxes. As a consequence, flying-foxes have been identified as a keystone species with a crucial role in the reproductive and evolutionary processes of forest communities. A keystone species is as a plant or animal that has unique and important role in the way the ecosystems functions.

Flying-foxes are a highly mobile species that has the ability to travel large distances during their nightly and seasonal foraging forays (Roberts et al. 2008). This ability to move over vast distances enables them to spread genetic and reproductive material (pollen and seeds respectively) across vast areas and between forest patches that would normally be geographically isolated (Parry-Jones and Augee 1992, Eby 1991, Roberts 2006, Roberts et al. 2008). However, pollination would continue to occur within

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these patches, even if flying-foxes were absent, due to the activities of bees, insects and small mammals (Hall and Richards 2000). Despite this being true, the movements of these species are limited in geographic range and extent and as a consequence the gene pool among those plants confined to these patches remains small, distinct, isolated and over time may result in a genetic bottle neck and potential collapse due to stochastic or unexpected events (Burgman and Lindenmayer 1998). Therefore, the role of flying-foxes must be recognised for the beneficial outcomes to the health, longevity and molecular diversity among and between vegetation communities, especially those that recently become highly fragmented and/or isolated.

7.5 Camps and roosting ecology

GHHFs roost by day in communal camps that are generally located among the coastal lowlands or in areas in close proximity to a waterway (river, creek and/or swamp) along the east coast of Australia (Roberts 2006). Despite exhibiting a degree of flexibility in their selection of camp vegetation, camps are typically patches of dense rainforest, paperbark swamp and mangrove vegetation (Ratcliff 1932, Roberts 2008).

The primary purpose of a camp is to provide a suitable location for roosting, resting, areas for social interactions such as reproduction (mating, conception and births), to raise young, and for protection against predation and climatic extremes. They also provide access to food or contribute to greater network of stop-overs (or stepping stones) that extends across a greatly modified and fragmented environment (Eby 2001, DECC 2007). A network of camps allows for flying-foxes to migrate in response to the seasonal availability of food resources.

The number of individuals and the length of time a camp is occupied can vary considerable (Eby 2001). Camps can either be occupied on a permanent or seasonal basis, and at times single camps have been shown to support hundreds to tens of thousands of individuals (Ratcliffe 1932, Parry Jones and Augee 1992, Eby et al. 1999, Geolink 2011). The numbers of individuals occupying a camp varies across different times of the year and across years. Camp occupancy is closely tied to the seasonal availability of local food resources (Eby 1991, Eby et al. 1999).

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8 Threats to Grey-headed Flying-foxes

Flying-foxes are affected by a number of threatening processes. The most serious of these is the loss of foraging and roosting habitat (Tidemann et al.1999). They generally occupy areas located within 50 km of the east coast of Australia. The species may prefer these areas because of the milder climatic conditions that are typical of these coastal regions, higher food resources and consistent yearly food resources. These are the same areas favoured for human habitation (Tidemann et al.1999).

8.1 Destruction of roosting and foraging habitats

Habitat loss and degradation through land clearing for agriculture, urban and industrial development, forestry and transport corridors is considered to be the main threat to the conservation of GHFF (Westcott et al. 2011, Geolink 2012). This has resulted in significant areas of the most highly productive and diverse habitats being lost or confined into small isolated patches. Changes to traditional fire regimes and the effects of eucalyptus dieback may lower the species richness and supply of food plants (Burgmann and Lindenmayer 1998, DECCW 2009, Geolink 2012).

8.2 Negative perceptions

Historically, the species was often perceived as being vermin and an economic pest due to its ability to destroy commercial crops (Roberts 2006). The media contributes to recent negative attitudes, which impedes development of flying-fox management strategies (Geolink 2011). Often these attitudes have resulted in local residents 'taking things into their hands' and conducting inappropriate courses of action that have potential to further negatively impact upon the species and local community. The resolution of conflict between humans and flying foxes is critical to the long-term conservation of GHFF throughout eastern Australia (Geolink 2012).

8.3 Competition and hybridisation

Competition with Black Flying-foxes (BFF) has been identified as a potential threatening process to the GHFFs. This possible threat may be due to a recent distribution shift among the BFF. Although there is some uncertainty about the extent of this impact, but both species share the same foraging and roosting habitats (Tidemann et al.1999).

8.4 Electrocution, predation and entanglement

Flying-foxes can be injured or killed through electrocution due to contact with powerlines or entanglement from aerial wires through following collisions with powerlines (Hall and Richards 2000, Geolink 2011).

8.5 Unregulated shooting and/or culling

Culling is usually done to protect orchards and the livelihood of growers. Although culling cannot be carried out without a permit issued from the relevant state and federal statutory bodies, Hall and Richards (2000) found only half of the flying-foxes culled between 1986 and 1992 were from permits and the rest were killed illegally.

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8.6 Predation

Flying-foxes form the diet of a range of predatory species including, *Haliaeetus leucogaster* (White-bellied Sea-eagle), *Haliastur indus* (Brahminy Kite), *Ninox strenua* (Powerful Owl), snakes, Dingos, *Canis domesticus* (domestic dogs) and feral cats (Hall and Richards 2000). The full impact of these native predators upon GHFFs is unknown.

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9 Kareela GHFF camp survey

ELA visited the Kareela camp on three occasions to improve understanding of the camp's dynamics. While visiting the camp ELA aimed to:

- conduct a thorough assessment of floral diversity at the site
- map the extent of the core vegetation communities
- conduct a static diurnal and two dusk fly-out population counts
- make an assessment of the primary direction of the dusk fly-outs.

9.1 Field assessments

Table 17 indicates the weather conditions during the surveys. Data is from the nearest Bureau of Meteorology (BOM) weather station at Sydney Airport.

Table 17: Weather conditions and GHFF estimates recorded during field work

DATE*	Count type	Time	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall over two days prior to survey (mm)	GHFF Counts
17/06/2013	Static	10.00 – 11.30 AM	8.3	16.4	0	5,700
17/06/2013	Fly out	5.15 – 5.50 PM				9,000
03/07/2013	Fly-out	5.25 – 5.45 PM	8.1	19.7	9	4,200
29/07/2013	Static	1.15 – 1.45	10.2	23.5	0	4,500

Source: http://www.bom.gov.au/

9.2 Methods

9.2.1 Vegetation assessments

Two ELA ecologists assessed vegetation on 17 June 2013. The survey focused on identifying flora species and confirming vegetation communities at Kareela. The entire study area was traversed slowly on foot, with all visible flora species identified. Care was taken not to disturb the roosting flying-foxes during field investigation.

The vegetation communities were mapped using GIS.

9.2.2 Counts and limitations

A static and first fly-out count was conducted on the 17 June 2013 and a subsequent fly-out count was conducted on the 3 July 2013 (**Table 17**). An additional static count was conducted on 29 July following report that high numbers of GHFF were still present over-wintering at Kareela.

The static counts involved counting the flying-foxes while they were roosting during the day time. Due to the large number of flying-foxes that required counting combined with the fact that they were largely obscured by vegetation, counts were performed by counting the flying-foxes in a single tree then multiplying by an estimation of inhabited trees present in the camp. However, because many of the inhabited roost trees were obscured from view, it is anticipated that the counts were an underestimate of the true camp size.

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The fly-out counts involved counting flying-foxes in the air as they exit the camp to conduct night foraging activities (Westcott et al. 2011). The dusk fly out counts were undertaken by two ELA ecologists placed at independent locations that provided a clear view of the camp and any flying GHFF in the night sky. Due to the volume of individuals leaving the camp at any one time, it was not possible to count every individual GHFF. Instead, groups of twenty GHFF were counted as they flew past. The fly out direction and proximity of flying-foxes to the school and residential dwellings were also monitored.

9.3 Results

9.3.1 Vegetation assessments

The reserve comprises a mosaic of distinct habitat types:

- open *Eucalyptus* dominated woodland
- dense weed-dominated central area (core GHFF camp habitat)
- open 10-15 m wide protective buffer on the western edge
- a mown area separating on the south-west edge and resident dwellings
- compensatory planting on the south-eastern boundary.

Appendix C identifies 84 (49 exotic and 35 native) plant species recorded within the reserve.

9.3.2 Camp counts

The count estimates were as follows:

- 5700 GHFFs during a static count undertaken on the 17 June 2013
- 8500 – 9000 during the dusk fly-out count undertaken on the 17 June 2013
- 4000 – 5000 during the dusk fly-out count undertaken on the 3 July 2013
- 4000 – 4500 during a static count undertaken on the 29 July 2013.

9.3.3 Previous camp counts and population fluctuations

The results of previous counts conducted at the camp show that GHFF numbers have fluctuated significantly over time. For example, lows of 500 individuals were recorded during the survey in July 2010 and a population peak of >12,000 was recorded on 24 May 2010 (John Martin pers. com.).

The dynamics experienced in camp numbers at Kareela reflect similar patterns observed in other camps. These patterns may be in response to annual and seasonal fluctuations in local and regional food resources (Eby and Law 2008, Roberts 2006). Previous studies have shown that the status and occupancy rates of most camps are often associated with the availability of food resources that are located within nightly feeding distance of 25 km to 50 km from roost sites (Eby 1995, Roberts 2005). A recent long-term satellite telemetry study found that some individuals conducted regular and considerable large nightly foraging movements (Roberts et al. 2012). Therefore, individuals from the Kareela camp are possibly taking advantage of the increased urban planting of nectar and fruit producing trees in the Sutherland Shire. This is consistent with the increased occurrence of urban GHFF camps in areas such as Melbourne where there are favoured food producing species along urban streets and backyards (ARCUE 2006).

9.3.4 Damage to vegetation and other factors

The larger roosting trees located in the centre of the reserve have been extensively damaged and are no longer suitable for the GHFF to roost. Consequently, the GHFF are now roosting among the *Ligustrum lucidum* (Broad-leafed Privet), *Syzygium* sp. (Lilly Pilly) and *Phoenix canariensis* (Phoenix

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Palm) that dominate the mid-strata vegetation. This also means the camp extends across a much larger expanse.

Roosting flying-foxes in other camps, including the RBG, have caused significant damage to roosting trees and introduce / encourage weed growth. Similar damage has also occurred at the Kareela camp, to taller Coral Trees and *Eucalyptus* species. When healthy, these trees would have significantly contributed to the upper canopy vegetation layer.

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Part C – Dispersal strategy

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10 Introduction

This dispersal strategy is to be read in conjunction with other information in the Plan of Management. The dispersal strategy is only to be initiated as a last resort and is not, as of January 2014, intended to be implemented in the immediate future as Stage One and Stage Two management options are to be implemented prior to consideration of dispersal.

Appropriate management of flying-fox camps is essential for conservation of the species. It is becoming an increasingly complex problem (Hall 2001). This complexity stems from an escalation in human and flying-fox conflicts, and desire by some people to have camps dispersed.

Previous attempts to disperse flying-fox camps have often been lengthy, expensive, difficult and unsuccessful. Some dispersal attempts have adversely affected flying-foxes and people. Consequently, any application to OEH to disperse a camp requires the development of a detailed plan to justify why dispersal should occur, what the objectives are, which activities will be undertaken, how much it will cost, and how the effectiveness of the action will be monitored and success measured.

This Kareela GHFF dispersal strategy has been prepared in accordance with the Flying-fox Camp Management Policy (FFSMP) (DECC 2007) and draws on the procedures described in ACRUE (2009). It provides the framework for development of a detailed dispersal plan if the results of short and medium term actions justify the need for dispersal of the Kareela camp. A detailed plan would need to be prepared in consultation with the Kareela community as well as communities in areas where the flying-foxes may relocate if necessary.

10.1 Justification

It is not currently possible to justify action to disperse the camp at Kareela and this is why the PoM recommends implementation of other options prior to consideration of dispersal. Justification for dispersal and consequences of not proceeding need to be explained in a detailed dispersal plan with reference to the actions previously taken (refer to Stage One and Two actions in this PoM). Results of performance monitoring will inform the justification.

10.2 Objectives

The objectives of the dispersal strategy are to:

- Identify alternative camp sites within the local area or region that may be suitable to receive dispersed GHFF.
- Disperse the Kareela GHFF camp to a more appropriate site or sites, and ensure that these sites are managed appropriately.
- Ensure that GHFFs dispersed from the Kareela camp do not establish at an inappropriate site (as defined by ARCUE 2009).
- Ensure the health, safety and amenity of the local community at Kareela is not compromised.
- Maintain the health, safety and amenity of the community close to the relocation area/s and consult the affected landholders.
- Minimise any potential negative impacts that may occur to individual GHFFs during the dispersal process.

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10.3 Assessment of issues and risks

Section 4.3 outlines typical risks associated with impacts upon the local community and GHFF during dispersal activities. This information should assist development of a detailed dispersal plan for the Kareela camp and potential relocation sites. Specific risks and contingencies to deal with these will need to be identified in the plan.

10.4 Monitoring and research

A suitable and robust monitoring and research program is a critical feature of any dispersal program. Long-term monitoring is needed to ensure the program is successful, with undesirable or unforeseeable outcomes identified and managed. Monitoring and research aims include:

- monitoring the dispersal from the Kareela camp and any reestablishment attempts
- monitoring likely relocation sites for establishment and ongoing suitability.

10.5 Performance criteria

Criteria that can be used as performance indicators and triggers for adaptive management are identified in the table below.

Table 18: Criteria for evaluating success of the Kareela flying-fox dispersal

Timeframe	Criteria for success
Prior to detailed dispersal plan	Obtain support from stakeholders, particularly landholders, that are likely to be affected by the dispersed flying-foxes
Short-term (6 months)	Appropriate approvals obtained, and long-term funding secured
	Suitable relocation sites identified and management feasible
	Dispersal without negative impacts to flying-fox welfare
	Some flying-foxes occupying appropriate new areas
Mid-term (1-2 years)	No reestablishment of flying-foxes at Kareela camp
	Ongoing vegetation and habitat modification works at Kareela progressing
	Flying-foxes occupying appropriate new sites
	Actions implemented in areas of inappropriate establishment
Long-term (>2 years)	Transformation of habitat at Kareela so as not suitable for flying-foxes
	Continued occupation of suitable relocation site
	No inappropriate sites established or occupied

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11 Potential camp sites

Pre-identified camp sites have never been successfully colonised, even those actively managed to encourage flying-fox occupancy (ARCUE 2009). Alternatively, this strategy provides criteria for suitable and inappropriate sites, and a desktop analysis of these.

Further field validation and assessment will be required of some areas prior to the implementation of any dispersal activities. This assessment should focus on fully identifying the quality of the habitat at the site, the likelihood of a camp establishing and determining if there is any potential for further conflict.

ARCUE (2009) criteria were used to predict the probable locations where the flying-foxes may be expected to disperse to. The areas are **suitable** according to the following criteria, based on knowledge of the species:

- within 10 km of the Kareela camp (flying-foxes displaced from Kareela will probably travel only short distances to maintain a connection with locally available food resources (Eby pers. comm. 2013)
- patch size to allow for seasonal influxes of flying-foxes and greater than 1 ha
- vegetation type containing vegetation in excess of 3 m in height and some dense foliage
- proximity to water
- historical use by flying-foxes.

A map of this suitable habitat is provided in **Figure 14**, developed from an analysis of suitable vegetation types and proximity to a watercourse.

Appropriate sites will also satisfy the following criteria:

- It is unlikely to negatively impact upon any threatened flora or fauna species or ecological communities.
- There is a minimum 300 m buffer separating the camp from residential dwellings (ARCUE 2009).
- The neighbouring landowners or managers are accepting of occupancy within their land or neighbouring areas.
- There is capacity to provide suitable roosting habitat for between 5000 and 12000 individuals.
- There is an area large enough and contains enough vegetation that will survive the destructive nature of permanent flying-fox occupation. Ideally the site will be of sufficient size and contain enough vegetation to allow the camp to occupy no more than one third of the available roost habitat at any given time (DECC 2007), this will allow the camp to shift and occupy other areas in response to the usual canopy degradation associated with flying-fox camps.

Inappropriate sites do not meet the above conditions.

A desktop mapping analysis of appropriate roosting habitat in proximity to the Kareela camp according to the criteria above is in

Figure 15.

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It is extremely likely that any flying-foxes from the Kareela camp will join other existing camps within the greater Sydney basin. It is unlikely that individuals from the camp will expend excessive levels of energy and move great distances away from a productive and currently available food resource (Peggy Eby pers. comm.). Accordingly, the most likely sites for relocation include:

- the permanently occupied Wolli Creek camp (**Figure 16**)
- the temporally occupied Myles Dunphy Reserve in Oatley (**Figure 17**)
- the vacant Kurnell campsite (**Figure 18**)
- the temporarily occupied Menai/Alfords Point area (noting that there is no data about the occupation of this camp) (**Figure 19**).

Of these sites, only the vacant camp at Kurnell fits both the suitable and appropriate criteria proposed. The precise location of the Menai camp is unknown and it is likely that this site will also meet the suitable and appropriate criteria. The permanent camp at Wolli Creek has been established for approximately seven years and few conflicts exist at this location, despite the proximity to some residential areas and consequently this site would also be considered to represent an appropriate relocation site.

These three sites are currently occupied, are potentially large enough and comprise sufficient habitat to support some new arrivals, and are all considered appropriate target sites for the relocation.

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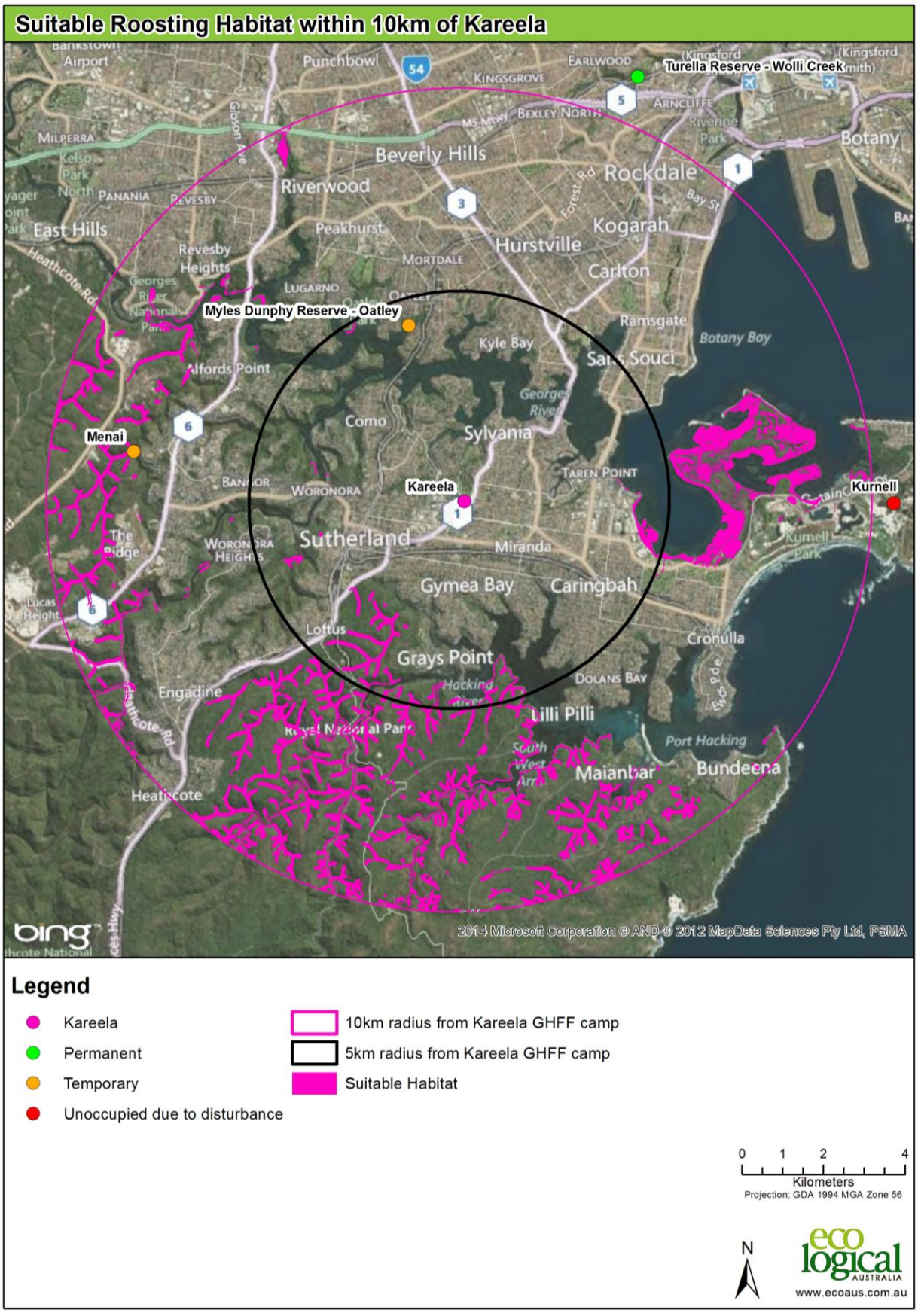

Figure 14: Habitat suitable for establishment of a GHFF camp

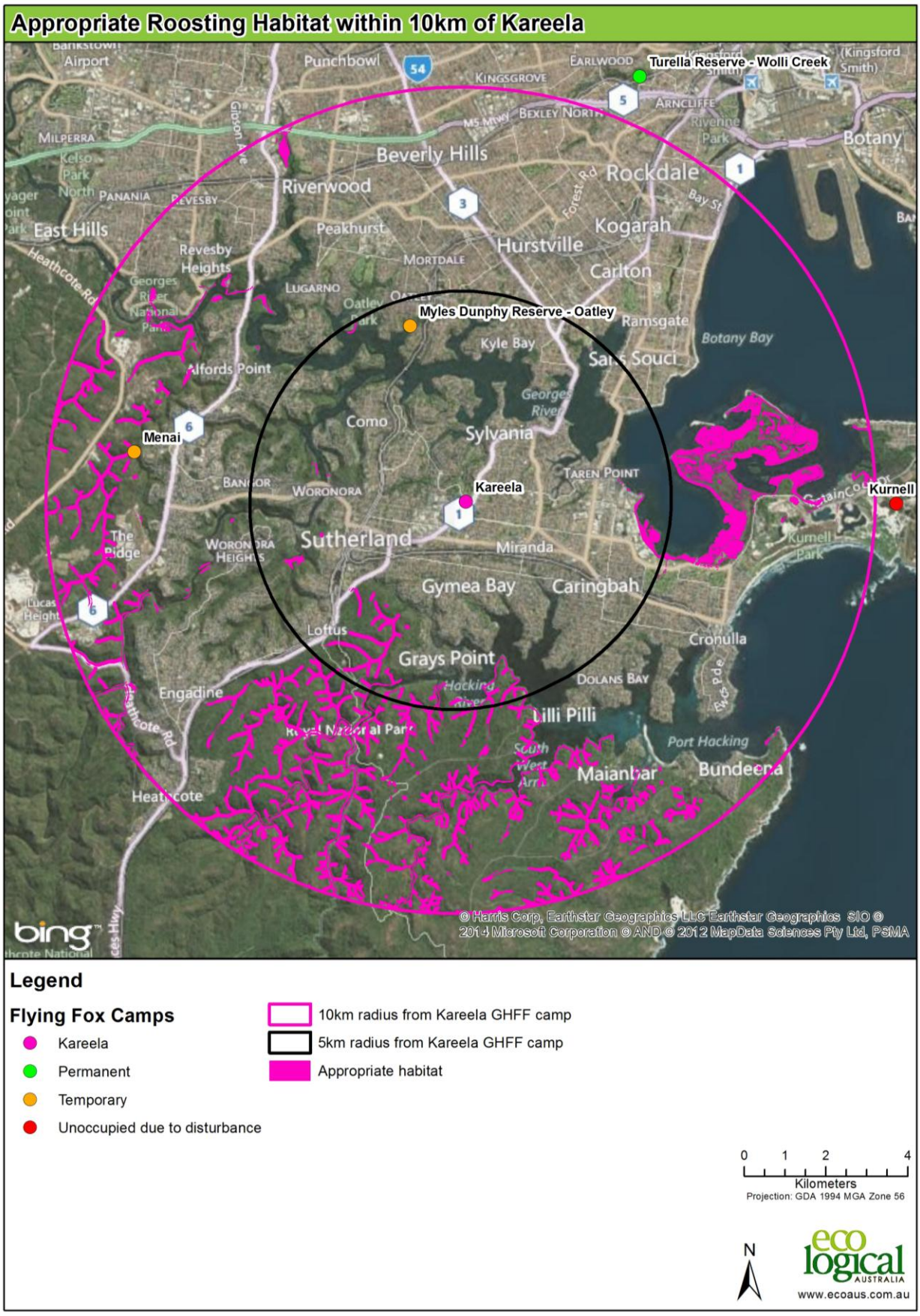

Figure 15: Habitat appropriate for establishment of a GHFF camp

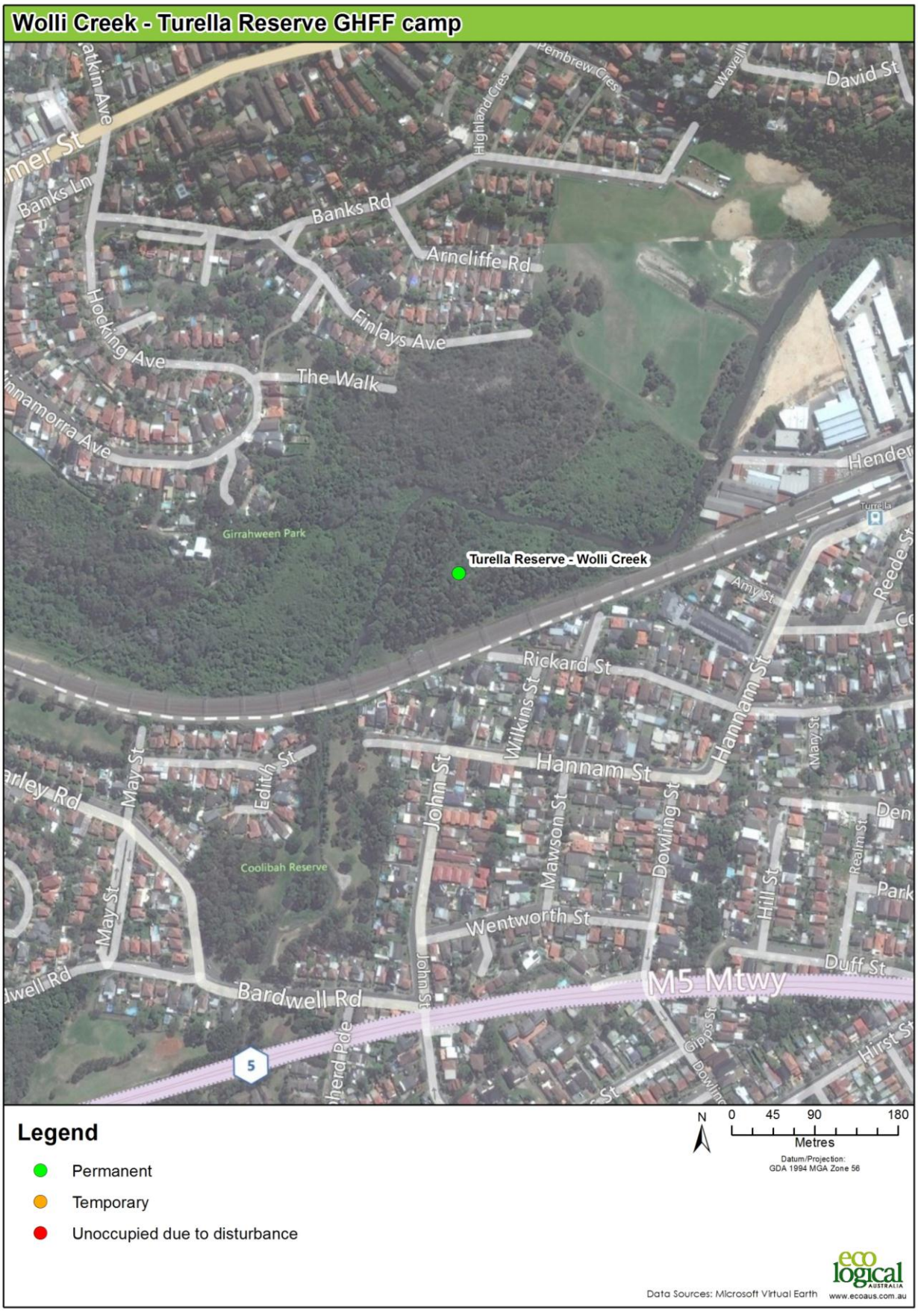

Figure 16: Wolli Creek camp

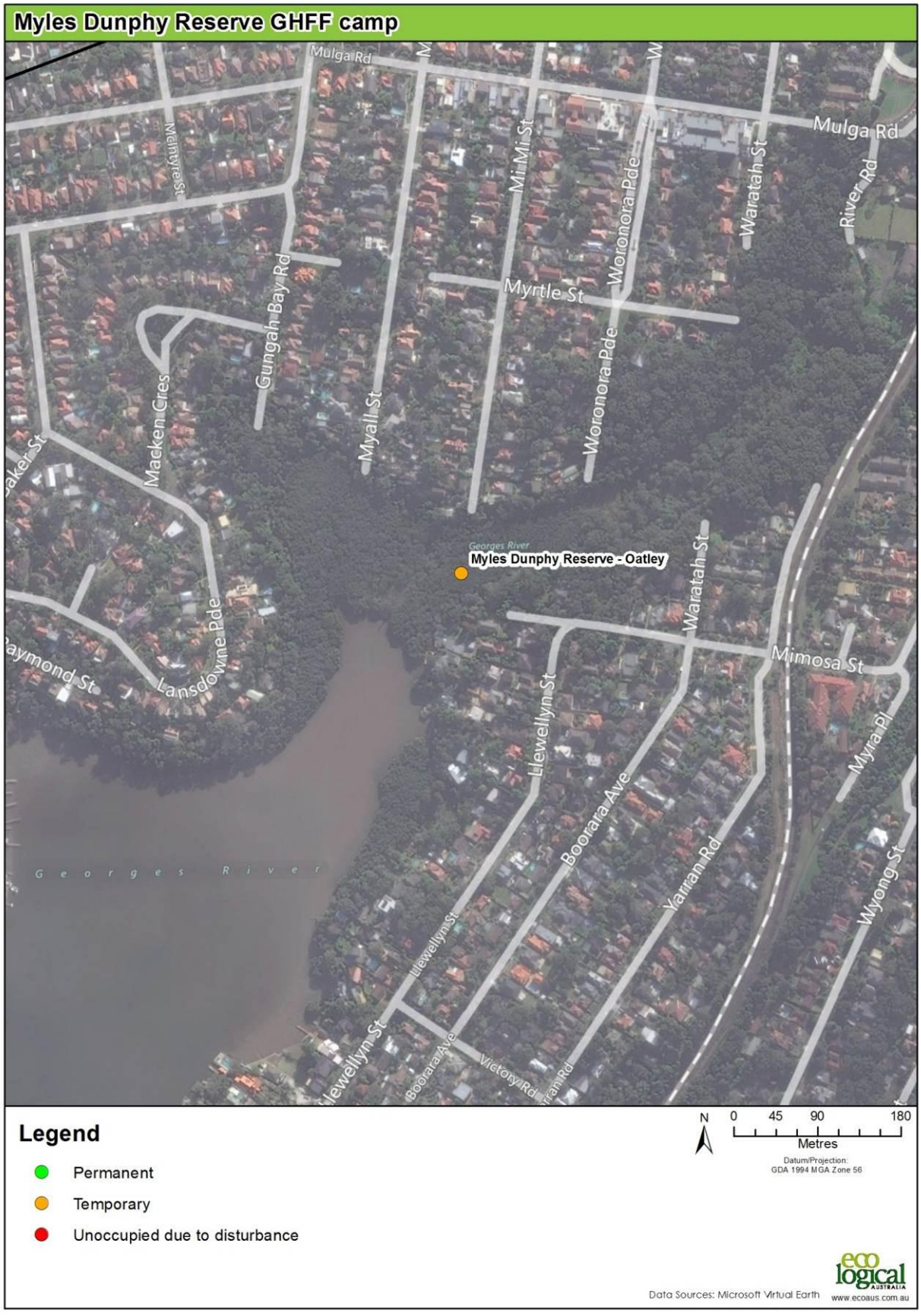

Figure 17: Myles Dunphy Reserve camp

Figure 18: Kurnell camp

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Figure 19: Menai camp

12 Actions

A number of components make up the dispersal of the Kareela flying-fox camp. These include monitoring, actions at Kareela, actions at potential inappropriate sites and actions at target camp sites.

Actions are as follows, with a flowchart for implementation in **Figure 20**.

- Identify likely camp sites, potential issues at those sites and commence enhancement works required to manage an influx of flying-foxes. Consult landowners and neighbours of these sites.
- Monitor the Kareela camp to understand the number of flying-foxes and the health of individuals for dispersal ability.
- Monitor relocation sites prior to dispersal to understand the numbers in those camps to help understand where dispersed individuals disperse to.
- Prepare detailed dispersal plan and obtain approvals.
- Undertake dispersal in winter and repeat in late summer if required and feasible.
- Monitor all suitable sites, both target camp sites and inappropriate sites during the dispersal to help understand the fate of dispersed individuals.
- If required begin dispersal actions at inappropriate locations.
- Begin any necessary management actions at relocation sites.
- Undertake habitat removal at Kareela to discourage reestablishment.
- If the flying foxes settle in an area considered appropriate, discussion with the land manager will be required. A management plan to protect and maintain the newly created camp may be required.

Further detail is given below the flow chart.

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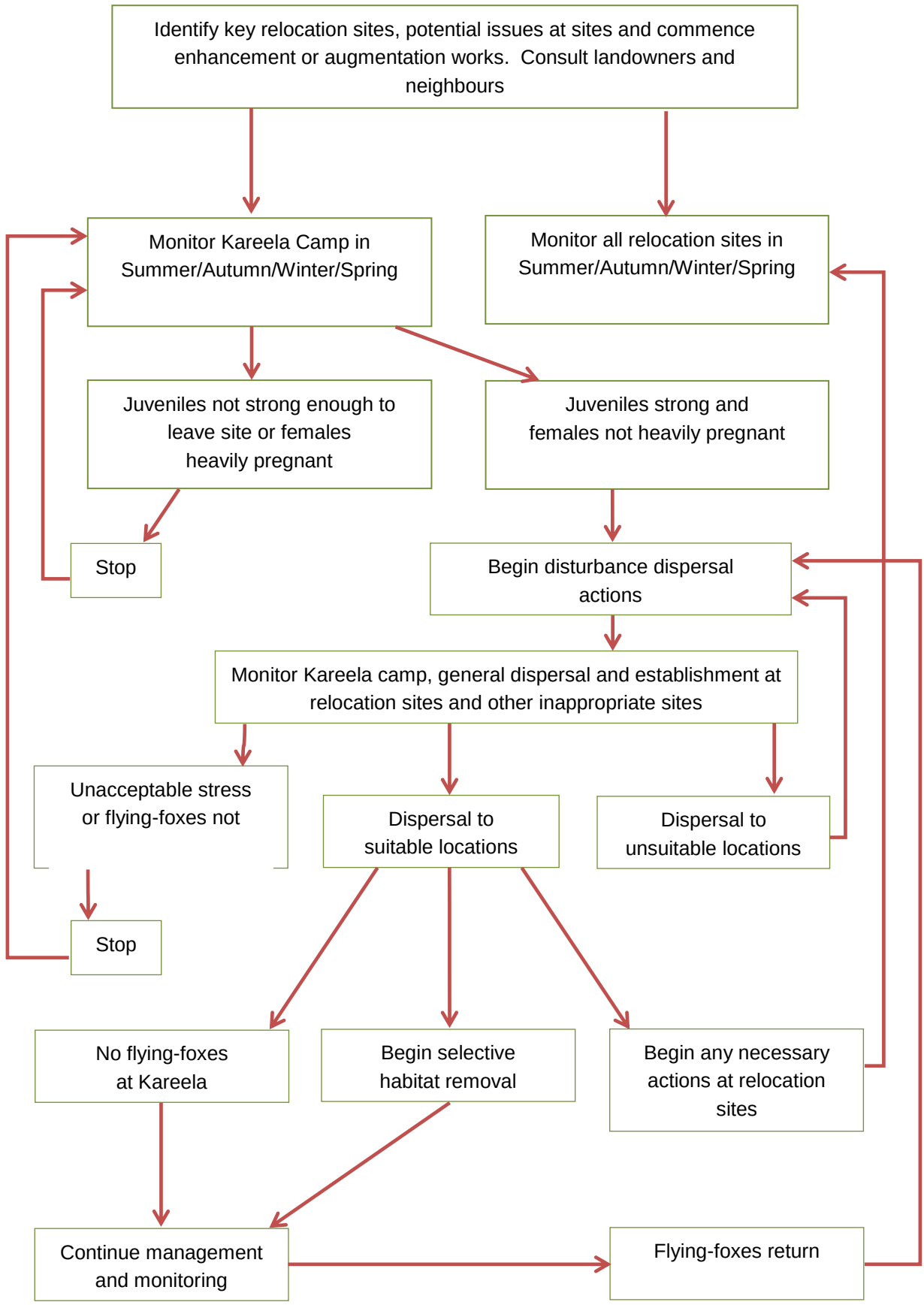

Figure 20: Flowchart for implementation of the dispersal strategy

12.1 Timeframe

The timing of the dispersal will extend over several years and will fluctuate as necessary with the outcomes of the various actions. A suggested timeline for the initial two years is proposed.

Dispersal actions should be undertaken during June, July and August provided females are not heavily pregnant. Dispersal may be supplemented in February and March but only if juveniles are deemed strong enough to survive dispersal.

Table 19: Timing of dispersal actions

Timing	Summer 2014	Autumn 2014	Winter 2014	Spring 2014	Summer 2015	Autumn 2015	Winter 2015	Spring 2015	Summer 2015
Monitoring of Kareela camp									
Monitoring of target dispersal sites									
Monitoring of inappropriate sites			If flying-foxes present	If flying-foxes present	If flying-foxes present	If flying-foxes present	If flying-foxes present	If flying-foxes present	If flying-foxes present
Dispersal actions			Jun/Jul/Aug		Feb/Mar if juveniles fit		Jun/Jul/Aug if required		Feb/Mar if juveniles fit & required
Habitat modification at Kareela			If flying-foxes relocated	If flying-foxes relocated	If flying-foxes relocated		If flying-foxes relocated	If flying-foxes relocated	If flying-foxes relocated
Management actions at appropriate relocation site			If flying-foxes relocated	If flying-foxes relocated	If flying-foxes relocated		If flying-foxes relocated	If flying-foxes relocated	If flying-foxes relocated

12.2 Monitoring

Monitoring will be required at a number of locations at various time scales and with varying intensity. All observers undertaking monitoring must have previous knowledge and experience with flying-foxes, undertaken previous population counts or undergo training prior to participating.

Unless identified specifically, monitoring will be undertaken using static daytime counts of flying-foxes. This involves counting the number of individuals roosting in sites and can be done by a single observer walking around the camp. This technique does not provide an exact count of the numbers of individuals but it is repeatable and easily resourced and any technique limitations will be repeated across sites and counts providing a repeatable measure suitable for understanding trends in population numbers.

Appropriate monitoring protocols for the various activities are provided below.

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Monitoring camp sizes and distribution

- Static daytime counts will be undertaken twice per season (8/year) to gather baseline population counts at the Kareela camp and target sites.
- Specific targeted counts will be undertaken at Kareela on the day prior to dispersal activities and every day of dispersal activities. These counts can occur just prior to evening dispersal actions or following early morning dispersal actions.
- Specific counts will be undertaken at all targeted relocation sites on the day prior to dispersal activities and every day following dispersal activities to understand whether flying-foxes are dispersing to these sites.
- Monitoring of likely inappropriate areas will be undertaken by visiting sites every day following disturbance activities to look for roosting flying-foxes. Sites containing roosting individuals will be targeted for additional dispersal actions if flying-foxes are observed to repeatedly roost in significant numbers in these areas. In addition, advice to residents throughout the area will be distributed to encourage members of the community to report unusual roosting of flying-foxes in novel locations.

Monitoring disturbance and flying-fox welfare

- Static counts and observations of the health of the flying-foxes at Kareela will be undertaken for a week prior to the start of any dispersal actions. Observations on the health of the flying-foxes must be undertaken by experienced flying-fox experts. For the winter disturbance this should involve observing the level of pregnancy of females to ensure no females are heavily pregnant and liable to abort their pregnancy during disturbance regimes. For the potential late summer disturbances, observations on the fitness of juveniles will be undertaken to judge whether they are strong enough to survive dispersal to another location, likely if they are not remaining in the camp in the evening.
- A suitably qualified expert or wildlife carer will monitor flying fox health during the dispersal to ensure the increased stress of the dispersal is not detrimental to individuals.

12.3 **Dispersal techniques**

As described in **Section 4.3** there are several dispersal methods available. A combination of techniques is proposed in this dispersal strategy to ensure the highest probability of success and this would be confirmed in a detailed dispersal plan. Suitable techniques include noise disturbance and selective habitat removal.

Flying-foxes will be dispersed initially using the noise disturbance techniques during the June to August period and will be dependent on camp health monitoring. As flying-foxes begin to disperse from the camp, selective habitat modification may be required. The timing of the habitat removal is critical to avoid adverse impacts to flying-foxes that do not disperse initially.

Following initial noise disturbance, favoured roosting trees for dominant males will be targeted for removal first and will be undertaken at night when flying-foxes have left the camp. This habitat removal will be undertaken each night, and directed by camp and welfare monitoring during the dispersal phase. Habitat removal can increase as flying-foxes begin to disperse, even during the day if flying-foxes are no longer present, with the long term goal to remove all roosting habitat and replace it with vegetation unsuitable for roosting.

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The iterative removal of suitable habitat during the dispersal of the flying-foxes should prevent the reestablishment of the camp and also prevent any negative impacts to the flying-foxes by dispersal activities at inappropriate times of the year when welfare issues are a higher concern.

If flying-foxes are not dispersing and are showing sign of stress, dispersal techniques will be stopped and reassessed.

12.4 Response to lack of dispersal

With any dispersal attempt there is the possibility that actions will not work as proposed. It is unlikely that the combined actions of both the noise dispersal and selective habitat removal will not cause sufficient disturbance. However, if this is the case additional habitat removal should be implemented if it is still in the appropriate time of the year.

If dispersal has not been successful within the appropriate time of the year (June to August) then the stakeholders and steering committee will be consulted to develop a way forward. This may include additional dispersal attempts in late summer as outlined in the dispersal methodology or abandonment of the relocation and focus efforts on alternative management options.

12.5 Actions at relocation sites

As discussed previously, the location that dispersed flying-foxes will relocate to is not predictable. The following actions are needed to maximise the chance that the flying-foxes will disperse to a suitable site:

Prior to dispersal

- Land managers will be contacted and liaised with regarding the suitability of sites for the dispersal of flying-foxes and any management actions considered necessary to be undertaken.
- An implementation plan will then be developed for each site to ensure management actions can be undertaken as required following confirmation of flying-fox relocation. Actions may include such things as vegetation management in buffer areas, habitat augmentation and revegetation to ensure sufficient habitat for an increased camp size, education of surrounding land holders.

During dispersal

- Identify where the flying-foxes are dispersing to, based on the monitoring protocol outlined in **Section 12.2**.

After dispersal

- Continue monitoring to confirm the location of the dispersed flying-foxes.
- Begin implementing management actions at appropriate sites as directed by the implementation plan.

12.6 Response to arrivals at inappropriate sites

Flying-foxes that do not join camps immediately may seek to form new camps or temporary roosts that may meet their roosting and foraging requirements, but are located in inappropriate areas. If flying-foxes begin to arrive in inappropriate locations the following actions will be undertaken:

- Monitor the site for few days to see if roosting is only temporary

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- If roosting becomes permanent then extra dispersal actions implemented. These actions along with monitoring will necessarily be need to be undertaken until flying-foxes have successfully established in an appropriate location
- Monitoring and dispersal activities (if required) at inappropriate sites is to be undertaken until flying-foxes establish at an appropriate location

12.7 Potential negative impacts on flying-foxes

There are a range of potential negative impacts that could occur to flying-foxes during the dispersal process. These potential impacts have been identified and strategies to manage these are proposed.

- Excessive Stress. All flying-foxes dispersed at any time of the year have the potential to undergo increased stress from the dispersal and as a result fail to find suitable roosting habitat or traverse to feeding resources due to fatigue. Dispersal actions have been developed to be as least stressful as possible and will be undertaken when the camp is at its smallest due to seasonal foraging movements to impact on as few flying-foxes as possible. Monitoring of flying-fox welfare during the dispersal actions to watch for signs of fatigue and stress will be undertaken. Those monitoring animal welfare will have the ultimate call as to whether dispersal actions can continue at any time.
- Abortion of young. Likely in September due to heavily pregnant females. Dispersal actions are targeted for June to August to avoid this sensitive time of the year. Monitoring of the camp prior to all dispersal activities will ensure no heavily pregnant females are present at the camp otherwise dispersal actions will not be implemented.
- Dropping of dependent pups or semi-dependent young. Likely from October to February when pups are suckling or about to be weaned. Dispersal actions will not be undertaken at this time.

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13 Costs

The budget below provides an estimate of the costs for the tasks outlined within this dispersal strategy and these would need confirmation in the detailed dispersal plan. Costs for the second year have been modified in some areas to take into consideration the potential for less effort being required based on successful first year dispersal. If dispersal actions are completely successful within the first year, then most dispersal components (identified in orange) will not be required in the second year, providing a saving of up to $137,000.

The budget has only been developed for two years. It is anticipated that any dispersal attempts that have not been successful within two years will not be continued.

Table 20: Two-year budget

Element	Notes	Year 1	Year 2	Total
Identify possible relocation sites				
Liaison	4 x meetings and site visits for one person @ $100/hr	$1,000	$1,000	$2,000
Management actions and implementation plan	Development of short report	$5,000	$5,000	$10,000
Monitoring				
Seasonal at Kareela	2 hours x 8 days per year (1 person @ $40/hr)	$640	$640	$1,280
Seasonal at target Sites	2 hours x 8 days per year x 4 sites (1 person @ $40/hr)	$2,560	$2,560	$5,120
Health at Kareela in week prior to dispersal	2 hours x 10 days per year (1 person @ $40/hr)	$800	$800	$1,600
During dispersal at Kareela	Budgeted within dispersal actions	-	-	-
During dispersal at target sites	2 hours x 90 days x 4 sites (1 person @ $40/hr)	$28,800	$28,800	$57,600
During dispersal at inappropriate sites	5 hours x 90 days (1 person @ $40/hr)	$18,000	$18,000	$36,000
Dispersal - noise actions				
At Kareela	As per PoM	$202,000	$60,000	$262,000
At inappropriate sites	As per PoM - 1 person, 5 hours/day 90 days, 3 sites	$64,000	$10,000	$74,000
Dispersal - selective habitat removal				
At Kareela	As per PoM	$80,000	$20,000	$100,000
Management of dispersal				
Actions at relocation sites	As per PoM for habitat augmentation	$60,000	$20,000	$80,000
Other costs				
Reporting	Annual report	$15,000	$15,000	$30,000
Miscellaneous	Travel, management	$5,000	$5,000	$10,000
TOTAL		$482,800	$186,800	**$669,600**

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Appendix A: Stakeholders and consultation

Consultation

Consultation during development of this PoM involved meetings and phone conferences described below.

- Initial project inception meeting 4 June 2013 with Council held between the involving Dr David Bain and Dr Rodney Armistead from ELA, and Beth Noel, Brendon Graham and Ian Drinnan from Council.
- A site evaluation and meeting with ELA, Council, representatives from the schools (Jill Deering and John McCormack from the Sylvanvale Foundation), and the Hon. Graham Annesley MP on 17 June 2013. .
- A progress meeting 3 July 2013 with ELA, Council and Deborah Stevenson from OEH.
- Phone conferences were conducted with:
    - Deb Stevenson from OEH
    - John Martin from RBG
    - Dr Peggy Eby a flying-fox expert
    - David Simm from Maitland Council
    - Rodney Wright from Clarence Council.

Steering Committee

A steering community will be established to oversee finalisation and implementation of the PoM. Suggested stakeholders include:

- Sutherland Shire Council – Mayor Steve Simpson, Deputy Mayor Cr Croucher, Cr Pesce, Ward Councillors, Ian Drinnan (Manager/Principal Environmental Scientist), Brendon Graham (Natural Areas Manager), Beth Noel (Environmental Scientist)
- A local resident/s or land holder/s
- Local State Member Hon. Barry Collier MP
- A representative from OEH
- A representative from Department of the Environment
- A representative from Sylvanvale – Alan Bish (Sylvanvale Acting CEO) and John McCormack (General Manager)
- A representative from Bates Drive Public School
- A representative from Mikarie
- A representative from Aspect
- Flying-fox experts who have considerable experience in the ecology, biology and other relocation attempts – Peggy Eby
- Eco Logical Australia – Ecologists and environmental managers who prepared the PoM
- A representative from WIRES and Sydney Wildlife
- A representative from nearby sporting clubs

Further details are below.

Schools

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Bates Drive Public School and Sylvanvale Foundation ASVC are situated at 2 Mikarie Place and 2G Bates Drive respectively, immediately adjacent the GHFF camp. The Sylvanvale ASVC provides day education programs and an accommodation service to enable people with disabilities to live independently. The daytime programs provide social and recreational activities that promote learning and skill development, and facilitate access, participation and integration with the local community. The Bates Drive Special School is for students that are aged between 4 and 18 years of age who have moderate to severe intellectual disabilities, autism and physical disabilities

The schools' priorities are associated with providing effective education as well as protecting the health and welfare of staff, students and their families. The greatest concern of the schools is to ensure the health and wellbeing of their students.

Local residents

The closest residences to the camp are along the south-western boundary of the reserve at Mikarie Drive. The dwellings are separated from the edge of the camp vegetation by a 20 m buffer of mown grass. The attitudes of the local residents to the camp range from being happy to have flying-foxes in the area, unaffected, to very negative.

Sport clubs

A number of training and playing fields are located immediately to the east of the camp. These fields are used by the Sutherland Soccer Football Club and support the Harrie Denning Soccer Centre. Staff from the Harrie Denning Soccer Centre suggested that to ELA that they would prefer it if the flying-foxes were dispersed away from area.

NSW Office of Environment and Heritage (OEH)

OEH has legislative responsibility for the protection and care of all native flora and fauna species in NSW. This includes all threatened species, populations and endangered ecological communities on private and publicly owned land. The GHFF is listed as vulnerable under the NSW TSC Act and is protected under ss118A and 118D of the NP&W Act.

The Department of the Environment

The Department of the Environment is responsible for the protection of Commonwealth listed flora, fauna and migratory species as well as endangered ecological communities. The GHFF is listed as vulnerable under the EPBC Act, which the Department of the Environment administers. The Department of the Environment is responsible to ensure that plans to disperse the species from the Kareela camps will not be harmful.

NSW Department of Health

The NSW Department of Health supports the roles of the NSW Minister of Health and Minister assisting the Minister for Health. Its goal is to keep people healthy, provide health care, deliver high quality services and manage NSW Health.

Sutherland Shire Council

Council is responsible for land use decisions and planning, land management and community well-being. It must aim to protect the environment and is responsible for any management issue that arise and actively manage from the Kareela GHFF camp in accordance with the FFCMP (DECC 2009) and the EPBC Act.

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Appendix B: Case studies

The management of flying-fox camps has become an increasing challenge for land managers, especially in urban environments (Roberts et al. 2011 & 2012). As interactions between humans and vegetation remnants within urban areas increase, conflicts continue to rise in residential communities including decreased amenity of some public areas, perceived health risks and impacts to areas of historical and cultural value.

Increasingly the most common management being sought by communities and implemented by land managers involves the active dispersal of flying-foxes (ARCUE 2009, Roberts et al. 2011). Generally, the practice of dispersing flying-foxes utilises non-lethal means and habitat modifications to encourage the flying-foxes to re-establish camps in more suitable areas (ARCUE 2009).

Roberts et al. (2011) reviewed relocation attempts between 1990 and 2009 and found that of nine relocations, only three resulted in the establishment of a new camp at an acceptable location and only two reported no ongoing conflicts at the original or the new camp location.

Recent case studies regarding the management of flying-fox colonies in NSW are summarised below.

Lorn Flying-fox Draft Management Strategy 2012

The flying-fox camp at Lorn in the Maitland Local Government Area is located on both private and publicly owned land between Lorn St and The Avenue. Presently 5000 to 20,000 individual flying foxes occupy the camp. The flying-foxes began arriving at Lorn in September 2009 and by March 2011 the numbers were high enough and the length of stay was sufficiently long enough to start causing negative impacts on the community. These issues included:

- excessive noise impacting on the sleep requirements of the local residents
- odour entering local residents' homes
- faecal drop on vehicles, washing, solar panels and footpaths
- general well-being of residents (irritability, sleep deprivation and the general safety concerns associated with a lack of sleep)
- perceived health risks associated with the potential for transmission of the Hendra virus, ABLV and/or Menangle virus
- reduced amenity from noise, odour, faecal drop and defoliation of vegetation, especially regarding the playground and use of park facilities
- vegetation damage caused by roosting flying-foxes.

The key objectives of the Lorn Flying-fox Management Strategy are to:

- address the concerns of local residents and Maitland City Council whilst not deferring the problem elsewhere
- manage the camp in a manner consistent with statutory obligations and policies.

Management actions, costs to date and current status of the Lorn flying-fox camp are tabulated below.

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Table 21: Lorn flying-fox camp

Criteria	Details
Management actions implemented	Two licence applications for habitat modification, both granted. Unfavourable camp conditions (pregnant females) did not allow actions to be undertaken under first licence Under the second licence, habitat modification was undertaken in June 2013 involving the removal of two and modification (height and branch span) of 21 identified roost trees on both council and private land. Monitoring ongoing everyday involving residents
Costs to Date	$30,000 for vegetation works
Current Status or Outcomes	Flying-foxes have not returned, although it has only been two months, during winter when the camp is to a large degree deserted, since the actions were completed Unknown where the flying-foxes have dispersed to

Source: David Simm (Maitland Council) pers. comm. (2013)

Flying-fox Management Strategy, Burdekin Park, Singleton 2012

Burdekin Park is the premier park within Singleton, located in the middle of the town on the New England Highway. It is listed as a heritage location of local significance with large mature trees as the major historic component. The flying-fox colony seasonally fluctuates between none and 20,000 individuals.

A steering committee looking at the management of the flying-foxes resolved to disperse the flying-foxes by non-lethal means. A number of disturbance actions were attempted over many years including loud noises, machinery and water although largely resulted in the flying-foxes relocating to other unfavourable areas.

The key issues of concern at Singleton have been:

- noise, odour and faecal drop resulting in the cessation of activities in Burdekin Park including weddings, community events in the park, Hunter Valley Guide monthly markets and military commemorations/celebrations
- perceived health risks including Hendra virus, Australian Bat Lyssavirus and Menangle virus
- vegetation damage.

The key objectives of the Flying-fox Management Strategy at Burdekin Park, Singleton are to

- manage the GHFF roosting site at Burdekin Park within the legislative requirements and within financial constraints.
- address the concerns of the local residents and the wider community of Singleton.

Management actions, costs to date and current status of the Burdekin Park flying-fox camp are tabulated below.

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Table 22: Burdekin Park flying-fox camp

Criteria	Details
Management actions implemented	2003 - dispersal actions (noise and water) 2007 - dispersal abandoned 2007 - licence to cull sought but never granted 2009 - Council resolve to abandon relocation and seek funding for rehabilitation at the park 2011 - Funding secured to create artificial habitat at two suitable locations 2.1 km and 4 km from the existing camp
Costs to Date	$117,000 (estimated $320,00 to continue relocation over 3 years)
Current Status or Outcomes	Initially flying-foxes dispersed less than 900m to less appropriate areas but have now returned to the park

Source: Singleton Council (2012), Roberts et al. (2011), Roberts (2006)

Maclean Flying-fox Management Strategy 2010

The flying-fox colony comprises approximately 25,000 individuals at Maclean on the far North Coast of NSW. It is centred on the Maclean Rainforest Reserve, Maclean High School, Maclean TAFE campuses and remnant vegetation along a gully to the northeast across Cameron Street. The camp has been occupied by GHFF, BFF and at times by LRFF (Geolink 2011).

Historically the management of flying-foxes at Maclean has been reactive rather than in accordance with a proactive long term strategy. Previously the management of the Maclean flying-foxes included culling, dispersal by noise and smoke (Geolink 2011). These actions were immediately successful in dispersing the flying-foxes from the rainforest and school areas to a gully to the north east. However, following the completion of the planned noise disturbance and significant flowering events the flying-foxes moved back into previously occupied areas.

Key issues of concern at Maclean have been:

- noise for local residents and education facilities
- odour entering local residents homes and causing concentration issues at education facilities
- faecal drop on vehicles, washing, solar panels and footpaths
- general well-being of residents (irritability, sleep deprivation)
- perceived health risks including Hendra virus, Australian Bat Lyssavirus and Menangle virus
- reduced amenity from noise, odour, faecal drop and defoliation of vegetation
- vegetation damage.

The key objectives of the Maclean Flying-fox Plan of Management were to address the concerns of local residents, Maclean High School & Technical and Further Education community, and the broader Maclean community whilst conserving and co-existing with the flying-fox population.

Management actions, costs to date and current status of the Maclean flying-fox camp are tabulated below.

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Table 23: Maclean flying-fox camp

Criteria	Details
Management actions implemented	1999 intensive dispersal actions 2010 onwards: • clearing of vegetation buffers and offset planting • community education • planting of alternative habitat • bush regeneration at Maclean Rainforest Reserve
Costs to date	$500,000 minimum
Current status or outcomes	Flying-foxes have established seven new camps, three of these in inappropriate areas with further conflicts Flying foxes continue to revisit the original camp with numbers fluctuating Actions have reduced public outcry and calls for relocation Conditions on licence to disperse very restrictive and very difficult to undertake and unlikely it ever will be undertaken

Source: Rodney Wright (Clarence Council) pers. comm (2013), Roberts et al. (2011), Geolink (2011),

Flying-fox Relocation, Royal Botanic Gardens, Sydney

The RBG is located adjacent to Sydney harbour and is regarded as significant cultural and botanical icon for Australia and the world. The gardens became home to a camp of GHFFs in 1989 and at its peak contained 20,000 individuals. Since this time BFF and LRFF have been recorded roosting within the gardens. However, in addition to the GHFF, only the BFF use the RBG on a permanent and maternal basis (ARCUE 2009).

Significant impacts have been associated with the flying-foxes, with the critical issue being the damaging and killing of highly significant trees (ARCUE 2009).

The main objective was to disperse the entire camp to another area within Sydney and not allow any further roosting. Relocation actions have consisted of various acoustic stimuli played both in the afternoons and in the early morning and evenings.

Management actions, costs to date and current status of the RBG Sydney flying-fox camp are tabulated below.

Table 24: Royal Botanic Gardens (RGB) flying-fox camp

Criteria	Details
Management actions implemented	Noise deterrents continuously used for dispersal since June 2012. Following the first two weeks of noise pre-dawn and close to sunset, only pre-dawn deterrent activities continue. Two years of monitoring of flying-fox camps around Sydney and satellite tagging of individuals to understand the dispersal of the animals from the gardens Daily relocation activities are conducted and will continue indefinitely
Costs to date	$2,000,000 includes approvals, permits, monitoring (e.g. satellite trackers), consultant fees, noise equipment, animal capture and condition assessments

Current status or outcomes	June 2013 – no flying-foxes roosting in the gardens Satellite tracking has shown the flying-foxes have moved to various camps around both Sydney and across the east coast

Source: Sydney RBG website (2013), Martin (RBG pers. comm. 2013), ARCUE (2009)

Appendix C: Plant species list

Scientific Name	Common Name	Core Camp Vegetation	Creek Vegetation	Open Woodland	Noxious Weed Cat
*Alstroemeria pulchella**	Parrot Alstroemeria		X		
*Andropogon virginicus**	Whisky Grass		X		
Angophora costata	Smooth-barked Apple		X	X	
Angophora floribunda	Rough-barked Apple	X			
*Anredera cordifolia**	Madeira Vine	X			WONS
*Araujia sericifera**	Moth Vine	X			
*Asparagus aethiopicus**	Asparagus Fern, Sprengeri Fern	X		X	Class 4 NSW, WONS
Banksia ericifolia	Heath-leaved Banksia	X			
Banksia serrata	Old-man Banksia			X	
*Bidens pilosa**	Cobbler's Pegs	X			
*Briza minor**	Shivery Grass		X		
*Bryophyllum delagoense**	Mother of millions	X			
Callistemon salignus	Willow Bottlebrush			X	
Callistemon viminalis	Weeping Bottlebrush	X			
*Capsella bursa-pastoris**	Shepherd's Purse	X			
Cassytha spp.				X	
*Cerastium vulgare**	Mouse-ear Chickweed	X			
*Cinnamomum camphora**	Camphor Laurel	X			
*Cirsium vulgare**	Spear Thistle		X		
Commelina cyanea	Native Wandering Jew	X			
*Conyza bonariensis**	Flaxleaf Fleabane	X			
*Coreopsis lanceolata**	Coreopsis	X			
*Cotoneaster lacteus**		X			
Cynodon dactylon	Common Couch	X	X		
*Cyperus eragrostis**	Umbrella Sedge		X		
Cyperus polystachyos			X		
Dianella caerulea	Blue Flax-lily	X		X	
*Digitaria sanguinalis**	Summer Grass, Crab Grass	X			
*Ehrharta erecta**	Panic Veldtgrass	X			
Entolasia marginata	Bordered Panic			X	
Entolasia stricta	Wiry Panic			X	
*Erythrina indica**	Indian Coral Tree	X			
Eucalyptus gummifera	Red Bloodwood	X		X	
Eucalyptus pilularis	Blackbutt			X	
*Foeniculum vulgare**	Fennel	X			
*Fumaria bastardii**	Bastards Fumitory		X		

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Scientific Name	Common Name	Core Camp Vegetation	Creek Vegetation	Open Woodland	Noxious Weed Cat
Glochidion ferdinandi	Cheese Tree	X		X	
Gonocarpus teucrioides	Raspwort		X		
Hibbertia aspera	Rough Guinea Flower			X	
*Hydrocotyle bonariensis**			X		
*Hypochaeris radicata**	Catsear	X			
Imperata cylindrica	Blady grass		X	X	
*Ipomoea indica**	Blue Morning Glory	X			
Lambertia formosa	Mountain Devil			X	
*Lantana camara**	Lantana	X			Class 4 NSW, WONS
Lepidosperma spp.				X	
Leptospermum arachnoides		X			
*Ligustrum lucidum**	Large-leaved Privet	X			Class 4 NSW
*Ligustrum sinense**	Small-leaved Privet	X			Class 4 NSW
Lomandra multiflora	Many-flowered Mat-rush			X	
Lomatia silaifolia	Crinkle Bush			X	
Melaleuca quinquenervia	Broad-leaved Paperbark	X			
*Monstera deliciosa**		X			
*Nephrolepis cordifolia**	Fishbone Fern	X			
*Nerium oleander**	Oleander	X			
Omalanthus populifolius	Bleeding Heart, Native Poplar		X		
Oplismenus aemulus		X			
*Paspalum urvillei**	Vasey Grass		X		
*Pennisetum clandestinum**	Kikuyu Grass	X	X		
Persicaria decipiens	Slender Knotweed		X		
*Phoenix canariensis**	Canary Island date palm	X			
Phyllostachys sp.*		X			
*Phytolacca octandra**	Inkweed		X		
Pittosporum undulatum	Sweet Pittosporum	X		X	
*Plantago lanceolata**	Lamb's Tongues		X		
Populus sp.*		X			
Pteridium esculentum	Bracken	X			
*Ricinus communis**	Castor Oil Plant	X			Class 4 NSW
*Rubus fruticosus sp. agg.**	Blackberry complex	X			Class 4 NSW, WONS
*Rumex obtusifolius subsp. obtusifolius**	Broadleaf Dock		X		
*Senecio madagascariensis**	Fireweed	X			WONS

Scientific Name	Common Name	Core Camp Vegetation	Creek Vegetation	Open Woodland	Noxious Weed Cat
*Senna pendula**		X			
*Setaria parviflora**	Slender Pigeon Grass	X			
Smilax glyciphylla	Sweet Sarsparilla			X	
*Solanum mauritianum**	Wild Tobacco Bush	X			
*Solanum nigrum**	Black-berry Nightshade	X			
*Sonchus oleraceus**	Common Sowthistle		X		
Swainsona sp.		X			
*Taraxacum officinale**	Dandelion	X			
*Tradescantia fluminensis**	Wandering Jew	X			
Typha orientalis	Broad-leaved Cumbungi		X		
*Verbena bonariensis**	Purpletop	X			
Xanthorrhoea media				X	
*Zantedeschia aethiopica**	Arum Lily	X			

*Identifies those plant species that are exotic

WONS = Weed of National Significance

Class 4 NSW = The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction and the plant may not be sold, propagated or knowingly distributed

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