Parramatta North Urban Renewal (PNUR) Proposed Rezoning

Ecological Management Plan

Prepared for
UrbanGrowth NSW

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Terms and abbreviations

Abbreviation	Description
DotE	Commonwealth Department of the Environment
EIA	Environmental Impact Assessment
EEC	Endangered Ecological Community
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
LEP	Local Environment Plan
LGA	Local Government Area
SEPP	State Environmental Planning Policy
SSD	State Significant Development
SSI	State Significant Infrastructure
TSC Act	NSW *Threatened Species Conservation Act 1995*

Executive summary

An ecological management plan has been prepared to accompany the ecological impact assessment (ELA 2014a) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* referral application (ELA 2014b) for rezoning of The Cumberland Precinct and the Sport and Leisure Precinct within the Parramatta North Urban Renewal area (PNUR). The plan identifies management strategies that aim to:

- retain the Grey-headed Flying-fox camp, remnant River-flat Eucalypt Forest and habitat for threatened species on site
- minimise potential impacts of the development through use of barriers, and appropriate design and construction techniques
- improve the ecological values of the site by enhancing the riparian corridor.

Results of ecological monitoring will inform adaptive management of the PNUR. The management actions will be further refined and implemented during subsequent planning, design, construction and operational phases of the development. This will include development of a detailed vegetation management plan, and erosion and sedimentation plan.

1 Introduction

Eco Logical Australia Pty Ltd has been engaged by UrbanGrowth NSW to prepare this management plan to accompany the ecological impact assessment (ELA 2014a) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* referral application (ELA 2014b) for rezoning of The Cumberland Precinct and the Sport and Leisure Precinct within the Parramatta North Urban Renewal area (PNUR) (**Figure 1**).

The PNUR rezoning will provide opportunities to protect and enhance significant heritage sites, and deliver housing, cultural uses and employment on the edge of the Parramatta CBD. The proposed rezoning aims to facilitate a sustainable long-term future for the two precincts that will achieve the ongoing conservation of their significant cultural heritage values.

The plan identifies management strategies that will be refined and implemented during subsequent planning, monitoring and assessment, design, construction and operational phases of the development. The management strategies aim to:

- minimise potential ecological impacts of the development
- reduce the risk of potential conflict between the Grey-headed Flying-fox (GHFF) camp and future residents
- improve the ecological values of the site by enhancing the riparian corridor.

Management strategies are broadly discussed in this plan as follows:

- **Chapter 3** - Strategies that aim to minimise potential impacts through appropriate design, construction and operation of PNUR infrastructure. These strategies relate to potential impacts from vegetation clearing, noise, light spill, rubbish and vandalism. Measures are identified that will help reduce future conflict between the GHFF camp and future residents.
- **Chapter 3** - Strategies that aim to enhance the ecological values of the site through management of the riparian corridor, including the GHFF camp.
- **Chapter 4** – Strategies that aim to raise community environmental awareness and participation.

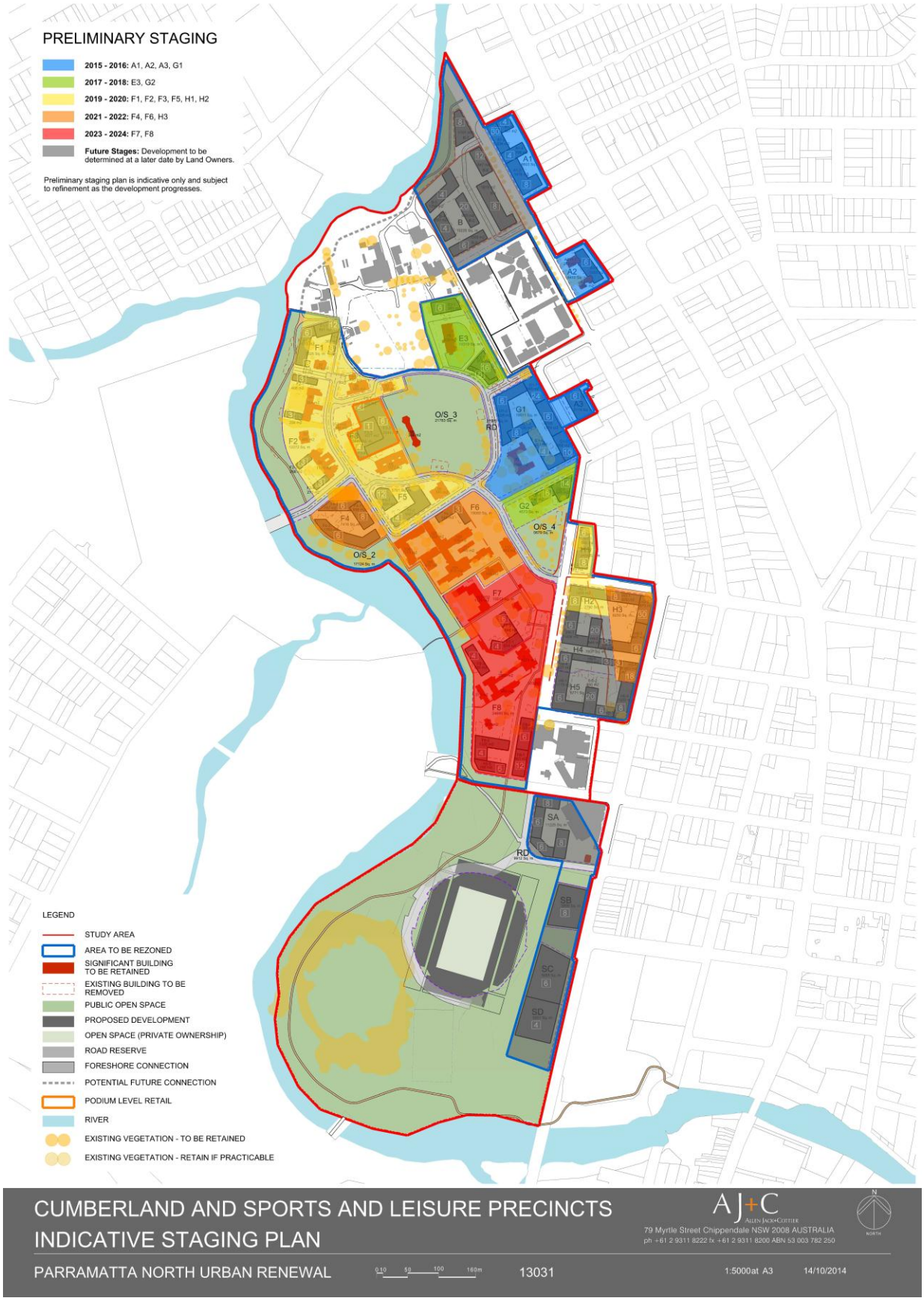

Figure 1: Indicative layout and staging plan for PNUR (AJ+C)

2 Summary of ecological values

Existing ecological values of the site are illustrated in **Figure 2** and **Figure 3** and include:

- Grey-headed Flying-fox camp
- River-flat Eucalypt Forest
- habitat for other threatened fauna species (birds and microbats) recorded or with potential to occur at the site.

The Parramatta River flows adjacent to PNUR lands and has significant aquatic ecological values that are affected by activities within the catchment. The river is mapped as Key Fish Habitat by NSW Fisheries.

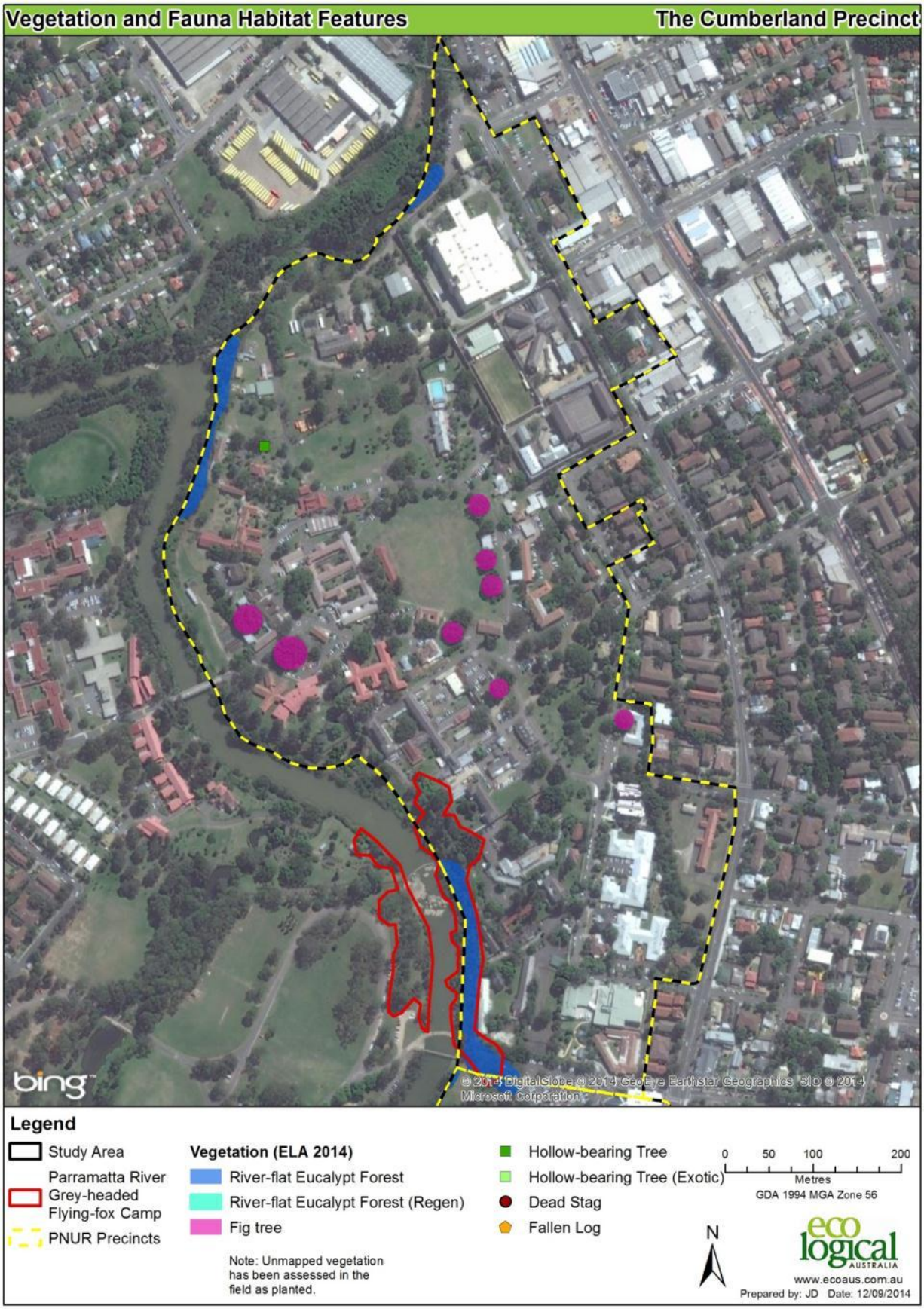

Figure 2: Ecological values of the Cumberland Precinct

Figure 3: Ecological values of the Sport and Leisure Precinct

2.1 Grey-headed Flying-fox camp

2.1.1 Ecological value of GHFF

Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) are highly significant to the health and maintenance of many ecosystems in eastern Australia. They are regarded as a 'keystone species', which means they have a unique and important role in the way ecosystems function.

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 are then transferred when it moves and begins foraging on the flowers of same trees or shrub species (Hall and Richards 2000).

2.1.2 Legal status

The GHFF has been recognised as a threatened species due to its ecological importance and declining numbers resulting from loss of foraging and roosting habitat. The GHFF is on the International Union for Conservation of Nature (IUCN) Red List 2008. It is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.* Approvals are therefore needed if the GHFF or its habitat will be damaged.

According to the Draft National Recovery Plan for GHFF (DECCW 2009), the Parramatta GHFF camp has foraging and roosting habitat critical to survival of the GHFF.

- Foraging habitat critical to survival of the species meets one or more of the following criteria:
    - Productive during winter and spring, when food bottlenecks for the species have been identified.
    - 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).
    - 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).

The DECCW Draft Recovery Plan recommends a 300 m buffer around GHFF camps to avoid conflict with human habitation. (Potential conflicts such as odour, noise and faecal droppings are discussed in **Appendix A**.) However, as shown in **Figure 4,** Parramatta North is a highly urbanised area and much of the area within the recommended buffer has previously been developed. A significant proportion of the existing development comprises heritage buildings which are proposed to be restored.

The Cumberland Precinct includes the Cumberland Hospital site, which retains significant buildings and structures from the Female Factory (1818-1848), Parramatta Lunatic Ayslum (1848-1878) and Hospital for the Insane (1909-1960). The precinct also includes Parramatta Gaol (c1836-2011) and the Norma Parker Centre/Kamballa, which retains significant buildings and structures from the Roman Catholic Orphan School (1844-1888) and the Girl's Industrial School (1888-1980). The Sports and Leisure Precinct forms part of the original Government Domain and is the site of the first Government Farm, Old King's School Oval, Parramatta Racecourse and Cumberland Oval. The precinct currently features the Ross Street Gatehouse (c1935), the Parramatta Swimming Pool Centre, Parramatta Stadium and the Parramatta Leagues Club.

2.1.3 Camp location and extent

The Parramatta River GHFF camp is one of 20 camps that are located within the greater Sydney region (**Figure 5**). The size, permanency and dynamics of most flying-fox camps are strongly tied to the availability of local and regional food resources as well as climatic extremes (Roberts et al. 2012).

Evidence provided from the use of satellite telemetry has shown individual GHFF often travel as far as 250 km in a single night (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 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 size of the Parramatta River camp fluctuates over time and across seasons, and generally contains 10 – 20,000 individuals, with peak numbers during spring and summer. The permanent status and size of the Parramatta River camp indicates that it is in an area that contains year-round food supplies for GHFF. The GHFF habitat present on site meets the criteria for consideration as roosting habitat critical to the survival of the GHFF (refer to **Section 2.1.2**).

The camp formed in 2003 on the eastern bank of the river where it occupies a linear strip of habitat and now covers an area of approximately 2 ha. The camp has gradually moved south along the Parramatta River (ELA 2008 and PPT 2007), possibly in response to the GHFF moving to habitat away from the areas that have been defoliated.

In 2007, a small number GHFF began roosting on the western bank of the river. It appears that the GHFF moved across the river in response to the noise created by the use of machinery within and near the core camp. Initially, the camp on the western bank was used intermittently for short periods, but an increasing number of individuals have consistently used this area over time.

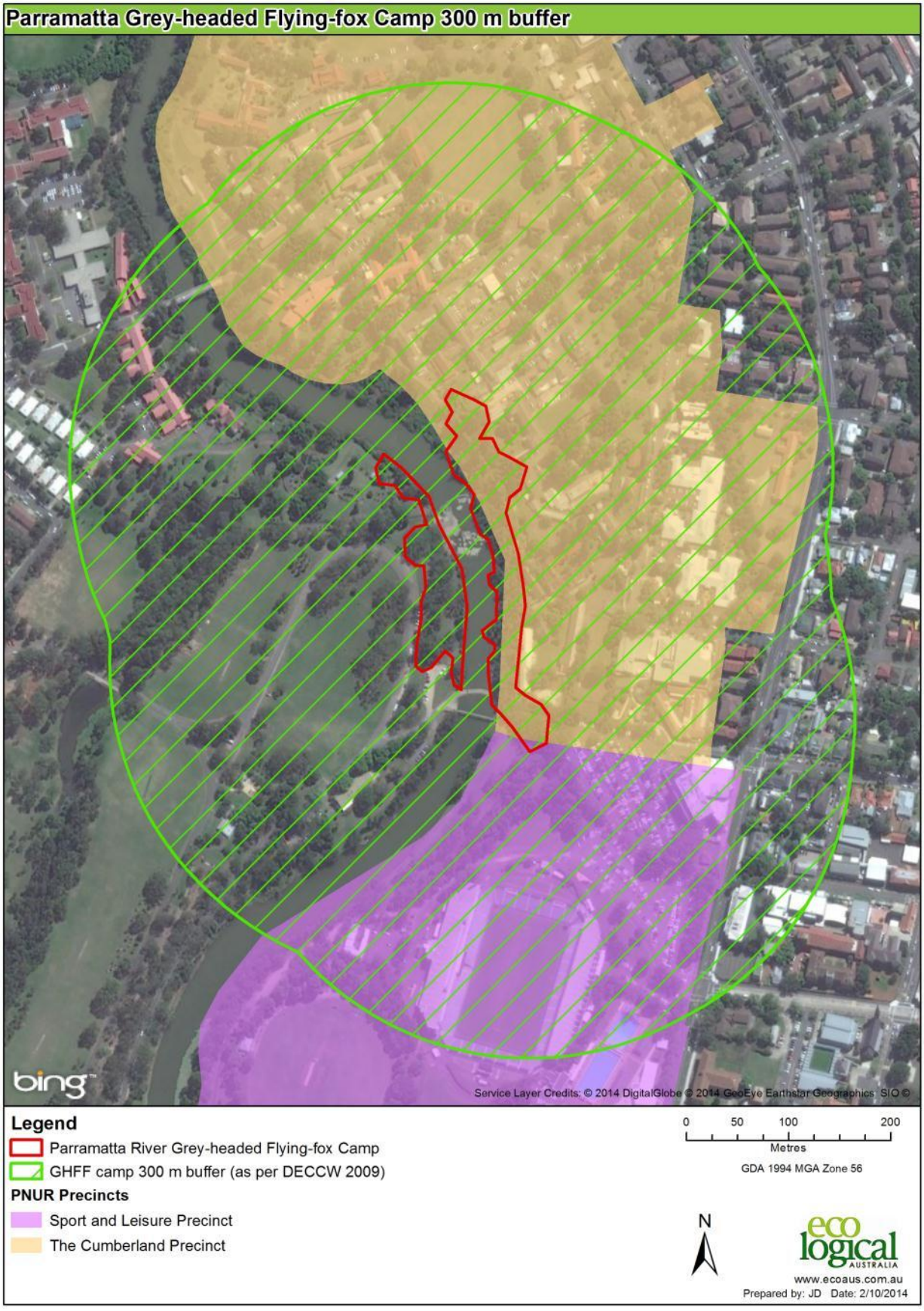

Figure 4: 300 m buffer to the GHFF camp in accordance with the DECCW (2009) Draft GHFF Recovery Plan

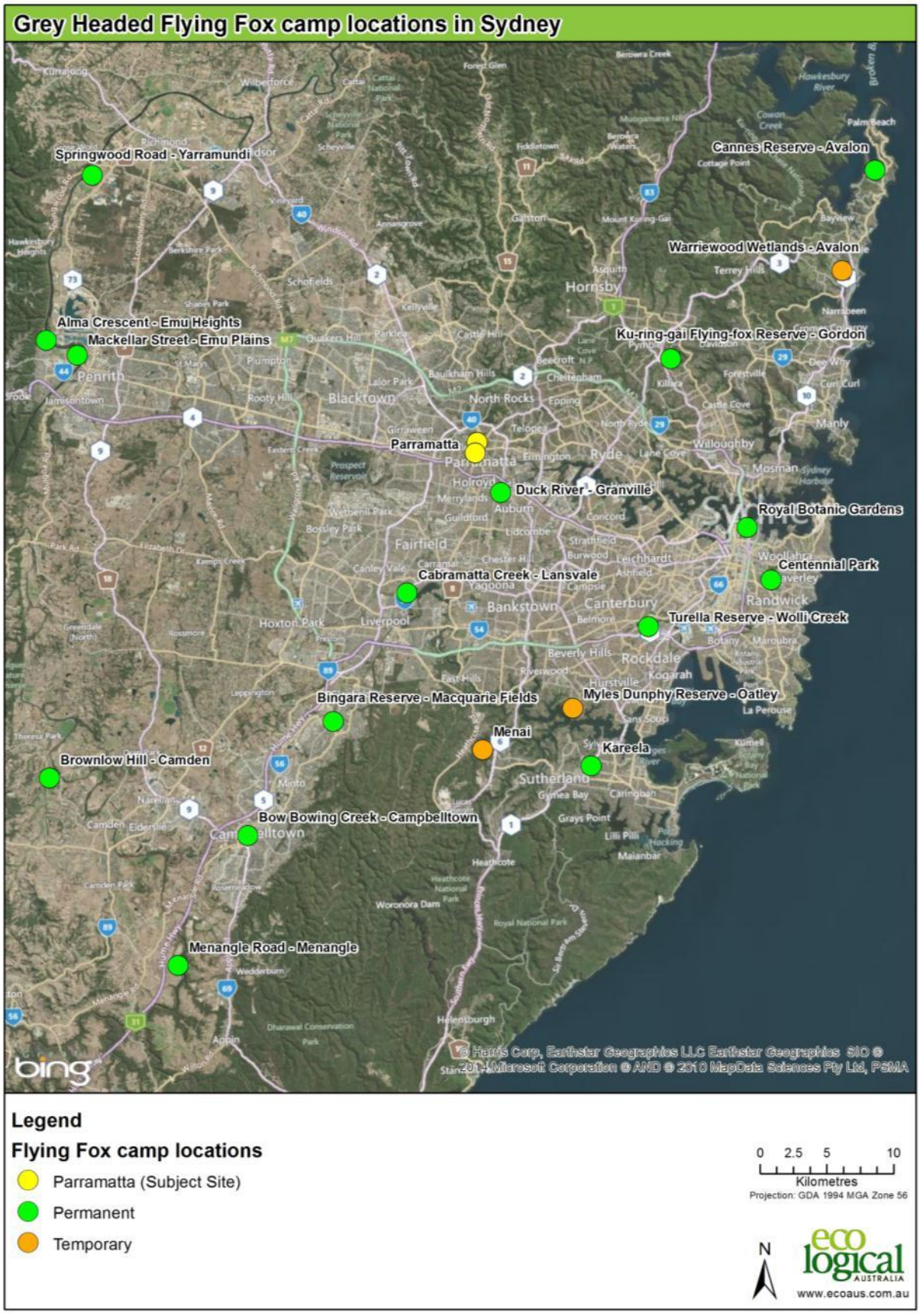

Figure 5: Locations of GHFF camps in Sydney

2.1.4 Habitat

Water and vegetation are key habitat features. GHFF camps are often positioned close to water such as rivers and swamps because water moderates temperatures, allows flying-foxes to cool by skimming over the water surface and provides a source for drinking.

Roost trees within the camp on the western bank exhibit few signs of degradation or foliage senescence typically caused by roosting flying-foxes. In comparison, native vegetation on the eastern bank is in a highly degraded state. This may be in response to the defoliation caused by roosting GHFF, weed proliferation from faecal drop nutrient loads, as well as the challenges associated with undertaking maintenance works in flying-fox camps.

The Draft National Recovery Plan (DECCW 2009) states that GHFF camps that are considered critical to the survival of the species may consist of introduced plants such as weeds.

2.2 River-flat Eucalypt Forest

Remnant vegetation along the river is River-flat Eucalypt Forest, which is listed as an Endangered Ecological Community under the TSC Act. Equivalent vegetation types under different classification schemes are tabulated below.

Table 1: Equivalent vegetation types

OEH (2013a and b)	NPWS (2002)	Biometric Vegetation Type	TSC EEC
Cumberland Riverflat Forest	Alluvial Woodland	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregion

Cumberland Riverflat Forest was characterised in the study area by a native canopy of *Eucalyptus tereticornis* (Forest Red Gum), *Angophora floribunda* (Rough-barked Apple), *Casuarina glauca* (Swamp Oak) and *Casuarina cunninghamiana* (River Oak). *E. amplifolia* (Cabbage Gum), *E. robusta* (Swamp Mahogany) and *E. moluccana* (Grey Box) were present in lower numbers. Native shrubs included *Bursaria spinosa* (Blackthorn), *Acacia decurrens* (Sydney Green Wattle), *Pittosporum undulatum* and *Acacia longifolia* (Sydney Golden Wattle), while the ground cover included the natives *Microlaena stipoides* (Weeping Grass), *Commelina cyanea, Lomandra longifolia* (Spiny Mat-rush) and *Dichondra repens* (Kidney Weed).

The current condition of this community varies, with most patches being low to moderate condition. Patches in moderate condition contained a tree canopy, shrub layer and ground layer. Weeds were common and in some parts of the patch dominant. Some patches were subject to regular management (such as weed removal) and had been fenced off to limit public access.

Patches in low condition contained little of the original vegetation, were small in area and lacked diversity. Some patches in low condition were subject to active vegetation restoration; plantings and weed management.

2.3 Fauna habitat

In addition to the GHFF, the site provides habitat for the following threatened bird and microbat species:

- *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat)
- *Mormopterus norfolkensis* (East-coast Freetail Bat)
- *Ninox strenua* (Powerful Owl)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Myotis macropus* (Southern Myotis).

Table 2 lists habitat types and the broad fauna groups that may use this habitat in the study area.

Table 2: Fauna habitat types in the study area

Fauna habitat type	Native fauna groups that may use this habitat	Potential use
Scattered trees	Birds, mammals, reptiles	Foraging, refuge, breeding
Riparian woodland	Birds, mammals, reptiles, frogs	Foraging, refuge, breeding
Hollow-bearing trees	Birds, mammals, reptiles	Refuge, breeding
Fallen logs	Mammals, reptiles, frogs	Foraging, refuge
Fig trees	Birds and mammals	Foraging refuge, breeding
Stags	Birds, mammals, reptiles	Refuge, breeding
Built environment	Mammals, reptiles	Refuge

4 Minimising potential impacts

This section sets out management measures that will be adopted to minimise potential impacts from development of PNUR lands. The overall objective is to minimise or avoid impacts to the GHFF camp, River-flat Eucalypt Forest and other ecological values of the site. This will be achieved by buffers, barriers, appropriate design and construction techniques, and ecological monitoring and adaptive management.

4.1 Buffers and barriers

The establishment of a 300 m buffer around the GHFF camp (as recommended in the DECCW Draft Recovery Plan for the species and depicted in **Figure 4**) is not realistic given that the site is located within an urban environment close to the Parramatta CBD. An existing brick wall (see **Figure 6** and **Figure 7**) will act as a barrier between the core GHFF camp and adjacent future uses, and protect the camp from direct impacts during construction and in the longer term. Adjacent uses will include a shared pedestrian / bike path, restored heritage buildings and new buildings as shown for stages F7 and F8 in **Figure 1**.

Public access and associated risk of disruption to the GHFF camp will be limited because the camp is positioned between the wall and the river. No infrastructure (e.g. paths, pipes, buildings) will be built in this area. As discussed in **Chapter 5**, the riparian corridor to the north and south of the GHFF camp will be extended by bush regeneration and revegetation. This will provide additional opportunities for the camp to expand or shift along the river as the population fluctuates.

The alignment of the shared path will be designed and constructed so that no remnant vegetation (River-flat Eucalypt Forest – see **Figure 2** and **Figure 3**) needs to be cleared. The shared path will be constructed outside of the GHFF camp boundary and will not require the modification of habitat utilised by the camp.

The risk of future potential conflicts between the GHFF population and residents (as discussed in **Appendix A**) will be reduced by situating the majority of higher yield residential dwellings further away from the camp boundaries, as depicted in **Figure 1**.

Where possible, landscaping outside the riparian corridor will retain hollow bearing trees and fig trees. If hollow bearing trees need to be removed, their loss in the short term will be compensated with artificial structures, such as nest boxes. Nest boxes will be designed for specific fauna, such as microbats, possums, birds. Nest box design will influence the types and species of fauna to use this supplementary habitat. Longer term, revegetated areas along the river will result in the creation of hollow bearing trees and provide habitat for various species.

Figure 6: Wall to be retained between the GHFF camp and adjacent uses (view from eastern side)

Figure 7: View of wall from river side

4.2 Noise

Noise has the potential to affect fauna during construction and longer term when the development is 'operational'.

Animals rely on meaningful sounds for communication, navigation, avoiding danger and finding food against a background of noise. For example, 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 disturbances, including dogs, people and the operation of machinery.

The effects of noise on most species are poorly understood and fauna will perceive noise impacts differently (AMEC Americas Ltd 2005; Office of Planning, Environment & Realty; Eco Logical Australia 2006). Some fauna become stressed by noise, which can affect foraging or breeding, or they may leave an area, whereas other species or populations do not seem to be affected or may adjust to noise over time. An example of this was when construction noise near the original camp on the eastern side caused some GHFF to permanent relocate to the quieter western side of the river in Parramatta Park.

Despite the uncertainty around the nature of noise likely to be experienced and the lack of understanding about how different fauna species may react to noise, the greatest risk of adverse impacts is likely to be during construction of infrastructure in close proximity to the GHFF camp. This will include noise associated with:

- construction of the shared path
- restoration of heritage buildings
- construction of new buildings in stages F7 and F8.

Management strategies to be implemented include:

- *Ensure all plant and equipment is maintained to Australian Standards to minimise noise generation.
- *Position plant and equipment as far from the GHFF camp as possible.
- *Shield noise at its source, where possible.
- *Avoid construction at dawn when the GHFF are returning to the camp to roost.Schedule construction of the shared path outside the GHFF breeding season (i.e. when the ratio of lactating or late-pregnancy females and/or dependent young is greater than 5% of the population in the camp).
- Commission an ecologist with suitable experience to monitor the health of the GHFF during the breeding season when new buildings are being constructed in F7 and F8. If GHFF become too stressed they can abort young. The ecologist would have authority to stop noisy construction work if the GHFF are stressed. The work would be allowed to resume at night when the camp is empty or when the ecologist determines that the GHFF are no longer stressed and at risk.

*These measures should also be implemented during construction of new buildings and restoration of heritage buildings in earlier stages of the PNUR development.

4.3 Light spill

Excessive lighting not only causes light pollution and wastes energy but also impacts on the natural environment by affecting the activity rhythms of both plants and animals (Outen 1998). Bats (flying-foxes and microbats) are affected by artificial lighting because of the following reasons (Fure 2006, Jones 2000):

- Many species of bats are known to sample the light levels before emerging from their roost; only emerging for their night's hunting when the light intensity outside reaches a critical level after sunset.
- Artificial lighting disrupts the normal 24-hour pattern of light and dark which is likely to affect the natural behaviour of bats. Light near a roost access point will delay bats from emerging and shorten the amount of time available to them for foraging.
- Bright light may reduce social flight activity and cause bats to move away from the light area to an alternative dark area.
- Illuminating a bat roost creates disturbance and may cause the bats to desert the roost.
- Artificial lighting can also affect the feeding behaviour of bats. In most bat species there is an evening period of activity followed by another at dawn. These two flights correlate with the peak flight times of nocturnal insect prey. Insects are attracted to light particularly if it is a single light source in a dark area.

- Artificial lighting can increase the chances of predation. It is believed that some species shun bright light as a predator avoidance strategy.

The following will be implemented to ensure public safety and amenity while minimizing adverse ecological impacts:

- Do not shine construction lights toward the GHFF habitat or other habitat areas.
- Install lights along the side of the path on the side furthest from the river.
- Install low bollards (1-2 m height) between the path and the riparian habitat where suitable, with post tops (4-5 m height) installed at key pedestrian junctions if required for public safety.
- Utilise low pressure sodium lamps with UV filters in landscaping near the riparian corridor.
- Minimise the time during which the lighting is used.
- Use lowest possible brightness.
- Direct light below the horizontal plane towards the path and shield riparian vegetation by fitting lights with hoods.

4.4 Monitoring impacts and adaptive management

Monitoring will be used to determine if the ecological values of the site are being impacted and if additional or alternative controls need to be implemented. Results of monitoring need to be considered in the context of previous data (e.g. seasonal fluctuations of the GHFF population, vegetation mapping).

The GHFF monitoring will include:

- fly-out population counts twice yearly (summer and winter) by at least two ecologists at either end of the camp to be undertaken for the duration of the development project
- determination of the presence/ratio of dependent young (flightless and flying) in the week prior to construction activities within 50 m of the camp
- determination of the presence / ratio of lactating or late-pregnancy females in the week prior to construction activities within 50 m of the camp
- monitoring GHFF health during construction of new buildings in stages F7 and F8 if construction occurs during the breeding season.

5 Enhancing ecological values

Improvements to riparian vegetation and minimising the risk of GHFF deaths from heat stress are additional measures proposed as part of the PNUR development.

5.1 Riparian vegetation

An enhanced riparian corridor will offer additional habitat for threatened and other species, assist with river bank stabilisation, as well as improve amenity. This approach is consistent with best management practice and is supported by requirements of the NSW *Water Management Act 2000* and various policies and plans.

Ecological management zones within the proposed riparian corridor have been mapped in **Figure 8** and **Figure 9** to show areas that share similar characteristics and management requirements. The zones are:

- Grey-headed Flying-fox camp in The Cumberland Precinct
- River-flat Eucalypt Forest (RFEF) primary weed control
- RFEF secondary weed control
- RFEF re-creation / rehabilitation.

The mapped zones are indicative and will need further refinement based on detailed site evaluation and design considerations. The RFEF re-creation / rehabilitation zone aims to improve ecological connectivity along the riparian corridor by filling substantial gaps between areas of existing RFEF, although there will be some areas where access will continue to be provided to the river. For the purposes of this plan, a consistent 40 m vegetated buffer from the river bank has been assumed for the riparian corridor, although this will vary following more detailed planning and consideration of site conditions (e.g. topography, existing remnant vegetation).

Where possible, RFEF will be regenerated, rehabilitated or re-created in the zones between the proposed shared path or stone wall and the river. Infrastructure such as the path and stone wall will define the landward boundary of management zones to assist with protection and management of ecological values along the river. It should also help minimise the risk of trampling or vandalism in vegetated areas.

Vegetation on the site that exists outside of the ecological management zones will be retained where possible and managed primarily for cultural heritage landscape values. This includes fig trees mapped in **Figure 2** and **Figure 3.** Information about heritage and landscaping is available in other specialist PNUR reports (by Musescape and Context).

A detailed vegetation management plan for the riparian corridor will need to be prepared that specifies:

- weed control measures
- species suitable for revegetation that are available and consistent with the RFEF community (see key species identified in **Section 2.2**)
- planting densities
- maintenance regimes.

The vegetation management plan will focus in the short term on rehabilitating or recreating areas outside of the GHFF. Long term control of understorey weeds within the camp will require careful

planning and implementation to avoid disturbing the GHFF population or increasing the risk of heat stress.

5.2 Managing GHFF heat stress

Heat stress or hypothermia would not be caused by the PNUR development, but it is a factor to be considered in management of the GHFF camp. It can result in mass injury and death of flying-foxes.

GHFF heat stress events occur when temperatures in the camp rise above 40^{o}C, with impacts increasing during consecutive days above 40^{o}C. Other contributing factors that might increase / decrease the impacts of heat stress include:

- access to or absence of adequate understorey vegetation – dense understorey vegetation provides a refuge to escape intense heat and should be considered in any bush regeneration program
- timing and age of GHFFs in the camp – during the birthing season or presence of juveniles in camp (juveniles are most susceptible to heat stress events)
- the numbers of GHFF in camp (more bats will lead to competition for cool roost locations and potentially more deaths)
- condition of GHFFs in camp – if they are already under stress from other factors (noise, low food resources, disease or a combination of these things), they will be more prone to heat stress events.

Actions needed to mitigate the impacts of heat stress include:

- provision of dense understorey vegetation to moderate temperature extremes and protects GHFF from direct sunlight
- lowering the temperature within the camp on hot days by:
    - spraying/pumping/misting water into the camp using large water pumps and hoses
    - spraying or misting water directly onto heat stressed individuals using small hand held pumps
- treating animals in triage.

A heat stress protocol for the Parramatta Camp should be developed, similar to that in Stanvic et al (2013). Mitigation measures such as spraying and triage should only be conducted by vaccinated ecologists and volunteers.

5.3 Monitoring and adaptive management

Enhancements to riparian vegetation and results of GHFF heat stress incidents need to be monitored as part of an adaptive management regime for PNUR. Monitoring requirements should be included in the vegetation management plan and heat stress protocol. Performance measures could include:

- extent and condition of native vegetation
- extent of suitable GHFF habitat
- GHFF deaths from heat stress.

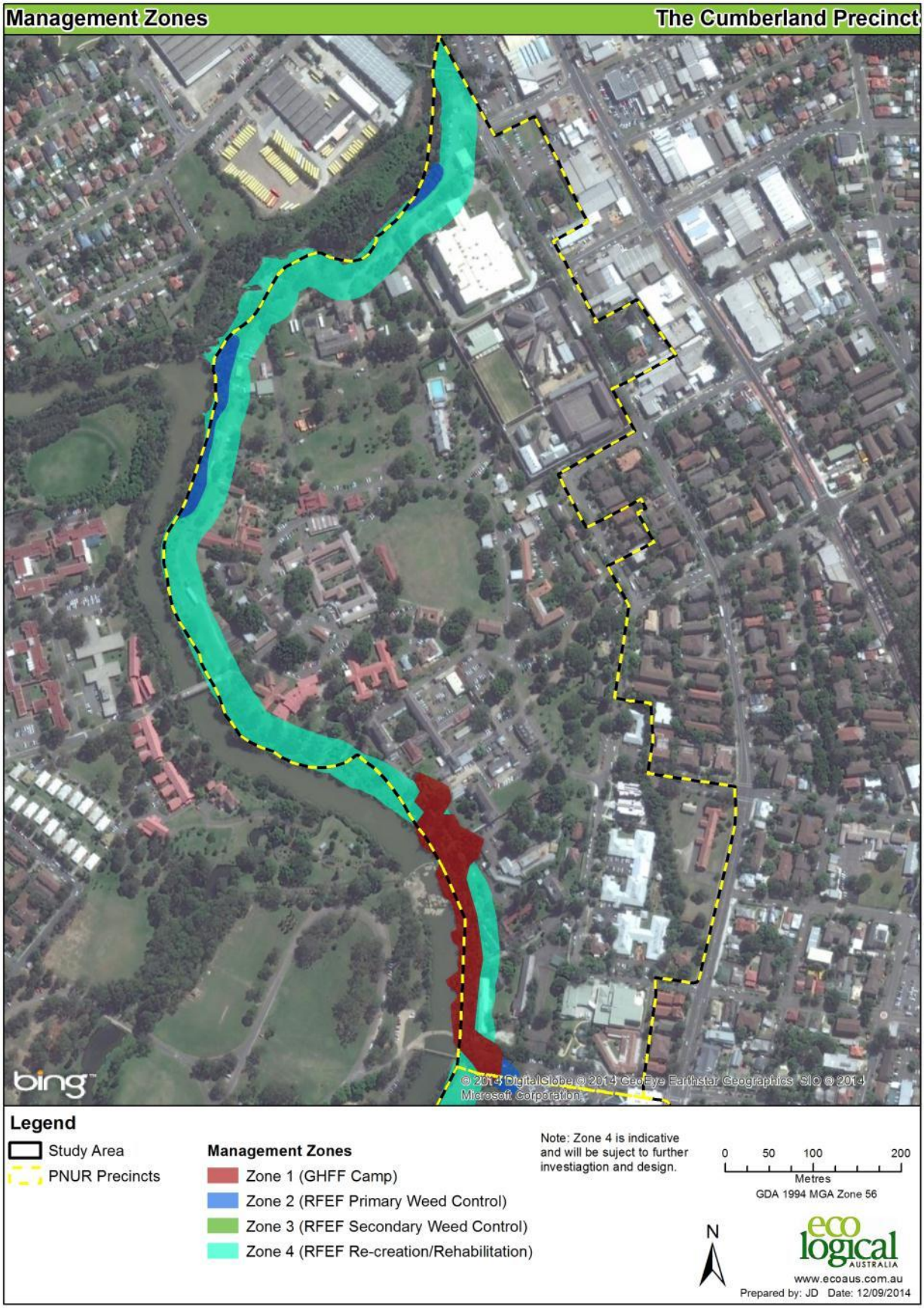

Figure 8: Ecological management zones for Cumberland Precinct

Figure 9: Ecological management zones for Sport and Leisure Precinct

6 Community education and participation

As the number of residents and users of PNUR lands grows in future, it is desirable that the community be informed about the ecological values of the area. It is also desirable that people be given opportunities to participate in management or appreciation of the natural local environment.

This section identifies opportunities for community environmental education and participation that are specific to PNUR. There are two focus issues:

- education and research related to the GHFF camp
- participation in bush regeneration activities in the riparian corridor e.g. via a Bushcare group.

Opportunities to raise community awareness about the importance of native vegetation for a healthy river and stimulate greater community involvement in riparian vegetation management include:

- 'graffiti-proofed' information boards at key locations along the river corridor to present heritage and environmental information, including what to do if you find a dead or injured bat (see **Appendix A**)
- information on relevant websites
- regular Bushcare activities to conduct on-ground works.

Bushcare is a community movement with volunteers of all ages involved in bush regeneration, weed removal, tree planting, habitat restoration, wildlife monitoring and water quality monitoring. In addition to the environmental benefits of community involvement, the social benefits to Bushcare volunteers include:

- learning new skills
- meeting new people
- getting to know the neighbours
- giving something back to the community
- being active and getting outdoors.

Community groups such as WIRES are already involved in monitoring the GHFF population at Parramatta and assist with conservation of the species by rehabilitating injured bats where possible. Community groups, together with government agencies and other institutions, may be interested in advising or assisting with a community education program.

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Appendix A Potential conflicts with GHFF camp

This section outlines the main sources of concern or conflict associated with flying-fox camps that are close to where people live or work, particularly where the camp is directly adjacent to residences, schools or other sensitive uses.

Faecal drop

Flying-foxes have a very efficient digestive system which allows food to pass through very quickly (12-30 minutes) and consequently 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 the potential to impact the proposed developments in the study area. This includes the construction of a raised boardwalk, outdoor settings, outdoor cafes/restaurants and even cars parked in exposed areas. During a recent site visit, ELA found considerable faecal drop immediately below the camp. ELA was present during two nocturnal foraging fly-outs and found that the majority of individuals flying north and south along the river which means that most faecal drop would most likely occur in the river. A small number of individuals were observed flying east over the Parramatta Stadium car park towards Victoria Street.

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 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).

Dogs, birds of prey, planes, machinery and people can disturb roosting GHFF (Roberts 2006). An example of this was when construction noise near the original camp on the eastern side caused some GHFF to permanent relocate to the quieter western side of the river.

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 - 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 camps 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.

Damage to native vegetation and proliferation of weeds

While landing and flying within their roosts, flying-foxes will often defoliate and break branches. Tree deaths are common in densely populated camps or during prolonged periods of camp occupation. GHFF have damaged the upper canopy and much of the mid strata native vegetation within the Parramatta camp, particularly on the eastern side of the river. This loss of canopy, combined with increased levels of sunlight reaching the lower vegetation strata and increased nutrient loadings has led to a proliferation of exotic weeds.

The Parramatta Park Trust has sought approval to control weeds in the camp in accordance with the Management Plan (ELA 2008). There have been difficulties in obtaining TSC Act section 91 licence for bush regeneration activities in the camp partly due to the limited time available to do the works (i.e. May-August).

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

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).

The expression of ABLV among wild populations of bat species is thought to be very low (DAFF 2007). Generally 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 can be 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).

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).

People at most 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.

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). The transmission of the virus appears to have occurred through horses consuming food that is contaminated by the faeces from infected flying-foxes.

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).

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.

Management of injured or dead flying-foxes

A dead GHFF was found within the satellite camp during the first site visit by ELA. There was no evidence to suggest why or how this individual had died. However, during periods of very hot weather individuals from the Parramatta camp appear to suffer considerably which often results in high mortality. During these periods, juvenile, injured or dead flying-foxes may be found on the ground. Other causes of death and injury include entanglement in power lines or netting.

If a sick, dead or injured GHFF is found it should be reported to PPT staff, Australian Wildlife Rescue Organisation or WIRES (1300 094 737). Staff from these organisations are trained in fauna handling and have been vaccinated. The public should not handle sick, dead or injured GHFF.

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