Biodiversity Impact Assessment

Amb Ecology and Heritage

Appendix Q

Western Sydney Stadium Stage 2: Biodiversity Assessment

Prepared by AMBS Ecology & Heritage Pty Ltd
for Lendlease Building Pty Ltd

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Executive Summary

Stage 2 of the Western Sydney Stadium project, i.e. the detailed design and construction, follows Stage 1, i.e. the demolition of the existing stadium and the concept plan. An EIS including a Biodiversity Assessment was prepared for Stage 1 of the project and Stage 1 has been approved. The Biodiversity Assessment for Stage 1 (Eco Logical 2016) found that the development footprint, i.e. the area to be directly affected by the demolition works, contained no native vegetation and no hollow-bearing trees. However, the Biodiversity Assessment for Stage 1 also confirmed: the presence of the EEC River-Flat Eucalypt Forest adjacent to the development site; the presence of hollow-bearing trees within the EEC; the presence of a large camp of the Grey-headed Flying-fox (a threatened species) to the north of the site; and areas containing planted native/exotic vegetation within the site, which would be removed for the demolition work.

Accordingly, the Biodiversity Assessment for Stage 1 made a number of recommendations aimed at avoiding or reducing impacts on the Grey-headed Flying-fox camp and the River-Flat Eucalypt Forest. Assessments of significance (7 Part Tests) were prepared for six threatened fauna and one EEC potentially affected by the Western Sydney Stadium project (including the Grey-headed Flying-fox, the Powerful Owl, several microbats, and River-Flat Eucalypt Forest). The conclusion of the assessments was that the project would not have a significant impact on any of these threatened fauna and flora.

The Biodiversity Assessment for Stage 1 also included an assessment of significance consistent with the EPBC Act for the Grey-headed Flying-fox, which found that the proposed works “may have” a significant impact on a population of this species. A referral to the Commonwealth Department of the Environment (referral 2016/7739) was made, which concluded that the proposed action was not a controlled action, mainly on the basis that:

- only a small amount of potential foraging habitat for the Grey-headed Flying-fox would be removed;
- lighting within the stadium will be consistent with the existing lighting and will not be directed at the camp or regular flight paths;
- Grey-headed Flying-fox foraging and roosting habitat will be retained and the camp will not be further fragmented;
- predicted construction noise is lower than the predicted sporting event noise during the evening and night; and
- to minimise the risk of significant impacts from surrounding activities in the short and long term:
    - new buildings will be located at least 50 m from the camp;
    - demolition and construction activities will be restricted, particularly during sensitive periods in the GHFF life-cycle;
    - noise during events will be managed under the existing Parramatta Stadium Noise Management Plan (PCCD 2008).

The Referral Decision was made by the Australian Government Department of Environment and Energy on 12 September 2016 was that the proposed action is not a controlled action.

The development footprint for Stage 2 of the Western Sydney Stadium project, i.e. the construction of the new stadium, is almost exactly the same as the development footprint assessed in the Biodiversity Assessment for Stage 1, with the exception of two small areas to the north and south containing planted trees and mown grass adjacent to or within existing car parks. Investigations for this study (the Stage 2 Biodiversity Assessment) were focussed on updating and complimenting the investigations undertaken for Stage 1 and included the following:

- updated database searches for threatened flora and fauna that may occur in the locality (in order to include data on threatened species that may have been recorded in the locality since the Stage 1 assessment, and on species, populations and ecological communities that may have been listed as threatened since the Stage 1 assessment);
- additional surveys of the River-Flat Eucalypt Forest, in order to confirm the current extent and condition of the community and to search for threatened plants that may not have been recorded during the field surveys for Stage 1 (which were undertaken on 23 May 2016, i.e. at the end of autumn); and
- additional surveys of the Grey-headed Flying-fox camp, in order to confirm the current extent of the camp and identify flight paths, which can vary seasonally.

The investigations undertaken for this study (the Stage 2 Biodiversity Assessment) confirmed the presence of areas of the EEC River-Flat Eucalypt Forest along the north-western boundary of the development site and to the north of the site alongside the current Parramatta Leagues Club car park. The AMBS investigation extended the boundary of the north-western patch of the EEC slightly, based on the presence of vegetation consistent with the Final Determination for the community, specifically *Eucalyptus saligna x botryoides* and *Backhousia myrtifolia*.

The River-Flat Eucalypt Forest along the north-western boundary of the site occurs as a strip of vegetation along a steep bank located between the existing stadium facilities (buildings, car parks, roads and paths, and a grassy mound to the north) and the Parramatta River, with part of the area alongside the river comprising a cleared, grassy flat. As such, the existing rainfall catchment for the community is very small, with most of the rainfall falling above the bank directed away from the community and into drainage channels and pipelines (AECOM 2016). This arrangement will continue under the Storm Water Management Plan prepared in relation to Stage 2 works (Aurecon 2017). As such, the potential for the River-Flat Eucalypt Forest to be significantly affected by changes to surface water runoff is low, and Aurecon (2017) concluded the Stage 2 works are unlikely to interfere with 'ground water dependent ecosystems.'

The AMBS survey located a number of hollow-bearing trees in the area of the EEC. It was noted that one large hollow-bearing tree was on the top of the bank, inside the boundary fence installed for the Stage 1 works. The tree appears to be one of a number of trees along the north-western boundary that will be retained. It is recommended that the Stage 2 works (and, ideally, the Stage 1 works) incorporate an internal boundary (i.e. inside the perimeter fence) to ensure that works are not undertaken within the critical root zone of any trees potentially associated with the EEC and that any works inside the primary root zone are done by hand under supervision of a qualified arborist.

It is also recommended that stringent erosion and sediment control measures are implemented during the construction of the stadium, as well as weed control and mechanisms to minimise the potential for the transmission of *Phytopthera*. An assessment of significance (7 Part Test) was applied to this community and concluded that, if strong control measures to ensure these potential indirect impacts are implemented and maintained during the Stage 2 works, the project is not likely to have a significant impact on the River-Flat Eucalypt Forest.

Field surveys undertaken by AMBS in February 2017 and by Eco Logical in May 2016 did not detect any threatened plant species and none are considered likely to occur.

Our findings in relation to the likelihood of occurrence of threatened fauna are consistent with those of the findings for Stage 1. There is the potential for the Powerful Owl and a number of microchiropteran bat species to occur in the vicinity; however, the project is not likely to result in a significant impact on any of these species, given that the potential habitat to be removed consists of planted trees in and around the existing facilities and represents only a small area of

potential foraging habitat. There is the potential for indirect impacts on the Grey-headed Flying-fox camp as a result of noise and activity during construction and also the Stage 2 works will remove a number of planted trees around the existing stadium and swimming pool facilities that were not included in the trees to be removed in Stage 1 approval.

It appears unlikely that the use of lights at the new stadium will significantly affect the Grey-headed Flying-fox camp, provided that lights during construction and operation are directed away from the camp and the Parramatta River. Field surveys undertaken for this study found that Grey-headed Flying-foxes exited the camp in all directions at dusk, but that the main fly-out paths for the camp (at the time of the surveys, in summer) were north along the Parramatta River, south along the Parramatta River and east over the Cumberland Hospital area. A smaller proportion of the colony flew out in a south-easterly direction and very few of those flew out over the stadium itself. The Eco Logical (2016) field survey in the winter of 2016 also reported few animals flying out in the direction of the stadium. The new stadium will be further away from the camp and the main flight paths than the existing stadium. The lighting towers will be replaced with roof mounted lighting, which will improve the light spill (A. Morten, pers. comm.).

The indirect impact with the greatest potential to affect the Grey-headed Flying-fox colony is noise. There is some risk that construction activity, in particular noise, will disturb flying-foxes and that risk is considerably increased if construction occurs at the same time as activity from other nearby developments. It is important therefore that works with the potential to disturb the camp are carefully planned, managed and monitored to minimise the level of impact that reaches the camp, in particular noise impacts during the day and impacts during the breeding season.

The camp currently exists with noise from events; however, event noise during operation of the new stadium operation may be more frequent than at present. It is recommended that a regularly updated Noise Management Plan be prepared, as per the Acoustic Logic (2017b) report, which incorporates management/monitoring of noise impacts on the Grey-headed Flying-fox.

Assessments of significance (7 Part Test and EPBC Act assessment) were undertaken in relation to impacts on the Grey-headed Flying-fox and concluded that, if noise is properly managed and noise reaching the camp is minimised, both from construction work and during events, the proposed stadium is unlikely to have a significant impact on the Grey-headed Flying-fox.

Direct impacts on riparian habitat as result of the project works are considered unlikely. Indirect impacts may include runoff from sediments, pollutants and other materials entering the area of vegetation and flowing into the river via surface water runoff from the construction site. These impacts should be managed as per the stormwater management plan. Advice provided to AMBS by Aurecon in relation to the operation of the new stadium is that peak flow rates into the Parramatta River will be similar to existing peak flow rates and that the quality of water flowing into the river will be improved.

However, at the time of preparation of this report it was unclear whether or not works on a drainage pipeline occurring in the area of River-Flat Eucalypt Forest will be required. If the works are required further assessment of potential impacts and mitigation measures may be necessary.

Any works within 40 m of the Parramatta River (top of bank) should consider the requirements of the *Water Management Act 2000*, the *Water Management Amendment Act 2014* and the *Water Act 1912*. A permit may be required.

Recommended mitigation measures are summarised as follows:

- Incorporate a buffer area and barrier between the demolition/construction area and the River-Flat Eucalypt Forest within the construction fence.
- Implement stringent sediment and erosion control measures, particularly near the EEC and the Parramatta River.
- Implement weed control measures as described in Section 4.3 near the EEC.
- Implement *Phytopthera* hygiene controls.
- Implement Stormwater Management Plan including Water Sensitive Urban Design as per Aurecon 2017.
- Undertake further assessment of impacts on the EEC if works to repair the existing stormwater pipe in the area of the EEC are required.
- Noise sensors should be installed near the Grey-headed Flying-fox camp and regularly monitored. During construction, noise levels reaching the camp should not exceed 52-57 dB(A) especially at dusk, dawn and when the colony is supporting dependant young.
- The mitigation measures outlined in the noise assessment report (Acoustic Logic 2017b) should be implemented to ensure noise emissions are limited. In addition, noise management plans should be incorporated into the Construction Environmental Management Plan that aim to minimise the level of noise reaching the Grey-headed Flying-fox roost.
- Construction works should not begin until after the bats have returned to roost and should cease at least 1 hour prior to the start of the fly-out. These times will vary seasonally and construction activities should be flexible to account for this seasonality.
- Monitoring surveys should be undertaken at the roost to monitor the response of the roost to sustained periods of elevated noise. The surveys would monitor the behaviour of individuals and assess the overall size of the roost. The surveys should be undertaken weekly for the first month of the project and then monthly for the duration of the project, or until it is established that noise is being managed at acceptable levels (i.e. the pre-construction background noise parameters described in Section 4.2.1).
- Stop work triggers should be incorporated into the projects Construction Environmental Management Plan in the event that roost distress (declining number or diurnal dispersal) or a decrease in animal health (including increased rate of mortality) is observed. Work will be stopped until appropriate management responses are developed to minimise the risk of further roost harm.
- Monitoring of noise and the health of the Grey-headed Flying-fox roost should be co-managed with monitoring programs being run for the Paramatta Leagues Club redevelopment.
- Develop a Noise Management Plan which is regularly updated after measurements of concerts and events, as per the Acoustic Logic report (2017b), and incorporate measurements/monitoring of noise impacts on the Grey-headed Flying-fox camp.
- Noise levels during operation of the stadium (particularly during music events) should also be managed in accordance with Parramatta Stadium Noise Management Plan policy and monitored.
- Commence noise generation at low levels during sound check and event, and work up to maximum volume gradually. Generation of sudden, very loud noises should be avoided until after the nightly fly-out.
- Lighting during construction or operation should be directed away from the Grey-headed Flying-fox camp.
- Incorporate information about the Grey-headed Flying-fox and the River-Flat Eucalypt Forest in project induction material.
- Plant potential feed trees for the Grey-headed Flying-fox to replace the feed trees removed, either included in suitable locations as part of the landscaping for the project, or in Parramatta Park.

Contents

Tables

Figures

1 Introduction

1.1 Introduction

This report supports a State Significant Development (SSD) Development Application (DA) submitted to the Minister for Planning pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Application (referred to as SSDA16_8175) follows the approval of a Stage 1 SSD DA (SSDA16_7534) in December 2016. The Stage 1 SSDA sets out a Concept Proposal for the redevelopment of the Western Sydney Stadium and future supporting uses. In summary, the Stage 1 Consent includes the following components:

- Concept Proposal for the Western Sydney Stadium, including building envelopes, a new 30,000 seat stadium, 500 surface car parking spaces, access, ancillary infrastructure and landscaping; and
- Detailed works for staged demolition and removal of the existing stadium and associated infrastructure and the Parramatta Swimming Centre.

1.2 Overview of Proposed Development

The proposal relates to a detailed ('Stage 2') DA for the detailed design and construction of the stadium. This SSD DA seeks approval for the following components of the development:

- Detailed design of the stadium, public domain and car parking spaces;
- Construction and use of the 30,000 seat stadium including:
  - General Admission Facilities including bars, food and drink stalls, amenities and viewing areas;
  - A function centre and kitchen facility;
  - Associated Stadium facilities including player and coaching facilities, media and press conference rooms, security and stadium managers' facilities;
  - Waste storage and loading dock;
- Construction and embellishment of the public domain including:
  - Outdoor sporting and recreation facilities;
  - Public plazas and entertainment areas;
  - General landscaping works;
- Provision of up to 500 car parking spaces with vehicle access to the development from O'Connell Street and internal roads for vehicular circulation;
- Provision of signage zones, lighting and other ancillary stadium elements;
- Pedestrian access and footpath upgrades along O'Connell Street; and
- Extension and augmentation of physical infrastructure / utilities as required.

1.3 Background

1.3.1 Stadia Strategy

The stadium is the first project to be delivered under the NSW Government's $1.6 billion Stadia Strategy, the largest investment in sporting infrastructure since the 2000 Olympics. The new Western Sydney Stadium will:

- be able to cater for bigger crowds, provide an improved game day experience and bring major benefits to the Western Sydney economy;
- generate approximately 1,200 jobs during construction and between 600 and 900 jobs once operational for sporting event days and major events;
- cater for a range of sporting and community uses within the precinct.

1.3.2 Concept Proposal

Infrastructure NSW (iNSW) on behalf of Venues NSW submitted a State Significant Development Application (SSDA) for the Stage 1 concept proposal and demolition of the existing stadium in July 2016. Consent for the Stage 1 SSDA was granted by the Minister for Planning on 7 December 2016 and includes:

- a maximum total GFA of approximately 60,000 m^2 (excluding the playing pitch) for the stadium development, including:
  - additional seating for approximately 10,000 more spectators in a seating bowl with 30,000 seats, including 27,000 general admission seats and 3,000 corporate seats;
  - playing pitch;
  - five levels of premium box/terrace, function/lounge offerings and a number of suite offerings;
  - flood lighting, stadium video screens and other ancillary fittings;
  - additional facilities for team, media, administration and amenity, including:
    - police facility and security office;
    - players changing rooms;
    - ticket gates and ticket boxes;
    - media interview rooms;
    - green room;
    - production suite and joint operation control room;
    - event briefing rooms;
    - hirers office and patron services offices;
    - first aid facilities;
    - loading docks for deliveries; and
    - food, beverage and retail facilities.
- a maximum GFA of approximately 20,000 m^2 for future development of ancillary uses within the northern corner of the Site;
- transport, parking and accessibility;
- public domain elements; and
- landscaping elements throughout the Site.

1.3.3 Design Excellence and Project Tender Phase

Since receiving the development consent for Stage 1, Venues NSW have appointed Lendlease as the contractor for the Stage 2 detailed design and the demolition and construction of the stadium. The tender process also served as a competitive design process in accordance with the Director General's Design Excellence Guidelines and Clause 7.10 of the *Parramatta Local Environmental Plan 2011.*

1.3.4 Site Establishment Works Modification

A modification application (MOD 1) was made to the Stage 1 DA pursuant to Section 96(2) of the EP&A Act in February 2017. The modification seeks to expand the approved range of site preparation works to include piling and remediation/earthworks, as outlined below:

- Remediation works comprising the excavation and storage of contaminated materials and bulk excavation. Contaminated materials will be stored on site and capped below ground in accordance with the recommendations outlined in the Remedial Action Plan.
- Piling works which will comprise the driving and drilling of concrete piles to establish foundations for the construction of a stadium located within the Stage 1 building envelope.

The modification application is currently under assessment by the Department of Planning and Environment (DPE) and is awaiting determination.

1.4 Site Description

The Western Sydney Stadium is located at 11-13 O'Connell Street, within the Parramatta Park on the north-eastern edge of the Parramatta CBD. It is bound to the south and west by the Parramatta Park and the Parramatta River, the Parramatta Leagues Club to the north and O'Connell Street to the east. The Site is located within the City of Parramatta local government area (LGA).

A locational context plan is provided at Figure 1.1 below.

Figure 1.1 – Site Context Plan

The site has an area of approximately 95,000m^2 and is owned by Venues NSW and The Parramatta Park Trust. The site is irregular in shape and is illustrated in Figure 1.2 below.

Figure 1.2 – Site Aerial Plan

1.5 Secretary's Environmental Impact Assessment Requirements

The Secretary's Environmental Impact Assessment Requirements (SEARs) for SSD 8175, Western Sydney Stadium (Design & Construction) includes the following in relation to biodiversity:

- *"Biodiversity impacts related to the proposal are to be assessed and documented in accordance with the Framework for Biodiversity Assessment, unless otherwise agreed by OEH, by a person accredited in accordance with s142B(1)(c) of the Threatened Species Conservation Act 1995.*
- *Investigate the hydrological flow regime with the nearby River-Flat Eucalypt Forest and identify any potential effects the development may have. The development must not cause negative impacts to this ecological community through alterations to the natural water cycle.*
- *Consider the cumulative impacts of this development on the environment, particularly in regard to the nearby riparian zone and aquatic ecosystems."*

Field surveys of the site undertaken for the Biodiversity Assessment prepared for the Stage 1 EIS (Eco Logical 2016) found that the site did not contain any native communities indigenous to the area and states that "*Therefore, the calculation of credits is not required, and the FBA cannot be undertaken for the proposed development. Correspondence between ELA and OEH on 31 May 2016, confirmed that the FBA would not be appropriate for this Project, and a Flora and Fauna*

Assessment report is suitable to assess impacts of the proposed works on threatened flora and fauna species, populations and ecological communities, and migratory species, likely to occur in the study area (Figure 1) through assessment of significance in accordance with the EP&A Act and the Commonwealth Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act)."

The information provided by Lendlease to AMBS in relation to the construction site for Stage 2 was that the construction 'footprint' for Stage 2 will be the same as that for Stage 1, with the following exceptions:

1. a small oblong-shaped area at the northern end, between the existing site boundary and the Parramatta Leagues Club car park, located in area of planted trees and mown grass; and
2. an area extending past the southern boundary of the Stage 1 assessment area into the existing car park.

Thus, all of the vegetation that will be removed or modified for the Stage 2 construction works was surveyed and assessed for the Stage 1 EIS, with the exception of a few planted trees and mown grass adjacent to or within existing car parks, and none of that vegetation comprised a native community indigenous to the study area. Accordingly, the approach taken for this Biodiversity Assessment for Stage 2 of the project was similar to that undertaken for Stage 1; i.e. to assess the impacts of the proposed works on threatened flora, fauna and ecological communities through assessments of significance.

However, it should be noted that there may be a requirement for works to the existing stormwater discharge pipe into the Parramatta River. Aurecon (2017) state that if the existing pipe is in good condition no works in the riparian corridor will be required, but that "*should the discharge pipe be unsuitable for re-use, minor excavation along the existing pipe route and the use of non-toxic materials such as rocks/boulders will be used to secure the new discharge pipe and prevent fluvial erosion*". The existing pipe route is located in an area that is a native vegetation community and is also part of an Endangered Ecological Community (EEC). The pipeline which may require repair is shown in Figure 1.3.

1.6 Authorship and Acknowledgements

Field surveys undertaken for this study were carried out by Roger Lembit and Chantelle Doyle (flora), and Christopher Jackson, Narawan Williams, Glenn Muir, Mark Semeniuk and Henry Cook (fauna). Ulrike Kloecker undertook database searches and prepared the maps. Mark Semeniuk generated the landscape score using the BioBanking Credit Calculator. This report was prepared by Christopher Jackson, Chantelle Doyle, Glenn Muir and Mark Semeniuk, with the exception of the text and maps in some of the introductory sections (1.1 to 1.4), which were provided by Lendlease. Mark Semeniuk and Glenn Muir are accredited in accordance with s142B(1)(c) of the TSC Act.

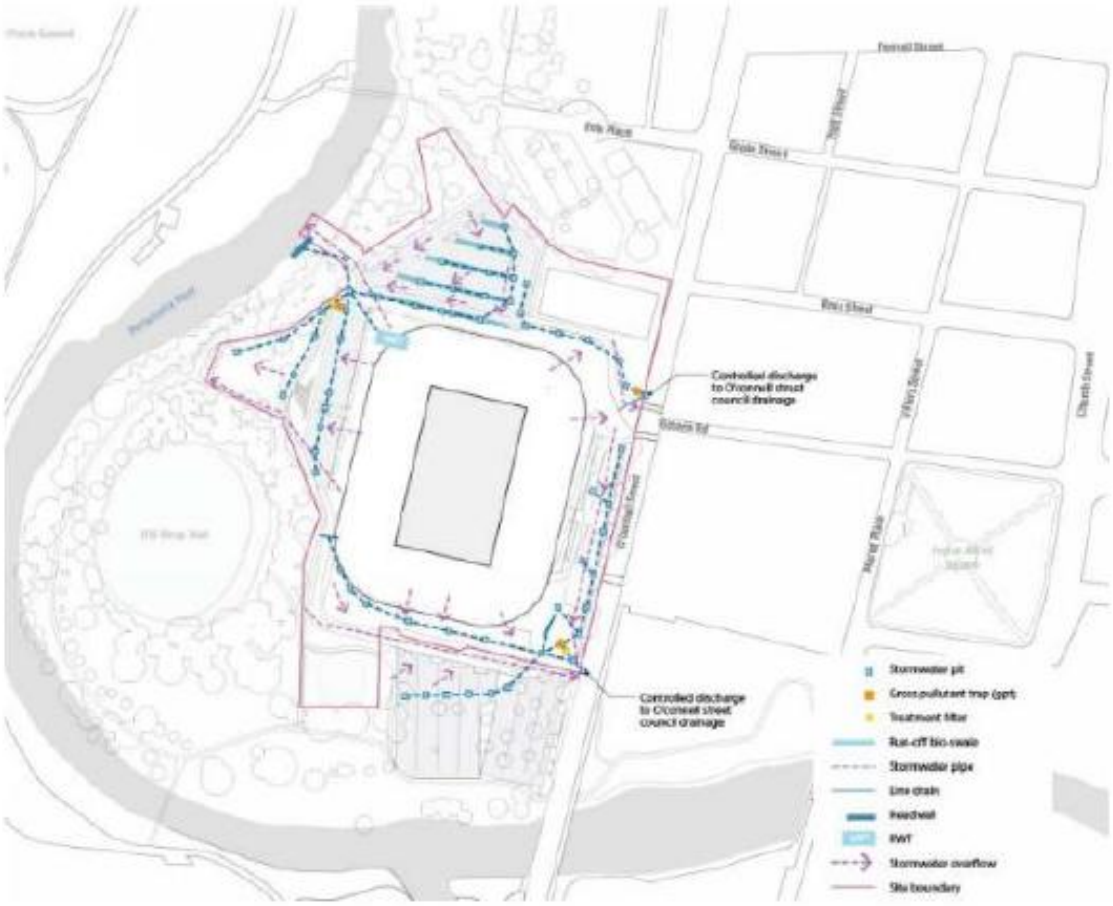

Figure 1.3 – Proposed drainage flow paths showing an outflow pipeline into the Parramatta River to the northwest of the Stadium. Source: Aurecon (2017).

2 Methodology

2.1 Approach

This study included five main components:

1. A desktop review of existing information, in particular studies undertaken in relation to the approved Stage 1 of the Western Sydney Stadium project (i.e. the demolition of the existing stadium and concept plan);
2. Targeted field surveys to compliment the previous studies;
3. Preparation of landscape maps and calculation of a "landscape score", consistent with Sections 1 to 4 of the FBA;
4. Assessment of the significance of the likely impacts of Stage 2 of the Western Sydney Stadium project on threatened species, populations and ecological communities; and
5. Recommendations for mitigation, management and/or monitoring of impacts.

2.2 Desktop Study

An initial desktop study was undertaken to examine existing information regarding the flora and fauna of the study area and surrounds. The desktop study included a search of the Office of Environment and Heritage (OEH) Atlas of NSW Wildlife for records of threatened flora and fauna listed on the Schedules of the TSC Act within a 5km radius of the study area. The Department of the Environment (DotE) Protected Matters search tool was used to search for relevant Matters of National Environmental Significance (threatened species, populations and ecological communities and migratory species) listed on the EPBC Act within a 5km radius of the study area. Threatened species records within the CMA subregion: Cumberland within Sydney Metro CMA were also searched.

The desktop study included a review of *The Native Vegetation of the Sydney Metropolitan Area* (OEH 2013) and a detailed review of the document *Western Sydney Stadium, Parramatta – Biodiversity Assessment* Prepared by Eco Logical Australia (Eco Logical 2016) for AECOM.

2.3 Field Assessments

Field surveys for this study focussed on an assessment of an area of the EEC River-Flat Eucalypt Forest known to occur adjacent to the site and the collection of data on a Grey-headed Flying-fox camp known to occur to the north of the site. An inspection of the River-Flat Eucalypt Forest adjacent to the site was undertaken on 14 February 2016 by botanists Roger Lembit and Chantelle Doyle. The survey area was located outside the construction area boundary fence already established for the Stage 1 works. The area was traversed to determine the extent, type and condition of the plant communities present, to record any threatened plant species, and to note potential fauna habitat features (in particular hollow bearing trees).

Information collected on the Grey-headed Flying-fox camp included an assessment of the area currently occupied by the animals, fly-out observations and counts, and counts of the number of juveniles left in the camp after the fly-out. The area currently occupied by the animals was assessed by direct observation about half an hour prior to the dusk fly-out. Adult population estimates and observations of the main flight paths used by flying-foxes exiting the camp at dusk were determined by positioning three ecologists with mechanical counters at different points around the camp prior to the fly-out on two non-consecutive nights. Each ecologist counted the bats flying within their survey area, making notes on the main direction in which the bats were flying. Counts of the juveniles remaining in the camp after the fly-out were made by inspecting the camp on foot using head-torches.

3 Results

3.1 Previous Studies

Recent investigations of the flora and fauna of the study area include a Biodiversity Assessment prepared for Stage 1 of the Western Sydney Stadium project by Eco Logical Australia Pty Ltd (Eco Logical 2016). This study included database searches for records of threatened flora and fauna within a 5km radius of the study area, an assessment of the likelihood of occurrence of threatened flora and fauna within the study area, diurnal field surveys of the study area including identification of plant species, an assessment of vegetation communities and "various microhabitats on Site (e.g. hollow bearing trees)" and an assessment of potential habitat for threatened flora and fauna species.

Prior to the Eco Logical (2016) study, the vegetation of the study area and surrounds was included in the vegetation mapping of OEH (2013).

Eco Logical (2016) found that the vegetation that will be directly affected during Stage 1 (i.e. the demolition of the existing stadium) consists of "Planted – Native/Exotic". This classification was an amalgam of three vegetation types mapped by OEH (2013), which were Plantation (native and/or exotic), Urban Exotic/Native, Weeds and Exotics.

Eco Logical (2016) also confirmed that an area adjacent to the site and an area to the north of the site contains the community *River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*, which is listed as an EEC on the TSC Act. This corresponds with the OEH 2013 vegetation mapping, which classifies the vegetation as Cumberland Riverflat Forest, a component of the EEC.

Eco Logical (2016) listed 18 threatened plant species known, or with the potential to occur, within a 5 km radius of the study area. They did not record any threatened plant species within the study area during the field survey.

Eco Logical (2016) listed 37 threatened animal species known, or with the potential to occur, within a 5 km radius of the study area. They located two hollow-bearing trees (both mapped as occurring outside, but close to, the site boundary). They found that "*The Site provides potential habitat for a small number of threatened fauna although it is likely that most of these species utilise the Site in a transitory nature and it is unlikely to provide key breeding habitat. However, the HBTs recorded within the study area provide potential roosting habitat for some microchiropteran bat (microbat) species. Threatened fauna that are known or have potential to utilise the site include:*

- *Pteropus poliocephalus (Grey-headed Flying-fox)*
- *Mormopterus norfolkensis (Eastern Free-tail Bat)*
- *Miniopterus schreibersii oceanensis (Eastern Bentwing-bat)*
- *Myotis macropus (Large-footed Myotis)*
- *Scoteanax rueppellii (Greater Broad-nosed Bat)*
- *Ninox strenua (Powerful Owl)".*

3.2 Threatened Plant Species and Populations

Interrogation of relevant databases was undertaken in order to confirm and update the Eco Logical (2016) as necessary; for example, with new species or species records that may have been listed since the previous assessment.

Fifty threatened plant species listed by the TSC Act and/or EPBC Act were identified as known, or with the potential, to occur within a 5 km radius of the study area (N.B. only 14 of these were represented by records in Bionet). An assessment of the likelihood of these species occurring on the site is presented in Appendix B.

No threatened plant species or populations were recorded during the AMBS survey. Although unlikely, there is potential for some threatened flora to occur, in particular two vines (*Cynanchum elegans* and *Marsdenia viridifolia*) and some orchids (e.g. *Pterostylis saxicola*). Orchids in particular are cryptic and being terrestrial are usually only recorded when flowering in Spring. Likewise, the two described vines are easily overlooked and the former, *Cynanchum elegans*, is sometimes mistaken for the weed Moth Vine (*Araujia sericifera*). The disturbed state of the ground layer however makes the likelihood of these species occurring very low

3.3 Threatened Animal Species and Populations

Seventy-three threatened fauna listed under either the TSC Act and/or EPBC Act, an additional 19 species listed as migratory under the EPBC Act and three threatened populations (Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas, White-fronted Chat population in the Sydney Metropolitan Catchment Management Area, Long-nosed Bandicoot population in inner western Sydney) were identified as known, or with the potential, to occur within a 5 km radius of the study area. A list of these species/populations is presented in Appendix A.

Our assessment of the likelihood of occurrence of these threatened species is generally consistent with that of Eco Logical (2016); that is, most of these species would either utilise the site in a transitory nature, or not at all; however, the hollow-bearing trees recorded near the site boundary could provide potential habitat for some threatened microbats known from the locality. The species most likely to be affected by both the Stage 1 and Stage 2 works is the Grey-headed Flying-fox. A camp containing thousands of individuals of this species occurs close to the site, to the north.

3.4 Landscape Features

The site is situated within the Interim Biogeographic Regionalisation for Australia (IBRA) “Sydney Basin” bioregion and the “Cumberland – Sydney Metro” subregion (Figure 3.1). The site occurs on the Mitchell Landscape “Ashfield Plains”, with “Port Jackson Basin” and “Pennant Hills Ridges” nearby.

There are no rivers, streams or estuaries within the Site Boundary (Figure 3.1). Parramatta River, which was classed as a “4th order stream” as per Strahler (1952), occurs near the Site Boundary. At its closest, the Site Boundary is within the “20 metre buffer” of the “4th order stream”. The development footprint does not result in the removal of any riparian vegetation (N.B. unless works to repair the stormwater pipe on the northwest of the site are required – see Figure 1.3).

The majority of the vegetation within both the 100 ha and the 1000 ha assessment circles consists of planted street trees, gardens and parks classified by OEH (2013) as “Plantation (native and/or exotic” and “Urban Exotic/Native”. Native vegetation mapped by OEH (2013) constitutes less than 5% of the land area within the 1,000 ha hectare circle, and less than 15% of the land area within the 100 ha circle. There is no change to the percent cover within either assessment circle following the development. The “Patch Size” was assessed as zero, and the Landscape Score calculated to a value of nine. Given no native Plant Community Types will be directly impacted by the Project, the BioBanking Credit Calculator could not be applied any further.

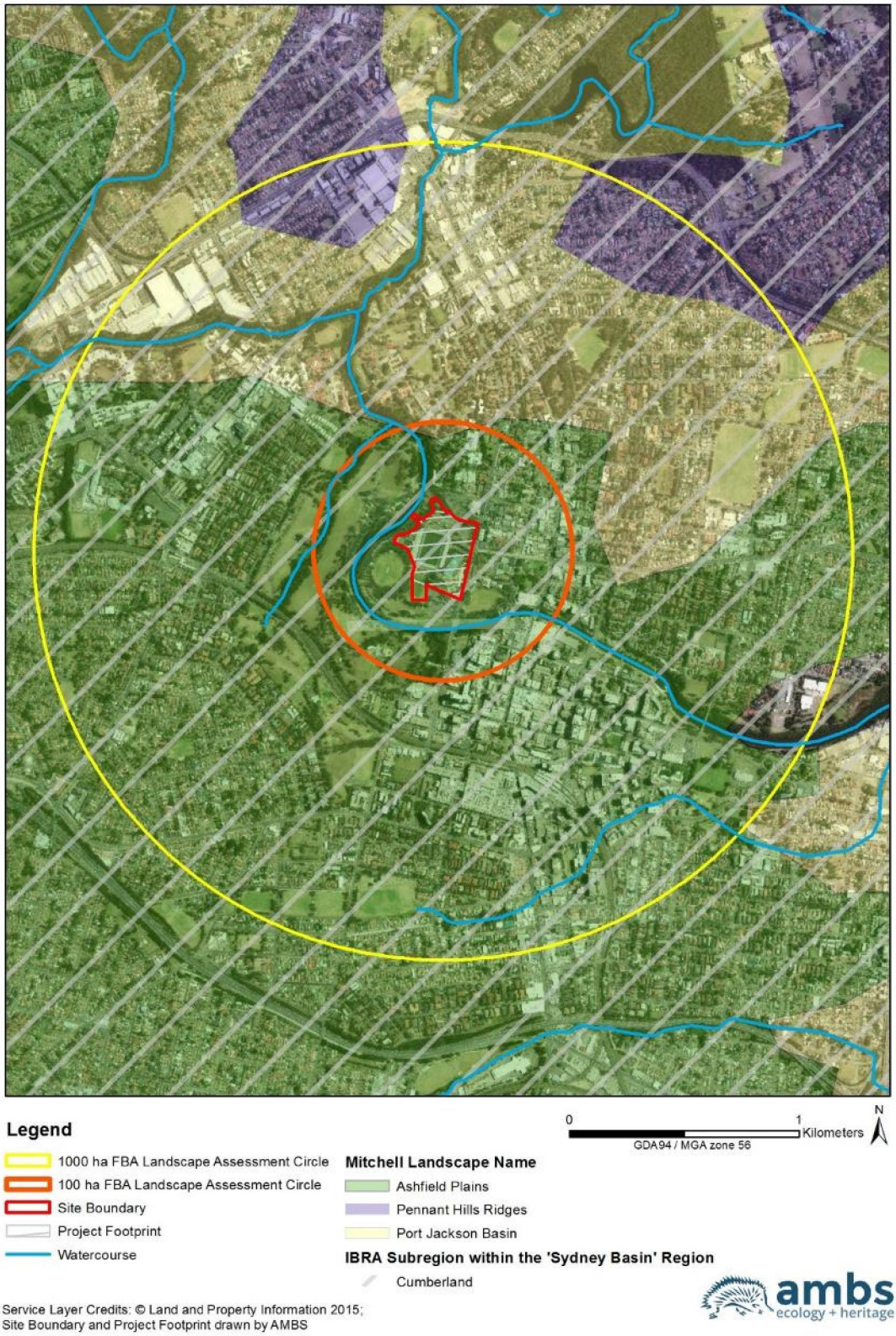

Figure 3.1 – Landscape features and assessment circles.

3.5 Threatened Ecological Communities

The AMBS field survey confirmed the presence of the EEC *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*, which occurs along the north-western boundary of the site, with another patch occurring to the north of the site adjacent to the Parramatta Leagues Club car park (Figure 3.2). The extent of the community was generally consistent with that mapped by Eco Logical (2016), although the area was extended slightly to the north (an additional 0.04 ha) on the basis of the AMBS field survey results, which found two remnant diagnostic species (*Eucalyptus saligna x botryoides* and *Backhousia myrtifolia*) in the expanded area.

River-Flat Eucalypt Forest is defined in the Final Determination (OEH 2011) as an ecological community associated with silts, clay-loams and loams on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The community structure is known to include tall forest and woodlands, often interspersed with other wetland communities. The species assemblage likewise varies based on soil profile, nutrient, moisture content and frequency/duration of waterlogging.

The area of vegetation classified as the EEC along the north-western boundary of the site occurs from the top of a steep bank, approximately where the Stage 1 construction boundary fence was located at the time of the survey, to the lower slope, located closer to the Parramatta River (Figure 3.3). One tree, a large hollow bearing *Eucalyptus saligna x botryoides*, was noted to occur on the top bank within the fence. The lower slopes, which at one time would have also represented this community, have been cleared and are now composed of mown grass with planted and naturally recruited trees, including *Casuarina glauca,* a species diagnostic of this community and *Eucalypus robusta* (Plate 3-1).

The vegetation was in moderate condition with scattered remnant canopy species. The vegetation structure of some areas suggested historic planting, but there was no evidence of recent activity or maintenance. Some trees contained hollows; these trees were probably recruited in the 1950's or 1960's, before which large areas of Parramatta Park were cleared (Roger Lembit, pers. comm.). The canopy layer was comprised of mixed EEC diagnostic species including; *Eucalyptus saligna x botryoides, Casuarina glauca, Angophora floribunda, Allocasuarina littoralis* and *Eucalyptus tereticornis*. Other (likely planted) species included *Lophostemon confertus* and *Eucalyptus robusta.*

Planted and/or recruited canopy and mid-layer species, some of which are diagnostic to this community included; *Callistemon salignus, Casuarina glauca* (suckering) and occasional *Bursaria spinosa, Glochidion fernandii, Acacia floribunda, Acacia implexa*, *Acacia parramattensis, Acacia decurrens* and *Melaleuca linariifolia.* Exotic mid-layer species were generally uncommon and on the western slope were predominantly *Lantana camara, Senna pendula* var. *glabrata* and *Erythrina x sykesii.* The far northern section of the EEC included frequent *Ligustrum lucidum.*

The ground layer was in poor condition and dominated by weed grasses and vines such as; *Ehrharta erecta, Ipomoea indica, Bidens pilosa, Tradescantia fluminensis* and *Cardiospermum grandiflorum* (Plate 3-2). A few scattered native ground layer species were observed including; *Microlaena stipoides, Einadia hastata, Einadia nutans* and *Kennedia rubicunda*. Ground layer species that were probably planted include *Lomandra longifolia* and *Hardenbergia violacea*. These species are ubiquitous across the Cumberland Plain, however, some are classified as diagnostic species within this EEC.

A list of all plant species observed in the vegetation associated with River-Flat Eucalypt Forest is included in Appendix C.

Figure 3.3 – Location of EEC River-Flat Eucalypt Forest near the site.

Plate 3-1 - Cleared vegetation on edge of Parramatta River with recruiting *Casuarina glauca.*

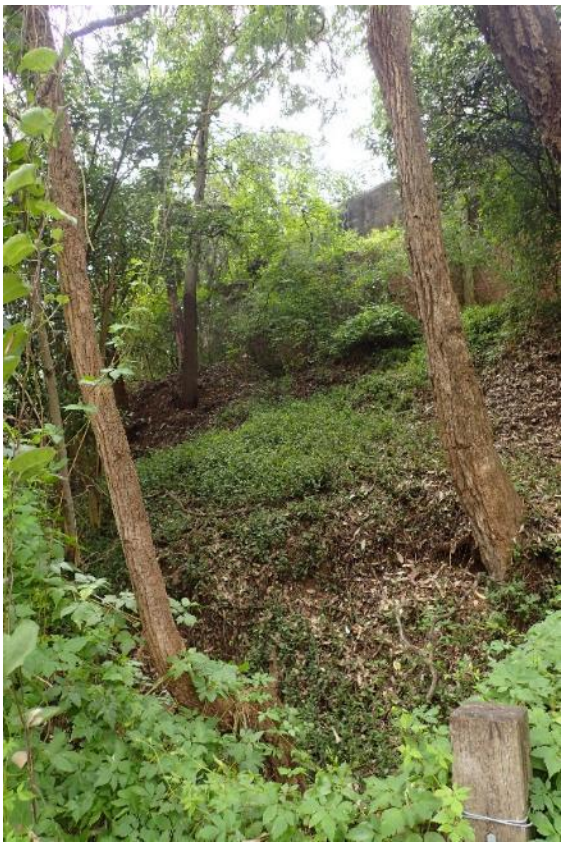

Plate 3-2 - Weed dominated ground layer in River-Flat Eucalypt Forest in the northern section of the study area.

3.6 Fauna and Habitat Features

The AMBS field assessment recorded seven hollow-bearing trees associated with the River-Flat Eucalypt Forest, four of which are close to the site boundary (Figure 3.2). One of these four hollow-bearing trees (tree no. 1 in Figure 3.2) is a large remnant *Eucalyptus saligna x botryoides*, which occurs at the top of slope within the fenced area (Plate 3-1). The tree is probably the same as that mapped by Eco Logical (2016) as occurring just outside the site boundary; however, at the time of the AMBS survey the tree was physically located within the boundary fence. This tree appears to be one of those marked for retention by Aspect Studios (2017) (Figure 3.3) and recommendations regarding on-site confirmation of the location and subsequent tree protection measures are provided in Section 4.2 of this report.

Hollows were observed to have formed in six tree species and one tree, a *Eucalyptus punctata*, was noted to have trunk scratches (probably from a possum).

Plate 3-3 – Hollow-bearing *Eucalyptus saligna x botryoides* occurring inside the boundary fence.

Eco Logical (2016) reported a number of animal species utilising the site during their survey, mainly bird species that are commonly observed in suburban parks and gardens (Noisy Miner, Galah, Little Corella and Rainbow Lorikeet). Numerous possums (brushtail and ringtail) were observed by AMBS in the Parramatta Park area during the nocturnal surveys and a fox was observed traversing the edge of the Parramatta Leagues Club car park. Large native eels were observed in the river.

Figure 3.2 – Location of hollow-bearing trees.

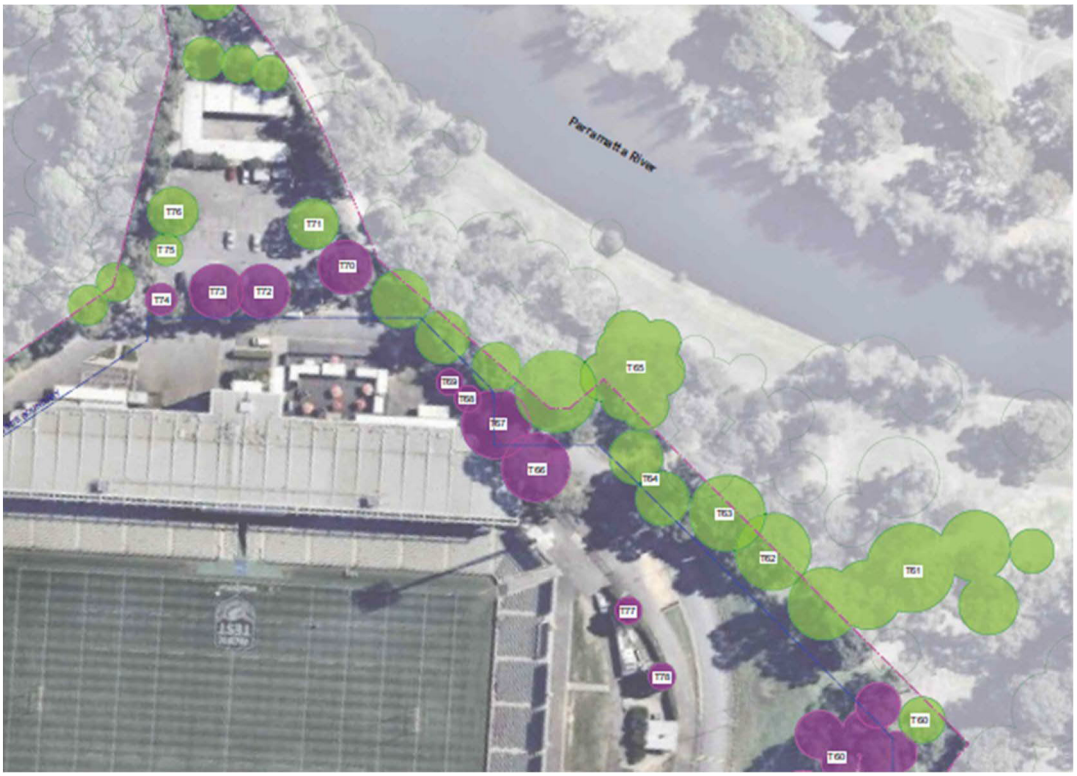

Figure 3.3 Trees marked for retention (green) and removal (purple) along the north-western boundary (Aspect Studios 2017).

3.7 Grey-headed Flying-fox (*Pteropus poliocephalus*)

Adult Grey-headed Flying-fox population estimates varied over the two non-consecutive nights of surveys (Table 3.1). The primary reason for the observed variation was survey site selection. On the first night of surveying, focus was placed on observing the numbers of bats flying over the project area. As such, a large number of bats flying south along the course of the Parramatta River were not counted. Additionally, access was restricted to the Cumberland Health Campus, north of the roost, on the first survey night. As a result, there was a gap between the north observation point and the east observation bats where bats were not counted.

The Parramatta River Grey-headed Flying-fox camp is one of several camps monitored as part of the National Flying-fox Monitoring Program (NFMP) undertaken by CSIRO. The estimate recorded on the second night of the AMBS February survey falls within the range recorded during the most recent NFMP monitoring survey (DoE, 2017).

Table 3.1 – Fly-out counts for Parramatta River Grey-headed Flying-fox camp in February 2017.

Date	North	East	South	Total	Juveniles left in camp
13/02/2017	4370	2030	385	6785	63
15/02/2017	6720	2670	3905	13295	58

Three main flight paths were identified during the February surveys (Figure 3.4). The vast majority of the bats observed were flying out either north along the river or south along the river. A smaller proportion were observed flying out in an easterly direction from the camp. Animals flying south and south-east over the project area and adjacent Parramatta Leagues Club car park represented a relatively small proportion of the population. On the night of 13 February only 385 flying-foxes were counted flying south and south-east over this area (compared to more than 4,000 flying northwards along the river on the same night). Most of the 385 animals were observed between

the existing stadium and the Parramatta Leagues Club, with many roughly following the tree-line between the existing stadium and the Parramatta Leagues Club car park. Few animals flew over the stadium itself; the maximum number of flying-foxes observed in the area between the stadium lights during the fly-out was 17.

The direction of flight paths can change seasonally in response to the emergence of food resources and the main flight paths in February 2017 varied somewhat to that observed by Eco Logical (2016), which were recorded at a different time of year; however, in both the Eco Logical and AMBS surveys the main flight paths were located away from the stadium area.

Juvenile individuals were detected during both nocturnal roost assessments. The average juvenile count represented less than 0.05% of the estimated roost population (N.B. it is likely to be much higher than this earlier in the season). The number of individuals detected indicates that at the time of the survey the roost had almost completed weaning from the previous mating season, but that the colony was still raising some young bats that could be susceptible to roost disturbance.

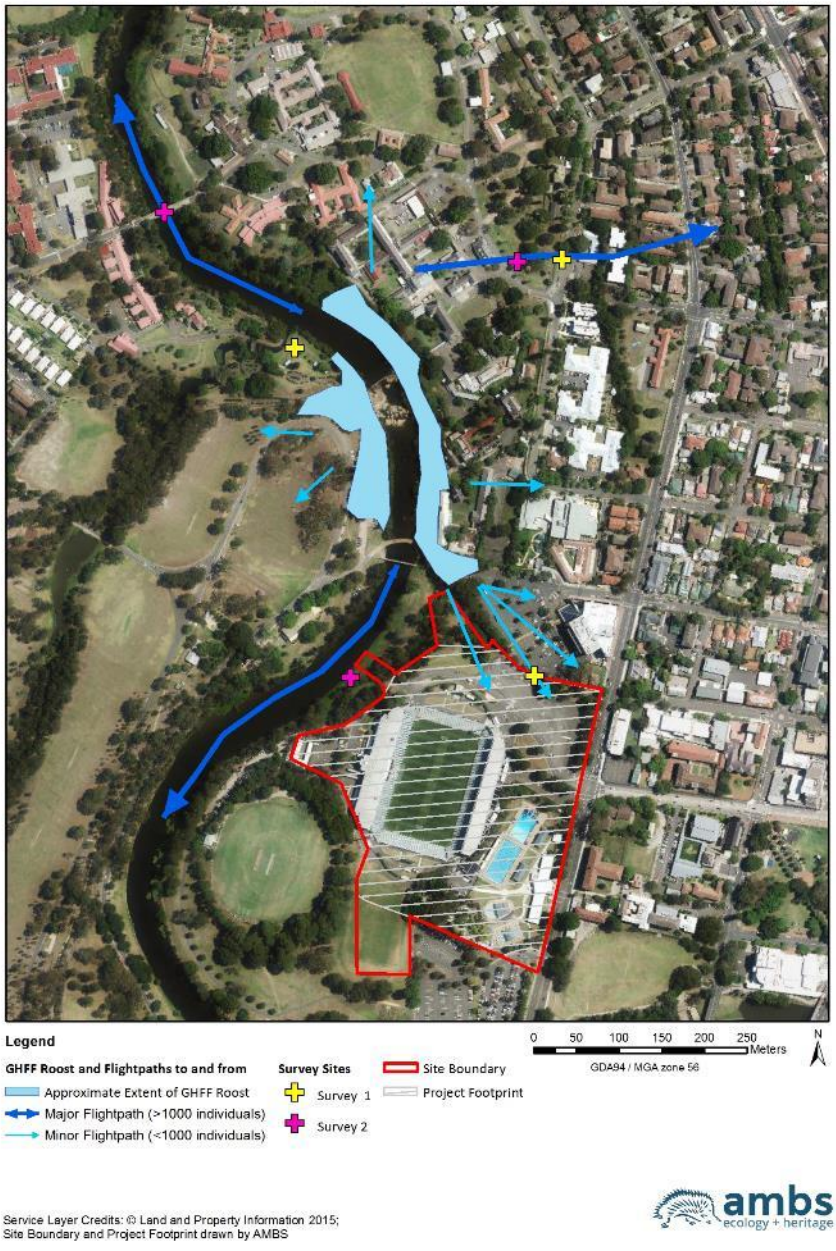

Figure 3.4 – Approximate extent of Grey-headed Flying-fox camp and observed fly-out directions in February 2017.

4 Impact Assessment and Mitigation Measures

4.1 Summary of Impacts

Impacts of Stage 2 of the Western Sydney Stadium project on the EEC River-Flat Eucalypt Forest are discussed in Section 4.3; impacts on the Grey-headed Flying-fox are discussed in Section 4.4; and impacts on aquatic environments are discussed in Section 4.5.

The EEC River-Flat Eucalypt Forest may be affected by the Stage 2 works if strong control measures to avoid or minimise indirect impacts are not applied. Recommendations in this regard are presented in Section 4.3. AMBS also recommends that prior to demolition/construction the boundary of the site should be inspected and the designation of a temporary interior boundary representing the primary/critical root zone and sediment/weed control boundary should occur. The interior boundary should be placed such that direct impacts on the hollow-bearing tree occurring at the top of the bank are avoided.

In the case that the drainage system and associated pipeline through the riparian zone/EEC area requires maintenance or replacement (as mentioned in Aurecon 2017), there will potentially be a localised direct impact on vegetation associated with the EEC River-Flat Eucalypt Forest. If this occurs further assessment of potential impacts and mitigation measures on the River-Flat Eucalypt Forest may be required and an offset may be required. Potential impacts are considered in Section 4.3.

Impacts of the project on other threatened species, populations or ecological communities are likely to be limited. The majority of the site is currently occupied by the existing stadium, car parks and other buildings/facilities. Vegetation on the site mainly comprises trees, lawns and gardens planted in and around the existing facilities (stadium, swimming pool and car parks). Much of this vegetation will be removed as part of the Stage 1 works. The Eco Logical (2016) survey did not locate any hollow-bearing trees within the site. The potential impacts during construction are likely to be similar to those assessed for the approved Stage 1 works and similar mitigation measures are recommended. The fauna occurring in the surrounding landscape are occupying an area already subject to impacts from noise, lights, activity etc. from the current and past use of the existing stadium.

4.2 Cumulative Impacts

The Stage 2 construction of the Western Sydney Stadium project will add to the impacts of the Stage 1 demolition works on native flora and fauna in the following ways:

1. Removal of additional vegetation, comprising a number of planted trees mainly located in and around the existing swimming pool, stadium and car park areas;
2. Extending the length of time in which the surrounding landscape will be subject to the indirect impacts of construction activity.

In relation to the above, AMBS has been advised that the Stage 2 proposal will include the planting more trees than will be removed. We recommend that trees planted during landscaping for the project include input from a botanist/ecologist, with the following objectives:

1. To provide plant species that are consistent with the native vegetation of the locality, particularly near the boundary with the River-Flat Eucalypt Forest;
2. If possible, to provide trees with the potential to become a food source for the Grey-headed Flying-fox in suitable locations (however, there are a number of locations where flying-fox feed trees could be considered unsuitable due to the potential for conflict with humans; e.g. a large fig tree in a car parking area is likely to result in cars with flying-fox droppings).

It is understood that operation of the stadium is likely to involve more events than that hosted by the existing stadium.

The Western Sydney Stadium project is one of several projects in the local area. To the north of the project area, the Cumberland Hospital East Campus is a site of the Parramatta North Urban Transformation Program. The timing of this project is unclear but at the time of preparation of this report it appears that the initial construction for this project is unlikely to coincide with the timing of the proposed stadium construction. It may, however, coincide with the operation of the stadium during which the Grey-headed Flying-fox camp may experience the first occurrence of a new noise regime.

Additionally, the Parramatta Leagues Club plans to redevelop car park space to build a multi-story carpark and leisure centre. Our understanding is that some of this work will be undertaken adjacent to the patch of River-Flat Eucalypt Forest that occurs to the north of the Stadium site and that the approval for the Leagues Club works includes measures to avoid or minimise impacts on this part of the EEC. Construction works at the Parramatta Leagues Club redevelopment could occur at the same time as the demolition and construction works for the Stadium. Our understanding is that the approval for the Leagues Club works include a condition that noise levels from the Parramatta Leagues Club redevelopment will be managed and regulated by a Noise Management Plan.

The cumulative impact of these additional projects, particularly the indirect impacts of construction activities taking place concurrently, is difficult to assess. The background noise level will likely be at higher for longer periods of time. It will be difficult to determine which project is contributing to various noise levels. However, if both projects proceed at the same time, the risk of impact from noise on the flying-fox camp is greater.

Recommendations for monitoring and managing the impacts of noise on the Grey-headed Flying-fox are presented in Section 4.7.

4.3 River-Flat Eucalypt Forest

The demolition and construction site is located immediately adjacent to an area of the EEC River-Flat Eucalypt Forest (along the north-western boundary) and close to another patch of the same EEC (to the north of the site) (Figure 3.3). To the north-west of the site the community mainly occurs along a steep bank between the existing stadium and the floodplain along the river. A hollow-bearing tree that is probably a remnant tree of this community occurs on the top of the bank inside the boundary fence for the demolition works (Figure 3.2).

Inadvertent damage to vegetation associated with River-Flat Eucalypt Forest immediately adjacent to the construction area is possible, particularly root damage. This should include the hollow bearing *Eucalyptus saligna x botryoides* that was recorded inside the fence. The likelihood of damage should be minimised by incorporating a buffer area and barrier within the construction fence (which for simplicity could co-occur with sediment/weed control barriers). It is recommended that the distances of buffers be similar to the approval conditions for the adjacent Parramatta Leagues Club (DA310.2015) which specified that construction work should not occur inside the critical root zone of trees associated with the EEC (Roeleven 2015). The conditions further specify work occurring between the primary root zone and the critical root zone must be completed by hand and under the supervision of an experienced arborist. The two roots zones are:

- Critical root zone; defined as 5 times the tree diameter 1400mm from ground level
- Primary root zone; defined as 10 times the trunk diameter 1400mm from ground level.

Prior to construction commencement the designation of a temporary interior boundary representing the primary/critical root zone and sediment/weed control boundary should occur.

The project works may exacerbate weeds and disease (such as *Phytopthora cinnamomi*) invasion as a result of edge effects, machinery operation and disturbance. To mitigate potential impacts from weed or disease invasions control measures should be implemented.

Recommended weed control measures include installation of a temporary interior control barrier as part of sediment fencing/capture. This should be installed prior to and for the duration of the project works and occur along the top bank adjacent to the EEC. The design should be similar to that outlined for works in the adjacent Parramatta Leagues Club (Roeleven 2015), in which a filter strip was recommended in conjunction with the sediment fence. The filter strip was designed to catch sediment and weed propagules and was to be buried to a minimum of 50 mm below ground and sit a minimum of 150 mm above ground. Any physical barriers installed as part of weed control measures for the Stage 2 works should be inspected regularly and emptied as required; all sediment and propagules should be disposed of responsibly.

Invasion by pathogens, particularly *Phytophthora cinnamomi,* poses a threat to the diversity and resilience of all vegetation communities, especially those already suffering weed invasion and fragmentation. Machinery hygiene measures for all vehicles entering the construction site should be used. Similarly, any persons entering the vegetation should observe hygiene measures on footwear. The application of these controls will reduce the likelihood of indirect impacts to the health and resilience of the River-Flat Eucalypt Forest EEC adjacent to the site.

Indirect impacts caused by changes to hydrology are considered unlikely because of the site topography, which by virtue of the original stadium construction design, directs local water (i.e. rainfall) from the upper bank edges inwards towards the stadium and along drainage channels, a north-western swale and pipelines (AECOM 2016). The Western Sydney Stadium Water Cycle Management and Flooding Working Paper for Stage 1 works (AECOM 2016) concluded the changes to the site design, topography and surface characteristics were not significant enough to alter the drainage strategies of the site. This was seconded by the Storm Water Management Plan prepared in relation to Stage 2 works (Aurecon 2017). The risk of erosion/scouring and sediment during construction phase is being managed by an Erosion and Sediment control plan (253451-CC048) which will include measures to capture run-off and direct it to sedimentation ponds (Aurecon 2017); these measures may include pits, silt fences (AECOM 2016) and sediment control straw bales (Civil drawing no 048 [Aurecon 2017]). The run-off captured will either infiltrate or be re-used for dust control. Reshaping of the site to manage drainage will be required, however Aurecon (2017) note this will not affect the 'riparian corridor' or artesian ground water. Water quality will be managed by Water Sensitive Urban Design (WSUD) principles such as water treatment nodes, pits and bio-swale filtration to improve water quality of any water discharged into the Parramatta River. Nonetheless, to protect the EEC from sediment and runoff during construction sediment control measures should specifically be installed on the upper banks between the construction footprint and the western slopes on which the vegetation occurs; these should form part of a temporary interior works boundary. If appropriate control measures are put in place can be surmised there will be no great alteration of water regimes or sediment loads potentially affecting the River-Flat Eucalypt Forest on the western edge of the study area.

Geotechnical surveys conducted in 1984 have been used to determine the presence of an ephemeral perched water table resting above the parent material (Aurecon 2017, AECOM 2016). Although the scope of this assessment did not specifically include ground water dependent ecosystems, they may include terrestrial vegetation that relies on shallow groundwater (Geoscience 2017). The status of this area of River-Flat Eucalypt forest as ground water dependent is unknown but it is possible some of deep-rooted species occurring in the EEC utilise the perched

water or artesian supply. Aurecon (2017) concluded the Stage 2 works are unlikely to interfere with 'ground water dependent ecosystems.' During the construction phase, water will not be drawn from groundwater sources to supress dust, nor will groundwater be used during stadium operation for the purposes of landscaping irrigation or otherwise. Water supply to the stadium during its operational phase is planned to be from on-site water re-use tanks and potable supply. The drainage design, particularly bio-swales in the northern car park, will contribute to recharge of the ground water through natural infiltration (Aurecon 2017). As the perched ground water is ephemeral, occurring in response to rainfall events, the fluctuations in its levels are unlikely to be of detriment to the EEC. Based on the assessment by Aurecon (2017) it is considered unlikely the project will result in a changed hydrology that causes significant detrimental impact to the EEC.

An assessment of significance was prepared in relation to the River-Flat Eucalypt Forest and is provided in Appendix C. It was considered that implementation of stringent control measures should minimise the likelihood of indirect impacts to the health of the EEC and afford a buffer between the construction work and vegetation, which may also reduce pathogen spread. If appropriate control mechanisms are implemented it is considered unlikely that there will be a significant impact on the River-Flat Eucalypt Forest.

Aurecon (2017) note that "*on-site investigation into the existing stormwater discharge pipe into Parramatta River is to be conducted as to ascertain the pipes capacity and current condition….. Should the discharge pipe be unsuitable for re-use, minor excavation along the existing pipe route and the use of non-toxic materials such as rocks/boulders will be used to secure the new discharge pipe and prevent fluvial erosion.*" If the proposed excavation is required direct impacts to vegetation associated with the River-Flat Eucalypt Forest are possible. These impacts would require further assessment and potentially offsetting.

Plate 4-1 – Two photographs of River-Flat Eucalypt Forest occurring outside the site boundary on the western bank of the study area.

4.4 Grey-headed Flying-fox

The Grey-headed Flying-fox is susceptible to disturbance and stress from increased noise levels and extended duration of noise. The species is particularly vulnerable to noise at dusk, dawn and when females are nursing young. Indeed, very loud noise is a recommended method for relocating Flying-fox roosts and is used to discourage foraging at some sites. Increased noise levels and extended durations of elevated noise resulting from the project could have a negative impact on the Parramatta River Grey-headed Flying-fox roost.

An acoustic assessment undertaken by AECOM (2016) states that the background noise 180 m from the current stadium was between 45-54 dB(A) with periodic spikes during music concerts and sporting events between 52-73 dB(A).

Potential noise levels during demolition, excavation and construction were assessed by Acoustic Logic (2017a). It is estimated that noise resulting from use of excavators, piling rigs, concrete pumps, concrete trucks, angle grinders and site cranes would be between 29-63 db(A) 135 metres form the project area and 33-72 dB(A) 190 metres from the project area (Acoustic Logic 2017a). These predicted noise levels assume the activity will be occurring continuously with no screening between the source and the receiver and are dependent on the type of equipment being used (Acoustic Logic 2017b). The reported levels were an upper limit, and would generally only be reached for limited periods and represent an absolute worst case.

Potential noise levels during music concerts have been estimated for the southerly and northerly extent of the Grey-headed Flying-fox Roost as well as the westerly satellite camp. The southern extent of the roost and the satellite roost may experience average noise of 75-76 dB(A) during a concert with occasional spikes up to 84 dB(A). The northern extent of the roost may experience average noise of 73 dB(A) with occasional spikes up to 81 dB(A). These numbers represent a worst-case scenario but they are outside the noise parameters in which the colony currently co-exists with.

The noise generated during demolition and construction of the project would fall within the levels that the colony co-existed with prior to the current demolition and construction plans for the project area. However, the noise levels will be higher than background levels for longer periods of time and sudden spikes may occur more frequently during works on the project area.

The noise generated during some music concerts and events will potentially be higher and/or more frequent then currently experienced by the Grey-headed Flying-fox roost.

There is a risk that these altered periods of elevated noise will have an impact on the Grey-headed Flying-fox roost, particularly in the southern parts of its current occupation.

Mitigation recommendations for monitoring and managing the impacts of noise on the Grey-headed Flying-fox are presented in section 4.6.

As per the recommendations of the Acoustic Logic (2017b) report, it is recommended that the Western Sydney Stadium Trust develop a Noise Management Plan which is regularly updated after measurements of concerts and events. The Noise Management Plan should incorporate impacts on the Grey-headed Flying-fox camp as well as on the human community.

The proposed Stage 2 construction will result in the removal of additional trees, some of which are likely to be a foraging resource. However, the flying-fox camp appears to contain more than 10,000 animals which fly out over a large area radiating from the camp site. The removal of the trees currently in the surrounds of the stadium would represent a very small reduction in the overall

foraging area. The proposed development includes the planting of more trees for landscaping than will be lost for the construction work. It is recommended that the landscaping include the planting of known feed trees for the Grey-headed Flying-fox in areas that will not create a likely conflict with human activity.

Assessments of significance were prepared in relation to the Grey-headed Flying-fox. It was concluded that the likely impacts of Stage 2 would not be a significant impact on the species, provided that indirect impacts (in particular noise) are contained and managed.

4.5 Riparian and Aquatic

It is considered that there are unlikely to be any direct impacts on riparian habitats as a result of the proposed development, given that the construction footprint does not extend to the Parramatta River, or any riparian vegetation along the river. The area that will be utilised for construction on the western side of the project (i.e. that part of the project that is closest to the river) currently comprises buildings (including the existing stadium) and a hard-stand car park, with a few areas of planted trees and shrubs (which will be removed during the approved Stage 1 demolition work). The majority of the project footprint is located at least 50 m from the river.

Notwithstanding the above, construction work along the western boundary of the project (i.e. the north-western side of the existing stadium and adjacent car park) will occur within an area that is close to the Parramatta River (about 15-20 m at the closest point) and immediately adjacent to an area of River-Flat Eucalypt Forest. There is therefore the potential for indirect impacts on this vegetation and the nearby river, in particular from sediments, pollutants and other materials entering the area of vegetation and flowing into the river via surface water runoff from the construction site. It is essential that the project avoid or minimise these indirect impacts as much as possible.

A stormwater management plan for the operation of the stadium has been prepared (Aurecon 2017). Advice provided by Aurecon to AMBS includes the following:

- *"the pre-development flow into Parramatta River peaks at 1.42 m^3/s, the post-development is estimated to be 1.45 m^3/s, a slight increase. This post-development flow is conservative (worst case) and is likely to be marginally less, hence, we can confirm that flow rates into Parramatta River during peak flow will remain as per the existing peak flow rates"* and
- *"the pre-development environmental flows (3-6 month flows) were never treated; nitrates, heavy metals, phosphates and gross pollutants freely entered the river. In the post-development case, these pollutants will be extracted and treated in line with environmental targets. Hence, the quality of run-off entering the river will be at a much higher quality."*

Aurecon (2017) also note that "*on-site investigation into the existing stormwater discharge pipe into Parramatta River is to be conducted as to ascertain the pipes capacity and current condition….. Should the discharge pipe be unsuitable for re-use, minor excavation along the existing pipe route and the use of non-toxic materials such as rocks/boulders will be used to secure the new discharge pipe and prevent fluvial erosion.*"

Any works within 40 m of the Parramatta River (top of bank) should consider the requirements of the *Water Management Act 2000*, the *Water Management Amendment Act 2014* and the *Water Act 1912*. A permit may be required.

4.6 Summary of Recommended Mitigation Measures

- Incorporate a buffer area and barrier between the demolition/construction area and the River-Flat Eucalypt Forest within the construction fence. Construction work should not occur inside the critical root zone (5 times the tree diameter 1400mm from ground level) of trees associated with the EEC and work occurring between the primary root zone (10 times the trunk diameter 1400mm from ground level) and the critical root zone must be completed by hand and under the supervision of an experienced arborist. The buffer zone should include the hollow-bearing tree located at the top of the bank.
- Implement stringent sediment and erosion control measures, particularly near the EEC and the Parramatta River.
- Implement weed control measures as described in Section 4.3 near the EEC.
- Implement *Phytopthera* hygiene controls.
- Implement Stormwater Management Plan including Water Sensitive Urban Design as per Aurecon 2017.
- Undertake further assessment of impacts on the EEC if works to repair the existing stormwater pipe in the area of the EEC are required.
- Noise sensors should be installed near the Grey-headed Flying-fox camp and regularly monitored. During construction, noise levels reaching the camp should not exceed 52-57 dB(A) especially at dusk, dawn and when the colony is supporting dependant young.
- The mitigation measures outlined in the noise assessment report (Acoustic Logic 2017) should be implemented to ensure noise emissions are limited. In addition, noise management plans should be incorporated into the Construction Environmental Management Plan that aim to minimise the level of noise reaching the Grey-headed Flying-fox roost.
- Construction works should not begin until after the bats have returned to roost and should cease at least 1 hour prior to the start of the fly-out. These times will vary seasonally and construction activities should be flexible to account for this seasonality.
- Monitoring surveys should be undertaken at the roost to monitor the response of the roost to sustained periods of elevated noise. The surveys would monitor the behaviour of individuals and assess the overall size of the roost. The surveys should be undertaken weekly for the first month of the project and then monthly for the duration of the project, or until it is established that noise is being managed at acceptable levels (i.e. the pre-construction background noise parameters described in Section 4.2.1).
- Stop work triggers should be incorporated into the projects Construction Environmental Management Plan in the event that roost distress (declining number or diurnal dispersal) or a decrease in animal health (including increased rate of mortality) is observed. Work will be stopped until appropriate management responses are developed to minimise the risk of further roost harm.
- Monitoring of noise and the health of the Grey-headed Flying-fox roost should be co-managed with monitoring programs being run for the Paramatta Leagues Club redevelopment.
- Develop a Noise Management Plan which is regularly updated after measurements of concerts and events, as per the Acoustic Logic report (2017), and incorporate measurements/monitoring of noise impacts on the Grey-headed Flying-fox camp.
- Noise levels during operation of the stadium (particularly during music events) should also be managed in accordance with Parramatta Stadium Noise Management Plan policy and monitored.
- Commence noise generation at low levels during sound check and event, and work up to maximum volume gradually. Generation of sudden, very loud noises should be avoided until after the nightly fly-out.

- Lighting during construction or operation should be directed away from the Grey-headed Flying-fox camp.
- Incorporate information about the Grey-headed Flying-fox and the River-Flat Eucalypt Forest in project induction material.
- Plant potential feed trees for the Grey-headed Flying-fox to replace the feed trees removed, either included in suitable locations as part of the landscaping for the project, or in Parramatta Park.

5 Conclusion

Stage 2 of the Western Sydney Stadium project, i.e. the detailed design and construction, follows Stage 1, i.e. the demolition of the existing stadium and the concept plan. An EIS including a Biodiversity Assessment was prepared for Stage 1 of the project and Stage 1 has been approved. The Biodiversity Assessment for Stage 1 (Eco Logical 2016) found that the development footprint, i.e. the area to be directly affected by the demolition works, contained no native vegetation and no hollow-bearing trees. However, the Biodiversity Assessment for Stage 1 also confirmed: the presence of the EEC River-Flat Eucalypt Forest adjacent to the development site; the presence of hollow-bearing trees within the EEC; the presence of a large camp of the Grey-headed Flying-fox (a threatened species) to the north of the site; and areas containing planted native/exotic vegetation within the site, which would be removed for the demolition work.

Accordingly, the Biodiversity Assessment for Stage 1 made a number of recommendations aimed at avoiding or reducing impacts on the Grey-headed Flying-fox camp and the River-Flat Eucalypt Forest. Assessments of significance (7 Part Tests) were prepared for six threatened fauna and one EEC potentially affected by the Western Sydney Stadium project (including the Grey-headed Flying-fox, the Powerful Owl, several microbats, and River-Flat Eucalypt Forest). The conclusion of the assessments was that the project would not have a significant impact on any of these threatened fauna and flora.

The Biodiversity Assessment for Stage 1 also included an assessment of significance consistent with the EPBC Act for the Grey-headed Flying-fox, which found that the proposed works “may have” a significant impact on a population of this species. A referral to the Commonwealth Department of the Environment (referral 2016/7739) was made, which concluded that the proposed action was not a controlled action, mainly on the basis that:

- only a small amount of potential foraging habitat for the Grey-headed Flying-fox would be removed;
- lighting within the stadium will be consistent with the existing lighting and will not be directed at the camp or regular flight paths;
- Grey-headed Flying-fox foraging and roosting habitat will be retained and the camp will not be further fragmented;
- predicted construction noise is lower than the predicted sporting event noise during the evening and night; and
- to minimise the risk of significant impacts from surrounding activities in the short and long term:
    - new buildings will be located at least 50 m from the camp;
    - demolition and construction activities will be restricted, particularly during sensitive periods in the GHFF life-cycle;
    - noise during events will be managed under the existing Parramatta Stadium Noise Management Plan (PCCD 2008).

The Referral Decision was made by the Australian Government Department of Environment and Energy on 12 September 2016 was that the proposed action is not a controlled action.

The development footprint for Stage 2 of the Western Sydney Stadium project, i.e. the construction of the new stadium, is almost exactly the same as the development footprint assessed in the Biodiversity Assessment for Stage 1, with the exception of two small areas to the north and south containing planted trees and mown grass adjacent to or within existing car parks. Investigations for this study (the Stage 2 Biodiversity Assessment) were focussed on updating and complimenting the investigations undertaken for Stage 1 and included the following:

- updated database searches for threatened flora and fauna that may occur in the locality (in order to include data on threatened species that may have been recorded in the locality since the Stage 1 assessment, and on species, populations and ecological communities that may have been listed as threatened since the Stage 1 assessment);
- additional surveys of the River-Flat Eucalypt Forest, in order to confirm the current extent and condition of the community and to search for threatened plants that may not have been recorded during the field surveys for Stage 1 (which were undertaken on 23 May 2016, i.e. at the end of autumn); and
- additional surveys of the Grey-headed Flying-fox camp, in order to confirm the current extent of the camp and identify flight paths, which can vary seasonally.

The investigations undertaken for this study (the Stage 2 Biodiversity Assessment) confirmed the presence of areas of the EEC River-Flat Eucalypt Forest along the north-western boundary of the development site and to the north of the site alongside the current Parramatta Leagues Club car park. The AMBS investigation extended the boundary of the north-western patch of the EEC slightly, based on the presence of vegetation consistent with the Final Determination for the community, specifically *Eucalyptus saligna x botryoides* and *Backhousia myrtifolia*.

The River-Flat Eucalypt Forest along the north-western boundary of the site occurs as a strip of vegetation along a steep bank located between the existing stadium facilities (buildings, car parks, roads and paths, and a grassy mound to the north) and the Parramatta River, with part of the area alongside the river comprising a cleared, grassy flat. As such, the existing rainfall catchment for the community is very small, with most of the rainfall falling above the bank directed away from the community and into drainage channels and pipelines (AECOM 2016). This arrangement will continue under the Storm Water Management Plan prepared in relation to Stage 2 works (Aurecon 2017). As such, the potential for the River-Flat Eucalypt Forest to be significantly affected by changes to surface water runoff is low, and Aurecon (2017) concluded the Stage 2 works are unlikely to interfere with 'ground water dependent ecosystems.'

The AMBS survey located a number of hollow-bearing trees in the area of the EEC. It was noted that one large hollow-bearing tree was on the top of the bank, inside the boundary fence installed for the Stage 1 works. The tree appears to be one of a number of trees along the north-western boundary that will be retained. It is recommended that the Stage 2 works (and, ideally, the Stage 1 works) incorporate an internal boundary (i.e. inside the perimeter fence) to ensure that works are not undertaken within the critical root zone of any trees potentially associated with the EEC and that any works inside the primary root zone are done by hand under supervision of a qualified arborist.

It is also recommended that stringent erosion and sediment control measures are implemented during the construction of the stadium, as well as weed control and mechanisms to minimise the potential for the transmission of *Phytopthera*. An assessment of significance (7 Part Test) was applied to this community and concluded that, if strong control measures to ensure these potential indirect impacts are implemented and maintained during the Stage 2 works, the project is not likely to have a significant impact on the River-Flat Eucalypt Forest.

Field surveys undertaken by AMBS in February 2017 and by Eco Logical in May 2016 did not detect any threatened plant species and none are considered likely to occur.

Our findings in relation to the likelihood of occurrence of threatened fauna are consistent with those of the findings for Stage 1. There is the potential for the Powerful Owl and a number of microchiropteran bat species to occur in the vicinity; however, the project is not likely to result in a significant impact on any of these species, given that the potential habitat to be removed consists of planted trees in and around the existing facilities and represents only a small area of potential

foraging habitat. There is the potential for indirect impacts on the Grey-headed Flying-fox camp as a result of noise and activity during construction and also the Stage 2 works will remove a number of planted trees around the existing stadium and swimming pool facilities that were not included in the trees to be removed in Stage 1 approval.

It appears unlikely that the use of lights at the new stadium will significantly affect the Grey-headed Flying-fox camp, provided that lights during construction and operation are directed away from the camp and the Parramatta River. Field surveys undertaken for this study found that Grey-headed Flying-foxes exited the camp in all directions at dusk, but that the main fly-out paths for the camp (at the time of the surveys, in summer) were north along the Parramatta River, south along the Parramatta River and east over the Cumberland Hospital area. A smaller proportion of the colony flew out in a south-easterly direction and very few of those flew out over the stadium itself. The Eco Logical (2016) field survey in the winter of 2016 also reported few animals flying out in the direction of the stadium. The new stadium will be further away from the camp and the main flight paths than the existing stadium. The lighting towers will be replaced with roof mounted lighting, which will improve the light spill (A. Morten, pers. comm.).

The indirect impact with the greatest potential to affect the Grey-headed Flying-fox colony is noise. There is some risk that construction activity, in particular noise, will disturb flying-foxes and that risk is considerably increased if construction occurs at the same time as activity from other nearby developments. It is important therefore that works with the potential to disturb the camp are carefully planned, managed and monitored to minimise the level of impact that reaches the camp, in particular noise impacts during the day and impacts during the breeding season.

The camp currently exists with noise from events; however, event noise during operation of the new stadium operation may be more frequent than at present. It is recommended that a regularly updated Noise Management Plan be prepared, as per the Acoustic Logic (2017b) report, which incorporates management/monitoring of noise impacts on the Grey-headed Flying-fox.

Assessments of significance (7 Part Test and EPBC Act assessment) were undertaken in relation to impacts on the Grey-headed Flying-fox and concluded that, if noise is properly managed and noise reaching the camp is minimised, both from construction work and during events, the proposed stadium is unlikely to have a significant impact on the Grey-headed Flying-fox.

Direct impacts on riparian habitat as result of the project works are considered unlikely. Indirect impacts may include runoff from sediments, pollutants and other materials entering the area of vegetation and flowing into the river via surface water runoff from the construction site. These impacts should be managed as per the stormwater management plan. Advice provided to AMBS by Aurecon in relation to the operation of the new stadium is that peak flow rates into the Parramatta River will be similar to existing peak flow rates and that the quality of water flowing into the river will be improved.

However, at the time of preparation of this report it was unclear whether or not works on a drainage pipeline occurring in the area of River-Flat Eucalypt Forest will be required. If the works are required further assessment of potential impacts and mitigation measures may be necessary.

Any works within 40 m of the Parramatta River (top of bank) should consider the requirements of the *Water Management Act 2000*, the *Water Management Amendment Act 2014* and the *Water Act 1912*. A permit may be required.

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Appendix A: Likelihood of Occurrence – threatened fauna

Class	Family	Scientific Name	Common Name	Conservation Status		Previously recorded or predicted to occur in locality			Likelihood of occurrence
				TSC Act	EPBC Act	OEH CMA Sub-region[1]	EPBC Report[2]	Bionet[3]	
Amphibia	Hylidae	*Litoria aurea*	Green and Golden Bell Frog	E	V	✓	✓	✓	No suitable habitat; unlikely to occur.
	Hylidae	*Litoria raniformis*	Growling Grass Frog	E	V		✓		No suitable habitat; unlikely to occur.
	Myobatrachidae	*Heleioporus australiacus*	Giant Burrowing Frog	V	V		✓		No suitable habitat; unlikely to occur.
	Myobatrachidae	*Mixophyes balbus*	Stuttering Frog	E	V		✓		No suitable habitat; unlikely to occur.
	Myobatrachidae	*Pseudophryne australis*	Red-crowned Toadlet	V		✓			No suitable habitat; unlikely to occur.
Aves	Acanthizidae	*Chthonicola sagittata*	Speckled Warbler	V		✓			No suitable habitat; unlikely to occur.
	Accipitridae	*Circus assimilis*	Spotted Harrier	V		✓			No suitable habitat; unlikely to occur.
	Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	V	C	✓		✓	No suitable habitat; unlikely to occur.
	Accipitridae	*Hieraaetus morphnoides*	Little Eagle	V		✓			No suitable habitat; unlikely to occur.
	Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V		✓			No suitable habitat; unlikely to occur.
	Accipitridae	*Pandion cristatus*	Eastern Osprey	V		✓	✓		No suitable habitat; unlikely to occur.
	Anatidae	*Stictonetta naevosa*	Freckled Duck	V		✓			No suitable habitat; unlikely to occur.
	Apodidae	*Apus pacificus*	Fork-tailed Swift		M		✓	✓	No suitable habitat; unlikely to occur.
	Apodidae	*Hirundapus caudacutus*	White-throated Needletail		M		✓		No suitable habitat; unlikely to occur.
	Ardeidae	*Botaurus poiciloptilus*	Australasian Bittern	E	E	✓	✓		No suitable habitat; unlikely to occur.
	Ardeidae	*Ixobrychus flavicollis*	Black Bittern	V		✓			No suitable habitat; unlikely to occur.
	Artamidae	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	V		✓			No suitable habitat; unlikely to occur.
	Burhinidae	*Burhinus grallarius*	Bush Stone-curlew	E		✓			No suitable habitat; unlikely to occur.
	Cacatuidae	*Callocephalon fimbriatum*	Gang-gang Cockatoo	V		✓			No suitable habitat; unlikely to occur.
	Cacatuidae	*Callocephalon fimbriatum*	Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas	E (pop)		✓			No suitable habitat; unlikely to occur.
	Cacatuidae	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V		✓			No suitable habitat; unlikely to occur.
	Charadriidae	*Charadrius bicinctus*	Double-banded Plover		M		✓		No suitable habitat; unlikely to occur.
	Charadriidae	*Charadrius leschenaultii*	Greater Sand-plover	V	V	✓	✓		No suitable habitat; unlikely to occur.
	Charadriidae	*Charadrius mongolus*	Lesser Sand-plover	V	E, M		✓		No suitable habitat; unlikely to occur.

Class	Family	Scientific Name	Common Name	Conservation Status		Previously recorded or predicted to occur in locality			Likelihood of occurrence
				TSC Act	EPBC Act	OEH CMA Sub-region[1]	EPBC Report[2]	Bionet[3]	
	Charadriidae	*Pluvialis fulva*	Pacific Golden Plover		M		✓		No suitable habitat; unlikely to occur.
	Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	E		✓			No suitable habitat; unlikely to occur.
	Climacteridae	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V		✓			No suitable habitat; unlikely to occur.
	Columbidae	*Ptilinopus superbus*	Superb Fruit-Dove	V		✓			No suitable habitat; unlikely to occur.
	Cuculidae	*Cuculus optatus*	Horsefield's Cuckoo		M		✓		No suitable habitat; unlikely to occur.
	Dasyornithidae	*Dasyornis brachypterus*	Eastern Bristlebird	E	E		✓		No suitable habitat; unlikely to occur.
	Dicruridae	*Monarcha melanopsis*	Black-faced Monarch		M		✓		No suitable habitat; unlikely to occur.
	Estrilidae	*Stagonopleura guttata*	Diamond Firetail	V		✓			No suitable habitat; unlikely to occur.
	Falconidae	*Falco hypoleucos*	Grey Falcon	E					No suitable habitat; unlikely to occur.
	Falconidae	*Falco subniger*	Black Falcon	V		✓			No suitable habitat; unlikely to occur.
	Laridae	*Hydroprogne caspia*	Caspian Tern		M				No suitable habitat; unlikely to occur.
	Laridae	*Sternula albifrons*	Little Tern	E		✓			No suitable habitat; unlikely to occur.
	Meliphagidae	*Anthochaera phrygia*	Regent Honeyeater	Ex	CE	✓	✓	✓	No suitable habitat; unlikely to occur.
	Meliphagidae	*Epthianura albifrons*	White-fronted Chat	V		✓			No suitable habitat; unlikely to occur.
	Meliphagidae	*Epthianura albifrons*	White-fronted Chat population in the Sydney Metropolitan Catchment Management Area	E (pop)		✓			No suitable habitat; unlikely to occur.
	Meliphagidae	*Grantiella picta*	Painted Honeyeater	V		✓	✓		No suitable habitat; unlikely to occur.
	Meliphagidae	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subspecies)	V		✓			No suitable habitat; unlikely to occur.
	Motacillidae	*Motacilla flava*	Yellow Wagtail		M		✓		No suitable habitat; unlikely to occur.
	Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V		✓			No suitable habitat; unlikely to occur.
	Petroicidae	*Melanodryas cucullata cucullata*	Hooded Robin (south-eastern form)	V		✓			No suitable habitat; unlikely to occur.
	Petroicidae	*Petroica boodang*	Scarlet Robin	V		✓		✓	No suitable habitat; unlikely to occur.
	Petroicidae	*Petroica phoenicea*	Flame Robin	V		✓			No suitable habitat; unlikely to occur.
	Procellariidae	*Pachyptila turtur subantarctica*	Fairy Prion (southern)		V		✓		No suitable habitat; unlikely to occur.
	Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V		✓			No suitable habitat; unlikely to occur.
	Psittacidae	*Lathamus discolor*	Swift Parrot	E	CE	✓	✓	✓	No suitable habitat; unlikely to occur.

Class	Family	Scientific Name	Common Name	Conservation Status		Previously recorded or predicted to occur in locality			Likelihood of occurrence
				TSC Act	EPBC Act	OEH CMA Sub-region[1]	EPBC Report[2]	Bionet[3]	
	Psittacidae	*Neophema pulchella*	Turquoise Parrot	V		✓			No suitable habitat; unlikely to occur.
	Psittacidae	*Polytelis swainsonii*	Superb Parrot	V	V	✓		✓	No suitable habitat; unlikely to occur.
	Rostratulidae	*Rostratula australis*	Australian Painted Snipe	E	E	✓	✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper		M			✓	No suitable habitat; unlikely to occur.
	Scolopacidae	*Arenaria interpres*	Ruddy Turnstone		M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper		M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Calidris canutus*	Red Knot		E, M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper	E	CE, M	✓	✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Calidris melanotos*	Pectoral Sandpiper		M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Calidris ruficollis*	Red-necked Stint		M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Calidris tenuirostris*	Great Knot	V	CE		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Gallinago hardwickii*	Latham's Snipe		M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Heteroscelus brevipes*	Grey-tailed Tattler		M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Limicola falcinellus*	Broad-billed Sandpiper	V		✓			No suitable habitat; unlikely to occur.
	Scolopacidae	*Limosa lapponica*	Bar-tailed Godwit		M	✓	✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Limosa limosa*	Black-tailed Godwit	V	M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Numenius madagascariensis*	Eastern Curlew		CE, M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Numenius phaeopus*	Whimbrel				✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Philomachus pugnax*	Ruff		M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Tringa nebularia*	Common Greenshank		M		✓		No suitable habitat; unlikely to occur.
	Scolopacidae	*Tringa stagnatilis*	Marsh Sandpiper		M		✓		No suitable habitat; unlikely to occur.
	Strigidae	*Ninox connivens*	Barking Owl	V		✓		✓	No suitable habitat; unlikely to occur.
	Strigidae	*Ninox strenua*	Powerful Owl	V		✓		✓	Potential foraging habitat present.
	Tytonidae	*Tyto novaehollandiae*	Masked Owl	V		✓			No suitable habitat; unlikely to occur.
Gastropoda	Camaenidae	*Meridolum corneovirens*	Cumberland Plain Land Snail	E		✓			No suitable habitat; unlikely to occur.
	Camaenidae	*Pommerhelix duralensis*	Dural Woodland Snail	E	E	✓	✓		No suitable habitat; unlikely to occur.
Mammalia	Burramyidae	*Cercartetus nanus*	Eastern Pygmy-possum	V		✓			No suitable habitat; unlikely to occur.
	Dasyuridae	*Dasyurus maculatus*	Spotted-tailed Quoll	V	E	✓	✓	✓	No suitable habitat; unlikely to occur.
	Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	V		✓		✓	No suitable habitat; unlikely to occur.

Class	Family	Scientific Name	Common Name	Conservation Status		Previously recorded or predicted to occur in locality			Likelihood of occurrence
				TSC Act	EPBC Act	OEH CMA Sub-region[1]	EPBC Report[2]	Bionet[3]	
	Macropodidae	*Petrogale penicillata*	Brush-tailed Rock-wallaby	E	V		✓		No suitable habitat; unlikely to occur.
	Molossidae	*Mormopterus norfolkensis*	Eastern Freetail-bat	V		✓		✓	Potential foraging habitat present.
	Muridae	*Pseudomus novaehollandiae*	New Holland Mouse		V		✓		No suitable habitat; unlikely to occur.
	Peramelidae	*Isoodon obesulus obesulus*	Southern Brown Bandicoot (eastern)	E	E		✓		No suitable habitat; unlikely to occur.
	Peramelinae	*Perameles nasuta - endangered population*	Long-nosed Bandicoot population in inner western Sydney	E (pop)		✓			No suitable habitat; unlikely to occur.
	Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V		✓			No suitable habitat; unlikely to occur.
	Phascolarctidae	*Phascolarctos cinereus*	Koala	V	V	✓	✓		No suitable habitat; unlikely to occur.
	Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V	✓	✓	✓	Known camp occurs to north of site. Foraging habitat present.
	Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	✓	✓		No suitable habitat; unlikely to occur.
	Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V		✓		✓	No suitable habitat; unlikely to occur.
	Vespertilionidae	*Miniopterus australis*	Little Bentwing-bat	V		✓			No suitable habitat; unlikely to occur.
	Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V		✓		✓	Potential foraging habitat present.
	Vespertilionidae	*Myotis macropus*	Southern Myotis	V		✓		✓	Potential foraging habitat present.
	Vespertilionidae	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V		✓		✓	Potential foraging habitat present.
Reptilia	Elapidae	*Hoplocephalus bungaroides*	Broad-headed Snake	E	V	✓	✓		No suitable habitat; unlikely to occur.
	Varanidae	*Varanus rosenbergi*	Rosenberg's Goanna	V		✓			No suitable habitat; unlikely to occur.

Notes:
EPBC Act = Environment Protection and Biodiversity Conservation Act 1999; TSC Act = Threatened Species Conservation Act 1995
V = Vulnerable, E = Endangered, E (pop) = Endangered Population, CE= Critically endangered, Ex = Extinct, M = Migratory
1 CMA subregion: Cumberland within Sydney Metro CMA
2 The report is based on an area within 5 km of the centre of the study area.
3 Only records included that fell within 5 km of the centre of study area.

Appendix B: Likelihood of Occurrence – threatened flora

Family	Scientific Name	Common Name	Conservation Status		Previously recorded or predicted to occur in locality			Likelihood of occurrence
			TSC Act	EPBC Act	OEH CMA Sub-region[1]	EPBC Report[2]	Bionet[3]	
Apocynaceae	*Cynanchum elegans*	White-flowered Wax Plant	E	E	✓			Potential to occur
	Marsdenia viridiflora subsp. viridiflora		E (pop)		✓		✓	Potential to occur
Campanulaceae	*Wahlenbergia multicaulis*	Tadgell's Bluebell	E (pop)		✓			Unlikely
Casuarinaceae	*Allocasuarina glareicola*		E	E		✓		Potential to occur
Convolvulaceae	*Wilsonia backhousei*	Narrow-leafed Wilsonia	V		✓		✓	Unlikely
Dilleniaceae	*Hibbertia fumana*		CE		✓			Unlikely
	Hibbertia puberula		E		✓			Unlikely
	Hibbertia sp. Bankstown		CE	CE	✓			Unlikely
	Hibbertia spanantha	Julian's Hibbertia	CE	CE	✓			Unlikely
	Hibbertia superans		E		✓		✓	Unlikely
Elaeocarpaceae	*Tetratheca glandulosa*		V		✓		✓	Unlikely
	Tetratheca juncea	Black-eyed Susan	V		✓			Unlikely
Ericaceae	*Epacris purpurascens var. purpurascens*		V		✓		✓	Unlikely
	Leucopogon exolasius	Woronora Beard-heath	V	V	✓			Unlikely
Euphorbiaceae	*Chamaesyce psammogeton*	Sand Spurge	E		✓			Unlikely
Fabaceae	*Dillwynia tenuifolia*		V		✓			Unlikely
	Pultenaea pedunculata	Matted Bush-pea	E		✓			Potential to occur
	Acacia bynoeana	Bynoe's Wattle	E	V	✓	✓		Unlikely
	Acacia pubescens	Downy Wattle	V	V	✓	✓	✓	Potential to occur
	Acacia terminalis subsp. terminalis	Sunshine Wattle	E		✓			Unlikely
Geraniceae	*Pelargonium sp. striatellum*	Omeo Stork's-bill	E	E		✓		Unlikely
Grammitidaceae	*Grammitis stenophylla*	Narrow-leaf Finger Fern	E		✓		✓	Unlikely
Haloragaceae	*Haloragodendron lucasii*		E	E	✓			Unlikely
Juncaginaceae	*Maundia triglochinoides*		V		✓			Unlikely
Lamiaceae	*Prostanthera marifolia*	Seaforth Mintbush	CE	CE	✓			Unlikely
Myrtaceae	*Callistemon linearifolius*	Netted Bottle Brush	V		✓		✓	Potential to occur
	Darwinia biflora		V	V	✓	✓		Unlikely

Family	Scientific Name	Common Name	Conservation Status		Previously recorded or predicted to occur in locality			Likelihood of occurrence
			TSC Act	EPBC Act	OEH CMA Sub-region[1]	EPBC Report[2]	Bionet[3]	
	Eucalyptus camfieldii	Camfield's Stringybark			✓			Unlikely
	Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	✓			Unlikely
	Leptospermum deanei		V	V	✓			Potential to occur
	Melaleuca deanei	Deane's Paperbark	V	V	✓	✓		Unlikely
	Syzygium paniculatum	Magenta Lilly Pilly	E	V	✓	✓	✓	Potential to occur
	Triplarina imbricate	Creek Triplarina	E	E			✓	Unlikely
Orchidaceae	*Caladenia tessellata*	Thick Lip Spider Orchid	E	V	✓			Unlikely
	Cryptostylis hunteriana	Leafless Tongue-Orchid	V	V		✓		Potential to occur
	Diuris aequalis	Buttercup Doubletail	E	V	✓			Unlikely
	Genoplesium baueri	Bauer's Midge Orchid	E	E	✓	✓		Potential to occur
	Pterostylis gibbosa	Illawarra Greenhood	E	E		✓		Unlikely
	Pterostylis nigricans	Dark Greenhood	V		✓			Unlikely
	Pterostylis saxicola	Sydney Plains Greenhood	E		✓	✓		Unlikely
Poaceae	*Deyeuxia appressa*		E	E	✓			Unlikely
Proteaceae	*Grevillea parviflora subsp. parviflora*	Small-flower Grevillea	V		✓			Unlikely
	Persoonia hirsute	Hairy Geebung	E	E	✓			Potential to occur
	Persoonia nutans	Nodding Geebung	E	E	✓	✓	✓	Unlikely
Rhamnaceae	*Pomaderris prunifolia*		E (pop)		✓		✓	Unlikely
Rutaceae	*Asterolasia elegans*		E	E		✓		Unlikely
Santalaceae	*Thesium austral*	Australian Toadflax	V	V		✓		Unlikely
Thymelaeaceae	*Pimelea curviflora var. curviflora*		V	V	✓	✓	✓	Unlikely
	Pimelea spicata	Spiked Rice-flower	E	E	✓	✓	✓	Unlikely
Zannichelliaceae	*Zannichellia palustris*		E		✓			Unlikely

Notes:
EPBC Act = Environment Protection and Biodiversity Conservation Act 1999; TSC Act = Threatened Species Conservation Act 1995
V = Vulnerable, E = Endangered, E (pop) = Endangered Population, CE= Critically endangered, Ex = Extinct, M = Migratory
1 CMA subregion: Cumberland within Sydney Metro CMA
2 The report is based on an area within 5 km of the centre of the study area.
3 Only records included that fell within 5 km of the centre of study area.

Appendix C: Plant Species List

Plant species observed in River-flat Eucalypt Forest and nearby vegetation.
*denotes exotic species

Scientific Name	Common Name	Notes
Acacia decurrens	Sydney Green Wattle	Planted (bush regeneration)
Acacia falcate	Sickle Wattle	
Acacia implexa	Hickory Wattle	
Acacia parramattensis	Parramatta Wattle	Planted (bush regeneration)
Allocasuarina littoralis	Black She-oak	
Angophora floribunda	Rough-barked Apple	
*Anredera cordifolia**	Anredera cordifolia	
*Avena fatua**	Wild Oats	
Backhousia myrtifolia	Grey Myrtle	
Banksia serrata	Old Man Banksia	Planted
Bidens pilosa	Cobblers Pegs	
Brachychiton acerifolius	Illawarra Flame Tree	Non-local invasive
Brachychiton populneus	Kurrajong	
*Bromus catharticus **	Prairie Grass	
Bursaria spinose	Native Blackthorn	
Callistemon citrinus	Crimson bottlebrush	
Callistemon salignus	Willow Bottlebrush	
*Cardiospermum grandiflorum**	Balloon Vine	
Casuarina glauca	Swamp Oak	
Cayratia clematidea	Native Grape	
*Cestrum parquii **	Green Cestrum	
*Cinnamomum camphora**	Camphor laurel	Planted
Commelina cyanea		
Cynodon dactylon	Couch	
Digitaria didactyla	Queensland Blue Couch	
*Ehrharta erecta **	Panic Veldtgrass	
*Erythina x sykesii**	Coral Tree	
Eucalyptus bauerana	Baeuerlen's Gum	Planted (probable)
Eucalyptus eugenoides	Thin-leaved Stringybark	
Eucalyptus grandis	Flooded Gum	Planted
Eucalyptus microcorys	Tallowwood	Planted
Eucalyptus muelleriana	Yellow Stringybark	Planted (probable, possible hybrid)
Eucalyptus puncata	Grey Gum	
Eucalyptus robusta	Swamp mahogany	Planted
Eucalyptus saligna x botryoides		
Eucalyptus tereticornis	Forest Red Gum	
Glochidion ferdinandi	Cheese tree	
Grevillea robusta	Silky Oak	Non-local invasive
Hardenbergia violacea	False Sarsaparilla	Planted (bush regeneration)
Indifgofra australis	Australian Indigo	Planted (bush regeneration)
*Ipomoea indica **	Morning Glory	
Kennedia rubicunda	Dusky Coral Pea	
*Lantana camara**	Lantana	
*Ligustrum lucidum **	Large-leaved Privet	
Lomandra longifolia	Spiny-headed Mat-rush	Planted (bush regeneration)
Lophostemon confertus	Brush Box	Planted

Melaleuca linariifolia	Flax-leaved Paperbark	
Microleana stipoides var. stipoides	Weeping grass	
*Paspalum dialatatum**	Paspalum	
*Phoenix canariensis **	Phoenix canariensis	
*Pinus pinea**	Stone Pine	
Pittosporum revolutum	Pittosporum revolutum	
Pittosporum undulatum	Sweet Pittosporum	
*Senna pendula var. glabrata **		
*Setaria palmifolia **	Palm Grass	
*Sida rhombifolia**	Paddy's Lucerne	
Sigesbeckia orientalis	Indian Weed	
Solanum nigrum	Solanum nigrum	
*Taraxacum offiicinale **	Dandelion	
*Tradescantia fluminensis **	Trad	

Appendix D: Assessments of Significance

Grey-headed Flying-fox

The Grey-headed Flying-fox is listed as vulnerable under Schedule 2 of the TSC Act. It has a primarily coastal distribution from Rockhampton, Queensland south to Adelaide, South Australia, although some records have been reported over 400km from the coast. It's distribution range may be expanding in response to factors such as climate change, habitat destruction and resource availability. Roosts in Adelaide, South Australia were established as recently as 2010.

The species utilises subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps, gardens and cultivated fruit crops. The fruits and flowers of a wide variety of species are the food source of the species.

The species forms large roosts (camps) which can reach up 200,000 individuals. Camps are usually formed within 20 km of a regular food source, although there are regular records of bats flying up to 50 kilometres to forage. The roosts are most often located close to a permanent water source or within sheltered gullies. Conflict between humans and the Grey-headed Flying-fox has arisen as the species has been known to form camps in urban areas and regularly forages on orchard fruits (OEH 2017).

Key threats to the species are loss of roosting and foraging sites, heat stress, electrocution on powerlines, entanglement in netting and on barbed-wire, and conflict with humans (OEH 2017).

The Parramatta River Grey-headed Flying-fox roost southern boundary is located approximately 140-150m north of the existing stadium. The proposed new stadium will be located further away from the roost; however, some of the facilities associated with the new stadium (in particular a car park) will be much closer. On the eastern bank, the roost extends approximately 400 metres north. The roost is monitored regularly as part of the National Flying-fox Monitoring Project. Numbers in the camp fluctuate but the population of the roost appears to be increasing in size with some surveys detecting above 20,000 mature individuals. As the population of the roost has increased, the area covered has also increased. Recently, an area of habitat on the western bank of the Parramatta River has become a permanent roost site.

The following impacts on the Grey-headed Flying-fox may occur as a result of proposed modifications:

- Construction and demolition noise levels of between 48-61 dB(A);
- Increased stress as a result of disturbance to GHFF during construction and events;
- Cumulative level of increased noise; and,
- Cumulative loss of foraging habitat.

GHFF 7 Part Test

The factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened species or their habitats are outlined below.

1. **in the case of a Threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction**

The primary threats to the life cycle of the Grey-headed Flying-fox resulting from the project are loss or vacation of roosting habitat due to noise disturbance, increases in the mortality rate, and increases in cumulative impacts.

Despite its use as a dispersal method, the impact of noise on Flying-fox species has been not been investigated thoroughly. Some data show that deliberate attempts to disturb a roost for relocation (including the use of noise) can lead to stress and increase prevalence of disease (Edson *et al.,* 2015, Plowright *et al*, 2008), although there appears to be little reporting into the level of noise that can trigger a stress response. Noise is used to encourage Flying-fox roosts to relocate and discourage them from foraging in certain areas, though rarely are the attempts to relocate roosts beyond the local area permanently successful (Tidemann 1999, Tidemann 2002, Tidemann 2003, Roberts *et al.,* 2011). The level of noise used to relocate roosts is rarely reported, though some recommended methods use devices (i.e. bird-frite, shell cracker cartridges) that generate sound at between 125 dB(A) and 145 dB(A) (Tidemann 2003). There are few data detailing the impact of regular sound above the usual background noise levels. Despite the gaps in reported data, it is possible that significant increases in noise levels resulting from the project could increase stress and mortality at the Parramatta River roost, especially if the noise occurs at dusk, dawn or when mothers are nursing young.

The levels of noise experienced by the roost prior to the project as well as the levels expected during and after the project are summarised in Section **Error! Reference source not found.**. It concludes that noise experienced during demolition and construction will fall within the ranges experienced by the roost prior to the project, though it will be at elevated levels for longer periods of time. It also concludes that the noise that could be experienced by the roost during music occasional music concerts could be higher than experienced by the roost.

The majority of music concerts held at the Western Sydney Stadium will occur at night. If the majority of the predicted elevated noise is experienced after the roost has had its dusk fly-out, the impacts of increased noise should be negligible. However, during the breeding season, increased levels of noise during music concerts could have a negative impact on mothers nursing young once the young have been left at the roost while its parents forage.

The cumulative impact of elevated background noise is more difficult to assess. The likely result of multiple developments being constructed at the same time is an increase in duration of elevated background noise with more frequent loud spikes in noise. If these noise patterns do occur, there is a much greater risk of stress in the roost resulting in increased levels of disease or mortality. There is also a higher chance that the roost could relocate.

Noise has the potential to cause a significant impact on the life-cycle of the species. Mitigation and management measures have therefore been recommended to monitor and minimise the impact of noise on the species (Section 4.6). If the recommended mitigation and management actions are undertaken, including the ability to stop work in the event roost distress is detected, noise should not significantly impact the life cycle of the species.

2. **in the case of an Endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the Endangered population such that a viable local population of the species is likely to be placed at risk of extinction**

Not applicable. The Grey-headed Flying-fox is not an Endangered population

3. **in the case of an Endangered ecological community or Critically Endangered ecological community, whether the action proposed:**

i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable.

ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable.

4. in relation to the habitat of a Threatened species, population or ecological community:

i. the extent to which habitat is likely to be removed or modified as a result of the action proposed

Stage 2 of the project will result in the removal of a number of trees, some of which are a likely foraging resource, from areas around the existing stadium. Landscaping for Stage 2 includes the planting of more trees than will be lost.

ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The proposed modification will not increase fragmentation or isolation of habitat for this highly mobile species.

iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The vegetation to be removed comprises trees planted in and around the existing stadium and swimming pool facilities and is not likely to be an important foraging resource. It's loss is not likely to threaten the long-term survival of the species in the locality.

5. whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Grey-headed Flying-fox.

6. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Draft National Recovery Plan for the Grey-headed Flying-fox (Department of Environment, Climate Change and Water NSW 2009) outlines the following actions:

- Identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes across their range;
- Enhance winter and spring foraging habitat for Grey-headed Flying-foxes;
- Identify, protect and enhance roosting habitat critical to the survival of Grey-headed Flying-foxes;
- Significantly reduce levels of deliberate Grey-headed Flying-fox destruction associated with commercial horticulture;
- Provide information and advice to managers, community groups and members of the public that are involved with controversial flying-fox camps;

- Produce and circulate educational resources to improve public attitudes toward Grey-headed Flying-foxes, promote the recovery program to the wider community and encourage participation in recovery actions;
- Monitor population trends for the Grey-headed Flying-fox;
- Assess the impacts on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and barbed wire, and implement strategies to reduce these impacts;
- Oversee a program of research to improve knowledge of the demographics and population structure of the Grey-headed Flying-fox; and,
- Maintain a National Recovery Team to oversee the implementation of the Grey-headed Flying-fox National Recovery Plan.

Of the management actions above, the most critical in relation to the proposed project is protecting and enhancing roosting habitat critical to the survival of Grey-headed Flying-foxes. The proposed project has the potential to impact an important roost for the species by increased levels and duration of noise during demolition, construction and operation. Cumulative impacts of noise from additional construction projects may enhance the risk of noise impacting the roosting habitat.

Implementation of mitigation measures outlined in this report will minimise the risk of impacts by noise on the roost.

7. whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed modifications may result in increasing the impact of one key threatening processes listed under the TSC Act, these being:

- Diseases, those exotic fungal infections, viruses and other pathogens that can weaken and kill native species.

Flying-foxes have been recorded experiencing higher levels of disease in response to stress (Edson *et al.,* 2015, Plowright *et al*, 2008). Roost disturbance can result in increased stress and may result in an increased impact of disease. There are few data available on the ability of noise alone to elicit a stress response in Flying-foxes. The data available on stress mediated disease responses do investigate Flying-foxes that have had roosts relocated using a variety of methods, including noise (most likely above 125 dB(A)). As such, it is likely that certain levels of noise can result in stress mediated disease responses. The levels of noise described in Section 4.2.1 are below the reported level of noise used to disperse Flying-fox roosts (i.e. Tidemann 2003).

It is uncertain if the proposed levels of noise will increase the levels of stress on some animals in the roost. Implementation of the recommended mitigation and monitoring measures will ensure the impact of the key threatening process is not increased due to the proposed modification.

Conclusion

The proposal is unlikely to constitute a significant impact on Grey-headed Flying-fox if mitigation measures to minimise excessive noise are implemented.

GHFF EPBC Act significance criteria

Grey-headed Flying-fox is listed as a vulnerable threatened species under the EPBC Act. An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Criterion a: lead to a long-term decrease in the size of an important population of a species

The major potential impact from the proposed project on the Grey-headed Flying-fox roost is noise. Despite its use as a dispersal method, the impact of noise on Flying-fox species has been not been investigated thoroughly. Some data show that deliberate attempts to disturb a roost for relocation (including the use of noise) can lead to stress and increase prevalence of disease (Edson *et al.,* 2015, Plowright *et al*, 2008), although there appears to be little reporting into the level of noise that can trigger a stress response. Noise is used to encourage Flying-fox roosts to relocate and discourage them from foraging in certain areas, although rarely are the attempts to relocate roosts beyond the local area permanently successful (Tidemann 1999, Tidemann 2002, Tidemann 2003, Law *et al.,* 2011). The level of noise used to relocate roosts is rarely reported, though some recommended methods use devices (i.e. bird-frite, shell cracker cartridges) that generate sound at between 125 dB(A) and 145 dB(A)(Tidemann 2013). There are few data detailing the impact of regular sound above the usual background noise levels. Despite the gaps in reported data, it is possible that significant increases in noise levels resulting from the project could increase stress and mortality at the Parramatta River roost, especially if the noise occurs at dusk, dawn or when mothers are nursing young.

The levels of noise experienced by the roost prior to the project as well as the levels expected during and after the project are summarised in Section 4. It concludes that noise experienced during demolition and construction will fall within the ranges experienced by the roost prior to the project (which the colony co-existed with), though it will be at elevated levels for longer periods of time. It also concludes that the noise that could be experienced by the roost during music occasional music concerts could be higher than experienced by the roost at present.

The majority of music concerts held at the Western Sydney Stadium will occur at night. If the majority of the predicted elevated noise is experienced after the roost has had its dusk fly-out, the impacts of increased noise should be negligible. However, during the breeding season, increased levels of noise during music concerts could have a negative impact on mothers nursing young once the young have been left at the roost while its parents forage.

The cumulative impact of elevated background noise is more difficult to assess. The likely result of multiple developments being constructed at the same time is an increase in duration of elevated background noise with more frequent loud spikes in noise. If these noise patterns do occur, there is a much greater risk of stress in the roost resulting in increased levels of disease or mortality. There is also a higher chance that the roost could relocate.

Noise has the potential to cause a long-term decline in the Parramatta River Grey-headed Flying-fox roost. Mitigation and management measures have been developed to monitor and minimise the impact of noise on the species (Section 4.6). If the recommended mitigation and management actions are undertaken, including the ability to stop work in the event roost distress is detected, noise should not significantly impact the life cycle of the species.

Criterion b: reduce the area of occupancy of an important population

No roosting habitat will be cleared. As such, no reduced area of occupancy is anticipated as a result of the proposed modification.

Criterion c: fragment an existing important population into two or more populations

The proposed action will not fragment an existing population into two or more populations, unless unmanaged elevated noise levels result in some Flying-foxes, or all, relocating from the roost. The risk of this is increased by the cumulative impacts of additional construction activities in the locality of the roost.

Data on attempts to relocate roosts indicate that it is difficult to relocate roosts using noise alone. If noise is the primary tool used to relocate roosts, the levels required are usually above 125 dB(A). To relocate a roost, repeated bursts of noise are used at dawn and dusk over several days (Law *et al.,* 2011, Tidemann 2003). Thus, should noise be managed appropriately, it should not cause population fragmentation at the Parramatta River Grey-headed Flying-fox roost.

If the management and mitigation measures outlined in section 4.6 are adhered to, the impact of noise should not lead to fragmentation of the local population

Criterion d: adversely affect habitat critical to the survival of a species

The Parramatta Grey-headed Flying-fox roost is considered to be critical to the survival of the species. It is a permanent roost site located along the banks of the Parramatta River, with 80% of the camp on the eastern bank of the Parramatta River (core camp) and the remaining on Parramatta Park land. The core camp currently contains between 10,000 and 16,000 individuals though some recent surveys have detected over 16,000 adults at the camp. The satellite camp supports an increasing number of adults. In recent years, the camp population has grown, as has the area covered by the roost, despite regular concerts and sporting events at the stadium 60 m to the south.

The proposed project will not directly impact the camp. While the roost can co-exist with loud events held at the sporting precinct close by, these events rarely last for more than 5 hours. Unmanaged and prolonged elevated levels of noise resulting from demolition and construction could reduce the suitability of the roost location for the bats. This could result in increased mortality or roost relocation.

If the management and mitigation measures outlined in section 4.6 are adhered to, the impact of noise should not adversely affect the critical roosting habitat along the Parramatta River.

Criterion e: disrupt the breeding cycle of an important population

An increase in background noise levels resulting from the proposed project has potential to cause stress to Grey-headed Flying-fox within the Parramatta camp. The greatest risk of impact occurs from sudden loud noises (e.g. during music concerts) at sensitive times for fauna such as during emergence and return to roosts at dusk and dawn and during breeding and lactation (October – February). Grey-headed Flying-fox females have been known to abort or abandon dependent young when stressed.

If the management and mitigation measures outlined in section 4.6 are adhered to, the impact of noise should not disrupt the breeding cycle of an important population.

Criterion f: modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The project will result in the removal of potential foraging trees. There are extensive areas of higher quality foraging habitat adjacent to the study area in Parramatta Park. In addition, the Grey-headed Flying-fox camp will be left in situ and no roosting habitat would be impacted.

Criterion g: Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

The project would not result in invasive species, such as weeds, that would be harmful to Grey-headed Flying-fox.

Criterion h: Introduce disease that may cause the species to decline;

Flying-foxes are susceptible to stress mediate disease responses (Eby *et al,* 2015, Plowman *et al*, 2008). The role of noise on stress mediated disease response is poorly understood, though it is likely to play a role (Edson *et al,* 2015, Plowman *et al*, 2008). Stress from disturbance is a significant issue when it is ongoing, occurs daily or more often than a species can recover from. Elevated and sustained stress may also be an issue during sensitive times in the lifecycle such as breeding or lactation.

Accordingly, management and mitigation measures aimed at minimising stress on the population are outlined in section 4.6.

Criterion i: Interfere substantially with the recovery of the species;

A Draft National Recovery Plan for the Grey-headed Flying-fox was developed in 2009. A Flying-fox Camp Management Policy was recently produced in 2015 by OEH. The proposed works do not substantially interfere with the objectives stated in either document or impede the recovery of this species.

Conclusion

The proposal is unlikely to constitute a significant impact on Grey-headed Flying-fox if mitigation measures to minimise excessive noise are implemented.

Powerful Owl *Ninox strenua* - 7 Part Test

The large forest owls of NSW, including *Ninox strenua* (Powerful Owl), are all listed as a vulnerable species under Schedule 2 of the TSC Act.

The Powerful Owl is endemic to eastern and south-eastern Australia and occurs mainly on the coastal side of the Great Dividing Range from Queensland to south-western Victoria. Evidence of inland populations in NSW is formed from scattered records along the western slopes and plains, suggesting a population pre-land clearing (OEH 2017).

Powerful Owls are known to occur in a range of vegetation communities, including forests and woodlands. Within the Sydney Metro Catchment their habitat can include rainforests/gullies, wetlands, watercourses wet and dry sclerophyll forests, grassy woodlands (OEH 2017) and also fragmented areas such as suburban parks and bushland patches (Birdlife 2017). Preferred habitat includes areas of dense leafy foliage of tall understorey trees or shrubs, which is used for day roosting (Birdlife 2017). Hollow bearing trees are also required for nesting and are the habitat of many prey items, often arboreal mammals (OEH 2017).

Studies of the Sydney populations (Wilson et al 2015) found Powerful Owls roosted in a variety of native and exotic trees and shrubs, providing these had dense foliage. The most common roost trees included Eucalypts (Grey Ironbark, Smooth- barked Apple, Spotted Gum, Broad-leaved Apple, Grey Gum, Blackbutt, Casuarina sp., Ironbarks, Figs and Tallowwood) and midstorey trees and shrubs (Pittosporum, Watergum, Privet, Lilly Pilly, Cheesetree, Banksia, Illawarra Flame Tree and Grey Myrtle) (Wilson et al 2015). They are typically associated with sheltered gullies, creek flats or drainage lines (OEH 2017).

Nesting occurs in late autumn tor mid-winter and relies on large hollows (greater than 45 cm wide and greater than 100 cm deep and often >150 years old) to which life bonded pairs preferentially return (OEH 2017, Birdlife 2017). Within the Sydney region nesting sites generally occur in reserves which contain large hollow bearing trees, in particular Blackbutt and Smooth- barked Apple, the latter of which contained 43% of all nests recorded in 2015 (Wilson et al 2017)

As top order carnivores, the presence of Powerful Owls may be an indicator for other hollow dependent species, in particular arboreal mammals (DEC 2006). Powerful Owls are recognised as having large home ranges (300-1500 ha [OEH 2017]) within which their diet varies. Scat analysis within the Sydney population identified prey preferential order as; Ringtail Possum, Brush tail Possum, Birds, Flying-fox and other (Wilson et al 2015), however Flying-fox are noted as an important food resource where colonies are present.

Powerful Owls are sensitive to habitat disturbance, in particular forest clearing and fragmentation, which results in loss of prey items and suitable nesting sites (OEH 2017). Disturbance around nesting sites (during pre-laying, laying and downy chick stages) and during breeding is also known to affect this species along with high frequency hazard reduction burning (affecting prey availability), secondary poisoning, road kills, and predation of fledglings by foxes, dogs and cats (OEH 2014b).

Ongoing studies of the Sydney Powerful Owl populations have not recorded nesting sites in the study area or vicinity of Parramatta Park (Wilson 2015). However, the study area and Parramatta Park provides suitable foraging habitat, including reliable and preferred prey items such as Ringtail Possums, Brushtail Possums and a colony of Grey-headed Flying Fox. Based on the species foraging range and availability of prey, Powerful Owls potentially occur in the study area.

1. **in the case of a Threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction**

Powerful Owls are reliant on large hollow bearing trees for nesting and presence of prey species. Similarly, dense canopy and shrub layer vegetation is used for roosting. No vegetation matching this description occurs within the area of proposed works.

The proposed works occurs in an area characterised by an already fragmented urban landscape, in which vegetation suitable for nesting, foraging and roosting is absent. Adjacent to the study area fragmented pockets of suitable habitat may occur interspersed through the Parramatta Park and Parramatta River. These areas of suitable habitat are known to contain preferred prey species and are likely more frequently used for foraging than the project area, although Powerful Owl nest sites have not been recorded (Wilson 2015).

Given that no potential breeding habitat or roosting habitat for the Powerful Owl occur in the project works area, it is unlikely that a local population of the Powerful Owl will be placed at risk of extinction.

2. in the case of an Endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the Endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable. The Powerful Owl is not an Endangered population.

3. in the case of an Endangered ecological community or Critically Endangered ecological community, whether the action proposed:

i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable.

ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable.

4. in relation to the habitat of a Threatened species, population or ecological community:

i. the extent to which habitat is likely to be removed or modified as a result of the action proposed

EcoLogical (2016) calculated Phase 1 project works would result in removal of 1.60 ha of planted native / exotic vegetation, representing potential foraging habitat for the Powerful Owl. The majority of the trees assessed in Phase 1 are planned for removal in Phase 2. However, all trees removed will be replaced with new plantings, plus additional trees will be installed. Although the removal of these trees may present a modification to foraging habitat, it is unlikely these changes will have a long term impact on prey resources.

Surveys of the study area recorded nocturnal fauna, in -particular possums and Grey-headed Flying Fox, both well know prey items. In the long term the proposed works are unlikely to impact possum habitation of the study area because these species are well adapted to urban life and will recolonise post disturbance, even during periods of stadium use. An Assessment of Significance undertaken for the Grey-headed flying fox colony found that the proposed works would not significantly impact roosting habitat associated with the GHFF camp if noise is appropriately managed and that ongoing stadium use is unlikely to result in a significant impact to the colony.

Given the study area does not contain roosting or nesting habitat, that any removed trees will be replaced and that ongoing use of the stadium for night-time events will be intermittent, it is surmised that the extent to which habitat will be modified is minimal.

Stage 2 of the project will result in the removal of a number of trees, some of which are a likely foraging resource, from areas around the existing stadium. Landscaping for Stage 2 includes the planting of more trees than will be lost.

ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The Stage 2 project works include removal of some planted native/exotic vegetation which may be associated with occasional Powerful Owl foraging. The change in vegetation associated with

construction works is unlikely to have a long term impact on prey (grey-headed Flying Fox and possums) occurring in the study area. Similarly, use of the stadium for night time events will be sporadic, and although these events are potentially disruptive to Powerful Owls movements, they will occur only periodically.

The large home range of Powerful Owls (300-1500ha [OEH 2017]) and the absence of nesting or roosting habitat means that foraging activities in the project area are likely to be irregular and the project area will probably only be avoided by Powerful Owls if it is in use (i.e. an event is occurring). The broad foraging range means that constructions works and stadium usage are unlikely to represent any fragmentation or isolated of habitat.

iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The Stage 2 project works may result in impacts to potential Powerful Owl foraging habitat through removal of some trees and occasional disruption to prey and foraging when events are occurring in the stadium. However, when considered form a landscape context, this habitat is probably infrequently visited as it occurs adjacent to Parramatta Park and Parramatta River, both areas which are known to contain prey species (possums and Grey-headed-flying Fox) and would be preferentially visited. Further, Powerful Owls are highly mobile and will avoid the stadium area when it is being used for night time events.

The habitat to be affected by the project works is therefore suggested to be of low importance long term survival of the species.

5. whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat has been declared for the Powerful Owl.

6. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The recovery plan for Large Forest Owls in NSW encompasses the Powerful Owl (DEC 2006). The overall objective of the recovery plan is to ensure large forest owl species remain viable in NSW through the implementation of detailed protection and management actions. They include; habitat protection, validation of habitat models, monitoring of territory occupancy and population parameters, promoting research and increasing community awareness and conservation (DEC 2006).

Objectives relevant to the project include:

- Objective 4 Ensure the impacts on large forest owls and their habitats are adequately assessed during planning and environmental assessment processes. This includes the evaluation and dissemination of tools used for assessing and mitigating the impact of development activities on large forest owls and their habitats (DEC 2006) and;
- Objective 5 Minimise further loss and fragmentation of habitat by protection and more informed management of significant owl habitat (including protection of individual nest sites). The outcomes of which will be habitat outside conservation areas being protected and restored.

Regarding objective 4, the biodiversity assessment conducted by Eco Logical (2016) as part of the Stage 1 EIS and the requirements outlined in the Stage 2 SEARS for SSD 8175, which includes the

compilation of this biodiversity assessment is considered an adequate level of assessment, in which any direct and indirect impacts to Powerful Owl habitat have been considered.

In relation to objective 5, the impacted area does not represent significate owl habitat, but may be used for opportunistic foraging. As previously mentioned impacts to foraging behaviour in the area will likely be short term as the proposed construction and ongoing stadium use will not result in removal of prey resources (possums and Grey-headed Flying Fox), provided recommended mitigation measures are undertaken.

No relevant threat abatement plans have been prepared for this species.

Activities to assist the species as described under the Saving Our Species program (OEH 2017) relate primarily to protecting roosting and nesting habitat. As no roosting or nesting habitat exist in the project area, these activities are irrelevant.

7. **whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.**

The Key Threatening Process (KTP), 'clearing of native vegetation' has been identified as having an adverse effect on the three large forest owls. However, as the project works do not intend to clear native vegetation this action does not constitute a key threatening process. Impacts of the proposed clearing on habitat and prey resources have been discussed previously.

The Saving Our Species program (OEH 2017) outlines a number of threats to Powerful Owl. Of these three have been considered and have been summarised as;

- loss of hollow-bearing trees that reduces the availability of suitable nest sites and prey habitat;
- disturbance around the nest site, particularly during pre-laying, laying and downy chick stages. Disturbance during the breeding period may affect breeding success and;
- Road kills.

As the project area does not contain hollow bearing trees, no impacts to potential nest sites will occur as a result of this project. Impacts to prey resources may however occur. The longevity and implications of these impacts have been discussed previously and are unlikely to be frequent or long-term given the foraging patterns of Powerful Owls and the continued presence of the Grey-headed Flying Fox camp.

Road kills are considered highly unlikely to be facilitated as a result of this project. The project does not include the addition of major roads within the area and although additional traffic may occur as a result of new carparks, the likelihood of interactions with owls during stadium events is low.

Conclusion

The Stage 2 project works and ongoing stadium use may result in a short-term impact in prey species availability, particular possums. However, these impacts are likely to be temporary as possums are highly urbanised and will recolonise the area once the construction is completed and new trees are planted. Further, if noise is appropriately managed, disruptions to the nearby Grey-headed Flying Fox colony will be mimimised.

Ongoing stadium use for events may deter Powerful Owl foraging for the duration of the event, but as this species has a wide range, they will be able to preferentially use other foraging sources in the nearby Parramatta Park and along the Parramatta River.

No hollow bearing or habitat trees will be lost as a result of the proposed works.

The proposed works are therefore unlikely to result in a significant impact on the Powerful Owl.

River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions – 7 Part Test

River-flat Eucalypt Forest is defined in the Final Determination (OEH 2011) as an ecological community associated with silts, clay-loams and loams on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The community structure is known to include tall forest and woodlands, often interspersed with other wetland communities. The species assemblage likewise varies based on soil profile, nutrient, moisture content and frequency/duration of waterlogging. Also influencing the characteristic assemblage are size of site, climatic conditions and disturbance factors (e.g. land use history, time since fire, grazing) (OEH 2011).

(**a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the lifecycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.**

Not applicable to an EEC.

(**b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the lifecycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction**.

Not applicable to an EEC.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

The proposed work plan indicates there will be no impact on the extent of the EEC.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

The EEC is currently in moderate condition with a weedy ground layer and a mixed native assemblage of remnant, recruited and planted canopy and mid strata. Although the influence of edge effects on the community are high (likely caused by a combination of past disturbance and its fragmented state and narrow linear shape) the presence of canopy and mid layer recruitment in the majority of the remnant areas suggests some community stability. Provided that mechanisms for indirect impacts are adequately controlled and indirect impacts avoided or minimised, the project is unlikely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

River-flat Eucalypt Forest will not be removed or intentionally modified as a result of this project, provided the pipeline upgrades are not required and the *Eucalyptus saligna x botriodes* occurring the construction footprint is retained. If the pipeline requires upgrading or repair further assessment and potential offsetting may be required.

Indirect impacts, such as changed hydrology, increased sedimentation, damage to vegetation, facilitated weed or pathogen invasion may result in minor state modification (e.g. increased weed density). However, given the current state of the community it is unlikely indirect impacts will result in modification of the community structure. To manage the risk of indirect impacts mitigation measures should be put in place. Indirect impacts and recommended mitigation measures are discussed in section G, Threatening Processes.

(iii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The extent of River-flat Eucalypt Forest will not be modified as a result of this project. The vegetation comprising this EEC is a semi interrupted band along the upper terrace banks of the Parramatta River within Parramatta Park. The current connectively will not be affected by the proposed works and habitat will not become further fragmented or isolated.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

River-flat Eucalypt Forest will not be removed, fragmented or isolated as a result of this project. Provided the pipeline upgrades are not required and the *Eucalyptus saligna x botriodes* occurring the construction footprint is retained direct modification will likewise not occur.

The vegetation contributes to a larger interrupted band occurring along the banks of the Parramatta River and likely provides habitat and seed resources. Given no vegetation will be removed, fragmented or isolated the potential for this population to act as habitat and a seed resource remains. Any modification to the community as a result of indirect impacts will be minimal, provided recommendations to reduce the likelihood of these events are adopted.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat for River-flat Eucalypt Forest occurs within the study area

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

No recovery or threat abatement plans are provided specifically for River-Flat Eucalypt Forest. However, the Cumberland Plain Recovery Plan (DECCW 2010) incorporates this community. Actions for the recovery of this community are primarily focused on awareness raising, best practice management and information dissemination. Likewise, the activities to assist the community under the Saving Our Species Program (OEH 2017) focus on active restoration/regeneration, fire control, feral and weed control and habitat projection. No planned actions undertaken as part of the proposed works directly impact the EEC (provided the pipeline does not require upgrading), likewise no actions undertaken as part of the proposed works are actively focused on the objectives of the recovery plan or the SOS activities.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Threats identified for River-Flat Eucalypt Forest are relevant to this assessment include climate change, weeds and disease. Within these, relevant threats outlined in the SOS program include;

- Further clearing for urban and rural development, and the subsequent impacts from fragmentation
- Flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development
- Changes in water quality, particularly increased nutrients and sedimentation
- Weed invasion.

Of the above threats, clearing and fragmentation will be of no impact providing the pipeline upgrades are not required and the *Eucalyptus saligna x botriodes* occurring the construction footprint is retained. If the pipeline requires upgrading or repair further assessment and potential offsetting may be required.

Invasion by pathogens, particularly *Phytopthora cinnamomi* poses a significant threat to the diversity and resilience of all vegetation communities, especially those already suffering weed invasion and fragmentation. Machinery hygiene measures for all vehicles entering the construction site should be used. Similarly, any persons entering the vegetation should observe hygiene measures of footwear. The application of these controls will reduce the likelihood of indirect impacts to the health and resilience of the River-flat Eucalypt Forest EEC adjacent to the site.

Weed invasion is also possible (although the ground layer of the community is already affected by weeds) and the measures described in Section 4.3 should be implemented to minimise the risk of key threatening processes associated with invasions by weeds and exotic plants.

Conclusion

The project is unlikely to have a significant impact on the EEC if stringent measures to avoid or minimise indirect impacts are implemented.