



Woollooware Bay Town Centre – Stage 4

Ecological Impact Assessment

Prepared for
Bluestone Capital Ventures No.1 Pty Ltd

10 July 2017



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Abbreviations

Abbreviation	Description
DEE	Commonwealth Department of Environment and Energy
DPE	NSW Department of Planning and Environment
ELA	Eco Logical Australia
EP&A	<i>Environmental Planning and Assessment Act 1979</i>
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
FM	<i>Fisheries Management Act 1994</i>
KTP	Key threatening process
TSC	<i>Threatened Species Conservation Act 1995</i>
WBTC	Woollooware Bay Town Centre

Executive summary

Bluestone Capital Ventures No.1 Pty Ltd proposes to modify the approved concept for a mixed use eastern precinct of Woollooware Bay Town Centre. The modification (MP10_0229 Mod 2 and MP10_0230 Mod 6) is referred to as Stage 4. It features additional storeys and changes to stormwater management, but no change to the on-ground development footprint.

This ecological assessment considered potential impacts at the subject site and to the wider study area, which includes Towra Point Aquatic Reserve and Towra Point Nature Reserve. Targeted fauna surveys were conducted for microbats, frogs and migratory shorebirds in accordance with relevant threatened species assessment guidelines. The assessment concluded that there would be no significant impact to threatened species, populations or communities. Mitigation and monitoring measures are recommended to further reduce the likelihood of environmental impacts.

1 Introduction

1.1 Purpose of this report

This report has been prepared to assess the potential ecological impacts of Stage 4 development at 471 Captain Cook Drive, Woollooware. It responds to a request for additional information from the NSW Department of Planning and Environment to JBA Urban Pty Ltd on 28 April 2017 regarding MP10_0229 Mod 2 and MP10_0230 Mod 6. The requirements are to:

- Provide an updated Biodiversity Assessment addressing the impacts of the proposal on the adjacent mangroves and fauna, based on data collected in up to date field surveys, and any mitigation measures to minimise impacts.
- Confirm whether the proposal is likely to cause significant impacts that would constitute a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, including evidence of consultation with the Federal Department of Environment and Energy.

1.2 The study area and subject site

The *subject site* is defined as the proposed mixed use development in the eastern precinct of Woollooware Bay Town Centre (WBTC) (**Figure 1**). It is referred to as Woollooware Bay Stage 4 (residential / hotel). It does not include the area of proposed landscaping on the edge of the mangroves as this will be covered by a separate development application.

The *study area* is defined in accordance with the *Threatened Species Assessment Guidelines* (DECC 2007) as the subject site plus any additional areas which are likely to be directly or indirectly affected by the proposal. It is defined as the WBTC site and surrounds, including the sports stadium, Woollooware Bay and Towra Point.

The study area encompasses Towra Point Aquatic Reserve (**Figure 2**) which is the largest aquatic reserve in NSW, covering approximately 1,400 ha from Shell Point in Woollooware Bay to Bonna Point, Kurnell. Towra Point Nature Reserve is a Wetland of International Importance and a declared Ramsar site (meaning, a wetland included in an international treaty for its preservation and protection). The nature reserve has an area of about 600 ha and provides breeding habitat for international migratory species.

1.3 Description of proposed development

In August 2012, the WBTC Concept Plan was approved under Section 75O of the NSW *Environmental Planning and Assessment Act 1979*. The Concept Plan was for a mixed use development at 461 Captain Cook Drive, Woollooware. Stage 1 of the Concept Plan was defined as neighbourhood retail, medical, and leisure centre on the eastern car park site and redevelopment of the Cronulla Sutherland Leagues Club facilities.

In 2017, Bluestone Capital Ventures No. 1 proposed a modification (**Figure 3**) to the approved concept¹. The aim of the modification is to expand the range of land uses within the eastern precinct to provide a more comprehensive town centre with residential apartment buildings and visitor accommodation to

¹ http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=6907

complement the retail, club and community facilities already approved. The amended key development parameters in relation to the concept plan include amending the building envelopes for the eastern precinct to allow two additional levels of car parking above the podium, and six buildings ranging between 8 and 15 storeys (including podium), and increasing the number of car parking spaces within the eastern precinct. Importantly for the purposes of this ecological impact assessment, the on-ground footprint of the proposed development will not differ to what was previously approved.

Table 1: Comparison of concept plan to the proposed modification

2012 Concept Plan as currently approved	Proposed 2017 modification
Staging of proposal into three stages.	No change.
Use of the site for a mixed use development with associated public open space.	Addition of tourist and visitor accommodation and residential apartment buildings above the approved retail centre in the eastern precinct.
Indicative building envelopes, including residential flat buildings up to 14 storeys in height within the western precinct.	Addition of residential flat buildings and hotel up to 16 storeys in height in the eastern precinct.
Parameters for Gross Floor Area (GFA) and Gross Building Area (GBA) as follows: <ul style="list-style-type: none"> GFA: 61,370m² on the western precinct and 27,412m² on the eastern precinct GBA: 115,402m² on the western precinct and 60,732m² on the eastern precinct 	No change to western precinct. <ul style="list-style-type: none"> GFA on eastern precinct increase by 39,450m² to 66,862m² GBA on eastern precinct increase by 68,425m² to 129,157m²
Car parking requirements for residential and retail/club uses within the town centre.	Increase in number of car parking spaces for eastern precinct from 770 to 1078, to be provided within the approved podium.
Road works to support the development.	No change.
New foreshore parkland and riparian zone, including revegetation, public open space and pedestrian and cycle paths.	No change.
Landscaping and public domain upgrades.	Podium-top landscaping in eastern precinct.
Expansion of the western stadium.	No change.
Sales and marketing facilities.	No change.
Superlot subdivision of Lot 11 DP 526592.	No change.
Stormwater drains from the site to Captain Cook Drive	Stormwater drains north towards Woollooware Bay to relieve the load on the existing stormwater system and reduce the impact of flooding in the area (see further detail on the following page)

The concept plan approval (B2) (August 2012) states that a vegetated riparian buffer corridor is to be provided along the foreshore, a minimum of 40 m wide, except for the 70 m stretch adjacent to the retail loading dock, where the vegetated riparian buffer corridor must be a minimum of 35 m wide. The extent of Stage 4 and the riparian buffer are shown in **Figure 3**.

Key features of the proposed stormwater system are described here based on Calibre Consulting (2016). The Stage 4 development would be constructed in two steps as follows:

1. The works include a bio-retention swale and discharge structure with a trash basket and scour protection at the outlet apron. The scour protection apron will reduce the velocity of discharge and direct the discharge into a stilling basin formed by a level spreader running east-west. This stilling basin will further reduce the risk of scour by preventing concentrated flow.
2. The bio-retention basin and outlet works from (1) will remain in operation. Stormwater drainage from the building will connect to the drainage works constructed in (1).

The proposed changes to the Stage 4 Residential/Hotel do not change the catchment area and thus have no impact on the quantity or flow rate of water discharged. (Calibre Consulting 2016)

The multiple stages of treatment have improved on the concept provided in the original Retail Civil Infrastructure Report prepared by AT&L by the addition of a gross pollutant trap (CDS unit) and cartridge filtration system that are more effective and more readily maintained to ensure that water quality targets can continue to be met in the future. In addition, the trash basket at the outlet provides a measure of redundancy and a visual indication of treatment efficiency. The presence of litter in that basket would be a trigger for checking whether the other upstream units might require maintenance. (Calibre Consulting 2016)

This standard of treatment would be at least as specified by Sutherland Shire Council and the Department of Primary Industries (Fisheries). The treatment has been modelled using the MUSIC software package. There will be no reduction in the quality of water discharged from the site as a result of the proposed amendment. (Calibre Consulting 2016)



Figure 1: Subject site and surrounds



Figure 2: Study area including Towra Point Aquatic Reserve and Towra Point Nature Reserve

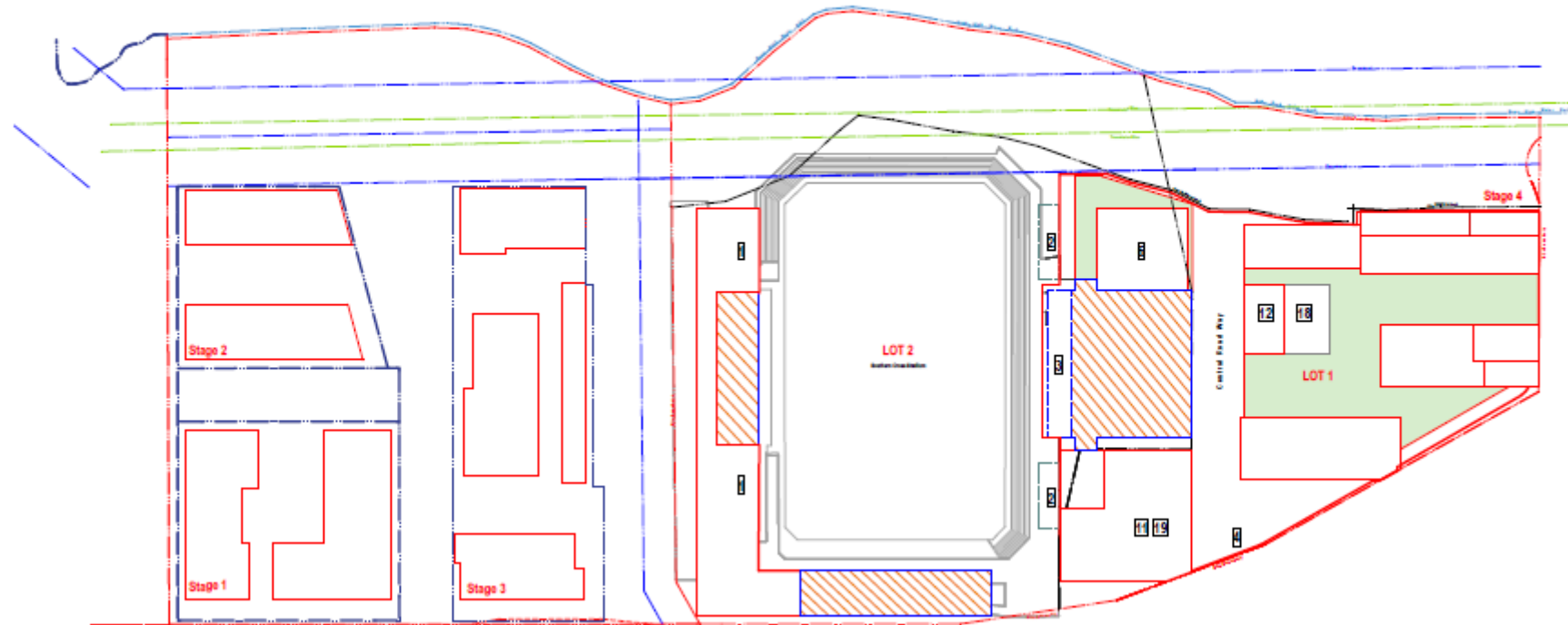


Figure 3: Staging boundaries for WBTC, with riparian buffer and shoreline at the top (JBA 2017)

2 Legislative context

The legislative context for this ecological assessment is summarised below.

2.1 International agreements

Towra Point Nature Reserve is subject to the following international migratory bird agreements:

- Ramsar Convention on Wetlands of International Importance
- Japan - Australia Migratory Bird Agreement (JAMBA)
- China - Australia Migratory Bird Agreement (CAMBA)
- Republic of Korea – Australia Migratory Bird Agreement (ROKAMBA)

The JAMBA and CAMBA agreements list terrestrial, water and shorebird species which migrate between Australia and other countries. In both cases, the majority of listed species are shorebirds. Both agreements require the parties to protect migratory birds by:

- limiting the circumstances under which migratory birds are taken or traded
- protecting and conserving important habitats
- exchanging information
- building cooperative relationships.

The JAMBA agreement also includes provisions for cooperation on the conservation of threatened birds.

2.2 Environmental Protection and Biodiversity Conservation Act 1999

The primary objective of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is to 'provide for the protection of the environment, especially those aspects of the environment that are matters of National Environmental Significance'. Environmental approvals under the EPBC Act are required for an 'action' (i.e. a project, development, undertaking, activity or series of activities) that is likely to have a significant impact on Matters of National Environmental Significance including:

- Ramsar wetlands of international importance
- Nationally listed threatened species and ecological communities
- Listed migratory species

Matters of National Environmental Significance have been recorded within a 5 km radius of the subject site.

In 2011, the Commonwealth determined that the WBTC redevelopment was not a controlled action based on the development concept at that time (EPBC Referral 2011/5889). The description of the proposed action considered in 2011 was: *To redevelop the Cronulla Leagues Club site in Woollooware, including upgrades to the existing clubhouse building, playing fields and training facilities, as well as the development and operation of new retail and residential developments, approximately 2km north-west of Cronulla, NSW.*

As outlined in **Section 1.1** of this report, in 2017 the NSW Department of Planning and Environment (DPE) requires confirmation of whether the proposed modification is likely to cause significant impacts

that would constitute a controlled action and evidence of consultation with the Commonwealth Department of Environment and Energy (DEE).

The applicant consulted DEE in May 2017. Outcomes of this are summarised in the Response to Submissions Report by JBA (2017a).

This report includes Significance Assessments for EPBC Act listed threatened species, populations and communities.

2.3 Environmental Planning and Assessment Act 1979

The EP&A Act is the principal planning legislation for NSW, providing a framework for environmental planning, and assessment of development proposals. The proposed modification will be determined by DPE under s75W of the EP&A Act. DPE will consider whether the development is likely to have a significant impact on threatened communities, populations or species listed in the TSC Act and FM Act.

This report includes Assessments of Significance for threatened species, populations and communities listed in the TSC Act and FM Act.

2.4 Threatened Species Conservation Act 1995

The land on which the development is proposed is not biodiversity certified under s126 of the TSC Act and therefore impacts to threatened species, populations and communities listed under the TSC Act are required to be assessed. A Species Impact Statement (SIS) will be needed if a proposed development is likely to significantly impact threatened species, population or communities.

2.5 Noxious Weeds Act 1993

The site itself is an asphalt carpark but the study area contains weeds listed under the NW Act. Class 4 noxious weeds *must not be sold, propagated or knowingly distributed*.

2.6 Fisheries Management Act 1994 (FM Act)

The FM Act lists threatened aquatic species which require consideration when addressing the potential impacts of a proposed development. A SIS is required to be prepared if a proposed development is likely to significantly affect a threatened species, population or their habitats.

The study area includes Towra Point Aquatic Reserve.

2.7 Water Management Act 2000 (WM Act)

A controlled activity approval under the WM Act is required for certain types of developments and activities that are carried out in or on waterfront land, which is land within 40 m of a river, lake or estuary.

The 2011 concept determination stated that a *vegetated riparian buffer corridor to be provided along the foreshore, must be a minimum of 40 m wide, except for the 70 m stretch adjacent the retail loading dock, where the vegetated riparian buffer corridor must be a minimum of 35 m wide*.

The footprint of the proposed modification does not differ to the approved retail precinct proposal.

2.8 Sutherland Shire Local Environmental Plan 2015

The subject site is zoned B2 Local Centre under the LEP. A narrow strip along the southern edge of the mangroves is zoned RE1 Public Recreation.

3 Methods

3.1 Literature review and databases

Database records, aerial photography, GIS datasets and literature pertaining to the ecology of the study area were reviewed for this assessment. Database searches from the NSW Atlas and EPBC Act tool (5 km radius from the subject site) were combined to produce a list of threatened species, populations and communities that may occur within the study area based on actual sightings (NSW Atlas) or available habitat (EPBC Act tool). The database searches have been updated several times since 2011 for this project. The most recent revision was in June 2017 and is presented in **Appendix B**.

3.2 Field investigations

A number of field investigations have been conducted by Eco Logical Australia at the subject site since 2011 to supplement information available from the desktop review. These have focused on the areas that are most likely to be directly or indirectly impacted ie the WBTC site and immediate surrounds, particularly mangrove habitat on the southern edge of Woollooware Bay and the channel on the western side of the stadium. Survey has been targeted to flora and fauna likely to be present at or near the site.

As indicated in the table below, field investigations have been undertaken over a number of years, with the site most recently inspected by ELA in June 2017. Importantly, targeted fauna survey at WBTC has been conducted during the summer months which is the preferred period in which to record migratory birds and microbats.

Table 2: Summary of field surveys by ELA at WBTC

Date	Type of field survey
July 2011	Flora species and vegetation communities Incidental fauna
February 2012	Birds Green and Golden Bell Frogs Micro-chiropteran bats (microbats)
January 2013	Microbats
January 2015	Microbats Water quality in the channel Mangroves in the channel
Various dates including June 2017	Site inspections and incidental flora/fauna records

Surveys were conducted in accordance with relevant guidelines including the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft* (DEC 2004). Further information about the fauna survey methods are provided below, and specific details (e.g. times, dates, weather conditions and results) are available in previous reports. Key information is summarised in this report.

3.2.1 Birds

Visual and call recognition surveys were conducted for birds present using an 'area search method'. This method involved spending twenty minutes at a particular location or habitat type searching for birds. Mudflat surveys were conducted from the observation platform located at the end of the Woollooware Bay

board walk. All birds observed or heard calling were recorded and identified to species' level using Geering et al. (2008) and Day and Simpson (2010).

3.2.2 Frogs

Green and Golden Bell Frog (*Litoria aurea*) (GGBF) surveys were conducted at four locations within WBTC and one site in the wider study area. Surveys were conducted over three separate nights. Each survey was conducted within a week of at least 5 mm of rainfall being recorded. Call-back surveys were conducted by playing recorded calls of breeding male GGBFs through a loud hailer. Each survey involved playing calls for at least five minutes followed by ten minutes listening for reply calls.

Active daytime searches were conducted in conjunction with each bird survey. The spotlight surveys were conducted in conjunction with the night time call back surveys.

3.2.3 Microbats

Microbat surveys were undertaken using anabat recording devices at various locations among or adjacent the mangroves at the WBTC site.

Bat calls were analysed using the program AnalookW (Version 3.8, 25 October 2012, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW².

Bat calls were analysed using species-specific parameters of the call profile such as call shape, characteristic frequency, initial slope and time between calls (Reinhold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et. al. 2006) were followed:

- Search phase calls were used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al. 2002)
- Recordings containing less than three pulses were not analysed and these sequences were labeled as short (Law et al. 1999)
- Four categories of confidence in species identification were used (Mills et al. 1996):
 - definite – identity not in doubt
 - probable – low probability of confusion with species of similar calls
 - possible – medium to high probability of confusion with species with similar calls
 - unidentifiable, poor or low quality– calls made by bats which cannot be identified to even a species group.
- *Nyctophilus* spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004)
- Sequences not attributed to microbat echolocation calls were labeled as junk or non-bat calls and don't represent microbat activity at the site.
- Sequences labelled as low were of poor quality and therefore not able to be identified to any microbat species, they can however be used as an indicator of microbat activity at the site.

Limitations of data analysis

The calls of Free-tail Bat Species and the Gould's Wattle Bat can be difficult to separate. Calls were identified as being from the Eastern Freetail Bat if the call shape was flat and the frequency was between

² Available at <http://www.forest.nsw.gov.au/research/bats/default.asp>

34.5 – 35 kHz whilst Gould's Wattle Bat was distinguished by a frequency of 27.5 – 33 kHz and alternation in call frequency between pulses.

The calls of the Large-footed Myotis are very similar to all Long-eared Bat species and it is often difficult to separate these species. Calls were identified as Long-eared Bat species when the time between calls (TBC) was higher than 95 ms and the initial slope (OPS) was lower than 300. Calls were identified as Large-footed Myotis when the TBC was lower than 75 ms and the OPS was greater than 400.

The calls of Forest Bat and the Chocolate Wattled Bat are also difficult to separate in the 50.5 – 53 kHz range. Calls were identified as Chocolate Wattled Bat when there was a down-sweeping tail or were identified as Forest Bat if the pulses were curved and had upsweeping tails.

When no distinguishing characteristics were present within the calls were assigned as combination of the most likely species. Many calls were assigned a low certainty level (probable, possible or grouped with other species) because many calls did not exhibit the full range of defining characteristics.

3.3 Field personnel

Personnel involved in various surveys and analysis include:

- Dr Rodney Armistead
 - PhD in Conservation Biology from Murdoch University, Perth Western Australia. 2008
 - Bachelor of Advanced Science (Honours), Deakin University, Geelong. 2001
- Ian Dixon
 - AUSRIVAS Accreditation (Australian River Assessment System) – 2011
 - Master of Tropical Environmental Management: The Relationship between Catchment, Aquatic and Riparian Condition – 2006
 - Graduate Diploma of Tropical Environmental Management – 2001
 - Bachelor of Landscape Architecture – 1999
- Lucas McKinnon
 - Bachelor of Environmental Science (Honours), University of Wollongong
 - BioBanking Accredited Assessor (No. 0076), *Threatened Species Conservation Act 1995*, TAFE NSW and DECCW
- Peter Knock
 - Bachelor of Applied Science, University of Canberra, 1990
 - Associate Diploma of Environmental Control, Mitchell College of Advanced Education 1988
- Rebecca Dwyer
 - Bachelor of Landscape Management and Conservation (Honours), University of Western Sydney
 - BioBanking Accredited Assessor, *Threatened Species Conservation Act 1995*, TAFE NSW and DECCW
- Beth Medway
 - Graduate Certificate in Change Management (AGSM UNSW) - current
 - Master of Environmental Engineering Science (UNSW) – 2000
 - Master of Environmental Studies (UNSW) – 1992
 - Bachelor of Science (Applied Physical Geography) (1st Class Hons) (UNSW) – 1991

4 Description of ecology

4.1 Overview

Aerial photographs of the study area are provided in **Appendix A** to show changes since the 1940s.

At the time of European settlement, the subject site would have been characterised by estuarine vegetation such as mangroves, saltmarsh and swamp oak floodplain forest. Between the 1950s and 1970s the site was backfilled with non-putrescible waste to be ‘reclaimed’ (refer to the geotechnical report by EIS 2011). The site was sold to the Cronulla Sharks in 1968 with the agreement that Sutherland Shire Council would fill the remainder of the site and then transfer management to the Sharks (EIS 2011).

The current ground surface (level asphalt car park) on the eastern side of the stadium was established by the late 1970s. Landscaping near the existing club building features mown grass, planted trees and garden beds. The site is primarily used for car parking (refer to **Figure 4** and **Figure 5**).

4.2 Habitat types

The subject site itself comprises a degraded asphalt carpark so the only potential habitat comprises scattered trees and garden beds near the Leagues Club building (**Figure 1**). Important habitat in the wider study area includes:

- mangrove forest fringing Woollooware Bay adjacent the WBTC site
- mangroves, saltmarsh and mudflats at Towra Point and around Woollooware Bay, including the Taren Point Shore Reserve (**Figure 2**)
- estuarine and marine habitats including seagrass beds.

As discussed below, no threatened species, populations or communities are present at the Stage 4 subject site due to the absence of habitat. However, the surrounding study area has significant ecological value with a number of threatened species, populations and communities recorded (**Figure 6**).

4.3 Vegetation

The subject site features planted native and exotic trees and shrubs, weeds and mown grass (see photos on the cover page of this report). Species include *Eucalyptus resinifera*, *Callistemon* sp., *Melaleuca* sp., *Lophostemon confertus* and *Eucalyptus paniculata*.

No hollow bearing trees or threatened flora species were recorded on the site. No vegetation communities were identified and the vegetation has minimal ecological value.

A mangrove forest is adjacent to the subject site. Mangrove trees contain hollows and provide other habitat for terrestrial and aquatic fauna. Mangroves are also important for protecting the stability of coastlines.

4.4 Birds

The database searches identified 83 species of threatened and/or migratory birds recorded or with suitable habitat in the study area (**Appendix B**).

A total of 38 birds were recorded during the surveys at and near the subject site. The majority of the species were recorded among the open grassy and bitumen areas present at the site.

Six bird species listed as migratory under the *Environmental Biodiversity Protection Act 1999* were recorded. All of the migratory birds were recorded on the Woollooware Bay mudflats at low tide as viewed through a 'spotter scope' from the end of the boardwalk.

One bird species recorded during field survey is listed as threatened under the *Threatened Species Conservation Act*. The Sooty Oystercatcher (*Haematopus fuliginosus*) was recorded roosting on a barge among the oyster beds.

Although the subject site offers little habitat for birds, the surrounding area provides important habitat for threatened and migratory bird species. The main flight paths for migratory birds inhabiting Towra Point and Taren Point do not appear to cross the WBTC site (Hazel Watson, Port Botany Expansion Project Officer for Birds Australia, pers comm 2016).

4.5 Frogs

No frogs of any species, including the target threatened species (the Green and Golden Bell Frog (GGBF)), were recorded during the surveys. The night time spotlight and day time searches revealed that all of the fresh or brackish waterways searched in the area were populated by the Plague Minnow (*Gambusia holbrooki*). This species of fish has been shown to have a significant impact on GGBF populations as they prey upon the tadpoles of the GGBF, and this is listed as a Key Threatening Process. It may have been a major contributing factor to some localised extinctions (DEC 2005).

It is considered unlikely that GGBF would inhabit the site.

4.6 Microbats

The database search indicated that threatened species of microbats are likely to be in the area (see **Appendix B**). *Myotis macropus* (Large-footed Myotis) and *Saccolaimus flaviventris* (Yellow Bellied Sheathtail Bat) were the only threatened microbat species recorded and this was confirmed by multiple targeted surveys. The following species of microbats have been recorded at the WBTC site, including:

- *Myotis macropus* Large-footed Myotis (vulnerable under TSC Act)
- *Saccolaimus flaviventris* Yellow Bellied Sheathtail Bat (vulnerable under TSC Act)
- *Chalinolobus gouldii* Gould's Wattled Bat
- *Chalinolobus morio* Chocolate Wattled Bat
- *Mormopterus* (Ozimops) *ridei* Eastern Freetail Bat
- *Nyctophilus* spp. Long-eared Bat
- *Tadarida australis* White-striped Freetail Bat
- *Vespadelus vulturnus* Little Forest Bat

The most commonly recorded species were the non-threatened *Chalinolobus gouldii* (Gould's Wattled Bat), *C. morio* (Chocolate Wattled Bat) and *Mormopterus* (Ozimops) *planiceps* (Eastern Free-tail Bat). The majority of calls at all sites were recorded during the early part of the evening. During this time, calls from multiple species were recorded at frequencies of two to three calls a minute. As the night progressed, the bat activity decreased and the rate of calls being recorded were reduced to a frequency of one to two every few minutes (see examples of call profiles in **Appendix C**).

There were low to moderate levels of microbat activity recorded. The majority of calls recorded appeared to be search sequences. A few and random feeding buzzes were observed throughout this data set. This indicates mixed activities occurring at each site (leaving their roosts, in flight searching for food, attack and feeding activities).

4.7 Flying-foxes

Grey-headed Flying-foxes are listed as vulnerable under the TSC Act and EPBC Act. They are known to forage and have camps in the study area. However, the closest, the Captain Cook Drive Camp, is more than 1 km from the subject site. Trees on the site may provide foraging habitat when in flower/fruit.



Figure 4: View of the subject site looking south-west toward Captain Cook Drive



Figure 5: View of the subject site looking west, with mangroves on the northern boundary

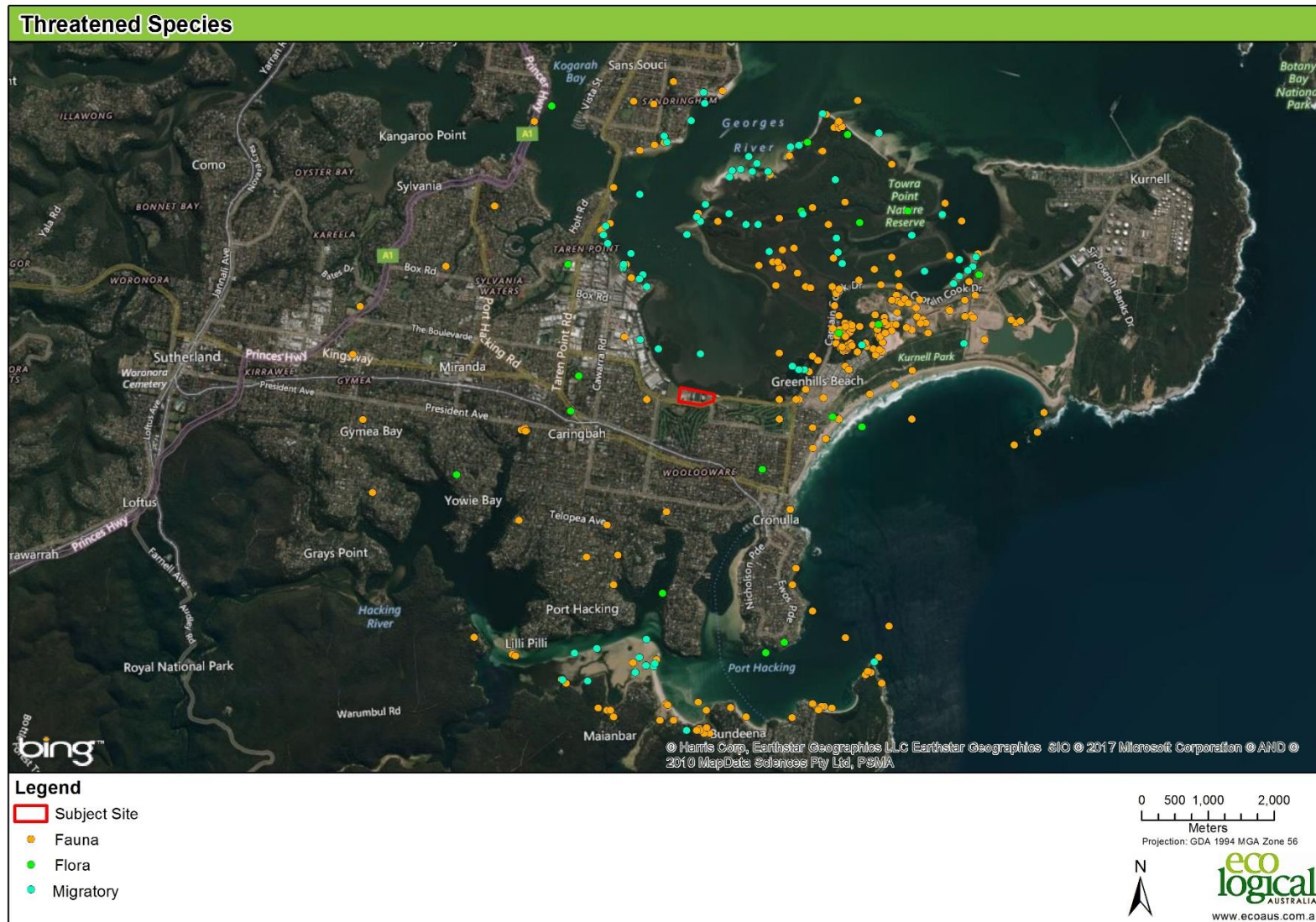


Figure 6: Records of threatened flora and fauna species within a 5 km radius from the subject site (OEI 09/06/2017)

5 Impact assessment

5.1 Key threatening processes

Consideration has been given to ‘key threatening processes’ listed under the TSC Act and EPBC Act that could directly or indirectly impact threatened species in the study area. The proposed Stage 4 development at WBTC would not involve:

- removal or fragmentation of threatened species habitat
- discharge of polluted runoff into the bay (all runoff from construction and operations would be treated prior to discharge)
- waste and rubbish from the site entering the adjacent wetland, which could result in entanglement or ingestion of debris by marine animals.

However, there is a risk of ‘disturbance to roosting and summer breeding sites’, which is a key threatening process for microbats. This could be caused by noise and light generated at the site during construction and operation spilling into the adjacent mangroves which provide roost habitat for microbats. Potential impacts from noise and light are assessed below.

Buildings higher than the mangrove canopy could present a hazard to birds in flight, so potential bird strike impacts are also assessed below.

5.2 Noise

5.2.1 Existing noise

Ambient noise levels at WBTC were measured by Acoustic Logic in April 2016. Acoustic Logic (2016) (p.21) recorded noise at 50-64 dB(A) at the site and at Towra Point, although it is not clear if these levels were recorded prior to Stage 1 construction commencing or under what conditions these noise levels were experienced (e.g. day or night). Acoustic Logic (2016) (p.7) states that the main existing sources of noise affecting the WBTC site are from traffic along Captain Cook Drive and games at the stadium.

During recent site visits, ELA noted that noise from construction activities on the western side of the stadium are generally not perceptible on the eastern side, although noise from the stadium during games is audible over a wide distance subject to wind direction.

5.2.2 Predicted noise

During construction

Noise levels predicted to occur at sensitive ecological sites during construction have been estimated by Acoustic Logic (2016) (p.22) (refer to **Table 3**). Acoustic Logic states that calculated levels represent a maximum noise level and as such will not be accumulative. All calculated noise levels assume no screening and would reduce by 5-8 dB(A) with screening from other structures.

During operation

Noise during operation of WBTC will be associated with activation of the site for retail, hotel and residential use including vehicle movements and activities at the loading dock (located at the northern eastern corner of the Stage 4 subject site). Noise levels during operation are not expected to be as high as during the construction phase.

Table 3: Maximum construction noise at surrounding locations (Acoustic Logic 2016)

Equipment Type	Sound Power Level (SWL)	Location					Discussion
		Mangroves directly adjacent to the site	20m from the site	40m from the site	60m From the Site	Towra Point 500m from the site	
Hydraulic Hammers	115	87 dB(A)	81 dB(A)	75 dB(A)	71 dB(A)	50 dB(A)	Intermittent noise level as equipment cannot run continuously
Concrete Saw Cutting	114	86 dB(A)	80 dB(A)	74 dB(A)	70 dB(A)	49 dB(A)	Only when in operation
Excavator (without hammer)	98	70 dB(A)	64 dB(A)	58 dB(A)	54 dB(A)	33 dB(A)	Detailed noise levels based on worst case levels (ie operating at boundary of the site with the wetlands)
Drill Pilling equipment	105	77 dB(A)	71 dB(A)	65 dB(A)	61 dB(A)	40 dB(A)	Detailed noise levels based on worst case levels (ie operating at boundary of the site with the wetlands)

5.2.3 Potential impact

Animals rely on meaningful sounds for communication, navigation, avoiding danger and finding food against a background of noise. The effects of noise on most species are poorly understood and fauna will perceive noise impacts differently (AMEC Americas Ltd 2005; Office of Planning, Environment & Realty; Eco Logical Australia 2006). Some fauna become stressed by noise, which can affect foraging or breeding, or they may leave an area, whereas other species or populations do not seem to be affected or may adjust to noise over time.

As far as determining impacts to fauna, the nature of the noise (e.g. high or low pitch; sudden or continuous) needs to be considered as well as the 'loudness' (measured in dB(A)) because some animals perceive noise differently to humans. For example, microbats such as the Large-footed Myotis are more attuned to the high frequency band (e.g. metal on metal sounds), so may not be concerned by steady low

pitch traffic noise (e.g. microbats often inhabit road culverts). However, loud ongoing noise may make it difficult for microbats to hear prey, which can adversely affect foraging (Siemers & Schaub 2011). As another example, many bird species are more sensitive to sudden loud noises (e.g. dogs barking) rather than continuous noise or noise that builds and fades away (e.g. aircraft).

Fauna inhabiting mangroves near the stadium and car park, as well as other areas near light industrial land uses around Woollooware Bay, may already be habituated to elevated noise levels compared to fauna at Towra Point. However, even at Towra Point, fauna would experience noise associated with boat and aeroplane movements.

Fauna at Towra Point are unlikely to be affected by the construction or operational noise from the proposed centre because of noise attenuation over distance. Higher levels of noise are likely to be experienced in the mangroves closest to the subject site and this may discourage fauna roosting and foraging in these areas, at least temporarily during the noisiest construction periods.

Mitigation measures include limiting noisy construction activity to avoid peak fauna foraging periods at dusk and dawn, and minimising noise at night post-construction.

5.3 Light

5.3.1 Existing conditions

The existing car park does not have permanent lighting, so current levels of light at the site are generally low. Periodic sources of light would include the adjacent stadium and headlights of vehicles using the car park at night.

5.3.2 Potential impact

Excessive lighting not only causes light pollution and wastes energy but also impacts on the natural environment by affecting the activity rhythms of both plants and animals (Outen 1998).

The mangroves adjacent the proposed centre provide roosting habitat for threatened species of microbats. Microbats are affected by artificial lighting because of the following reasons (Fure 2006, Jones 2000):

- Many species of bats are known to sample the light levels before emerging from their roost; only emerging for their night's hunting when the light intensity outside reaches a critical level after sunset (Swift 1980).
- Artificial lighting disrupts the normal 24-hour pattern of light and dark which is likely to affect the natural behaviour of bats. Light near a roost access point will delay bats from emerging and shorten the amount of time available to them for foraging.
- Bright light may reduce social flight activity and cause bats to move away from the light area to an alternative dark area.
- Illuminating a bat roost creates disturbance and may cause the bats to desert the roost.
- Artificial lighting can also affect the feeding behaviour of bats. In most bat species there is an evening period of activity followed by another at dawn. These two flights correlate with the peak flight times of nocturnal insect prey. Insects are attracted to light particularly if it is a single light source in a dark area.
- Artificial lighting can increase the chances of predation (Jones 2000). It is believed that *Myotis* species shun bright light as a predator avoidance strategy.

The riparian buffer (35-40 m wide) would reduce light from the proposed Stage 4 redevelopment from entering the nearby mangrove habitat. Further safeguards include directing lighting to where it is needed

for security purposes rather than into the mangroves or night sky. It is unlikely that there would be a significant impact to ecology from proposed lighting.

5.4 Bird strike

5.4.1 Background

Studies from North America and Europe report that significant numbers of birds are killed or injured due to impact with windows on buildings, particularly when buildings are situated within migratory flight paths and the building facade is plain mirrored glass (see example in **Figure 7**). Birds hit windows for three reasons:

- they don't see them as a barrier and attempt to fly through them
- they see habitat reflected in them and attempt to navigate to some point in the reflection
- they are attracted to lights on buildings at night and fly near to them.

There are no comparable Australian studies that were identified and this remains an area of potential future research.

5.4.2 Proposed facades

The proposed north-facing facades of Stage 4 are illustrated in **Figure 8**. The proposed design would reduce potential for bird strike by featuring a variety of window and external wall treatments and styles, rather than a uniform reflective facade as shown in **Figure 7**. Further, flight patterns for migratory birds in the study area do not appear to be near the WBTC site, further reducing the likelihood of potential bird strike.



Figure 7: Example of a mirrored glass façade that can cause bird strike (from Sheppard 2011)



Figure 8: Stage 4 photomontage showing different façade styles (Source: Turner Architects)

5.5 Tests of significance and conclusion

TSC Act and EPBC Act assessments of significance are tabulated below. These relate to threatened microbat species, and migratory and threatened species of shorebirds that are known or likely to occur in the broader study area, including the adjacent mangroves and Towra Point reserves. As previously stated, the subject site itself has low ecological value.

The tests indicate that significant ecological impact is unlikely to result from the proposed construction or operation of Stage 4 of the WBTC because habitat would not be substantially modified and lifecycles of threatened species (breeding, feeding, migration or resting) would not be seriously disrupted. Safeguards would be implemented to further minimise possible impacts (see **Chapter 6**).

Table 4: TSC Act test of significance

Test	Response
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.	No - The study area (Towra Point and mangroves) provides potential foraging, breeding, over-wintering, dispersal and/or roosting habitat for threatened species of microbats, flying-foxes and birds. Habitat in the study area may be affected by noise and light, particularly the mangrove forest adjacent the subject site. However, Towra Point Nature Reserve would not be affected and offers a substantial area of alternative habitat. The proposal is therefore unlikely to affect the life cycle of any

Test	Response
	threatened species such that it would be placed at risk of extinction.
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	No endangered population.
In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	No EECs will be affected by the proposal
<p>In relation to the habitat of a threatened species, population or ecological community:</p> <p>The extent to which habitat is likely to be removed/modified</p> <p>Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat</p> <p>The importance of the habitat to be removed etc to the long term survival of the species</p>	<p>No – Habitat will not be removed, fragmented or isolated. The adjacent mangroves provide habitat for threatened microbats and may be modified by additional disturbance in the area. However, given this area is currently a car park to the edge of the mangroves, this habitat is not considered important for the long term survival of the species.</p>
Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)	No critical habitat will be affected
Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan	There are a number of recovery plans relevant to species found in the study area. For example, recovery plans for the Little Tern (<i>Sterna albifrons</i>) (NPWS 2003) and Marine Turtles in Australia (DECC 2017). The actions proposed, including mitigation and monitoring measures, are not inconsistent with the recovery plans.
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 proposal is likely to result in disturbance of roosting and summer breeding sites (mangrove hollows in the adjacent wetland), which is a key threatening process (KTP) for microbats. Rubbish that enters the waterways is a KTP for aquatic fauna. Refer to Section 5.1 for further detail on KTPs and Chapter 6 for mitigation and monitoring measures.

Table 5: EPBC Act Significance assessment for Wetlands of International Importance (Towra Point)

Significant impact criteria – Is there a real chance or possibility that it will result in...	Response
areas of the wetland being destroyed or substantially modified	No - Towra Point wetland would not be affected by the Stage 4 proposal
a substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland	No - The proposed changes to the Stage 4 Residential/Hotel do not change the catchment area and thus have no impact on the quantity or flow rate of water discharged. (Calibre Consulting 2016)
the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected	No – There would be no serious affect to terrestrial or aquatic species
a substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health	No - This standard of treatment would be at least as specified by Sutherland Shire Council and the Department of Primary Industries (Fisheries). The treatment has been modelled using the MUSIC software package. There will be no reduction in the quality of water discharged from the site as a result of the proposed amendment. (Calibre Consulting 2016)
an invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland	No – Weeds and feral animals are already present throughout the region. Improved weed and rubbish control at the WBTC site would be a positive step.

Table 6: EPBC Act Significance assessment for migratory shorebird species

Significant impact criteria – Is there a real chance or possibility that it will result in...	Response
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	No – Migratory bird species habitat in the study area would not be substantially modified, destroyed or isolated
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	No – Weeds and feral animals are already present throughout the region. Improved weed and rubbish control at the WBTC site would be a positive step.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	No – The lifecycle of migratory species at Towra Point would not be affected

Table 7: EPBC Act Significance assessment for vulnerable or endangered species

Criteria	Response
Lead to a long-term decrease in the size of an important population of a species	No – Vulnerable and endangered species of shorebirds listed under the EPBC Act are unlikely to be affected by the proposal
Reduce the area of occupancy of an important population or species	No – Shorebirds do not appear to currently use the subject site (as it is a carpark) or adjacent mangroves as they prefer other habitat types e.g. mudflats. Their area of occupancy will therefore not be reduced
Fragment an existing important population into two or more populations	No – Habitat areas would not be fragmented
Adversely affect habitat critical to the survival of a species	No - There will be no impact to Towra Point habitat, which is considered critical to survival of shorebird species
Disrupt the breeding cycle of an important population	No - Species listed under the EPBC Act do not breed at or near the WBTC subject site. Breeding behaviour at Towra Point would be unaffected by the proposed development.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No – The quality of available habitat near the site (including mudflats on the northern edge of the mangroves) may decline due to noise at WBTC. However, there is substantial alternative habitat in the area. Plus, a wider riparian buffer approved under the concept plan would improve habitat at the site.
Result in invasive species that are harmful to a vulnerable or endangered species becoming established in the vulnerable species' habitat	No – Weeds and feral animals are already present throughout the region. Improved weed and rubbish control at the WBTC site would be a positive step.
Introduce disease that may cause the species to decline	No
Interfere substantially with the recovery of the species	No

6 Mitigation and monitoring

This chapter summarises environmental mitigation measures relevant to WBTC Stage 4. Measures should be incorporated in detailed design, or Construction or Maintenance Environmental Management Plans, as appropriate. Monitoring and environmental compliance reports will be submitted to Council by the construction manager or body corporate (or equivalent).

Table 8: Mitigation measures

Issue	Mitigation measures
Vegetation	<p>Landscape vegetation to be removed from the site in preparation for construction will be managed as green waste.</p> <p>Plants used in landscaping for Stage 4 (e.g. rooftops and between buildings – this does not include the riparian buffer) should feature native species where possible to increase the habitat value of the new urban environment. Landscaped areas will be monitored and maintained free of weeds and rubbish.</p>
Water	<p>Water sensitive urban design principles will be applied to the site so that rain will be captured and reused where possible. Other management measures to be installed include gross pollutant traps and bioretention swales (Calibre Consulting 2016). These will be monitored and maintained to ensure the quantity and flow rate of water discharged meet required standards.</p>
Noise	<p>Where possible, select quieter types of machinery and equipment, or use construction techniques that are quieter.</p> <p>Limit construction noise to daylight hours so that peak fauna foraging periods at dawn, dusk and night-time are avoided, particularly when construction activity is in close proximity to the mangroves.</p> <p>Consider installing noise monitors at Towra Point Nature Reserve to determine if noise from WBTC is detectable and if further controls would be needed e.g. more restrictive periods of work or types of activities.</p>
Bird strike	<p>Use a variety of façade designs to minimise the risk of bird strike.</p>
Light	<p>Do not direct lights for construction, landscaping and security into the mangroves or into the night sky.</p>
Waste and rubbish	<p>Collect all rubbish and waste from the site during construction and operation, and dispose at a licenced facility.</p> <p>Monitor the adjacent areas regularly and remove any litter.</p>
Environmental education	<p>Use signage and brochures to educate the community about how to help protect the environmental values of the area.</p>

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Appendix A Aerial photos

Imagery from 1943 to 2010 has been sourced from Sutherland Shire Council's website (<http://www.sutherlandshire.nsw.gov.au/Development/Shire-Maps>). Council's records include an image from 1930 showing the site as vegetated, but the image quality is too poor to reproduce.



1943 aerial photo



1955 aerial photo



1978 aerial photo



1984 aerial photo



2010 aerial photo



2017 aerial photo (Source Google Images)

Appendix B Species, populations and communities

The following tables have been prepared based on Bionet and EPBC Act protected matters search database records, collated from observations and habitat availability in the study area. These species, populations and communities have not been confirmed as being at the subject site or in the study area. The list is provided as context for the assessment.

Coastal saltmarsh in Sydney Basin	E	Estuarine tidal flats generally adjacent to mangrove forests.
Taren Point shorebird community	E	Community if restricted to a site located to the 3km NW of the proposed site. Species within this community such as Bar-tailed Godwit and Eastern Curlew have been recorded on site.
Shale Sandstone Transition Forest of the Sydney Basin Bioregion	CE	Occurs at the edges of the Cumberland Plain in western Sydney, most now occurs in the Hawkesbury, Baulkham Hills, Liverpool, Parramatta, Penrith, Campbelltown and Wollondilly local government areas.

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Ecology and Habitat
FAUNA				
Amphibia				
<i>Litoria aurea</i>	Green and Golden Bell Frog	E1	V	Marshes, dams and stream-sides, particularly those containing <i>Typha</i> spp. (bullrushes) or <i>Eleocharis</i> spp. (spikerushes). Some populations occur in highly disturbed areas.
Aves				

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Ecology and Habitat
<i>Actitis hypoleucos</i>	Common Sandpiper		M	Coastal wetlands and some inland wetlands, especially muddy margins or rocky shores. Also estuaries and deltas, lakes, pools, billabongs, reservoirs, dams and claypans, mangroves.
<i>Anous stolidus</i>	Common Noddy		M	Marine.
<i>Anthochaera phrygia</i>	Regent Honeyeater	E4A	CE	Eucalypt woodland and open forest, wooded farmland and urban areas with mature eucalypts, and riparian forests of <i>Casuarina cunninghamiana</i> (River Oak). Primarily feeds on nectar from box and ironbark eucalypts, occasionally banksias and mistletoes.
<i>Apus pacificus</i>	Fork-tailed Swift		M	Riparian woodland, swamps, low scrub, heathland, saltmarsh, grassland, Spinifex sandplains, open farmland and inland and coastal sand-dunes.
<i>Ardea alba</i>	Great Egret			Swamps and marshes, grasslands, margins of rivers and lakes, salt pans, estuarine mudflats and other wetland habitats.
<i>Ardea ibis</i>	Cattle Egret			Grasslands, wooded lands and terrestrial wetlands.
<i>Arenaria interpres</i>	Ruddy Turnstone		M	Tidal reefs and pools; pebbly, shelly and sandy shores; mudflats; inland shallow waters; sewage ponds, saltfields; ploughed ground.
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E1	E	Permanent freshwater wetlands with tall, dense vegetation, particularly <i>Typha</i> spp. (bullrushes) and <i>Eleocharis</i> spp. (spikerushes).
<i>Burhinus grallarius</i>	Bush Stone-curlew	E1		Occurs in lowland grassy woodland and open forest.
<i>Calamanthus fuliginosus</i>	Striated Fieldwren	E1		Swampy coastal heaths, tussock grasslands and swamp margins.
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper		M	Shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation.

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Ecology and Habitat
<i>Calidris alba</i>	Sanderling	V	M	Coastal areas on low beaches of firm sand, near reefs and inlets, along tidal mudflats and lagoons; rarely recorded in near-coastal wetlands.
<i>Calidris canutus</i>	Red Knot		E, M	Forages on intertidal mudflats or sandflats, lakes, sewage ponds and floodwaters. Roosts on sandy beaches, spits and islets, and mudflats; also in shallow saline ponds of saltworks.
<i>Calidris ferruginea</i>	Curlew Sandpiper	E1	CE, M	Forages in or at the edge of shallow water, occasionally on exposed algal mats or waterweed, or on banks of beach-cast seagrass or seaweed. Roosts on shingle, shell or sand beaches; spits or islets on the coast or in wetlands; or sometimes in salt marsh, among beach-cast seaweed, or on rocky shores.
<i>Calidris melanotos</i>	Pectoral Sandpiper		M	Shallow fresh to saline wetlands, including coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.
<i>Calidris ruficollis</i>	Red-necked Stint		M	Tidal mudflats, saltmarshes, sandy and shelly beaches, saline and freshwater wetlands, saltfields, sewage ponds.
<i>Calidris subminuta</i>	Long-toed Stint		M	Coastal and inland shallow wetlands, sewage ponds, tidelines, tidal mudflats.
<i>Calidris tenuirostris</i>	Great Knot	V	CE, M	Intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons.
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V		Old growth attributes required for nesting and roosting purposes. Also utilises less heavily timbered woodlands and urban fringe areas to forage, but appears to favour well timbered country.
<i>Charadrius leschenaultii</i>	Greater Sand-plover	V	V, M	Almost entirely restricted to coastal areas in NSW, mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks.

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Ecology and Habitat
<i>Charadrius mongolus</i>	Lesser Sand-plover	V	E, M	Almost entirely coastal in NSW, using sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats, sandy beaches, coral reefs and rock platforms.
<i>Charadrius veredus</i>	Oriental Plover		M	Open plains, ploughed land, inland swamps, tidal mudflats, claypans, coastal marshes, grassy airfields, playing fields, lawns.
<i>Circus assimilis</i>	Spotted Harrier	V		Grassy open woodland, inland riparian woodland, grassland, shrub steppe, agricultural land and edges of inland wetlands.
<i>Epthianura albifrons</i>	White-fronted Chat population in the Sydney Metropolitan Catchment Management Area	E2		Saltmarsh of Newington Nature Reserve and in grassland on the northern bank of the Parramatta River. Saltmarsh and on the sandy shoreline of a small island of Towra Point Nature Reserve.
<i>Epthianura albifrons</i>	White-fronted Chat	V		Saltmarsh vegetation, open grasslands and sometimes low shrubs bordering wetland areas.
<i>Esacus magnirostris</i>	Beach Stone-curlew	E4A		Forage in the intertidal zone of beaches and estuaries. Breed above the littoral zone, at the backs of beaches, or on sandbanks and islands, among low vegetation of grass, scattered shrubs or low trees; also among open mangroves.
<i>Falco subniger</i>	Black Falcon	V		Woodland, shrubland and grassland, especially riparian woodland and agricultural land. Often associated with streams or wetlands.
<i>Gallinago hardwickii</i>	Latham's Snipe		M	Freshwater, saline or brackish wetlands up to 2000 m above sea-level; usually freshwater swamps, flooded grasslands or heathlands.

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Ecology and Habitat
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet	V		Open forests and woodlands, mallee habitats. Feeds primarily on nectar and pollen of flowering Eucalypts. Breeds away from feeding areas, utilising hollow branches, holes in trees or dense vegetation.
<i>Glossopsitta pusilla</i>	Little Lorikeet	V		Dry, open eucalypt forests and woodlands, including remnant woodland patches and roadside vegetation.
<i>Grantiella picta</i>	Painted Honeyeater	V	V	Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus <i>Amyema</i> .
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	V		Rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries.
<i>Haematopus longirostris</i>	Pied Oystercatcher	E1		Forages on exposed sand, mud and rock at low tide. Nests mostly on coastal or estuarine beaches although occasionally they use saltmarsh or grassy areas.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	V		Freshwater swamps, rivers, lakes, reservoirs, billabongs, saltmarsh and sewage ponds and coastal waters. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, forest and urban areas.
<i>Hirundapus caudacutus</i>	White-throated Needletail		M	Occur most often over open forest and rainforest, as well as heathland, and remnant vegetation in farmland.
<i>Ixobrychus flavicollis</i>	Black Bittern	V		Terrestrial and estuarine wetlands. Also flooded grassland, forest, woodland, rainforest and mangroves where permanent water is present.
<i>Lathamus discolor</i>	Swift Parrot	E1	CE	Box-ironbark forests and woodlands. Favoured feed trees include winter flowering species such as <i>Eucalyptus robusta</i> (Swamp Mahogany), <i>Corymbia maculata</i> (Spotted Gum), <i>C. gummifera</i> (Red Bloodwood), <i>E. sideroxylon</i> (Mugga Ironbark), and <i>E. albens</i> (White Box).

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Ecology and Habitat
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	V	M	Sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs.
<i>Limosa lapponica</i>	Bar-tailed Godwit		M	Intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons, bays, seagrass beds, saltmarsh, sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats. Rarely inland wetlands, paddocks and airstrips.
<i>Limosa limosa</i>	Black-tailed Godwit	V	M	Usually sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Further inland, it can also be found around muddy lakes and swamps.
<i>Lophochroa leadbeateri</i>	Major Mitchell's Cockatoo	V		Wide range of treed and treeless inland habitats, always within easy reach of water.
<i>Lophoictinia isura</i>	Square-tailed Kite	V		Timbered habitats including dry woodlands and open forests, particularly timbered watercourses.
<i>Merops ornatus</i>	Rainbow Bee-eater			Open forests and woodlands, shrublands, farmland, areas of human habitation, inland and coastal sand dune systems, heathland, sedgeland, vine forest and vine thicket.
<i>Monarcha trivirgatus</i>	Spectacled Monarch			Mountain/lowland rainforest, wooded gullies, riparian vegetation including mangroves.
<i>Motacilla flava</i>	Yellow Wagtail		M	Swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land, lawns.
<i>Myiagra cyanoleuca</i>	Satin Flycatcher		M	Eucalypt-dominated forests, especially near wetlands, watercourses, and heavily-vegetated gullies.

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Ecology and Habitat
<i>Neophema chrysogaster</i>	Orange-bellied Parrot	E4A	CE	Winter habitat is mostly within 3 km of the coast in sheltered bays, lagoons, estuaries, coastal dunes and saltmarshes. Also small islands and peninsulas, saltworks, golf courses, low samphire herbland and taller coastal shrubland.
<i>Ninox strenua</i>	Powerful Owl	V		Woodland, open sclerophyll forest, tall open wet forest and rainforest. It roosts by day in dense vegetation comprising species such as <i>Syncarpia glomulifera</i> (Turpentine), <i>Allocasuarina littoralis</i> (Black She-oak), <i>Acacia melanoxylon</i> (Blackwood), <i>Angophora floribunda</i> (Rough-barked Apple), <i>Exocarpus cupressiformis</i> (Cherry Ballart) and eucalypt species.
<i>Numenius madagascariensis</i>	Eastern Curlew		CE, M	Estuaries, bays, harbours, inlets and coastal lagoons, intertidal mudflats or sandflats, ocean beaches, coral reefs, rock platforms, saltmarsh, mangroves, freshwater/brackish lakes, saltworks and sewage farms.
<i>Numenius minutus</i>	Little Curlew		M	Dry grasslands, open woodlands, floodplains, margins of drying swamps, tidal mudflats, airfields, playing fields, crops, saltfields, sewage ponds.
<i>Numenius phaeopus</i>	Whimbrel		M	Estuaries, mangroves, tidal flats, coral cays, exposed reefs, flooded paddocks, sewage ponds, grasslands, sports fields, lawns.
<i>Onychoprion fuscata</i>	Sooty Tern	V		Marine species which breeds in large colonies in sand or coral scrapes on offshore islands and cays including Lord Howe and Norfolk Islands.
<i>Oxyura australis</i>	Blue-billed Duck	V		Coastal and inland wetlands and swamps.
<i>Pandion cristatus</i>	Eastern Osprey	V		Rocky shorelines, islands, reefs, mouths of large rivers, lagoons and lakes.
<i>Pluvialis fulva</i>	Pacific Golden Plover		M	Estuaries, mudflats, saltmarshes, mangroves, rocky reefs, inland swamps, ocean shores, paddocks, sewage ponds, ploughed land, airfields, playing fields.
<i>Pluvialis squatarola</i>	Grey Plover		M	Mudflats, saltmarsh, tidal reefs and estuaries.

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Ecology and Habitat
<i>Polytelis swainsonii</i>	Superb Parrot	V	V	Box-gum woodland, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest.
<i>Pterodroma leucoptera leucoptera</i>	Gould's Petrel	V	E	Marine. Nesting habitat is located within steeply sloping rock scree gullies with a canopy of Cabbage Tree Palms.
<i>Ptilinopus superb</i>	Superb Fruit-Dove	V		Rainforest and closed forests. May also forage in eucalypt or acacia woodland where there are fruit-bearing trees.
<i>Rhipidura rufifrons</i>	Rufous Fantail		M	Wet sclerophyll forests, subtropical and temperate rainforests. Sometimes drier sclerophyll forests and woodlands.
<i>Rostratula australis</i>	Australian Painted Snipe	E1	E	Swamps, dams and nearby marshy areas. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. Forages nocturnally on mud-flats and in shallow water.
<i>Sternula albifrons</i>	Little Tern	E1	M	Sheltered coastal environments, harbours, inlets and rivers.
<i>Thinornis rubricollis</i>	Hooded Plover	E4A		Sandy ocean beaches, tidal bays and estuaries, rock platforms, rocky or sand-covered reefs, and small beaches in lines of cliffs. Also use near-coastal saline and freshwater lakes and lagoons.
<i>Tringa brevipes</i>	Grey-tailed Tattler		M	Sheltered coasts with reefs and rock platforms or intertidal mudflats; intertidal rocky, coral or stony reefs; shores of rock, shingle, gravel or shells; embayments, estuaries and coastal lagoons; lagoons and lakes; and ponds in sewage farms and saltworks.
<i>Tringa incana</i>	Wandering Tattler		M	Rocky coasts with reefs and platforms, offshore islands, shingle beaches or beds; occasionally coral reefs or beaches.

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Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Ecology and Habitat
<i>Tringa nebularia</i>	Common Greenshank		M	Terrestrial wetlands (swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans, saltflats, sewage farms and saltworks dams, inundated rice crops and bores) and sheltered coastal habitats (mudflats, saltmarsh, mangroves, embayments, harbours, river estuaries, deltas, lagoons, tidal pools, rock-flats and rock platforms).
<i>Tyto novaehollandiae</i>	Masked Owl	V		Dry eucalypt forests and woodlands from sea level to 1100 m.
<i>Xenus cinereus</i>	Terek Sandpiper	V	M	Occurs in mudbanks and sandbanks near mangroves, rocky pools and reefs, and occasionally up to 10 km inland around brackish pools. Generally roosts communally amongst mangroves or dead trees, often with related wader species.
Mammalia				
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Wet and dry sclerophyll forests, Cyprus Pine dominated forest, woodland, sub-alpine woodland, edges of rainforests and sandstone outcrop country.
<i>Dugong dugon</i>	Dugong	E1	M	Wide shallow protected bays, wide shallow mangrove channels and in the lee of large inshore islands. Will also occupy deeper waters.
<i>Miniopterus australis</i>	Little Bentwing-bat	V		Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day.

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Ecology and Habitat
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V		Rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland. Maternity roosts may be located in caves, abandoned mines, concrete bunkers and lava tubes. Over-wintering roosts used outside the breeding period include cooler caves, old mines, and stormwater channels, under bridges and occasionally buildings.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E1	V	Rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges.
<i>Phascolarctos cinereus</i>	Koala	V	V	Eucalypt woodlands and forests.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	Subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V		Woodland, moist and dry eucalypt forest and rainforest. Usually roosts in tree hollows, but has also been found in buildings.
Reptilia				
<i>Caretta caretta</i>	Loggerhead Turtle	E1	E, M	Marine. Nesting occurs on beaches.
<i>Chelonia mydas</i>	Green Turtle	V	V, M	Marine. Nesting occurs on beaches.
<i>Dermochelys coriacea</i>	Leatherback Turtle	E1	E, M	Marine. Nesting occurs on beaches.
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	E1	V	Dry and wet sclerophyll forests, riverine forests, coastal heath swamps, rocky outcrops, heaths, grassy woodlands. Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring.

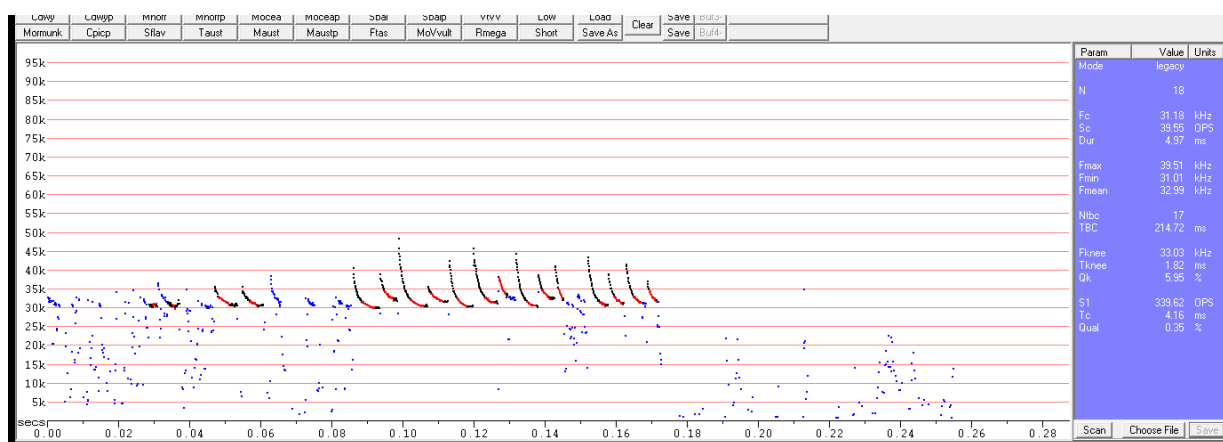
Flora

<i>Caladenia tessellata</i>	Thick Lip Spider Orchid	E1	V	Grassy sclerophyll woodland on clay loam or sandy soils, or low woodland with stony soil.
<i>Callistemon linearifolius</i>	Netted Bottle Brush	V		Dry sclerophyll forest.
<i>Chamaesyce psammogeton</i>	Sand Spurge	E1		Fore-dunes, pebbly strandlines and exposed headlands, often with <i>Spinifex sericeus</i> (Spinifex) and <i>Zoysia macrantha</i> (Prickly Couch).
<i>Hibbertia puberula</i>		E1		Low heath, dry sclerophyll woodland, upland swamps, on sandy soils or clay.
<i>Maundia triglochinosoides</i>		V		Swamps, lagoons, dams, channels, creeks or shallow freshwater 30 - 60 cm deep on heavy clay.
<i>Prostanthera densa</i>	Villous Mint-bush	V	V	Sclerophyll forest and shrubland on coastal headlands and near-coastal ranges, chiefly on sandstone.
<i>Senecio spathulatus</i>	Coast Groundsel	E1		Frontal dunes in coastal areas.
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	E1	V	Subtropical and littoral rainforest on gravels, sands, silts and clays.
<i>Allocasuarina glaireicola</i>		E1	E	Castlereagh woodland on lateritic soil. Found in open woodland with <i>Eucalyptus parramattensis</i> , <i>Eucalyptus fibrosa</i> , <i>Angophora bakeri</i> , <i>Eucalyptus sclerophylla</i> and <i>Melaleuca decora</i> .
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V	V	Coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest.

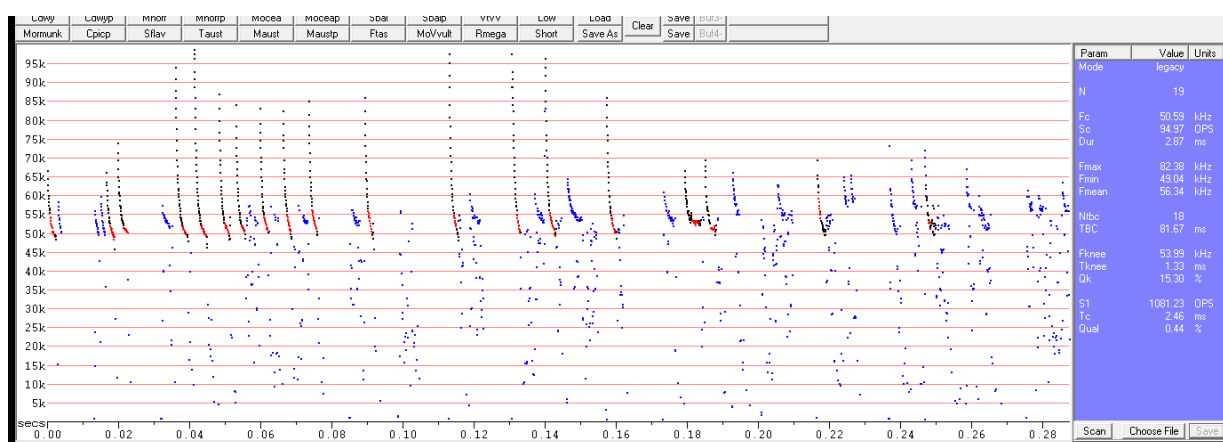
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<i>Genoplesium baueri</i>	Bauer's Midge Orchid	E1	E	Dry sclerophyll forest and moss gardens over sandstone.
<i>Pimelea curviflora</i> var. <i>curviflora</i>		V	V	Woodland, mostly on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes.
<i>Thelymitra kangaloonica</i>	Kangaloon Sun Orchid	E4A	CE	Swamps in sedgeland over grey silty grey loam soils.
<i>Thesium australe</i>	Austral Toadflax	V	V	Grassland on coastal headlands or grassland and grassy woodland away from the coast.

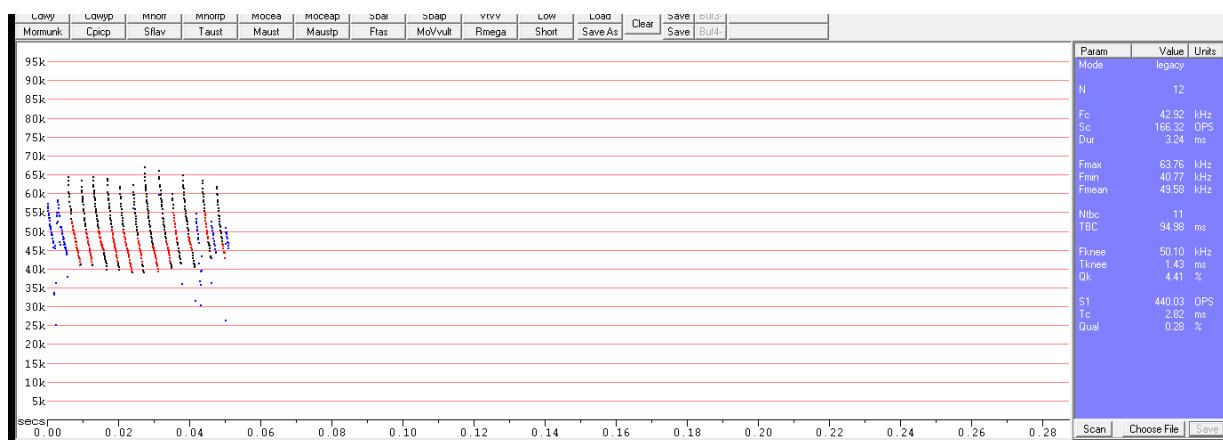
Appendix C Examples of Anabat call profiles



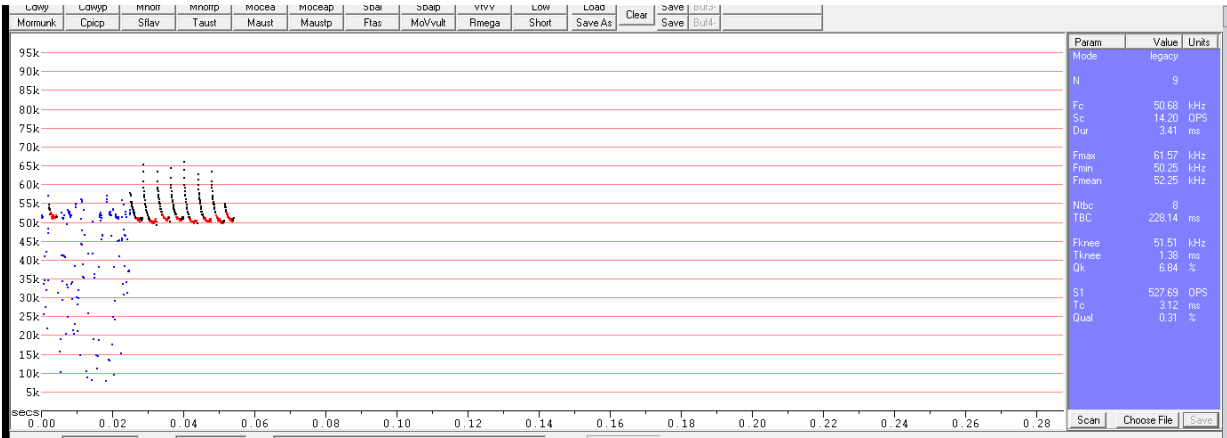
Call profile for *Chalinolobus gouldii* recorded on SN81997 at 20:11, 17 January 2015



Call profile for *Chalinolobus morio* recorded on SN81997 at 19:57, 16 January 2015



Call profile for *Myotis macropus* recorded on SN81997 at 21:07 on 16 January 2015



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