Wedgerock Pty Ltd

ABN: 15 099 038 123

Karuah South Quarry

Biodiversity Development Assessment Report

Prepared by

Ecoplanning Pty Ltd

February 2019

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Biodiversity Development Assessment Report

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COMMONLY USED ACRONYMS

AHD	Australian Height Datum
BAM	Biodiversity Assessment Method
BC Act	N*SW Biodiversity Conservation Act 2016*
BC Reg	NSW Biodiversity Conservation Regulation 2017
BCF	Biodiversity Conservation Fund
BDAR	Biodiversity Development Assessment Report
BMP	Biodiversity Management Plan
BOS	Biodiversity Offset Strategy
BSA	Biodiversity Stewardship Agreement
BVT	Biometric Vegetation Types
CEEC	Critically Endangered Ecological Community
CWD	Clean Water Diversion
DoEE	Commonwealth Department of the Environment and Energy
EEC	Endangered Ecological Community
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
IBRA	Interim Biogeographic Regionalisation of Australia
KRH	???
OEH	NSW Office of Environment and Heritage
PCT	Plant Community Type
PEA	Preliminary Environmental Assessment
SAII	Serious and Irreversible Impacts
SEARs	Secretary's Environmental Assessment Requirements
TEC	Threatened Ecological Community
TSC Act	NSW Threatened Species Conservation Act 1995

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EXECUTIVE SUMMARY

Wedgerock Pty Ltd is proposing to develop and operate the Karuah South Quarry (the Project) that would extract and process hard rock for use in construction and infrastructure projects within the Hunter and Greater Sydney Metropolitan Regions. The Project would be constructed and operated on the southern section of Lot 11, DP1024564, (the Site). The Site is approximately 21 hectares (ha) and is located approximately 40 kilometres (km) north of Newcastle and 4 km northeast of Karuah.

The Project would utilise conventional drill and blast, load and haul and processing methods to produce up to 600 000tpa of quarry products. Extraction would be undertaken in a staged manner, i.e. over two stages with each stage comprising three sub-stages. Production during the initial sub-stages of extraction would be lower with production during subsequent sub-stages gradually increasing. An estimated 10 million tonnes of fresh rock and 1.25 million tonnes of weathered rock have been identified within the proposed extraction area.

Secretary's Environmental Assessment Requirements ('SEARs'; SSD 17_8795 dated 2 August 2018) have been issued for the Project, which require a detailed assessment of likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, and having regard to the NSW Biodiversity Offsets Scheme (BOS) and the Biodiversity Assessment Method (BAM; OEH2017a).

This Biodiversity Development Assessment Report (BDAR) has been prepared in accordance with the BAM to document impacts to biodiversity and has been prepared by an Accredited Assessor in accordance with the NSW *Biodiversity Conservation Act 2016* (BC Act) and NSW *Biodiversity Conservation Regulation 2017*. This format for this BDAR follows that of the different 'stages' outlined within the BAM including:

- Stage 1 – Biodiversity assessment. Includes sections 1 to 4 of this BDAR including the introduction, site context including landscape features, native vegetation and threatened species.
- Stage 2 – Impact assessment. Includes sections 5 to 7 of this BDAR which identify measures to avoid and minimise impacts, assessment of residual impacts to biodiversity, mitigation measures, offset requirements and credit calculations.

  In accordance with the BAM, a number of features are assessed within the subject land and a 1,500 m buffer around the subject land. These landscape features are used to identify biodiversity values that are important for the subject land and inform the habitat suitability of the subject land for threatened species.

Native vegetation was identified and mapped across 11.59 ha of the approximately 16.36 ha of the subject land. Areas which did not support native vegetation included areas identified as being 'cleared' or areas supporting 'exotic vegetation'. Generally, the 'cleared' areas were associated with existing buildings/infrastructure, tracks and disturbed areas in the north of the property associated with the adjoining Karuah Quarry. Four Plant Community Types (PCTs) were identified within the subject land, namely:

- PCT 1590: Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest;

- PCT 1567: Tallowwood - Brush Box - Sydney Blue Gum moist shrubby tall open forest on foothills of the lower North Coast;
- PCT 1527: Bangalow Palm - Coachwood - Sassafras gully warm temperate rainforest of the Central Coast;
- PCT: 1550: Small-fruited Grey Gum - Turpentine - Tallowwood moist open forest on foothills of the lower North Coast; and

Of the PCTs identified within the subject land, one PCT (PCT 1527), comprises an Endangered Ecological Community under the BC Act, namely *'Lowland Rainforest in the NSW North-Coast and Sydney Basin Bioregions'*. This vegetation also meets the definition of the *'Lowland Rainforest of Subtropical Australia'*, Critically Endangered Ecological Community (CEEC) as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Habitat for threatened species has been assessed in accordance with section 6 of the BAM. One threatened species listed as Vulnerable under the BC Act and EPBC Act, Koala (*Phascolarctos cinereus*), was recorded within the subject land and a species polygon has been determined for this species which includes all areas of native vegetation within the subject land.

Neither the *'Lowland Rainforest in the NSW North-Coast and Sydney Basin Bioregions'* or the Koala are identified as threatened entities which are candidates for Serious and Irreversible Impacts (SAII).

Impacts to species and ecological communities listed under the EPBC Act, including the Koala, Grey-headed Flying-fox (*Pteropus poliocephalus*), Rufous Fantail (*Rhipidura rufifrons*) and Lowland Rainforest of Subtropical Australia, have been assessed in accordance with the relevant significant impact guidelines (DotE 2013; DotE 2014). These assessments, which have been informed by a previous referral to the Commonwealth Department of the Environment and Energy (DoEE; EPBC Ref: 2012/6600), concluded that these entities would not be significantly impacted by the Project and another referral to the DoEE is not required.

In accordance with section 8 of the BAM, this BDAR outlines actions taken to avoid and minimise impacts through minimising the disturbance footprint and locating the Project to avoid mapped drainage lines. Mitigation measures to avoid impacts to biodiversity are recommended within this BDAR and include the preparation of a best practice Biodiversity Management Plan in consultation with OEH to describe the short, medium, and long term measures to be undertaken to manage the remnant vegetation and fauna habitat on the site.

All residual impacts to biodiversity, after measures to avoid, minimise and mitigate impacts have been assessed using the BAM calculator and offset requirements, in terms of biodiversity credits, have been calculated in accordance with section 11.2 and Section 11.3 of the BAM to achieve the 'no net loss standard' as established by the BAM. A total of 274 ecosystem credits and 355 species credits are required to offset the impacts of the Project. The measures proposed to address the offset obligation outlined above will be determined as the Project approvals progress. Initial investigations have commenced to identify credits available for purchase, land available to purchase and enter into a Biodiversity Stewardship Agreement (BSA) and the costs of credits through payment into the Biodiversity conservation Fund (BCF). It is likely that a combination of measures will be used to retire the required credits including entering into a BSA, payment into the BCF and purchase of credits on the open market.

1. INTRODUCTION

Wedgerock Pty Ltd (the Applicant) is proposing to develop and operate the Karuah South Quarry (the Project) that would involve the extraction and processing of hard rock for use in construction and infrastructure projects within the Hunter and Greater Sydney Metropolitan Regions. The Project would be constructed and operated on the southern section of Lot 11, DP1024564, (the Site). The Site is approximately 21 hectares (ha) and is located approximately 40 kilometres (km) north of Newcastle and 4 km northeast of Karuah (refer **Figure 1**).

Secretary's Environmental Assessment Requirements ('SEARs'; SSD 17_8795 dated 2 August 2018) have been issued for the Project, which require a detailed assessment of likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, and having regard to the NSW Biodiversity Offsets Scheme (BOS) and the Biodiversity Assessment Method (BAM).

The BAM, established under Section 6.7 of the NSW *Biodiversity Conservation Act 2016* (BC Act), assesses the impacts of developments on threatened species, ecological communities and their habitats as required under the BC Act. The process of applying the BAM for a proposed development must be fully documented in a Biodiversity Development Assessment Report (BDAR). This BDAR has been prepared in accordance with the BAM to document the predicted impacts to biodiversity and has been prepared by Brian Towle, an Accredited Assessor (BAAS17057) in accordance with the BC Act and NSW *Biodiversity Conservation Regulation 2017* (BC Reg). This BDAR describes the outcome of the development assessment case (00012266/BAAS17057/18/00012267) conducted consistent with the BAM.

The SEARs also outline a number of additional requirements in relation to ecology which have been addressed within this BDAR. **Table 1** summaries the assessment requirements with regard to ecology and outlines where in this BDAR these requirements have been addressed.

Table 1
Coverage of Environmental Assessment Requirements Relating to Ecology

Agency / Organisation	Relevant Requirement	Relevant Section(s)
BIODIVERSITY		
Department of Planning and Environment 02/8/18	• accurate predictions of any vegetation clearing on site;	Section 3
	• a detailed assessment of the likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, and having regard to the NSW Biodiversity Offsets Scheme and the Biodiversity Assessment Method; and	Sections 3 and 4
	• a strategy to offset any residual impacts of the development in accordance with the NSW Biodiversity Offsets Scheme.	Sections 6 and 7

Table 1 (Cont'd)
Coverage of Environmental Assessment Requirements Relating to Ecology

Agency / Organisation	Relevant Requirement	Relevant Section(s)
BIODIVERSITY (Cont'd)		
Office of Environment & Heritage 22/5/18	The EIS must map the following features relevant to water including: • Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method). • Wetlands as described in s4.2 of the Biodiversity Assessment Method.	
	• Biodiversity impacts related to the proposed development (SSD 17_8795) are to be assessed in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the *Biodiversity Conservation Act* 2016 (s6.12), *Biodiversity Conservation Regulation* 2017 (s6.8) and Biodiversity Assessment Method.	This report in its entirety
	• The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method.	Sections 6 and 7
	• The BDAR must include details of the measures proposed to address the offset obligation as follows; – The total number and classes of biodiversity credits required to be retired for the development/project; – The number and classes of like-for-like biodiversity credits proposed to be retired; – The number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; – Any proposal to fund a biodiversity conservation action; – Any proposal to conduct ecological rehabilitation (if a mining project); – Any proposal to make a payment to the Biodiversity Conservation Fund. • If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.	Sections 6 and 7
	• The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s6.10 of the *Biodiversity Conservation Act 2016.*	Section 1

Figure 1 Locality Plan

1.1 SITE DESCRIPTION

For the purposes of this report, 'the Site' refers to the section of Lot 11, DP1024564, south of the existing Karuah Quarry. The 'subject land', refers to all areas of the Site which would be subject to proposed direct and indirect impacts and covers a total area of approximately 16.36ha. The Site generally consists of a moderately steep, south to south-east facing slope which supports forest vegetation with the exception of small areas cleared of vegetation and cleared vehicle tracks. The Site is bound by:

- Karuah Quarry (owned by Hunter Quarries) operations which are currently conducted on the central section of Lot 11 // DP1024564 immediately north of the Site;
- Blue Rock Close and the Pacific Highway to the south;
- Native forested vegetation sign-posted as a 'biodiversity offset area' to the east with the Karuah East Quarry located beyond the offset area; and
- A small area of native forest vegetation and disturbed land associated with former quarry operations to the west (**Figure 2**).

1.2 PROPOSED DEVELOPMENT

The Project would utilise conventional drill and blast, load and haul and processing methods to produce up to 600 000tpa of quarry products. Extraction would be undertaken in a staged manner, i.e. over two stages with each stage comprising three sub-stages. Production during the initial sub-stages of extraction would be lower with production during subsequent sub-stages gradually increasing. An estimated 10 million tonnes of fresh rock and 1.25 million tonnes of weathered rock have been identified within the proposed extraction area.

It is expected that extraction and processing operations would continue for a period of approximately 25 years following Project commencement.

Figure 3 displays the following principal components of the Project that would be located on the Site, including the following components:

- Extraction Area - Stage 1

  The Stage 1 extraction area would cover approximately 4.9ha with its footprint typically between approximately 30m AHD and 75m AHD (to a floor with an elevation of 8m AHD).

- Extraction Area - Stage 2

  The Stage 2 extraction area would cover approximately 5.9ha with its footprint typically between 75m AHD and 120m AHD (to a sloping floor from an elevation of 8m to 12m AHD).

- Quarry Infrastructure Area

  The quarry infrastructure area would be located on the southern side of the extraction area and would incorporate the product stockpiling area, ancillary components area and mobile processing plant.

Figure 2 Site Location

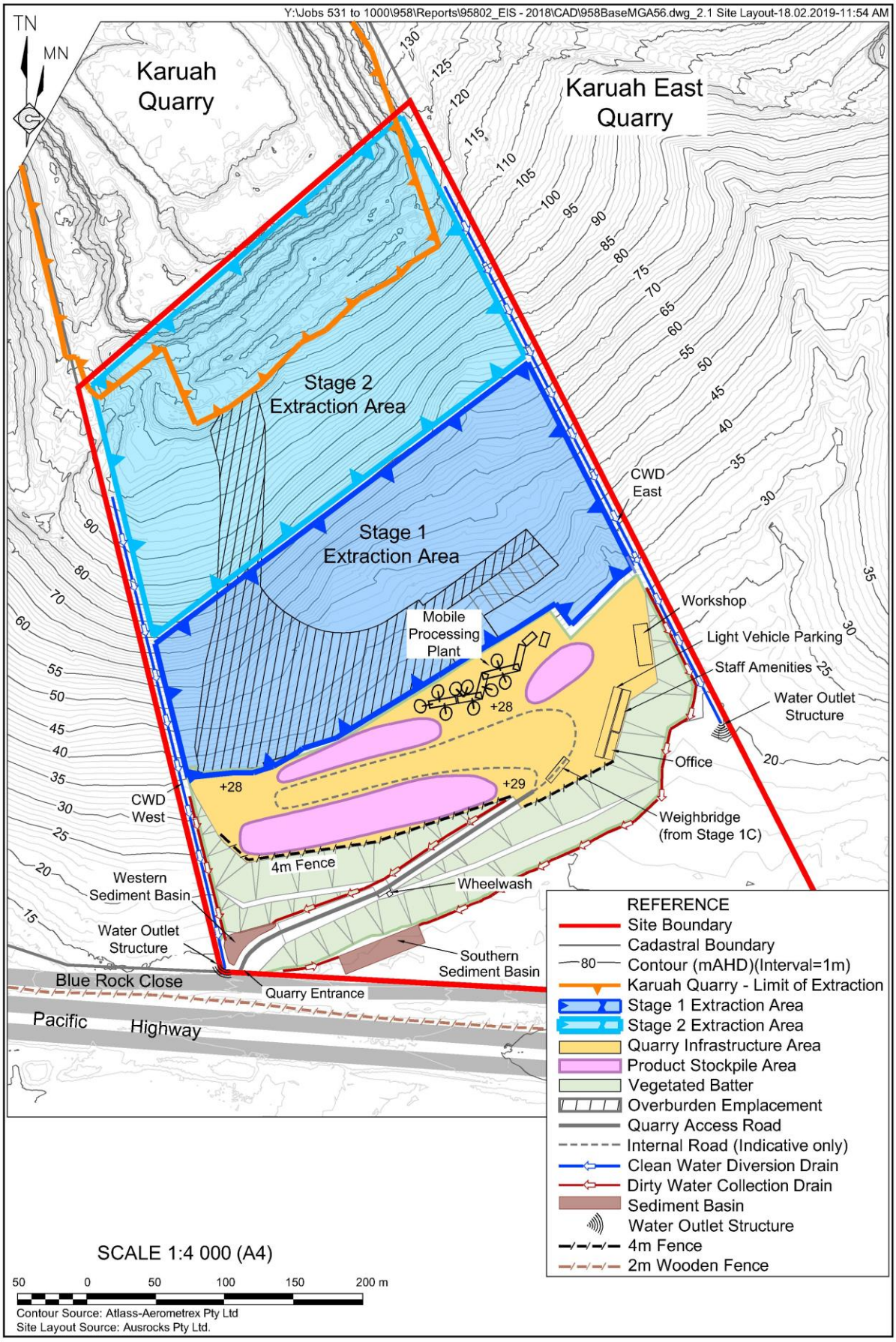

Figure 3 Indicative Site Layout

- Product Stockpiling Area

  The product stockpiling area would be located on the northern section of the quarry infrastructure area during Stage 1. This area would be expanded to cover northern, southern and western portions of the quarry infrastructure area during Stage 2 (see **Figure 3**).

- Mobile Processing Plant

  The mobile processing plant would incorporate a range of crushers and screens and would be located on the western section of the quarry infrastructure area during Stage 1. During Stage 2, the mobile processing plant would be relocated to the eastern section of the quarry infrastructure area to minimise product haulage distances.

- Internal Roads

  A network of roads to provide access for off-road haul trucks between the extraction and processing area.

- Quarry Access Road

  The inclined, sealed section of road extending from the quarry entrance to the southern side of the quarry infrastructure area.

- Sediment Basins

  Two sediment basins (Western and Southern), each with a with pre-treatment pond, would be constructed to collect sediment laden runoff from the disturbed sections of the Quarry.

- Diversion Drains

  Two clean water diversion (CWD) drains (CWD East and CWD West) would be constructed to direct runoff from undisturbed areas upslope of the extraction area.

Quarry products would be despatched by road using the existing road network with access to the Site via a new entrance to Lot 11, DP1024564 from Blue Rock Close. The location of the quarry entrance would be close to the existing entrance to the property and would be constructed to accommodate quad-dog trailers and semi-trailers.

The overall footprint of the operation would be kept as small as possible during all stages of operation, with vegetation and soil removed immediately prior to the progressive extension of operations. Progressive rehabilitation would be undertaken as soon as practicable following disturbance.

2. LANDSCAPE CONTEXT

2.1 IDENTIFY LANDSCAPE FEATURES

In accordance with the BAM, a number of features are assessed within the subject land and a 1,500m buffer around the subject land. These landscape features are used to identify biodiversity values that are important for the subject land and inform the habitat suitability of the subject land for threatened species. Other features, such as rivers, streams, estuaries and wetlands, habitat connectivity, karst areas or areas of outstanding biodiversity value are considered, where appropriate.

2.1.1 IBRA Bioregions and Subregions

The Interim Biogeographic Regionalisation of Australia (IBRA, DoEE 2012) represents a landscape-based approach to classifying the land surface, including attributes of climate, geomorphology, landform, lithology, and characteristic flora and fauna species present. The subject land is wholly located within the NSW North Coast IBRA bioregion and the Karuah Manning subregion (IBRA version 7). The Sydney Basin bioregion and the Hunter subregion are located approximately 8 km west of the subject land.

2.1.2 NSW Landscape Regions

The subject land, and land within the 1,500 m assessment circle, occurs in only one NSW Mitchell Landscape, being the '*Newcastle Coastal Ramp*' landscape (Mitchell Landscapes V3). The landscape '*Myall – Forster Barrier*' occurs approximately 1 km north of the 1,500 m assessment circle and to the south of the 1,500 m assessment circle within the Port Stephens estuary.

2.1.3 River Streams and Wetlands

Rivers, streams and wetlands located within the 1,500 m buffer of the subject land, including the associated riparian buffers calculated in accordance with Appendix 3 of the BAM, are shown in **Figure 4** and **Figure 5**.

The area within the 1,500 m buffer of the subject land contains a number of drainage lines including un-named tributaries of the Karuah River in the north, tributaries of Bulga Creek in the east and Yalimbah Creek and its tributaries in the central and southern areas. A detailed description and assessment of drainage within the subject land has been undertaken by R. W Corkery & Co Pty Limited (2018). This assessment identified that within the Site drainage consists of topographically controlled, ephemeral, first order drainage features which traverse the south-eastern section of the Site. These first order drainage features are characterised by relatively small contributing catchments and a short flow path which generally displays a low capacity channel (if evident at all) that likely reflects the short duration of flow events (R. W Corkery & Co Pty Limited 2018).

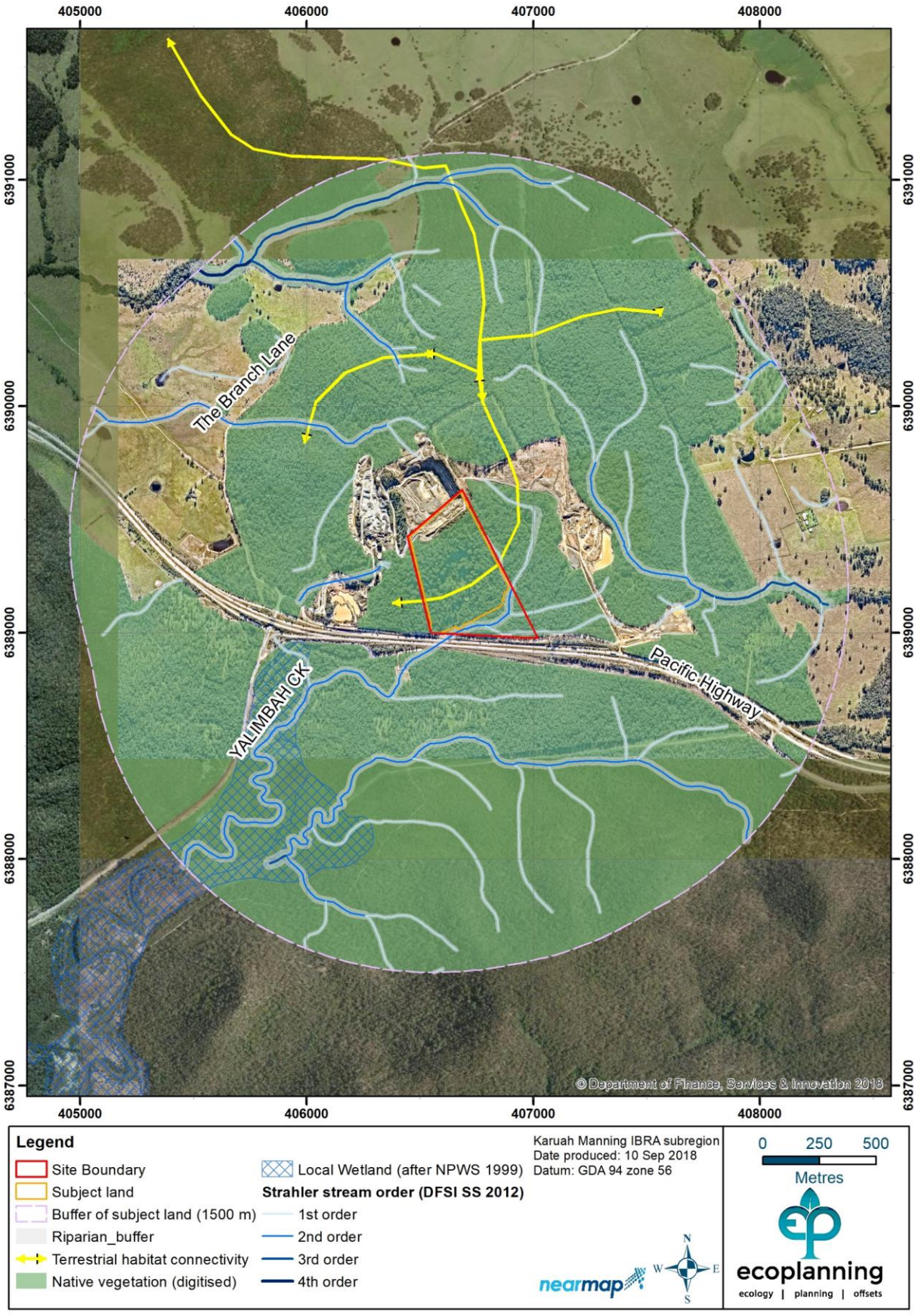

Figure 4 Location Map

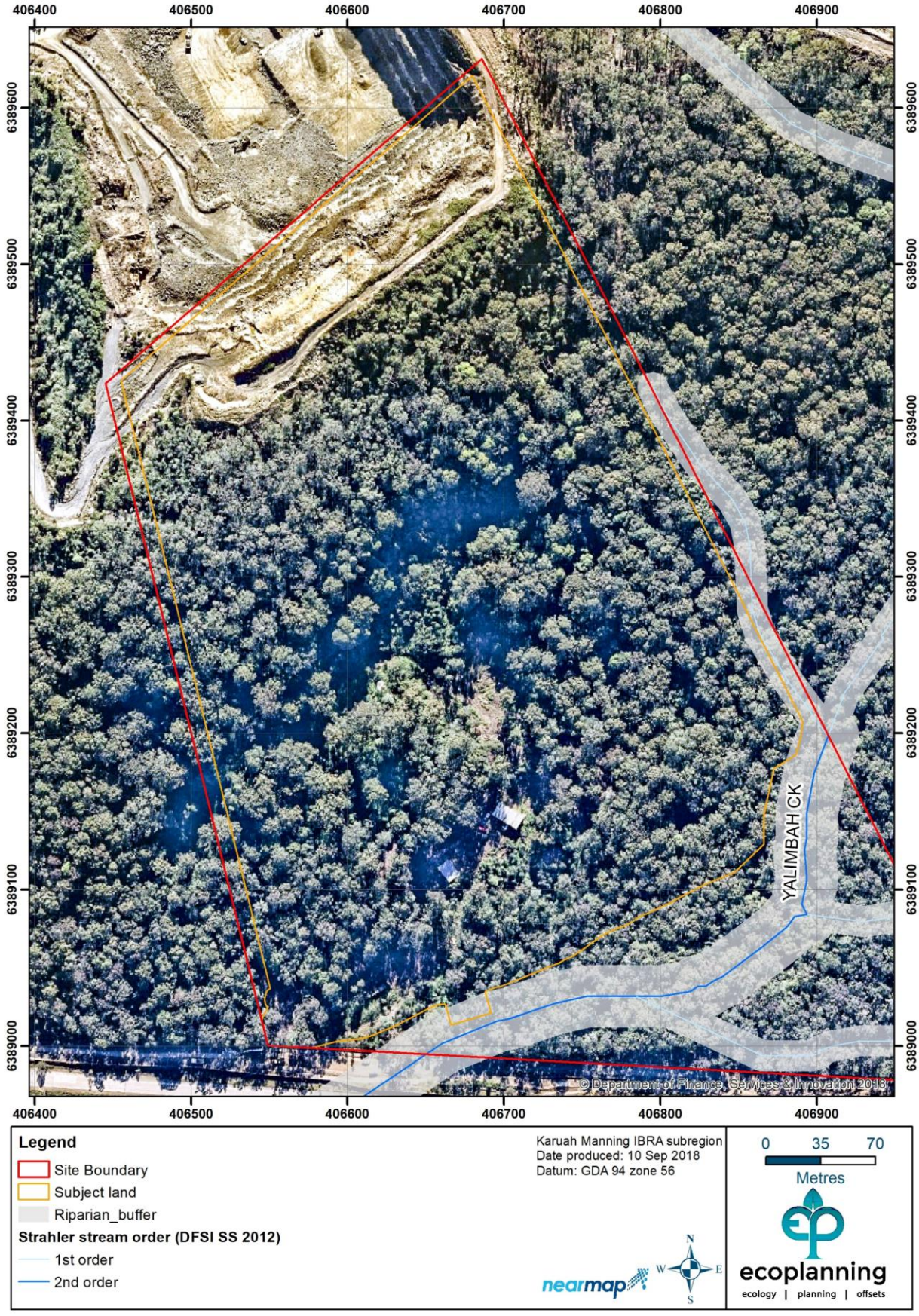

Figure 5 Rivers, Streams and Wetlands

Prior to the development of the Pacific Highway, the flow path of Yalimbah Creek would have traversed the southern section of the Site in a northeast to southwest direction prior to turning south into the present tidal wetlands of this system, downstream of the Site. However, the development of the Pacific Highway and its subsequent upgrade to a dual carriage motorway has substantially overprinted and removed much of the former flow path. All discharge from the Yalimbah Creek catchment upstream of the Pacific Highway, is now directed to a bank of culverts which convey discharge first, under Blue Rock Close and subsequently under the Pacific Highway (R. W Corkery & Co Pty Limited 2018).

No important wetlands are present within the 1,500 m buffer of the subject land. The nearest important wetland, as defined under the BAM, to the subject land is the 'Port Stephens Estuary' which is identified as occurring along the Karuah River upstream of the junction of Yalimbah Creek and the Karuah River. The stretches of Yalimbah Creek to the south of the Pacific Highway constitute a local wetland, as defined under the BAM, and are present within the 1,500 m buffer of the subject land (**Figure 4**). This local wetland does not occur within the subject land.

The subject land does not contain any 'Key Fish Habitat' as defined under the *Fisheries Management Act 1994* and mapped by NSW Department of Primary Industries. Areas within the 1,500 m buffer including areas downstream of the subject land such as the portions of Yalimbah Creek south of the Pacific Highway and the Karuah River are identified as Key Fish Habitat.

2.1.4 Habitat Connectivity

Habitat within the subject land is contiguous with areas supporting broadly similar forest and woodland vegetation to the north and for a short distance to the east and west (**Figure 4**). The subject land is located within a moderately large area of native vegetation which extends approximately 3 km north of the subject land fragmented only by Branch Lane. The area of native vegetation in which the subject land is located is eventually fragmented from adjacent areas of native vegetation by cleared agricultural landscapes to the north, east and west. The four-lane Pacific Highway and Blue Rock Close isolates the subject land and adjacent areas from areas of native vegetation, including Karuah Nature Reserve, to the south (**Figure 4**). The Site is not located adjacent to land which forms part of the NPWS estate. Karuah Nature Reserve, owned and managed by NPWS, is located south of the Pacific Highway and downslope of the Site.

A regional wildlife corridor (entitled ‘Karuah Mountain 1’) has been mapped by NPWS (2001) as occurring across the subject land and continuing in an east-west direction parallel to the Pacific Highway. The mapping of this regional corridor in 2001 predates clearing of native vegetation undertaken to the north, east and west of the subject land.

2.1.5 Other Landscape Features

No other landscape features including areas of geological significance (including karst, caves, crevices and cliffs) or soil hazard features have been identified within the subject land and 1,500 m buffer around this land.

2.2 DETERMINING SITE CONTEXT

2.2.1 Assessing Native Vegetation Cover

In accordance with Section 4.3.2 of the BAM, native vegetation cover must be estimated for a 1,500 m buffer around the subject land to determine the landscape context of the site. The extent of native vegetation on the subject site and immediate surrounds was mapped using the vegetation mapping for the Greater Hunter area (Silvertsen et al 2011) with revisions made based upon recent aerial photograph interpretation (**Figure 4**).

Within the 967.45 ha area which includes the subject land and a 1,500 m buffer, 744.38 ha was mapped as supporting native vegetation. This equates to a cover of native vegetation across 76.94% of the subject land including the 1,500 m buffer, which is within the >70% class in accordance with the BAM.

2.2.2 Assessing Patch Size

Patch size as defined by the BAM as '*an area of native vegetation that*:

- a) occurs on the development site or biodiversity stewardship site, and
- b) includes native vegetation that has a gap of less than 100m from the next area of moderate to good condition native vegetation (or ≤30m for non-woody ecosystems).

Patch size may extend onto adjoining land that is not part of the development site or biodiversity stewardship site.'

Under the BAM, patch size is required to be assessed as one of four classes per vegetation zone mapped, being <5 ha, 5-24 ha, 25-100 ha or >100 ha. All vegetation within the subject land is contiguous with, or within 100 m of, areas of moderate to good native vegetation which extends north of the subject land to Billygoat Hill (**Figure 4**). The patch size for the area of vegetation extending from the subject land towards Billygoat Hill is approximately 530 ha. In accordance with section 5.3.2 of the BAM, the patch size for all vegetation zones within the subject land was assigned as being within the >100 ha class.

3. NATIVE VEGETATION

3.1 EXISTING INFORMATION ON NATIVE VEGETATION

In accordance with section 5.2.1.5 of the BAM, existing information relevant to the native vegetation of the subject land and the 1,500 m buffer area has been reviewed. Vegetation information associated with regional vegetation assessments and more site-specific vegetation assessments have been reviewed.

3.1.1 Regional Vegetation Assessments

Regional vegetation mapping for the subject land and 1,500 m buffer was reviewed (Silvertsen et al 2011). Vegetation mapping by Silvertsen et al (2011) was found to include grassy woodland vegetation communities in association with basalt which are typical of the Liverpool Plains and Upper Hunter Valley regions. These vegetation communities, identified by Silvertsen et al (2011), did not reflect the vegetation within the subject land and 1,500 m buffer.

3.1.2 Previous Ecological Studies

3.1.2.1 Conacher Environmental Group (2012)

Conacher Environmental Group (CEG) prepared a 'Biodiversity Assessment Report' for 61 Blue Rock Close, Karuah which included the entire subject land for this BDAR and sections of Lot 11, DP1024564 to the north of the current subject land. CEG (2012) was informed by a previous ecological assessment undertaken by HWR Ecological (2004).

Three vegetation communities were identified by CEG (2012), two of which were identified as occurring within the subject land for this BDAR, namely:

- 'Spotted Gum – Ironbark forest'; and
- 'Blue Gum / Brush Box Closed Forest'.

CEG (2012) mapped 'Spotted Gum – Ironbark forest' (Map Unit 1) as occurring across the lower slopes present across the southern portions of the subject land. This vegetation community was described as a tall forest dominated by *Angophora costata* (Sydney Red Gum)*, Corymbia maculata* (Spotted Gum)*, Eucalyptus punctata* (Grey Gum)*, Eucalyptus acmenoides* (White Mahogany) and *Eucalyptus fibrosa* (Red Ironbark) with a sub-canopy of *Allocasuarina torulosa* (Forest Oak). A variable shrub layer with a range of sclerophyllous species and a grassy understorey was also described for this vegetation community (CEG 2012). High levels of weed invasion were noted for the areas of this vegetation community within the subject land for this BDAR (CEG 2012).

A second vegetation community, 'Blue Gum / Brush Box Closed Forest' (Map Unit 2) was mapped by CEG (2012) across the northern half of the subject land for the current BDAR. This vegetation community was described as a tall closed forest dominated by *Eucalyptus microcorys* (Tallowwood)*, Eucalyptus propinqua* (Small-fruited Grey Gum)*, Eucalyptus fibrosa, Angophora costata, Eucalyptus acmenoides, Eucalyptus saligna* (Sydney Blue Gum) and *Lophostemon confertus* (Brush Box). A sub-canopy and shrub layer including several *Melaleuca* spp. and mesic species including *Glochidion ferdinandi* and *Syzygium oleosum* is

described as occurring within this vegetation community along with an understorey of sedges, graminoids and grasses (CEG 2012). CEG (2012) notes that patches of closed forest occur within the central areas of this vegetation community and contain "rainforest-type" species including *Archontophoenix cunninghamiana* (Bangalow Palm), *Ficus coronata* (Sandpaper Fig) and *Eupomatia laurina* (Bolwarra; CEG 2012). Weed invasion is described as low to moderate within this community.

None of the vegetation within the subject land of this BDAR was identified by CEG (2012) as forming part of any Threatened Ecological Communities (TECs) listed at the time under the NSW *Threatened Species Conservation Act 1995* (TSC Act) or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

No threatened flora species were observed within the Study Area during the surveys undertaken by CEG (2012), although *Tetratheca juncea* (Black-eyed Susan), a vulnerable species listed under the BC Act, was recorded beyond the western boundary of the Study Area (CEG 2012). Ten threatened fauna species were reported by CEG (2012) from literature and database review as having been observed on or adjacent to the Study Area during surveys and were considered likely to utilise the site, namely:

- Stephen's Banded Snake (*Hoplocephalus stephensii*) – observed to the east of the Study Area (RPS HSO 2010)
- Glossy Black-Cockatoo (*Calyptorhynchus lathami*) – observed in the northern portion of Lot 11 to the north of the study area (HWR Ecological 2004)
- Powerful Owl (*Ninox strenua*) – Observed 600m NE of the Study Area (HWR Ecological 2004)
- Varied Sittella (*Daphoenositta chrysoptera*) – observed foraging within the Study Area (CEG 2012)
- Brush-tailed Phascogale (*Phascogale tapoatafa*) – captured to north of the Study Area (HWR Ecological 2004)
- Koala (*Phascolarctos cinereus*) – scats observed within the Study Area (HWR Ecological 2004) and single individual observed (CEG 2012)
- Grey-headed Flying-fox (*Pteropus poliocephalus*) – observed within the Study Area (HWR Ecological 2004)
- Little Bentwing-bat (*Miniopterus australis*) – observed within the Study Area (CEG 2012)
- Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) – observed within the Study Area (CEG 2012)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) – observed within the Study Area (CEG 2012)

An adequacy review of the Biodiversity Assessment Report (CEG 2012) was conducted by OEH (2012). This adequacy review identified several 'issues of concern', criticising the survey effort, inappropriately timed surveys, lack of specific targeted searches and a reliance on 'out-of-date' surveys. The results of CEG (2012) have informed this BDAR but the data collected, and survey effort, have not been relied upon for this BDAR.

3.1.2.2 Karuah East Quarry

The Karuah East Quarry, located less than 200 m from the north-east corner of the subject land, has been subject to a terrestrial ecology survey (RPS 2013) and Biodiversity Offset Strategy (ELA 2013). The terrestrial ecology surveys (RPS 2012) identified three native vegetation communities across this area. The three vegetation communities identified were:

- 'Spotted Gum – Grey Ironbark – Grey Gum – White Mahogany Moist Sclerophyll Forest', which was recorded on the hillcrest and steep southern sheltered hill slopes of Karuah Mountain. This vegetation community was identified as supporting a mix of dry sclerophyllous and dry rainforest taxa in the mid stratum. The understorey was described as a mosaic of grasses, forbs, graminoids and ferns. This vegetation community was identified by RPS (2012) as being the Biometric Vegetation Type (BVT; see OEH 2012) equivalent ('best fit') to the 'Spotted Gum-Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin'. This vegetation community was not identified as forming a TEC listed under the then TSC Act or EPBC Act.
- 'Smooth barked Apple – Red Bloodwood-Brown Stringybark Dry Sclerophyll Forest' was recorded on flat to undulating hills on loams and clay loams (RPS 2012). Dominant canopy species included *A. costata, C. gummifera, E. acmenoides* and *E. capitellata* (Brown Stringybark). A diverse shrub layer of sclerophyllous shrub species and an understorey including a mosaic of grasses, forbs, graminoids and ferns is described for this vegetation community (RPS, 2012). This vegetation community was identified by RPS (2012) as the BVT equivalent ('best fit') to the 'Sydney Peppermint – Smooth barked Apple shrubby open forest on coastal hills and plains of the southern North Coast and northern Sydney Basin'. This vegetation community was not identified as forming a TEC listed under the then TSC Act or EPBC Act.
- 'Grey Myrtle Dry Rainforest' was recorded on along the south-western flank of Karuah Mountain along a dry, rocky gully which represents the headwaters of Yalimbah Creek. A diverse canopy of rainforest species was present in this community with an understorey including *Lomandra longifolia* (Spiny-headed mat-rush), a number of ferns and other rainforest understorey species. A number of climbers were identified as occurring within this vegetation community including *Geitonoplesium cymosum* (Scrambling Lily), *Eustrephus latifolius* (Wombat Berry), *Sarcopetalum harveyanum* (Pearl Vine), *Dioscorea transversa* (Native yam) and *Morinda jasminoides* (Sweet Morinda; RPS 2012). This vegetation community was identified by RPS (2012) as being the BVT equivalent ('best fit') to the 'Shatterwood-Giant Stinging Tree-Yellow Tulipwood dry rainforest of the North Coast and northern Sydney Basin'. RPS (2012) identified that this vegetation type supported some elements of the 'Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast' Vulnerable Ecological Community as listed under the then TSC Act, but did not form part of the 'Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions' listed as endangered under the then TSC Act and Critically Endangered under the EPBC Act.

The Biodiversity Offset Strategy for Karuah East Quarry (ELA 2013) involved ecological surveys of land located immediately east of the Karuah East Quarry (approximately 500 m east of the subject land for this BDAR).

Five BVTs were identified within the offset site (ELA 2013), namely:

- 'Spotted Gum – Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin' which was identified as occurring on the upper slopes (ELA 2013);
- 'Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin' present on the south facing gently, undulating areas, particularly near the Pacific Highway (ELA 2013);
- 'Blackbutt - Turpentine - Tallowwood shrubby open forest of the coastal foothills of the central North Coast' identified as occurring generally along the more sheltered mid to lower slopes of the southern half of the offset site (ELA 2013);
- 'Sydney Peppermint - Smooth-barked Apple shrubby open forest on coastal hills and plains of the southern North Coast and Northern Sydney Basin' located in the sheltered southern portion of the offset site in the vicinity of the Pacific Highway (ELA 2013); and
- 'Brush Box – Turpentine shrubby open forest of the coastal ranges of the North Coast' located as part of riparian vegetation along two south facing slopes and associated watercourses in the southern half of the offset site (ELA 2013).

None of the vegetation communities identified in ELA (2013) were identified as TECs listed under the then TSC Act or EPBC Act.

The vegetation community classification and nomenclature used by RPS (2012) and ELA (2013) do not utilise the current PCT community classification, which is required as part of a BAM assessment. While ELA (2013) assigned BVTs to identified vegetation communities, these BVTs have since been decommissioned and no direct relationship between these BVTs and the current PCT classification has been identified.

Three threatened flora species currently listed under the BC Act and EPBC Act were recorded within the Study Area for the Karuah East Quarry terrestrial ecology survey (RPS 2012), which are:

- *Tetratheca juncea* (Black-eyed Susan),
- *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) and
- Asperula asthenes.

These three species were also recorded within the land to the east of the Karuah East Quarry Study Area by ELA (2013). An additional five species were identified as 'subject species' for this survey, on the basis of suitable habitat, and were subjected to targeted surveys within areas of suitable habitat, namely:

- Callistemon linearifolius;
- Angophora inopina;
- Corybas dowlingii;
- Cryptostylis hunteriana; and
- Melaleuca groveana.

A total of five threatened fauna species listed under the BC Act were recorded during the RPS (2012) surveys, namely:

- Powerful Owl (Ninox strenua) – recorded during surveys (RPS 2012)
- Varied Sittella (Daphoenositta chrysoptera) – recorded during surveys (RPS 2012)
- Glossy Black Cockatoo (Calyptorhynchus lathami) – recorded during surveys (RPS 2012)
- Eastern Freetail Bat (Mormopterus norfolkensis) – recorded during surveys (RPS 2012)
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) – recorded during surveys (RPS 2012)
- A further 15 threatened fauna species were considered to have potential habitat but were not identified during targeted surveys by RPS (2012), namely:
- Green thighed Frog (Litoria brevipalmata) – potential habitat present
- Stuttering Frog (Mixophyes balbus) – potential habitat present
- Swift Parrot (Lathamus discolor) – potential habitat present
- Stephens' Banded Snake (Hoplocephalus stephensii) – potential habitat present
- Little Lorikeet (Glossopsitta pusilla) – potential habitat present
- Masked Owl (Tyto novaehollandiae) – potential habitat present
- Koala (Phascolarctos cinereus) – potential habitat present
- Long-nosed Potoroo (Potorous tridactylus) – potential habitat present
- Brush-tailed Phascogale (Phascogale tapoatafa) – potential habitat present
- Squirrel Glider (Petaurus norfolcensis) – potential habitat present
- Eastern Bentwing-bat (Miniopterus schreibersii subsp. oceanensis) – potential habitat present
- Little Bentwing-bat (Miniopterus australis) – potential habitat present
- Greater Broad-nosed Bat (Scoteanax rueppellii) – potential habitat present
- Large-footed (Southern) Myotis (Myotis macropus) – potential habitat present
- Grey headed Flying Fox (Pteropus poliocephalus) – potential habitat present

3.1.2.3 Preliminary environmental assessment

Preliminary mapping of PCTs across the subject land was undertaken by Biosis (2017), as included in the PEA (RW Corkery & Co 2017). Five PCTs were identified across the Site including:

- PCT 1527: Bangalow Palm - Coachwood - Sassafras gully warm temperate rainforest of the Central Coast. Mapped as occurring in a small central area of the subject land;
- PCT 1566: White Mahogany - Turpentine moist shrubby tall open forest. Mapped as occurring on the lower slopes present in the south-east of the subject land;

- PCT 1567: Tallowwood - Brush Box - Sydney Blue Gum moist shrubby tall open forest on foothills of the lower North Coast. Mapped as occurring across the mid to upper slopes present within the subject land;
- PCT 1590: Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest. Mapped as occurring across the upper slopes and ridgeline at the top of the subject land; and
- PCT 1647: Red Bloodwood - Smooth-barked Apple heathy woodland on coastal sands of the Central and lower North Coast. Mapped as occurring across a small gently inclined area in the south-east corner of the Site, outside of the subject land.

The vegetation mapping of Biosis (2017) identifies the area of PCT 1527 as being equivalent to the *Lowland rainforest in the NSW North Coast and Sydney Basin Bioregion* Threatened Ecological Community. This ecological community is listed as 'Endangered' under the BC Act and where certain condition thresholds are met, is listed as 'Critically Endangered' under the EPBC Act.

3.2 VEGETATION EXTENT

Native vegetation was identified and mapped across 11.59 ha of the approximately 16.36 ha of the subject land. Areas which did not support native vegetation included areas identified as being 'cleared' or areas supporting 'exotic vegetation'. Generally, the 'cleared' areas were associated with existing buildings/infrastructure, tracks and disturbed areas in the north of the property associated with the adjoining Karuah Quarry. It is noted that aerial photography indicates the presence of native vegetation in northern parts of the subject land mapped as being 'cleared'. This is due to vegetation disturbance and clearing undertaken as part of the Karuah Quarry operations post the date of the aerial photography and post the survey of vegetation integrity plots within the subject land. Areas identified as supporting exotic vegetation, which consisted of dense thicket of *Lantana camara** (Lantana), were present adjacent to cleared areas.

In accordance with section 5.1 of the BAM, areas which are not native vegetation do not require further assessment, except where they represent habitat for threatened species. No further assessment of the vegation within 'cleared' areas has been undertaken.

3.3 PLANT COMMUNITY TYPES

3.3.1 Survey Methodology

Identification and mapping of vegetation community and PCTs was based upon validation of the preliminary mapping of PCTs within the subject land by Biosis (2017). All vegetation polygons mapped by Biosis (2017) were traversed whilst observing the vegetation structure and dominant species within each structural layer. The entire distribution of each vegetation polygon mapped by Biosis (2017) was traversed to sample any spatial variation within each polygon, validate boundaries between PCTs and to record and variation in the broad condition state of vegetation polygons to identify and map vegetation zones.

Based upon traverses of each of the vegetation polygons and revisions to mapped boundaries, vegetation communities within the subject land were identified. The floristics of each of these vegetation communities were then sampled within plot-based floristic vegetation surveys consistent with section 5.2.1.9 of the BAM. The location of floristic plots is shown in **Figure 6**. The plot locations also represented the location of vegetation integrity plots in accordance with section 5.3 of the BAM. The location of floristic vegetation plots was based upon randomly sampling areas of each vegetation community whilst ensuring that the plot-based surveys included representative areas within each community, sampled the geographic range of each community and that plots were not influenced by edge effects (i.e. located close to edges of vegetation extent) or ecotones with adjacent vegetation zones.

The identification of PCTs for each vegetation community was in accordance with the NSW PCT classification as described in the BioNet Vegetation Classification. Determination of the most appropriate PCTs for vegetation communities within the subject lands used the BioNet Vegetation Classification database to filter PCT types within the NSW North Coast Bioregion which included the canopy species which had the greatest percent foliage cover and abundance as recorded within floristic plots. The data for each PCT including vegetation formation, descriptive attributes and distribution information were then reviewed to determine the most appropriate PCT for each of the vegetation polygons sampled within the subject land. Observations of vegetation structure and composition made during traverses of the subject lands as well as previous floristic data for adjacent land (section 3.2) also informed the determination of most appropriate PCTs for the vegetation communities within the subject land.

3.3.2 Plant Community types

Five PCTs were identified across the Site, with the distribution of these communities related to the topographical position, slope and aspect within the Site (**Figure 6**). Boundaries between the PCTs were often difficult to identify, with broad ecotones between vegetation communities present and many flora species from all structural layers shared by adjacent vegetation communities. The boundaries were distinguished based upon changes in topography, vegetation structure and the dominance of primary canopy species. The five PCTs identified within the Site are:

- PCT 1590: Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest;
- PCT 1567: Tallowwood - Brush Box - Sydney Blue Gum moist shrubby tall open forest on foothills of the lower North Coast;
- PCT 1527: Bangalow Palm - Coachwood - Sassafras gully warm temperate rainforest of the Central Coast;
- PCT: 1550: Small-fruited Grey Gum - Turpentine - Tallowwood moist open forest on foothills of the lower North Coast; and
- PCT 1618: Smooth-barked Apple - White Stringybark - Red Mahogany - Melaleuca sieberi shrubby open forest on lowlands of the lower North Coast.

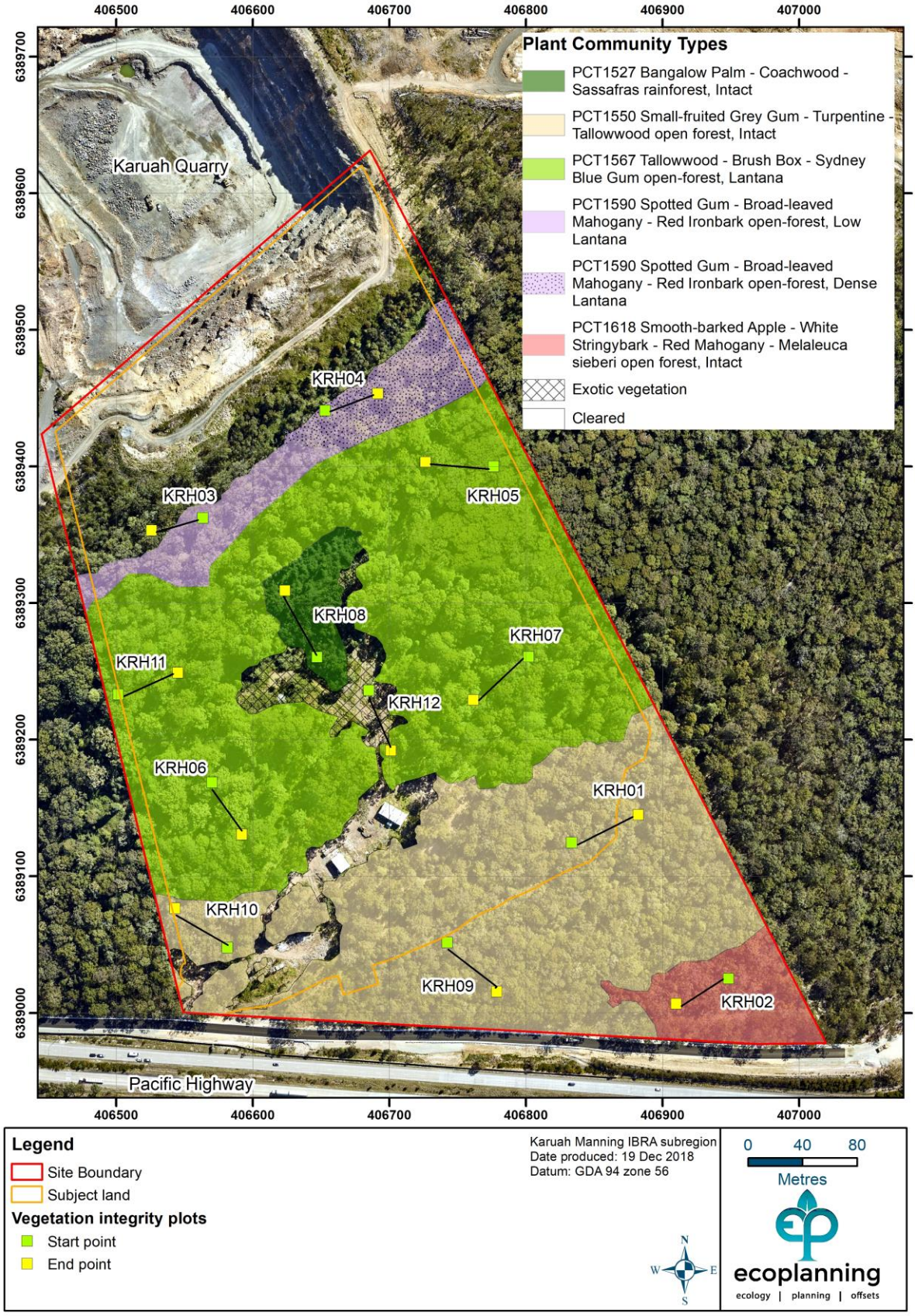

Figure 6 **Plant Community Types (PCTs) and Vegetation Integrity Plot Locations**

One of the PCTs identified within the Site, PCT 1618, was not identified as occurring within the subject land. No further assessment of this PCT is required. Details of each of these PCTs within the subject land are summarised in **Table 2**, with the distribution of the PCTs within the Site shown in **Figure 6**. Descriptions of each of the PCTs identified within the subject land are outlined below.

Table 2
Plant Community Types (PCTs) Identified within the Subject Land

PCT	Vegetation Class	Vegetation zones	Area (ha)	PCT percent cleared	TEC
1590 - Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest	Hunter-Macleay Dry Sclerophyll Forests	Dense Lantana	0.58	48%	None[1]
		Low Lantana	0.56		
1567 - Tallowwood - Brush Box - Sydney Blue Gum moist shrubby tall open forest on foothills of the lower North Coast	North Coast Wet Sclerophyll Forest	Lantana	7.45	2%	None
1527 - Bangalow Palm - Coachwood - Sassafras gully warm temperate rainforest of the Central Coast	Northern Warm Temperate Rainforests	Intact	0.47	70%	Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions (BC Act) 'Lowland Rainforest of Subtropical Australia' (EPBC Act[2])
1550 - Small-fruited Grey Gum - Turpentine - Tallowwood moist open forest on foothills of the lower North Coast	Northern Hinterland Wet Sclerophyll Forests	Intact	2.53	25%	None
Exotic vegetation	N/A	-	0.53	-	-
Cleared land	N/A	-	4.24	-	-
Total			**16.36***		

* Rounding errors may apply

1 Note this PCT is associated with Lower Hunter Spotted Gum – Ironbark Forest EEC, however the vegetation in the subject land does not meet the definition of this EEC as described by the NSW SC (2010).

2. See Section 3.3.5 for details regarding the listing of this community under the EPBC Act

3.3.3 Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest (PCT 1590)

This vegetation community is located in the northern part of the subject land (**Figure 6**) on the gentle upper slopes of the hill and is an open-forest dominated by *C. maculata, E. acmenoides* and *E. paniculata* (**Plate 1**). *Eucalyptus fibrosa* was also identified as being present within this PCT. This PCT supported an open midstorey which included a number of mesic shrub species including *Cryptocarya rigida* (Forest Maple) and *Clerodendrum tomentosum* (Hairy

Clerodendrum) over a diverse grassy understorey. The condition of this vegetation community was variable with some areas being in a relatively undisturbed condition with low levels of *Lantana camara** (Lantana) infestation, while other areas have been disturbed as part of the approved activities within the adjacent Karuah Quarry and supported a sparse canopy layer and very dense infestations of *L. camara**. Two vegetation zones (based upon areas in a broadly similar condition state, consistent with section 5.3.1.1 of the BAM) were identified for this PCT, which separated areas with low *L. camara** cover and a higher density of native shrub and understorey species (termed 'Low lantana') from those areas with a dense cover of *L. camara** and lower cover of native shrub and understorey species (termed 'Dense lantana').

Plate 1 Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest (PCT 1590) – Low Lantana.

The identification of the most suitable PCT was based upon consideration of PCTs with *C. maculata* as a co-dominant with the NSW North Coast Bioregion. A number of PCTs were excluded based upon a more northerly distribution, including vegetation types associated with the Clarence and Macleay River Valleys, or drier grassy vegetation types with a more westerly distribution, including grassy woodland of the Hunter Valley with co-dominant species, *E. crebra* (Narrow-leaved Ironbark) and *E. moluccana* (Grey box). Three potential PCTs were considered as being most representative of the vegetation within the subject land, including PCTs 1549, 1584 and 1590. Ultimately, PCT 1549 was excluded based upon the described dominance of *E. microcorys* within this PCT, as this species was absent within the defined area of this PCT within the subject land. Similarly, PCT 1584 was excluded based upon the absence of any Ironbark species in the description of this community and the topographic position, which is described as including gullies and lower slopes mainly on sandstone substrates and at mid to lower elevations. Consequently, PCT 1590 was considered the 'best fit' for the dry sclerophyll forest vegetation on the gentle upper slopes of the subject land.

The NSW BioNet Vegetation Classification identifies PCT 1590 to be associated in part with the 'Lower Hunter Spotted-Gum Ironbark Forest in the Sydney Basin Bioregion' endangered ecological community (EEC), listed under the BC Act. However, the vegetation which was identified as being PCT 1590 within the subject land does not form part of this EEC. The 'Lower Hunter Spotted-Gum Ironbark Forest in the Sydney Basin Bioregion' EEC is identified as being restricted to a range of approximately 65 km by 35 km centred on the Cessnock – Beresfield area in the Central and Lower Hunter Valley (NSW SC 2010) which does not include the current subject land. Additionally, there are other differences between the geology, soil landscapes and geographic distribution of the EEC and the vegetation within the subject land (NSW SC 2010).

3.3.4 Tallowwood - Brush Box - Sydney Blue Gum moist shrubby tall open forest on foothills of the lower North Coast (PCT 1567)

This vegetation community is located across the central and midslope areas of the subject land (**Figure 6**) and is associated with the steepest and more sheltered areas. This PCT was characterised by a tall open forest dominated by *Lophostemon confertus* (Brush Box), *E. saligna* (Sydney Blue Gum) and *E. acmenoides* (**Plate 2**). *Eucalyptus microcorys* was also present as a sub-dominant species within the canopy of this community. The midstorey included a number of mesic species such as *Eupomatia laurina* (Bolwarra), *Synoum glandulosum* subsp. *glandulosum* (Scentless Rosewood), *Neolitsea dealbata* (Hairy-leaved Bolly Gum) and *Cryptocarya rigida* (Forest Maple). A number of climbers and lianas were present climbing over the shrub layer within this vegetation community including *Smilax australis* (Lawyer Vine), *Dioscorea transversa*, *Cissus antarctica* (Water Vine), *Stephania japonica* var*. discolor* (Snake Vine) and *Eustrephus latifolius* (Wombat Berry). The understorey of this vegetation community included a number of ferns and herbs including *Blechnum neohollandicum* (syn. *Doodia aspera*), *Adiantum formosum* (Black Stem), *Calochlaena dubia* (Rainbow Fern), *Blechnum cartilagineum* (Gristle Fern), *Oplismenus spp*. (Basket Grasses) and *Commelina cyanea*. The exotic species *L. camara** was present throughout all areas of this PCT with cover varying from moderate to dense. The distribution of *L. camara** within this PCT was also highly variable forming a mosaic of more open areas with little cover interspersed with areas of dense impenetrable thickets. As *L. camara** was consistently present throughout this PCT and highly variable in density across very small distances, all areas of this vegetation community were identified as the one vegetation zone, termed 'Lantana'.

Identification of the most equivalent PCT was based upon filtering those PCTs within the NSW North Coast Bioregion, which included *L. confertus* and *E. saligna* as the dominant canopy species. A number of PCTs with a broadly similar canopy were identified within this Bioregion, with a number excluded based upon their more northerly distribution (i.e. PCTs 747, 748 and PCT 1243). Similarly, PCTs 1263 and 1571 were excluded based on elevation (PCT 1263 is described as occurring at high elevations north of Bulga Tops and PCT 1571 is identified as occurring between 400 and 1000 metres above the AHD)), as the subject land is less than approximately 120m AHD. Consequently, PCT 1567 was considered the 'best fit' for tall open-forest vegetation on the mid slopes of the subject land.

PCT 1567, does not form part of any TEC listed under the BC Act or the EPBC Act.

Plate 2 Tallowwood - Brush Box - Sydney Blue Gum moist shrubby tall open forest on foothills of the lower North Coast - Lantana.

3.3.5 Bangalow Palm - Coachwood - Sassafras gully warm temperate rainforest of the Central Coast (PCT 1527)

This PCT was identified as occurring in the centre of the subject land, in a small area (approximately 0.47 ha, **Figure 6**) sheltered by steep slopes to the west. This PCT occurred as a closed forest which was dominated by a diverse range of rainforest canopy species (**Plate 3**). The canopy within this area is multi-layered and dominated by *Archontophoenix cunninghamiana* with a range of other co-dominant canopy species including *N. dealbata, S. glandulosum* subsp. *glandulosum*, *Pararchidendron pruinosum* var. *pruinosum* (Snow Wood), *Sloanea australis* (Maiden's Blush), *Dendrocnide excelsa* (Giant Stinging Tree) and *Diploglottis australis* (Native Tamarind). A range of lianas and climbers were present within this PCT including *S. australis, Morinda jasminoides, Dioscorea transversa, Cissus spp*. and *Ripogonum fawcettianum* (Small Supplejack). A sparse understorey was present below the dense canopy and included a number of ferns such as *Lastreopsis microsora* subsp. *microsora* (Creeping Shield Fern), *Pteris umbrosa* (Jungle brake), *Pteris tremula* (Tender brake) and *Adiantum formosum*. Exotic species were generally absent from the small area of this community, although very dense thickets of *L. camara** enclosed the small patch of this PCT. The entire area of this PCT was in a broadly similar condition state and was identified as a single vegetation zone, termed 'Intact'.

Identification of the most likely PCT was initially limited to those PCTs within the NSW North Coast Bioregion and which formed part of the 'Rainforest' vegetation formation of Keith (2004). A number of PCTs within the rainforest vegetation formation are identified for the NSW North Coast Bioregion, however none of these PCTs included *A. cunninghamiana*, which represented the most distinctive component and one of dominant species within the canopy of this PCT within the subject land. Only one PCT within the rainforest vegetation formation

identifies *A. cunninghamiana* as a component of the canopy, PCT 1527. The floristic description of this PCT was identified as being broadly equivalent to the vegetation within the subject land, although the identified landscape for this PCT (sheltered gullies on the sandstone ranges of the Central Coast) does not accurately describe the occurrence within the subject land. Additionally, the distribution of this community is limited to the Sydney Basin Bioregion and Hunter subregion (IBRA v7), which has its northern limit approximately 9 km south of the Site. Nonetheless, PCT 1527 was identified as the 'best fit' description of the vegetation community within the subject land.

Plate 3 Bangalow Palm - Coachwood - Sassafras gully warm temperate rainforest of the Central Coast - Intact

PCT 1527 forms part of the 'Lowland Rainforest in the NSW North-Coast and Sydney Basin Bioregions' EEC as listed under the BC Act. This vegetation also meets the definition of the 'Lowland Rainforest of Subtropical Australia', Critically Endangered Ecological Community (CEEC) as listed under the EPBC Act. The listing of this ecological community under the EPBC Act includes only patches of the ecological community that are most functional, relatively natural and in relatively good condition. Condition thresholds identify patches of the ecological community which meet the definition of the community under the EPBC Act. To meet this definition under the EPBC Act, a patch must:

1. have mature residual canopy trees present;
2. be greater than or equal to 0.1 ha in area;
3. have greater than 70% projected foliage cover including lianas;
4. contain greater than or equal to 30 native woody species as listed under Appendix A of the listing advice; and
5. have greater than or equal to 50% of the vegetation within the patch native.

Vegetation within the subject land meets all five of the criteria above. It is noted that in relation to criteria 4, a complete census of all flora species within the patch of the vegetation community has not been undertaken. Based upon the floristic plot and traverses through the patch, 35 of the native woody species (as included in Appendix of the listing advice) have been observed within or immediately adjacent to the patch of this PCT within the subject land. Consideration of impacts to species and ecological communities listed under the EPBC Act is provided in **Annexure 1**.

3.3.6 Small-fruited Grey Gum - Turpentine - Tallowwood moist open forest on foothills of the lower North Coast (PCT 1550)

This PCT was identified as occurring on the lower slopes of the subject land (**Figure 6**) and consisted of a tall-open forest which supported a diverse canopy most commonly dominated by *E. propinqua, E. microcorys, Angophora floribunda* (Rough-barked Apple), *E. acmenoides, Syncarpia glomulifera* (Turpentine) and *E. paniculata* (**Plate 4**). A variable midstorey was present within this vegetation community including *Cryptocarya rigida*, *Acmena smithii* (Lilly Pilly), *Melaleuca styphelioides* (Prickly-leaved Tea Tree) and *Callistemon salignus* (Willow Bottlebrush). An open understorey including a variety of grasses and graminoids was present within this vegetation community including *Lomandra longifolia*, *Themeda triandra* (Kangaroo Grass), *Imperata cylindrica* (Blady Grass), *O. imbecillis* (Creeping Beard Grass) and *Poa labillardierei* var*. labillardierei* (Tussock). The cover of exotic species was generally low within this vegetation community, although *L. camara** was commonly present at low abundances. All areas of this PCT within the subject land were identified as being in a broadly similar condition state, termed 'Intact'.

Plate 4 Small-fruited Grey Gum - Turpentine - Tallowwood moist open forest on foothills of the lower North Coast – Intact

Identification of the most likely PCT was based upon identification of PCTs which included the dominant and most consistently present canopy species within the variable canopy of this vegetation community. PCTs were filtered for those including *E. propinqua, E. microcorys* and *S. glomulifera*, which was limited to PCT 1550. A number of other PCTs were also identified as representing a moderate fit for the vegetation within the subject land including PCTs 1562 and 1566. Ultimately PCT 1550 was considered the best representation of the vegetation within the subject land as the description of this PCT includes a more diverse canopy (which matches the vegetation within the subject land) than other similar PCTs.

This PCT does not form part of any TEC listed under the BC Act or the EPBC Act.

3.3.7 Exotic Vegetation

Within the central area of the subject land (**Figure** 6), in an areas where native vegetation has been virtually cleared, dense stands of exotic vegetation dominated by *L. camara*, Solanum mauritianum** (Wild Tobacco), *Bidens pilosa** (Cobbler's Pegs), *Paspalum ciliatifolium** (One-spiked Paspalum), *Paspalum urvillei** (Vasey Grass), *Setaria sphacelata** (South African Pigeon Grass) and *Cirsium vulgare** (Spear Thistle) were present (**Plate** 5). No native canopy or mid-storey was present within this vegetation community and native ground cover species were generally uncommon.

Plate 5 Exotic Vegetation within the Subject Land (foreground)

3.4 GROUNDWATER DEPENDENT ECOSYSTEMS

The NSW *Water Management Act 2000* defines GDEs as "Ecosystems which have their species composition and ecosystem processes wholly or partially determined by groundwater".

A desktop review of aquatic and terrestrial GDE mapping generated by the Groundwater Dependent Ecosystem Atlas (BOM 2018), which is the most comprehensive inventory of the location and characteristics of groundwater dependent ecosystems for Australia, shows no aquatic GDEs are mapped within the subject land, with the nearest aquatic GDEs occurring in association with the Karuah River. Aquatic GDEs are ecosystems which ecosystems that rely on the surface expression of groundwater. Terrestrial GDEs, those ecosystems which rely on the subsurface presence of groundwater, are mapped within the subject land by (BOM 2018) which identifies low, moderate and high potential GDEs across the subject land. High and moderate potential GDEs identified within the subject land by BOM (2018) include those identified in association with two vegetation types, '*Red Bloodwood / Smooth-barked Apple heathy woodland*' and '*Swamp Mahogany/ Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast'*, neither of which are comparable to the PCTs identified within the subject land.

Exploration holes have been drilled within the subject land and adjacent area as part of the Karuah East Quarry. Whilst groundwater was encountered in some exploration holes, this was assumed to occur in fractures within bedrock of limited extent and connectivity (RW Corkery 2017). The PCTs identified within the subject land do not represent recognised GDEs and if species within these PCTs are accessing groundwater, they are likely to be using this resource opportunistically, rather than being dependent upon its presence.

3.5 CURRENT AND FUTURE VEGETATION INTEGRITY SCORES

As outlined above, each of the PCTs identified within the development site were classified into vegetation zones in accordance with section 5.3 of the BAM. The vegetation zones are based on the condition descriptions above with the area of each vegetation zones shown in **Table 3**.

Each vegetation zone identified within the subject land was surveyed and quantitative measures of the composition, structure and function attributes recorded in accordance with section 5.3.4 of the BAM. The locations of the plot-based vegetation integrity surveys are shown in **Figure 6**. The number of plots surveyed for each vegetation zone are equal to or greater than the required number of plots as outlined in Table 4 of the BAM and shown in **Table 3**. For each plot/transect, the vegetation composition, structure and function were assessed in accordance with the BAM and using the BAM Calculator a vegetation integrity score was calculated for each vegetation zone (**Annexure 2**). Vegetation integrity scores for each vegetation zone are presented in **Table 3**. For the areas mapped as 'Exotic vegetation', data collected from the single vegetation integrity plot for this vegetation type was entered into the BAM Calculator as a zone of PCT 1567 in order to calculate a vegetation integrity score. This area was entered as a zone of PCT 1567 as this represents the PCT which would have most likely occurred in this area prior to the past disturbance.

Vegetation integrity scores ranged from 52.6/100 to 64.9/100 for vegetation zones within areas of native vegetation while the 'exotic vegetation' zone had a vegetation integrity score of 6.3/100 (**Table 3**). Future vegetation integrity scores were allocated for each vegetation zone. The Project would involve the complete removal of all vegetation within the subject land and the default future vegetation integrity score of 0 for each vegetation within the subject land was retained.

Table 3
The Area of each PCT Within the Subject Land and Number of Plots Surveyed.

Vegetation zone	Area	Plots Required	Plots Surveyed	Vegetation Integrity Score
1590 - Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest – Dense Lantana	0.58	1 plot/transect	1 (KRH 04)	52.6
1590 - Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest – Low Lantana	0.56	1 plot/transect	1 (KRH 03)	61.5
1567 - Tallowwood - Brush Box - Sydney Blue Gum moist shrubby tall open forest on foothills of the lower North Coast Lantana	7.45	3 plot/transects	4 (KRH 05, 06, 07 and 11)	63.2
1527 - Bangalow Palm - Coachwood - Sassafras gully warm temperate rainforest of the Central Coast Intact	0.47	1 plot/transect	1 (KRH 08)	64.9
1550 - Small-fruited Grey Gum - Turpentine - Tallowwood moist open forest on foothills of the lower North Coast Intact	2.53	2 plot/transects	3 (KRH 01, 09, 10)	62.1
Exotic vegetation	0.53	-	1 (KRH 12)	6.3
Cleared land	4.24	-	0	-
Total	**16.36***			

* Rounding errors may apply;

4. ASSESSING HABITAT SUITABILITY FOR THREATENED SPECIES

Section 6 of the BAM details the process for determining the habitat suitability for threatened species.

Under the BAM, threatened species are separated into two classes, 'ecosystem' and 'species' credit species. Those threatened species where the likelihood of occurrence of a species or elements of the species' habitat can be predicted by vegetation surrogates and landscape features, or for which a targeted survey has a low probability of detection, are identified as 'ecosystem' credit species. Targeted surveys are not required for ecosystem species and potential impacts to these species are assessed in conjunction with impacts to PCTs.

Threatened species where the likelihood of occurrence of a species or elements of suitable habitat for the species cannot be confidently predicted by vegetation surrogates and landscape features and can be reliably detected by survey are identified as 'species' credit species. A targeted survey or an expert report is required to confirm the presence or absence of these species on the subject land.

Some threatened species, are identified as both ecosystem and species credit species, with different aspects of the habitat and life cycle representing different credit types. Commonly, threatened fauna species may have foraging habitat as an ecosystem credit, while their breeding habitat represents a species credit.

The following sections outline the process for determining the habitat suitability for threatened species within the subject lands, and the results of targeted surveys for candidate threatened species.

4.1 IDENTIFY THREATENED SPECIES FOR ASSESSMENT

Threatened species that require assessment are initially identified based upon the following criteria.

- The distribution of the species includes the IBRA subregion in which the subject land.
- The subject land is within any geographic constraints of the distribution of the species within the IBRA subregion.
- The species is associated with any of the PCTs identified within the subject land.
- The native vegetation cover within an assessment area including a 1,500 m buffer around the subject land is equal to or greater than the minimum required for the species.
- The patch size that each vegetation zone is part of is equal to or greater than the minimum required for that species.
- The species is identified as an ecosystem or species credit species in the Threatened Biodiversity Data Collection.

The process for identifying threatened species which meet the above criteria is completed through the BAM Calculator. The PCTs identified within the subject land, patch sizes and native vegetation cover, as outlined in Sections 2 and 3 of this report, were entered into the BAM Calculator and a preliminary list of threatened species were identified.

4.1.1 Ecosystem Credit Species

The ecosystem credit species predicted on site are provided in **Table 4**. All ecosystem credit species were maintained in the assessment.

Table 4
Ecosystem Credit Species Predicted to occur within the Subject Land

Species / common name	**NSW Listing Status* (BC Act)**	**National Listing Status* (EPBC Act)**
Anthochaera phrygia Regent Honeyeater (Foraging)	CE	CE
Callocephalon fimbriatum Gang-gang Cockatoo (Foraging)	V	-
Calyptorhynchus lathami Glossy Black-Cockatoo (Foraging)	V	-
Chthonicola sagittata Speckled Warbler	V	-
Climacteris picumnus victoriae Brown Treecreeper (eastern subspecies)	V	-
Daphoenositta chrysoptera Varied Sittella	V	-
Dasyurus maculatus Spotted-tailed Quoll	V	E
Falsistrellus tasmaniensis Eastern False Pipistrelle	V	-
Glossopsitta pusilla Little Lorikeet	V	-
Haliaeetus leucogaster White-bellied Sea-Eagle (Foraging)	V	-
Hieraaetus morphnoides Little Eagle (Foraging)	V	-
Kerivoula papuensis Golden-tipped Bat	V	-
Lathamus discolor Swift Parrot (Foraging)	E	CE
Lophoictinia isura Square-tailed Kite (Foraging)	V	-
Melanodryas cucullata cucullata Hooded Robin (south-eastern form)	V	-
Melithreptus gularis gularis Black-chinned Honeyeater (eastern subspecies)	V	-
Miniopterus australis Little Bentwing-bat (Foraging)	V	-
Miniopterus schreibersii oceanensis Eastern Bentwing-bat (Foraging)	V	-
Mormopterus norfolkensis *Eastern Freetail-bat*	V	-
Neophema pulchella *Turquoise Parrot*	V	-

Table 4 (Cont'd)
Ecosystem Credit Species Predicted to occur within the Subject Land

Species / common name	NSW Listing Status* (BC Act)	National Listing Status* (EPBC Act)
Ninox connivens Barking Owl (Foraging)	V	-
Ninox strenua Powerful Owl (Foraging)	V	-
Petaurus australis Yellow-bellied Glider	V	-
Petroica boodang Scarlet Robin	V	-
Phascolarctos cinereus Koala (Foraging)	V	V
Pomatostomus temporalis temporalis Grey-crowned Babbler (eastern subspecies)	V	-
Potorous tridactylus Long-nosed Potoroo	V	V
Pseudomys gracilicaudatus Eastern Chestnut Mouse	V	-
Pteropus poliocephalus Grey-headed Flying-fox (Foraging)	V	V
Ptilinopus magnificus Wompoo Fruit-Dove	V	-
Ptilinopus regina Rose-crowned Fruit-Dove	V	-
Ptilinopus superbus Superb Fruit-Dove	V	-
Saccolaimus flaviventris Yellow-bellied Sheathtail-bat	V	-
Scoteanax rueppellii Greater Broad-nosed Bat	V	-
Stagonopleura guttata Diamond Firetail	V	-
Thylogale stigmatica Red-legged Pademelon	V	-
Tyto novaehollandiae Masked Owl (Foraging)	V	-
Tyto tenebricosa Sooty Owl (Foraging)	V	-

4.1.2 Species Credit Species

As outlined above, species credit species are predicted in the BAM Calculator following assessment of geographic and habitat features in the credit calculator, such as site location (IBRA subregion), PCTs and condition, patch size and the area of surrounding vegetation within the 1,500 m buffer of the subject land. A total of 17 flora and 38 fauna species credit species were identified as potentially occurring within the subject land.

4.2 ASSESSMENT OF HABITAT CONSTRAINTS, VAGRANT SPECIES AND HABITAT SUITABILITY/DEGRADATION

Some candidate species credit threatened species require further assessment of habitat constraints and/or geographic limitations before being confirmed as candidate species for assessment. Where a species has a specific habitat constraint, which is not present within the subject land, or if the species is a vagrant within the IBRA subregion, the species is considered unlikely to occur and no further assessment is required. **Table 5** outlines the questions asked for these species, and whether the species is confirmed as a candidate species. Three potential candidate species were dismissed based on the location of the subject land (Rufous Bettong (*Aepyprymnus rufescens*), *Allocasuarina simulans* and *Diuris arenaria*) while one species, the Brush-tailed Rock-wallaby (*Petrogale penicillata*) was dismissed based upon the habitat constraints for this species (**Table 5**). The subject land does not support the required rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliff lines required by the Brush-tailed Rock-wallaby, nor are they present within 1 km of the subject land.

Table 5
Assessment of Habitat and Geographic Limitations for Candidate Threatened Species

Species	**Habitat | Geographic Constraints**	**Maintained as Potential Candidate Species**
Aepyprymnus rufescens (Rufous Bettong)	North of Gloucester	No
Allocasuarina simulans (Nabiac Casuarina)	Within 25 km of Forster	No
Angophora inopina (Charmhaven Apple)	South of Wootton	Yes
Burhinus grallarius (Bush Stone-curlew)	Fallen/standing dead timber including logs	Yes
Chalinolobus dwyeri (Large-eared Pied Bat)	Within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within 2 km of old mines or tunnels.	Yes
Diuris arenaria (Sand Doubletail)	South from Soldiers Point	No
Hoplocephalus stephensii (Stephens' Banded Snake)	1. Hollow bearing trees 2. Or within 500 m of this habitat | Other 3. Within 500 m of arboreal vine tangles | Fallen/standing dead timber including logs 4. Or within 500 m of this habitat	Yes
Litoria aurea *(Green and Golden Bell Frog)*	1. Semi-permanent/ephemeral wet areas 2. Within 1km of wet areas | Swamps 3. Within 1km of swamp | Waterbodies 4. Within 1km of waterbody	Yes
Melaleuca biconvexa *(Biconvex Paperbark)*	1. Swamps 2. Swamp margins or creek edges	Yes

Table 5 (Cont'd)
Assessment of Habitat and Geographic Limitations for Candidate Threatened Species

Species	Habitat | Geographic Constraints	Maintained as Potential Candidate Species
Mixophyes iteratus (Giant Barred Frog)	1. Other 2. Inhabits land within 50 m of semi-permanent and permanent drainages.	Yes
Myotis macropus (Southern Myotis)	1. Hollow bearing trees 2. Within 200 m of riparian zone | Other 3. Bridges, caves or artificial structures within 200 m of riparian zone	Yes
Petrogale penicillata (Brush-tailed Rock-wallaby)	1. N/A | Other 2. Land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliff lines	No
Phascogale tapoatafa (Brush-tailed Phascogale)	1. Hollow bearing tress	Yes
Vespadelus troughtoni (Eastern Cave Bat)	1. Caves 2. Within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within 2 km of old mines, tunnels, old buildings or sheds." | N/A	Yes

In accordance with section 6.4.1.17 of the BAM, a candidate species credit species can also be considered unlikely to occur within the subject land (or specific vegetation zones) where habitat is substantially degraded such that the species is unlikely to utilise area. As discussed in **Sections 2** and **3**, much of the vegetation within the subject land and 1,500 m buffer has been previously cleared, fragmented and is subject to ongoing disturbance associated with the noise and edge effects including in association with surrounding quarries (Karuah Quarry and Karuah East Quarry) and the Pacific Highway. A predicted candidate species credit species that is not considered to have suitable habitat on the subject land (or specific vegetation zones) in accordance with section 6.4.1.17 of the BAM does not require further assessment on the subject land (or specific vegetation zones). The reasons for determining that a predicted species credit species is unlikely to have suitable habitat on the subject land (or specific vegetation zones) must be documented.

Table 6 outlines the candidate threatened species which are considered unlikely to have suitable habitat on the subject land including the reasons for this decision. As per section 6.4.1.5 of the BAM, any threatened species that has been previously recorded within the subject lands by past surveys, must be identified as being a species that requires assessment.

Based upon the assessment of available habitat for predicted candidate species within the subject land, the following predicted candidate species in **Table 7** were confirmed for the subject land.

Table 6
Candidate Threatened Species Considered Unlikely to Occur Within the Subject Land

Species	Justification[1]
Anthochaera phrygia (Regent Honeyeater (Breeding)	No suitable breeding habitat within the subject land. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands.
Lathamus discolor (Swift Parrot - Breeding)	No suitable breeding habitat within subject land. This species breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland.
Miniopterus australis (Little Bentwing-bat - Breeding)	No suitable breeding habitat within the subject land. Maternity colonies form in spring and birthing occurs in early summer with males and juveniles disbursing in summer. Females leave their babies in nursery caves at night to go and hunt, returning in the morning. Nursery caves have specific requirements and only five nursery sites / maternity colonies are known in Australia. In NSW the largest maternity colony is in close association with a large maternity colony of Eastern Bentwing-bats (*Miniopterus schreibersii*) and appears to depend on the large colony to provide the high temperatures needed to rear its young.
Miniopterus schreibersii oceanensis (Eastern Bentwing-bat - Breeding)	No suitable breeding habitat within the subject land. This species forms discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Maternity caves have very specific temperature and humidity regimes. At other times of the year, populations disperse within about 300 km range of maternity caves.
Phascolarctos cinereus - endangered population Koala, Hawks Nest and Tea Gardens population	The subject land is outside the geographic boundaries identified for this endangered population. This species is maintained as a candidate species, but the endangered population does not for part of this assessment.

1. Unless otherwise stated, habitat information is sourced from OEH (2018b)

Table 7
Confirmed Candidate Threatened Fauna Species

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Common name	Scientific name
Amphibians	
Diurnal birds – hollow-dependent	
Gang-gang Cockatoo (Breeding)	*Callocephalon fimbriatum*
Glossy Black-Cockatoo (Breeding)	*Calyptorhynchus lathami*
Diurnal birds – Ground-dwelling	
Emu population in the NSW North Coast Bioregion	*Dromaius novaehollandiae - endangered population*
Diurnal birds - raptors	
White-bellied Sea-Eagle (Breeding)	*Haliaeetus leucogaster*
Little Eagle (Breeding)	*Hieraaetus morphnoides*
Square-tailed Kite (Breeding)	*Lophoictinia isura*
Eastern Osprey (Breeding)	*Pandion cristatus*

Table 7 (Cont'd)
Confirmed Candidate Threatened Fauna Species

Common name	Scientific name
Nocturnal birds	
Barking Owl (Breeding)	*Ninox connivens*
Powerful Owl (Breeding)	*Ninox strenua*
Masked Owl (Breeding)	*Tyto novaehollandiae*
Bush Stone-curlew	*Burhinus grallarius*
Red-backed Button-quail	*Turnix maculosus*
Sooty Owl (Breeding)	*Tyto tenebricosa*
Mammals (non-flying) – terrestrial	
Parma Wallaby	*Macropus parma*
Common Planigale	*Planigale maculata*
Mammals (non-flying) – Arboreal hollow-dependent	
Eastern Pygmy-possum	*Cercartetus nanus*
Squirrel Glider	*Petaurus norfolcensis*
Brush-tailed Phascogale	*Phascogale tapoatafa*
Mammals – Arboreal (other)	
Koala (Breeding)	*Phascolarctos cinereus*
Grey-headed Flying-fox (Breeding)	*Pteropus poliocephalus*
Microchiropteran bats	
Large-eared Pied Bat	*Chalinolobus dwyeri*
Southern Myotis	*Myotis macropus*
Eastern Cave Bat	*Vespadelus troughtoni*
Amphibians	
Green and Golden Bell Frog	*Litoria aurea*
Green-thighed Frog	*Litoria brevipalmata*
Stuttering Frog	*Mixophyes balbus*
Giant Barred Frog	*Mixophyes iteratus*
Reptiles	
Pale-headed Snake	*Hoplocephalus bitorquatus*
Stephens' Banded Snake	*Hoplocephalus stephensii*

4.3 DETERMINE THE PRESENCE OR ABSENCE OF A CANDIDATE THREATENED SPECIES CREDIT SPECIES

Those candidate species credit species for which the habitat suitability of the subject land cannot be ruled out based upon habitat or geographic constraints or habitat degradation, require targeted surveys to determine their presence or absence from the subject land. Targeted surveys for species credit species must be undertaken in accordance within section 6.5 of the BAM, including undertaking surveys during the nominated survey period specified for each candidate species and in accordance with OEH threatened species survey guidelines. The following sections outline the surveys undertaken, and survey requirements, for the candidate species identified for the subject land.

4.3.1 Targeted Surveys – Flora

A total of 15 threatened flora species were identified from the BAM Calculator as candidate species for the surveys (Table 8). Targeted surveys for threatened flora were undertaken in accordance with OEH's *NSW Guide to Surveying Threatened Plants* (OEH 2016) and involved initial searches to determine potential habitat of the candidate species within the subject land and parallel traverses within areas of potential habitat. Flora survey effort is shown on **Figure 7.** In accordance with OEH (2016), surveys for candidate threatened orchid species (*Pterostylis chaetophora*, *Corybas dowlingii* (Red Helmet Orchid) and *Diuris praecox* (Rough Doubletail)) were undertaken during the flowering period of the species as confirmed by visiting a reference population of each species. Surveys for *Cryptostylis hunteriana* (Leafless Tongue Orchid), were completed when the species was known to be flowering at a reference site (G. Phillips, Seedbank Officer - Royal Botanic Gardens, pers. comm 2018), although the reference population itself was not inspected. Additionally, surveys during the nominated survey period for *Rhizanthella slateri* (Underground Orchid) were undertaken without visiting a reference site for this species given the highly cryptic nature of this species. The underground nature of this species, with flowers maturing below the soil surface or extending up to 2 cm above the ground, makes surveying for this species extremely problematic, with most discoveries of this species being accidental during earthworks (Jones 2006). Additional details for each of the flora surveys are outlined in the following sections.

Table 8
Nominated Survey Period for Threatened Candidate Flora Species

Species	Nominated Survey Months (OEH, 2018)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Asperula asthenes (Trailing Woodruff)	Y	Y	Y							Y	Y	Y
Callistemon linearifolius	Y	Y	Y						Y	Y	Y	Y
Cryptostylis hunteriana (Leafless Tongue Orchid)	Y	Y									Y	Y
Cynanchum elegans (White-flowered Wax Plant)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Eucalyptus glaucina (Slaty Red Gum)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Grevillea guthrieana (Guthrie's Grevillea)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Grevillea parviflora subsp. *parviflora* (Small-flower Grevillea)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Melaleuca biconvexa (Biconvex Paperbark)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pomaderris queenslandica	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pterostylis chaetophora									Y	Y	Y	
Rhizanthella slateri (Underground Orchid)									Y	Y	Y	
Senna acclinis (Rainforest Cassia)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Solanum sulphureum	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Syzygium paniculatum (Magenta Lilly Pilly)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Tetratheca juncea (Black-eyed Susan)							Y	Y	Y	Y	Y	Y

BLUE columns indicate months of surveys

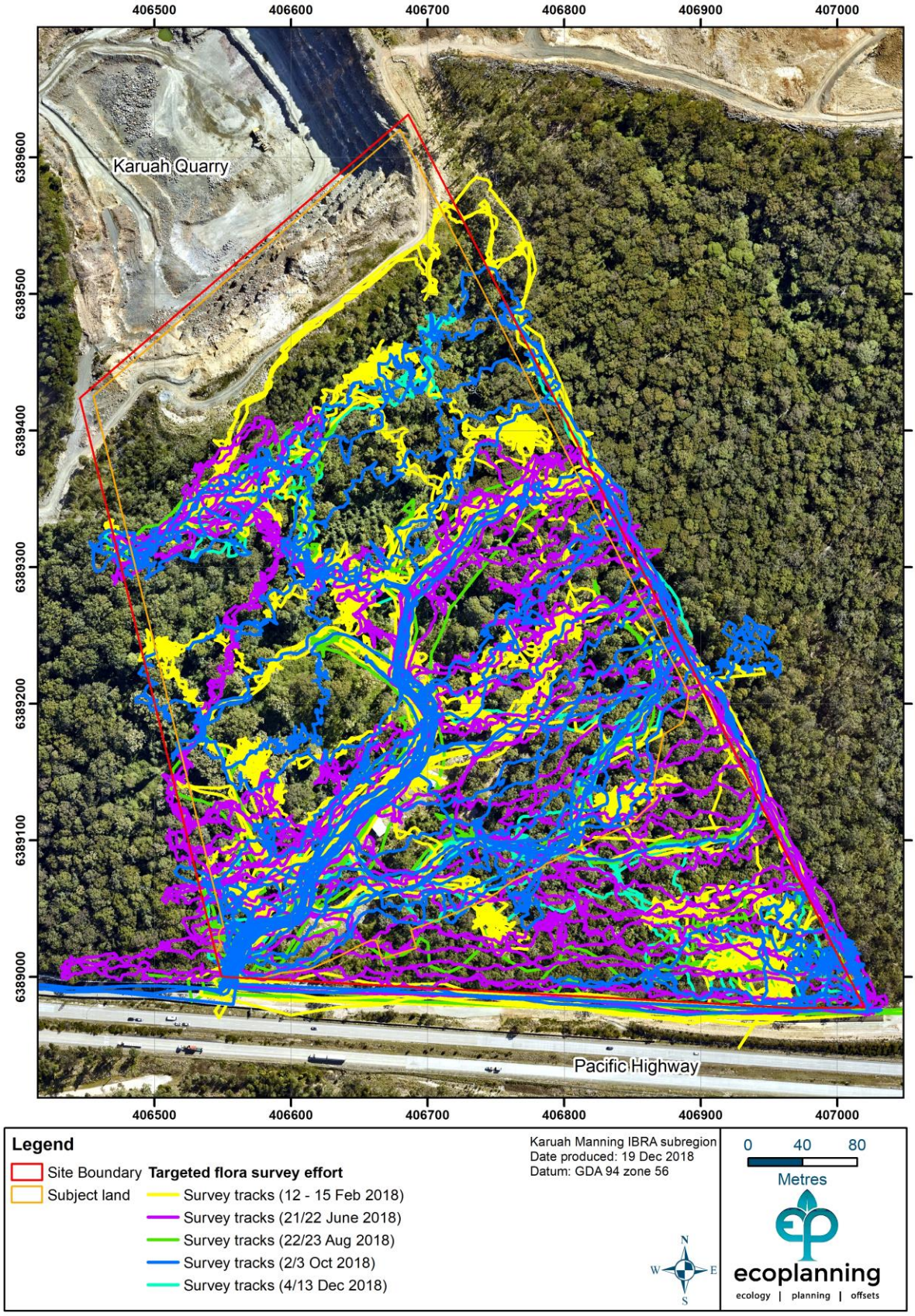

Figure 7 Survey Effort for Candidate Threatened Flora Species

Initial targeted flora surveys were undertaken by two ecologists on the 12, 13, 14 and 15 February 2018 (total survey effort approximately 64-person hours) in conjunction with the mapping of PCTs and completion of vegetation integrity plots. As a component of traversing the subject land and vegetation zones, habitat for candidate threatened flora species was identified and traverses were undertaken within areas of suitable habitat. Targeted threatened flora included the more distinct candidate species including trees and shrub species which are able to be surveyed for at any time of year. It is noted that these species were also subject to additional targeted surveys during subsequent surveys.

Additional targeted flora surveys were undertaken by two ecologists on the 21 and 22 June 2018 (total survey effort approximately 30-person hours). These surveys were timed to coincide with the flowering period of *Corybas dowlingii* (Red Helmet Orchid) which was predicted to occur within PCT 1618, which at the time of these surveys occurred within the Project footprint. These surveys were undertaken by walking parallel traverses separated by approximately 5 m through areas of potential habitat within the subject land in accordance with (OEH 2016). While corresponding habitat for this species, as identified within the Threatened Biodiversity Data Collection (BioNet; OEH 2018) was limited to the area mapped as PCT 1618, all PCTs and habitat within the subject land was surveyed as part of this survey, apart from large patches of dense *Lantana camara* (**Figure 7**).

Further targeted flora surveys were also undertaken by one ecologist on the 22 and 23 August 2018 (total survey effort approximately 15-person hours). These surveys were timed to coincide with the flowering period of *Diuris praecox* (Rough Doubletail) which was predicted to occur within PCT 1618, which at the time of these surveys occurred within the Project footprint. These surveys also coincided with the flowering period of *Tetratheca juncea* (Black-eyed Susan) as confirmed from references sites adjacent to the subject land (**Plate 6**). These surveys were undertaken by walking parallel traverses separated by approximately 5 m through areas of potential habitat within the subject land in accordance with OEH (2016). Areas of potential habitat for *Diuris praecox* were generally limited to those areas mapped as PCT 1618 (based upon predicted habitat for this species included within the Threatened Biodiversity Data Collection (BioNet; OEH 2018)), although areas with an open canopy or minimal canopy including disturbed easements and forest edges across all PCTs were surveyed. Areas of potential habitat for *Tetratheca juncea* included areas of PCTs 1618 and 1590 (based upon predicted habitat for this species included within the Threatened Biodiversity Data Collection (BioNet; OEH 2018)).

Further targeted flora surveys were also undertaken by two ecologists on the 2 and 3 October 2018 (total survey effort approximately 24-person hours). These surveys were timed to coincide with the flowering period of *Pterostylis chaetophora* as confirmed from a refence site approximately 9 km from the subject land (**Plate 7**). These surveys also coincided with the survey period of *Asperula asthenes* (Trailing Woodruff), *Callistemon linearifolius, Rhizanthella slateri* (Underground Orchid) and *Tetratheca juncea*. These surveys were undertaken by walking parallel traverses separated by approximately 5 m through areas of potential habitat within the subject land in accordance with OEH (2016). Areas of potential habitat for these species were generally considered to be present across the subject land, although were more commonly present in the south of the subject land and not within areas supporting dense infestations of *Lantana camara**.

Plate 6 *Tetratheca juncea* within Northern Section of Lot 11 // DP1024564 (Outside the Subject Land), photo taken 23 August 2018

Plate 7 *Pterostylis chaetophora* Flowering at a Reference Site Approximately 9 km from the Subject Land, photo taken 2 October 2018

An early summer targeted survey was undertaken by one ecologist over two days on the 4 and 13 December 2018 (total survey approximately 15-person hours). These surveys were timed to coincide with the flowering period of *Cryptostylis hunteriana* which was predicted to occur within PCTs 1590 and 1618. These surveys also coincided with the flowering period of *Tetratheca juncea* (Black-eyed Susan) as confirmed from references sites. These surveys were undertaken by walking parallel traverses separated by approximately 5 m through areas of potential habitat within the subject land in accordance with OEH (2016). Areas of potential habitat were generally limited to those areas mapped as PCT 1590 and 1618 (based upon predicted habitat for this species included within the Threatened Biodiversity Data Collection (BioNet; OEH 2018)), although additional areas near the margins of these PCTs were also surveyed.

No threatened flora species were recorded within the subject land. One threatened flora species, *Tetratheca juncea* (Black-eyed Susan), was recorded in the northern section of Lot 11, DP 1024564 outside of the subject land and the Site (**Figure 8**). As neither the individuals observed, or their species polygons calculated in accordance with section 6.4.1.29 of the BAM, are located within the subject land no further assessment is required for this species. A full list of flora species recorded within the Site is present in **Annexure 3**.

4.3.2 Targeted Surveys – Fauna

The fauna surveys undertaken were designed to create an inventory of the fauna species utilising the subject land with a focus on candidate threatened species. Targeted fauna surveys were completed across several survey periods to coincide with the survey periods for candidate species outlined within the BAM. The following sections outline the surveys undertaken for the various fauna groups and candidate threatened fauna species.

For the purposes of this fauna survey, the subject land was initially divided into three stratification units based upon vegetation formations identified within previous vegetation mapping (Biosis 2017). However, during field investigations, it was identified that the vast majority of the subject land (approximately 86%) comprised a single stratification unit, Wet Sclerophyll Forests, with the area of other stratifications units (Dry Sclerophyll Forests and Rainforest) occupying small areas on the margins of the subject land or small areas too small to sample independently (**Table 9**). Additionally, the habitat values and attributes of the preliminary stratification units were generally similar, and their boundaries were indistinct, such that fauna species were considered unlikely to be restricted to anyone of the preliminary stratification units. Consequently, the subject land was sampled as a single stratification unit and the survey designed to sample the full variation of vegetation and habitat types within the subject land.

Table 9
Preliminary Fauna Stratification Units

Fauna stratification units (Vegetation Formations)	PCTs	Area (ha)
Wet Sclerophyll Forests	1567 and 1550	9.98
Dry Sclerophyll Forest	1590	1.14
Rainforest	1527	0.47

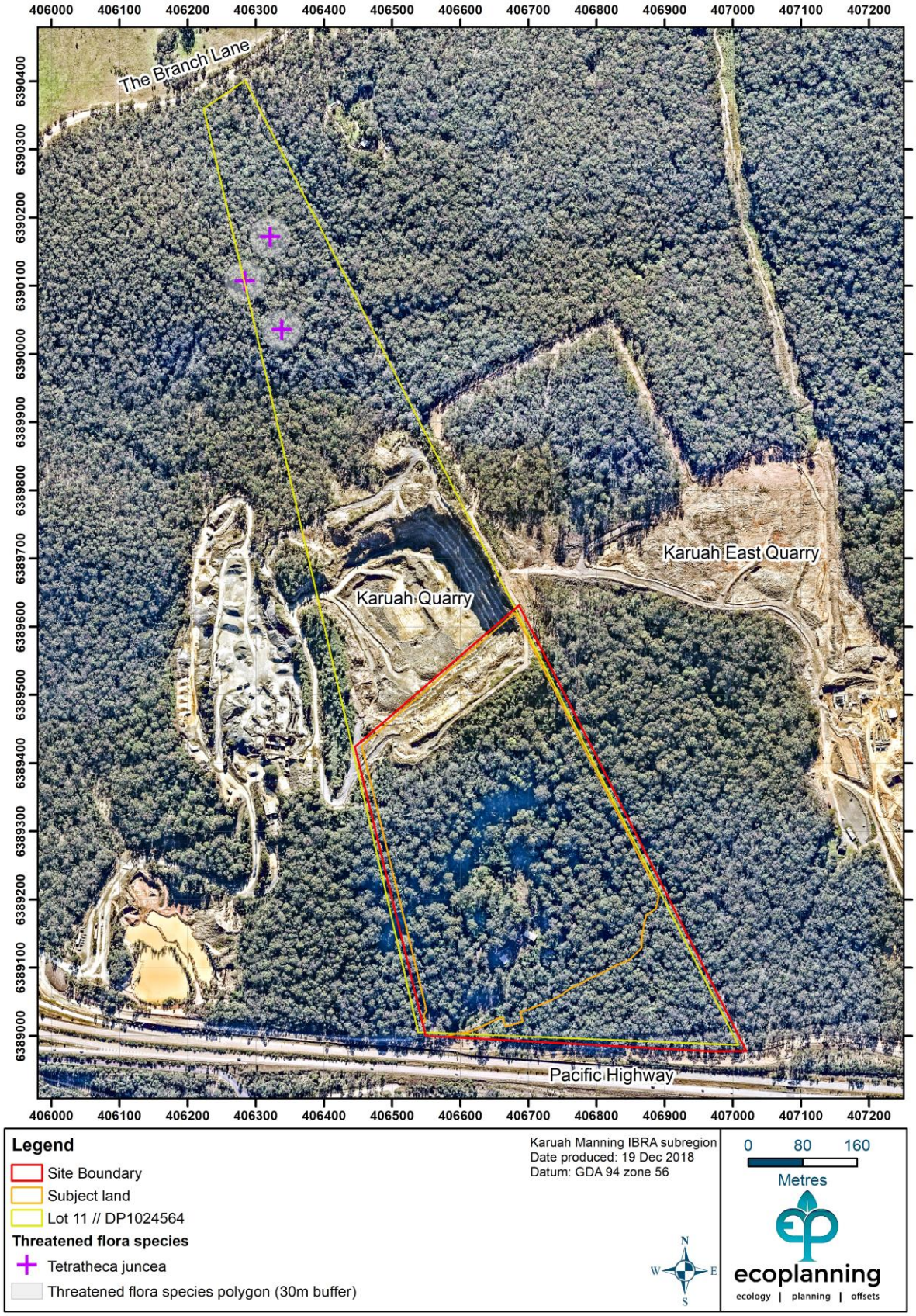

Figure 8 Threatened Flora Species

Fauna surveys comprised the methodologies listed below to survey for candidate threatened fauna species.

- Nocturnal watercourse searches for amphibians
- Nocturnal call playback
- Spotlighting
- Diurnal bird surveys (incidental and 20 min / 2 ha surveys)
- Hollow-bearing trees and nest searches
- Remote camera trapping
- Hair tubes (small [50 mm] and large [110x70 mm])
- Ultrasonic sounds detection (Anabats)
- Arboreal Elliott traps (A, B and E traps)
- Pitfall traps (30 cm diameter)
- Listening surveys during large owl breeding season
- Searches for indirect evidence of fauna species (white wash, pellets, scats, tracks, scratches)

The survey effort for each of these methods, including dates, are presented in **Table 10** with survey locations shown in **Figure 10**. A list of fauna species observed is included in **Annexure 3**. Weather conditions during the surveys periods are summarised in **Table 11** with rainfall across the surveys period graphed in **Figure 9**.

Table 10
Fauna Survey Methods, Effort and Timing

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Reference	Date	Survey method	Survey Effort
Diurnal Birds			
HWR Ecological (2004)	20-25/10/02	Diurnal fauna searches	12 hours
CEG (2012)	10-12/7/12	Opportunistic observations x 2 observers	26 person hours
This assessment (Ecoplanning 2018)	13-15/2/18	20 minute bird census x 2 observers	5 surveys
	12-16/2/18	Raptor nest search	5 days x 4 observers
	12-16/2/18	Opportunistic observations	5 days x 4 observers
	15/3/18	Opportunistic observations	1 day x 2 observers
	21-22/6/2018	Opportunistic observations	2 days x 2 observers
	2-3/10/18	Opportunistic observations	2 days x 2 observers

Table 10 (Cont'd)
Fauna Survey Methods, Effort and Timing

Reference	Date	Survey method	Survey Effort
Nocturnal Birds			
HWR Ecological (2004)	20-25/10/02	Recorded owl call playback	10 hours
		Diurnal fauna searches	12 hours
		General spotlighting	20 hours
CEG (2012)	10-12/7/12	Diurnal habitat search / hollow-bearing tree assessment x 2 observers	26 person hours
	10-11/7/12	Spotlighting / call playback x 2 observers	8 person hours
This assessment (Ecoplanning 2018)	12-16/2/18	Hollow-bearing tree survey - opportunistic	5 days x 4 observers
	20-21/6/18	Targeted large forest owl survey – listening at dusk	1.5 hours x 2 observers x 2 nights
	21-22/08/2018	Targeted large forest owl survey – listening at dusk	1.5 hours x 1 observer x 2 nights
	13-14/2/18	Spotlighting	4 person hours
	13-14/2/18	Call playback – Powerful Owl, Barking Owl, Masked Owl, Koala. 5 minutes listen, 5 minutes call, 5 minutes listen	2 nights
	20-21/6/18	Spotlighting	4 person hours
	21-22/08/18	Spotlighting	2 person hours
	2-3/10/18	Spotlighting	4 person hours
	12-16/2/18	Diurnal habitat and signs search - opportunistic	5 days x 4 observers
	20-21/6/18	Diurnal breeding habitat and signs search – opportunistic	2 days x 2 observers
	2-3/10/18	Diurnal breeding habitat and signs search - opportunistic	2 days x 2 observers
	2-3/10/18	Call playback Bush Stone-curlew	2 nights
Mammals (non-flying)			
HWR Ecological (2004)	20-25/10/02	Arboreal trapping	840 trap nights
		Terrestrial trapping	420 trap nights
		Hair tubing 16 tubes x 14 days/nights	224 tube days/nights
		Diurnal fauna searches	12 hours
		General spotlighting	20 hours
CEG (2012)	10-12/7/12	Diurnal habitat search / opportunistic observations x 2 observers	26 person hours
	10-11/7/12	Spotlighting / nocturnal habitat search x 2 observers	8 person hours

Table 10 (Cont'd)
Fauna Survey Methods, Effort and Timing

Reference	Date	Survey method	Survey Effort
Mammals (non-flying) (Cont'd)			
This assessment (Ecoplanning 2018)	12-16/2/18	Elliott A arboreal trapping	61 trap nights (28 in Dry Sclerophyll Forest and 33 in Wet Sclerophyll Forest)
	12-16/2/18	Elliott B arboreal trapping	61 trap nights (28 in Dry Sclerophyll Forest and 33 in Wet Sclerophyll Forest)
	12-16/2/18	Elliott E terrestrial trapping	61 trap nights (28 in Dry Sclerophyll Forest and 33 in Wet Sclerophyll Forest)
	12/2/18-15/3/18	Remote camera facing an Eastern Pygmy-possum artificial nest	592 trap nights (253 in Dry Sclerophyll Forest, 258 in Wet Sclerophyll Forest, and 81 in Rainforest)
	12/2/18-15/3/18	Remote camera facing tracks	104 trap nights
	13-14/2/18	Stag watch from 30 mins before sunset until after dusk	4 stag watches
	12-16/2/18	Pitfall trapping (50 cm deep x 30 cm wide)	11 trap nights
	12/2/18-15/3/18	Small terrestrial hair tube (50 mm diameter)	592 trap nights (253 in Dry Sclerophyll Forest, 258 in Wet Sclerophyll Forest, and 81 in Rainforest)
	12/2/18-15/3/18	Large terrestrial hair tube (110 mm x 70 mm diameter)	592 trap nights (253 in Dry Sclerophyll Forest, 258 in Wet Sclerophyll Forest, and 81 in Rainforest)
	20-21/6/18	Spotlighting	4 person hours
	2-3/10/18	Spotlighting	4 person hours
Microchiropteran Bats			
HWR Ecological (2004)	20-25/10/02	General spotlighting	20 hours
		Bat echolocation call recording	80 hours
	Not provided	Harp trapping	No information provided
CEG (2012)	10/7/12	Ecolocation call survey x 2 Anabat detectors	2 x Anabat detectors x 4 hours
This assessment (Ecoplanning 2018)	13-15/2/18	Ecolocation call survey x 2 Anabat detetors	4 recording nights
	21-22/08/18	Ecolocation call survey x 1 Anabat detetors	2 recording nights
	2-3/10/18	Ecolocation call survey x 4 Anabat detetors	8 recording nights
	4-12/12/18	Ecolocation call survey x 2 Anabat detetors	16 recording nights

Table 10 (Cont'd)
Fauna Survey Methods, Effort and Timing

Reference	Date	Survey method	Survey Effort
Amphibians			
HWR Ecological (2004)	20-25/10/02	Diurnal fauna searches	12 hours
		General spotlighting	20 hours
CEG (2012)	10-12/7/12	Diurnal habitat search / call detection / opportunistic observations x 2 observers	26 person hours
	10-11/7/12	Spotlighting / nocturnal habitat search x 2 observers	8 person hours
This assessment (Ecoplanning 2018)	12-16/2/18	Pitfall trapping (50 cm deep x 30 cm wide)	11 trap nights
	13-14/2/18	Spotlighting / nocturnal watercourse searches	4 person hours
	2-3/10/18	Spotlighting / nocturnal watercourse searches	4 person hours
	12-16/2/18	Opportunistic observations	5 days x 4 observers
	15/3/18	Opportunistic observations	1 day x 2 observers
	20-21/6/18	Opportunistic observations	2 days/nights x 2 observers
	22-24/8/18	Opportunistic observations	2 days/nights x 1 observer
	2-3/10/18	Opportunistic observations	2 days/nights x 2 observers
Reptiles			
HWR Ecological (2004)	20-25/10/02	Diurnal fauna searches	12 hours
		General spotlighting	20 hours
CEG (2012)	10-12/7/12 10-11/7/12	Diurnal habitat search / call detection / opportunistic observations x 2 observers	26 person hours
		Spotlighting / nocturnal habitat search x 2 observers	8 person hours
This assessment (Ecoplanning 2018)	12-16/2/18	Pitfall trapping (50 cm deep x 30 cm wide)	11 trap nights
	13-14/2/18	Spotlighting	4 person hours
	2-3/10/18	Spotlighting	4 person hours
	12-16/2/18	Opportunistic observations	5 days x 4 observers
	15/3/18	Opportunistic observations	1 day x 2 observers
	2-3/10/18	Opportunistic observations	2 days/nights x 2 observers

Table 11
Daily Weather Observations across Survey Periods at Nelson Bay (station 061054), approx. 20km East of the Subject Land

Date	Temperature (ºC)		Rainfall (mm)	Wind Speed (3pm)	
	Min	Max		Direction	Speed (km/h)
12/02/2018	22.9	29.5	0.5	ENE	19
13/02/2018	22.4	29.5	0	ENE	20
14/02/2018	23.0	-	0	NE	19
15/02/2018	23.5	28.7	0	E	22
16/02/2018	22.1	29.1	0	ESE	31
21/06/2018	10.0	15.0	5.2	SW	4
22/06/2018	9.5	14.0	0.4	SW	9
23/06/2018	9.8	18.4	0	SW	7
22/08/2018	10.5	16.6	0	SSE	20
23/08/2018	9.8	17.6	0	SSE	20
02/10/2018	12.0	22.6	0	NNE	37
03/10/2018	15.1	22.5	0	NNE	28
04/10/2018	16.4	20.0	0	SE	15
4/12/2018	19	26.4	0	E	33
5/12/2018	19.5	26.4	0	E	17
6/12/2018	19.8	23.8	0.6	NNE	33
7/12/2018	17.6	24.1	0.1	NE	43
8/12/2018	15.2	24.5	0	NNE	46
9/12/2018	14.2	24.4	0	NNE	48
10/12/2018	12.5	27.2	0	E	11
11/12/2018	19.7	23.3	1.4	S	15
12/12/2018	18.8	24.9	8	ENE	28

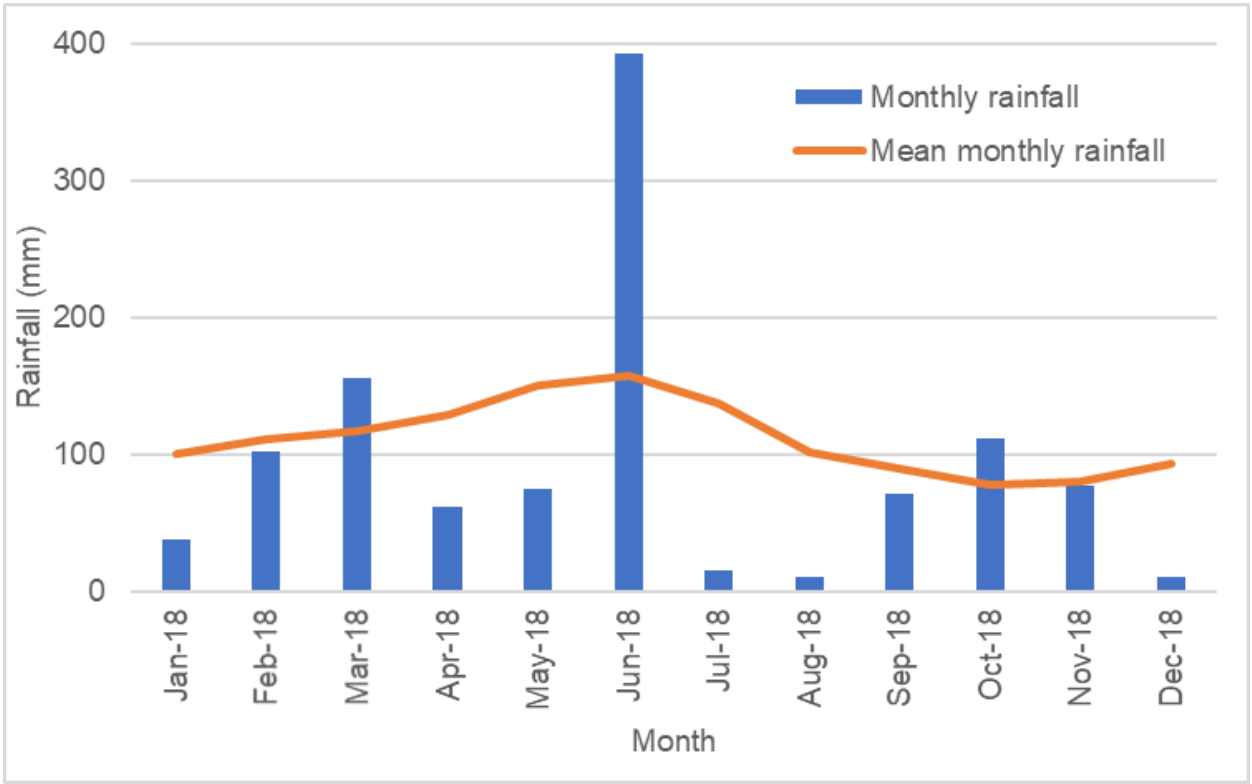

Figure 9 **Rainfall (mm) recorded at Nelson Bay (station 061054) across the Entire Survey Period (01 January to 12 December 2018)**

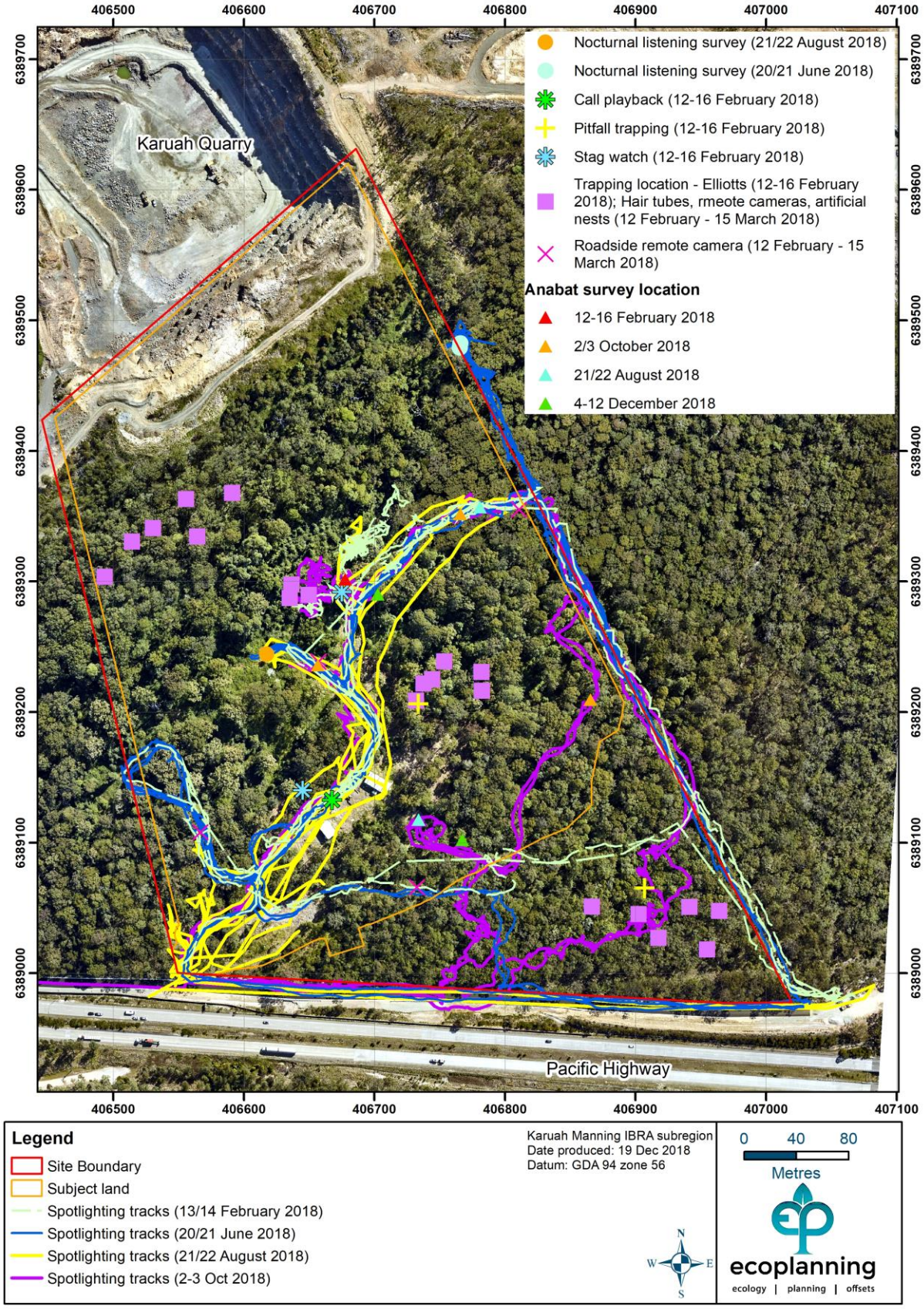

Figure 10 Survey Effort for Candidate Threatened Fauna Species

4.3.2.1 Diurnal Birds – Hollow-dependent

Two hollow-dependent diurnal bird species were identified as candidate threatened fauna species for the subject land, the Gang-gang Cockatoo (*Callocephalon fimbriatum*) and Glossy Black-Cockatoo (*Calyptorhynchus lathami*). Both candidate species are listed as ecosystem credit species (for foraging habitat) and species credit species (for breeding habitat).

The Glossy Black-cockatoo has been previously recorded in bushland surrounding the subject land (RPS 2013, HWR Ecological 2004). Glossy Black-Cockatoos breed within hollows of large, old eucalypt trees, alive or dead with nests located between 3 m to 30 m above the ground (OEH 2018). In NSW, breeding takes place from March to August (OEH 2018).

Gang-gang Cockatoos have not previously been recorded within the subject land or adjacent bushland areas (RPS 2013; HWR Ecological 2004; CEG 2012). Gang-gang Cockatoos build nests within hollows that are 10 cm in diameter or larger and at least 9 m above the ground (OEH 2018). Breeding takes place over the spring to summer period (October to January; Birdlife 2018).

Targeted surveys for breeding Glossy Black-cockatoos and Gang-gang Cockatoos were undertaken in the subject land which involved 20 minute bird census (5 surveys undertaken) and searches for and observations of suitable hollow-bearing trees (including signs of hollow-use or nearby activity such as chewed cones). These observations were made during traverses of the subject land to record hollow-bearing trees and in conjunction with other targeted searches. Opportunistic observations across all surveys period would also allow for identification of these species from their distinctive calls. Survey effort is detailed in **Table** 10 and the survey timing coincided with the allowable survey periods for both of these species as shown in **Table** 12. No breeding Glossy Black-cockatoos or Gang-gang Cockatoos were observed within the subject land. A total of 26 diurnal birds species were recorded within the Site, including one species listed as 'Migratory' under the EPBC Act, Rufous Fantail (*Rufuous Rhipidura*) (**Annexure 3**; **Figure** 11). Assessment of impacts to the Rufous Fantail in accordance with DotE (2013) are included in **Annexure 1**.

Table 12
Survey Months for Candidate Hollow-dependent Diurnal Bird Species

Candidate threatened fauna species	Survey months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gang-gang Cockatoo (Breeding) (*Callocephalon fimbriatum*)	Y									Y	Y	Y
Glossy Black-Cockatoo (Breeding) (*Calyptorhynchus lathami*)			Y	Y	Y	Y	Y	Y				

4.3.2.2 Diurnal Birds – Ground-dwelling

One ground-dwelling diurnal bird was identified as a candidate threatened fauna species for the subject land, the Emu (*Dromaius novaehollandiae*) population in the New South Wales North Coast Bioregion and Port Stephens local government. On the NSW north coast, Emus occur in a range of predominantly open lowland habitats, including grasslands, heathland, shrubland, open and shrubby woodlands, forest, and swamp and sedgeland communities, as well as the ecotones between these habitats (OEH 2018).

This bird, and its scats, are conspicuous with surveys able to be undertaken across all months of the year. This species was targeted during diurnal bird surveys (five 20 minute bird census) and opportunistic surveys including as part of traverses of the subject land to record hollow-bearing trees and other targeted species surveys. No Emus were observed within the subject land during any of the surveys undertaken.

4.3.2.3 Diurnal Birds – Raptors

Four raptor species were identified as candidate threatened fauna species for the subject land, White-bellied Sea-Eagle (*Haliaeetus leucogaster*), Little Eagle (*Hieraaetus morphnoides*), Square-tailed Kite (*Lophoictinia isura*) and Eastern Osprey (*Pandion cristatus*). The four raptor candidate species are listed as ecosystem credit species (for foraging habitat) and species credit species (for breeding habitat). Breeding habitat for all of these raptor species is a conspicuous, large nest made of sticks.

Targeted surveys for breeding habitat for these species involved searches for large stick-nests within canopy trees throughout the subject land. These searches were initially conducted from the 12 – 16 February 2018 with additional searches undertaken in conjunction with surveys in March 2018, June 2018, August 2018, October 2018 and December 2018. The surveys undertaken coincided with the allowable survey periods for all four of the raptor candidate threatened fauna species (**Table 13**).

One of these species, the Little Eagle, was observed flying over the subject land during diurnal bird surveys in February 2018, although this species was not observed roosting or nesting within the subject land. Additionally, the White-bellied Sea-Eagle has also been previously recorded within the subject land (HWR Ecological 2004). The observation of these species flying over, or within the subject land does not indicate that breeding habitat for the species is present. One stick nest was observed within the subject land (**Plate 8**), however, observations of this nest suggested it was too small to be used by any of the candidate threatened raptor species, and observations during the breeding seasons for each of the raptor species did not observe any bird species using the nest.

Table 13
Survey Months for Candidate Raptor Species

Candidate Threatened Fauna Species	Survey Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)							Y	Y	Y	Y	Y	Y
Little Eagle (*Hieraaetus morphnoides*)								Y	Y	Y		
Square-tailed Kite (*Lophoictinia isura*)	Y								Y	Y	Y	Y
Eastern Osprey (*Pandion cristatus*)				Y	Y	Y	Y	Y	Y	Y	Y	

Plate 8 Stick Nest Observed within the Subject Land

4.3.2.4 Nocturnal Birds

Four large forest owl species were identified as candidate threatened fauna species for the Project, Barking Owl (*Ninox connivens*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) and Sooty Owl (*Tyto tenebricosa*). All four of these species are listed as ecosystem credit species (for foraging habitat) and species credit species (for breeding habitat). Of the four species, the Powerful Owl has been previously observed north and east of the subject land (RPS 2010, HWR Ecological 2004). Breeding habitat for all of these species includes large hollow-bearing trees within woodland to rainforest vegetation types.

The DEC (2004a) survey guidelines are based upon presence/absence surveys for these species and do not distinguish between surveys for breeding habitat compared to foraging habitat. Surveys for breeding habitat followed the guidelines of Birdlife (2015) and LMCC (2014) which involve listening for calls of owl species from high vantage point within the subject land from sunset until half an hour after dark. Calls heard near dusk will signify breeding activity nearby as the birds have not yet dispersed from their breeding habitat. Two targeted dusk surveys were conducted during the breeding period for large forest owls, with each survey comprising two consecutive nights (21-22 June and 22-23 August 2018, total survey effort was four nights; **Figure** 10). Following each of the dusk surveys, an approximately one-hour spotlight was undertaken through the subject land.

In addition to the survey targeting breeding habitat, surveys outside the breeding period (12 – 16 February 2018, 2-3 October 2018) included spotlighting and call playback for large forest owls. Call playback was performed before each spotlighting survey. The survey involved broadcasting the call of each large forest owl with a five-minute period of listening either side of the broadcast. This survey also involved call playback for Koala.

Additionally, diurnal surveys (12–16 February; 21-22 June; 22-23 August; 2-3 October; 4,13 December 2018) for roosting birds, whitewash, and pellets were undertaken.

The surveys undertaken for large forest owl included dusk surveys over four nights during the breeding season and nominated survey months within the BAM Calculator. (**Table 14**). None of the candidate large forest owl species were observed within the subject land.

Table 14
Survey Months for Candidate Large Forest Owls

Candidate threatened fauna species	Survey months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barking Owl (*Ninox connivens)*					Y	Y	Y	Y	Y	Y	Y	Y
Powerful Owl (*Ninox strenua*)					Y	Y	Y	Y				
Masked Owl (*Tyto novaehollandiae*)					Y	Y	Y	Y				
Sooty Owl (*Tyto tenebricosa*)				Y	Y	Y	Y	Y				

Two additional nocturnal bird species, the Bush Stone-curlew (*Burhinus grallarius*) and Red-backed Button-quail (*Turnix maculosus*), were identified as a candidate species for the subject land. Targeted surveys for these species included call-playback, spotlighting and daytime habitat searches.

Call playback for the Bush Stone-curlew consisted of playing calls for approximately 30 seconds, followed by 4.5 minutes of listening with the 5-minute cycle repeated three times. Call playback for this species was undertaken over 2 nights in spring (2-3 October 2018) with spotlighting for this species undertaken over multiple seasons including summer (12-16 February) and winter (21-22 June and 22-23 August). Additionally, daytime searches which can flush individuals of the species, were undertaken in conjunction with the spotlighting surveys. The surveys undertaken for this species coincide with the year round survey period for this species nominated within the BAM Calculator. No minimum survey effort is outlined for this species by DEC (2004a).

Survey for the Red-backed Button-quail (*Turnix maculosus*) included diurnal habitat searches and opportunistic surveys for this species. However, given the dusk and nocturnal habits of this species, they were also targeted as part of nocturnal spotlighting traverses. Spotlighting surveys were undertaken over eight nights including surveys in February, June, August and October 2018. No call-playback was undertaken for this species as it is not known whether the species responds and in what months it mostly calls (OEH 2018).

No Bush Stone-curlew or Red-backed Button-quail were observed within the subject land during any of the targeted surveys for these species.

4.3.2.5 Mammals (non-flying) – Arboreal Hollow-dependent

Three hollow-dependent non-flying mammal species were identified as candidate species for the subject land, Eastern Pygmy-possum (*Cercartetus nanus*), Brush-tailed Phascogale (*Phascogale tapoatafa*) and Squirrel Glider (*Petaurus norfolcensis*). Of these three species, the Brush-tailed Phascogale was previously detected north and west of the subject land (HWR Ecological 2004). These species were targeted using a combination of arboreal Elliott A trapping, arboreal Elliott B trapping (**Plate 9**), terrestrial Elliott E trapping (**Plate 10**), pitfall trapping, stag watching, Reconyx HC600 remote camera detection (**Plate 11**), artificial nest detection, and spotlighting.

Plate 9 Tree Mounted Elliott A and Elliott B Traps

Plate 10 Terrestrial Elliott E Trap

Plate 11 Fauna Survey Techniques including Remote Camera Facing an Artificial Nest and Small and Large Hair Tubes

Eastern Pygmy-possums were surveyed using artificial nests and remote cameras, pitfall traps, terrestrial Elliott E traps and arboreal Elliott A traps. Artificial nests were tied to a low shrub or tree near flowering shrubs. A remote camera was positioned to detect any activity in or near the artificial nest. The nests and remote cameras were left in the subject land for between 27 and 29 days/nights (total survey effort included 592 trap nights with cameras facing artificial nests). Three pitfall traps (30cm wide x 50cm deep) were connected using plastic drift fencing to encourage species to the traps (total 11 trap nights).

Six Elliott trap stations were set up at along each of the four fauna transects (except in the rainforest where three stations were set up). At each trap station an arboreal Elliott A, arboreal Elliott B and terrestrial Elliott E trap was located. The terrestrial Elliott E traps were positioned in low shrubs and grass clumps. The arboreal Elliott A and B traps were placed on a platform which was drilled into the trunk of large canopy trees, approximately 3m above the ground. The Elliott traps were baited with a universal bait (honey, oats, peanut butter) and beef stock. All traps were checked in the hour following dawn and rebaited as required. The Elliott traps were covered in calico bags and filled with bedding. Total survey effort for each Elliott trap size was 61 trap nights (28 in Dry Sclerophyll Forest and 33 in Wet Sclerophyll Forest). The survey effort exceeds the minimum 24 trap nights recommended (per 50 ha stratification unit) for arboreal mammals by DEC (2004a), although is less than the 100 recommended nights for terrestrial mammals (per 50ha stratification unit). Nonetheless, given the total survey area was approximately 16ha, the 61 trap nights for terrestrial mammals in conjunction with 592 trap nights with cameras, is considered sufficient for the purpose of this assessment.

Squirrel Glider were surveyed using arboreal Elliott B traps. These traps were placed on an adjacent tree to the Elliott A traps and set up using the same methods as described for the Elliott A traps above. Total survey effort was 61 trap nights.

Brush-tailed Phascogale were surveyed using arboreal Elliott B traps over 61 trap nights. Methods are described above. The bait used was a universal bait with beef stock, specifically targeting this carnivorous species.

In addition to these targeted survey methods, broad survey techniques were used to search for arboreal mammals including spotlighting and stag watching. A stag-watch was undertaken during dusk before each spotlight during the summer survey (12 – 16 February 2018). The stag-watch involved watching a large hollow-bearing tree for an hour from dusk until complete darkness. Two ecologists stag-watched a tree each. Spotlighting was conducted on two consecutive nights during both the summer and winter (21-22 June and 22-23 August) and spring (2-3 October) survey periods. Two ecologists walked along existing tracks with high-powered hand-held spotlights. The survey effort for spotlighting exceeded the minimum survey effort recommended by DEC (2004a) of spotlighting on two separate nights for an hour and covering 1 km of total distance.

No Eastern Pygmy-possum, Squirrel Glider or Brush-tailed Phascogale were observed within the subject land. Two arboreal mammals were recorded within the Site, the Common Brushtail Possum (*Trichosurus vulpecula*) and Common Ringtail Possum (*Pseudocheirus peregrinus* **Annexure 3**).

4.3.2.6 Mammals (non-flying) – Terrestrial

Two terrestrial non-flying mammal species were identified as a candidate threatened fauna species for the subject land, the Parma Wallaby (*Macropus parma*) and Common Planigale (*Planigale maculata*).

The preferred habitat for the Parma Wallaby is moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest. The nominated survey period for the Parma Wallaby within the BAM Calculator includes all seasons and months of the year. Surveys undertaken for this species included remote cameras, spotlighting, terrestrial small (50 mm) hair tube survey, large (70 mm x 110 mm) hair tube survey, and opportunistic searches. The remote cameras were positioned to target high-fauna activity tracks within the subject land for a total of 104 trap nights. As the Parma Wallaby is nocturnal, spotlighting included searching areas of open eucalypt forest and adjoining grassy open areas with total spotlighting effort exceeding 8 hours of spotlighting on foot). A small and a large hair tube was placed at each fauna trapping site, near the base of a tree or along a fauna track (total of 592 trap nights each for small and large hair tubes). Each hair tube was baited with a universal bait of honey, oats and peanut butter and were left in the subject land for between 27 and 29 days. Additionally, the diurnal opportunistic surveys traversed through dense areas suitable for daytime sheltering habitat. Survey locations are shown in **Figure 10**.

The survey effort for the Parma Wallaby including remote cameras for between 27 and 29 nights, spotlighting over more 8 nights (12-16 February, 21-22 June, 22-23 August, 2-3 October), large and small hair tube surveys over 592 trap nights and diurnal searches for scats and tracks exceed the survey guidelines for terrestrial mammals in DEC (2004a). It is noted that DEC (2004a) recommends sand plot surveys for medium to large terrestrial mammals, however remote camera surveys have been undertaken in place of sand plots. Given the age of the DEC (2004a) guidelines no minimum surveys effort is nominated for remote cameras.

No individuals of this species were observed within the subject land and this species has not been previously recorded within the subject land (CEG 2012). Two macropods were recorded within the subject land, Swamp Wallaby (*Wallabia bicolor*) and Red-necked Wallaby (*Macropus rufogriseus*; **Annexure 3**).

The Common Planigale is a small, carnivorous terrestrial mammal which habit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water (OEH 2018). he nominated survey period for the Common Planigale includes all months of the year. Surveys for the Common Planigale included pitfall traps (11 trap nights) and hair tubes (592 traps nights using large and small hair tubes). Additionally, this species can be detected opportunistically during spotlighting surveys conducted over eight nights across the survey period. No Common Planigales were observed within the subject land. Three terrestrial mammals were recorded within hair tube traps including Brown Antechinus (*Antechinus stuartii*), Rat (*Rattus* sp.) and Common Brushtail Possum (**Annexure 3**).

4.3.2.7 Mammals – Arboreal (other)

One non-hollow dependent arboreal mammal was identified as a candidate threatened species for the subject land, the Koala (*Phascolarctos cinereus*). The Koala listed as an ecosystem credit species for foraging habitat and species credit species for breeding habitat. The Koala has previously been recorded within the subject land (CEG 2012).

Targeted surveys for Koala were conducted during nominated survey period for this species which includes all months of the year and included call playback, spotlighting, and opportunistic surveys. Additionally, the remote cameras set up to face the Eastern Pygmy-possum nests were set up to pick up any activity of arboreal mammals climbing tree trunks. Call playback survey involved broadcasting the call of the Koala with a five-minute period of listening either side of the broadcast. The remote camera surveys and spotlighting surveys are as described above.

One Koala was observed within the south of the Site (**Figure 11**) outside the subject land and was captured on a remote camera. A species polygon has been calculated in accordance section 6.4.1.28 of the BAM for the Koala which covers 11.12 ha of the subject land and includes all areas of the subject land with the exception of areas which did not support eucalyptus species (areas mapped as cleared, exotic vegetation or rainforest). Consideration of the impacts of the Koala as listed under the EPBC Act including assessment against the referral guidelines (DotE 2014) is provided in **Annexure 1**.

4.3.2.8 Mammals - Bats

A total of four bat species were identified as candidate threatened fauna species for the subject land, including the Grey-headed Flying-fox (*Pteropus poliocephalus*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Southern Myotis (*Myotis macropus*) and Eastern Cave Bat (*Vespadelus troughtoni*). The Grey-headed Flying-fox is listed as ecosystem credit species for foraging habitat and a species credit species for breeding habitat, while the remaining three microchiropteran bat species are all species credits for aspects of their lifecycle.

Figure 11 Threatened Fauna Species recorded during Targeted Surveys

The Grey-headed Flying-fox has previously been observed adjacent to the subject land (CEG 2012), however, this record alone does not indicate the presence of breeding habitat for this species within the subject land. Grey-headed Flying-foxes roost within communal 'camps', which are large congregations of many individuals of this species, where individuals hang from branches with limited protection. Many of these camps act as maternity camps where annual breeding and rearing of young takes place (DEC 2004b). Camps are typically located near water, such as lakes, rivers or the coast and commonly include rainforest patches, stands of Melaleuca, mangroves and riparian vegetation, but colonies also use highly modified vegetation in urban and suburban areas (van der Ree et al. 2005).

As part of the 'National Flying-fox Monitoring Program' maps of known camps of this species have been prepared, with no known camp mapped within the subject land (DoEE 2018). The nearest known camp of this species is located approximately 7 km south of the subject land on Schnapper Island, within the Port Stephens estuary, with between 1-499 individuals of this species recorded from this camp in November 2016 (DoEE 2018).

The method for surveying for the presence of unrecorded day roosts involved diurnal observations across the subject land. Flying-fox camps are easily recognised from a distance due to the distinctive audible calls that are heard most frequently in the early morning or under sunny conditions. Other signs include their distinctive odour and droppings.

No camps for this species were observed within the subject land including during traverses undertaken during the allowable survey period the Grey-headed Flying-fox under the BAM (2-3 October, **Table 15**).

Table 15
Survey Months for Candidate Bat Species

Candidate threatened fauna species	Survey months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Grey-headed Flying-fox (*Pteropus poliocephalus*)										Y	Y	Y
Large-eared Pied Bat (*Chalinolobus dwyeri*)	Y	Y	Y						Y	Y	Y	Y
Southern Myotis (*Myotis macropus*)	Y	Y	Y								Y	Y
Eastern Cave Bat (*Vespadelus troughtoni*)	Y										Y	Y

Targeted surveys for the Large-eared Pied Bat, Southern Myotis and Eastern Cave Bat included ultrasonic Anabat detection over 14 nights (13-14 February, 21-22 August, 2-3 October 2018, 4-12 December 2018) using multiple devices equating to a total of 30 survey nights. However, two of the surveys nights (August) were outside the survey period for all of the candidate bat species. Survey effort for all candidate species is equal to or greater than the recommended survey effort in the recently (October 2018) published "*'Species credit' threatened bats and their habitats*" (OEH 2018b).

A total of ten Microchiropteran bat species were detected from calls within the Site (**Annexure 3**) including the two species listed as Vulnerable under the BC Act (Little Bentwing Bat and Eastern Bentwing Bat). Additionally, calls which could not be separated between the Eastern False Pipistrelle (listed as Vulnerable under the BC Act), Greater Broad-nosed Bat (listed as Vulnerable under the BC Act) and Eastern Broad-nosed Bat (not listed under the BC Act) were

recorded. The foraging habitat for these species is treated as an ecosystem credit under the BAM and impacts to these species are assessed in conjunction with the impacts to PCTs. No further assessment of these species is required.

Of the three candidate species, the Large-eared Pied Bat and Southern Myotis were not recorded within the Site. Several calls were recorded within the site which were identified as belonging to Vespadelus species but could not be distinguished between the Little Forest Bat (*Vespadelus vulturnus*), which has commonly been recorded within the site, and the Eastern Cave Bat (*Vespadelus troughtoni*) a candidate threatened bat species. Given that the Little Forest Bat is a common and widespread species which has been frequently recorded within the site, the calls which could not be identified to species level are much more likely to belong to this species than the Eastern Cave Bat. Nonetheless, the process for determining a species polygon for the Eastern Cave Bat has been undertaken as per the recently released bat survey and assessment guidelines (OEH 2018b). The guidelines state that a species polygon for the Eastern Cave Bat should include '…a*ll habitat on the subject land where the subject land is within 2km of caves, scarps, cliffs, rock overhangs and disused mines.'* (OEH 2018b). The guidelines also identify that high-resolution aerial imagery and topographic maps should be used to identify potential roost habitat features on the subject land when it is within 2km caves, scarps, cliffs etc (OEH 2018b). As a search of high-resolution aerial imagery and topographic maps did not identify any caves, scarps, cliffs, rock overhangs or disused mines within 2 km of the subject land, no part of the subject land would form part of a species polygon for the Eastern Cave Bat. Consequently, no further assessment of this species is required.

4.3.2.9 Amphibians

Four amphibian species were identified as candidate species for the subject land including the Green and Golden Bell Frog (*Litoria aurea*), Green-thighed Frog (*Litoria brevipalmata*), Stuttering Frog (*Mixophyes balbus*), and Giant Barred Frog (*Mixophyes iteratus*). Potential habitat for these species within the subject land was very limited as the steep first order drainage-line did not include standing water during any of the surveys, with these species all requiring permanent or semi-permanent water bodies (DECC 2009). The only semi-permanent water sources within the subject land is a single small constructed dam. It is noted that natural semi-permanent water bodies in association with Yalimbah Creek are present in the south of the Site outside of the subject land.

Surveys completed included nocturnal searches along drainage lines and call surveys within the subject land and areas adjacent to semi-permanent waterbodies outside the subject land. Additionally, pitfall traps over 11 trap nights were conducted within the Site. Surveys were undertaken during the nominated survey months for the four candidate amphibian species (13-14 February and 2-3 October 2018, **Table 16**), however, did not coincide with the ideal survey conditions including during or following summer storms. However, given the very limited occurrence of potential habitat within the subject land the survey effort to date is considered sufficient for this assessment. None of the candidate amphibian species were recorded within the subject land. A total of five amphibians were recorded within the Site including the Broad-palmed Frog (*Litoria latopalmata*), Red-backed Toadlet (*Pseudophryne coriacea*), Peron's Tree Frog (*Litoria peronii*), Smooth Toadlet (*Uperoleia laevigata*) and Common Eastern Froglet (*Crinia signifera*).

Table 16
Survey Months for Candidate Amphibian Species

Candidate threatened fauna species	Survey months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Green and Golden Bell Frog (*Litoria aurea*)	Y	Y	Y								Y	Y
Green-thighed Frog (*Litoria brevipalmata*)	Y	Y	Y							Y	Y	Y
Stuttering Frog (*Mixophyes balbus*)	Y	Y	Y						Y	Y	Y	Y
Giant Barred Frog (*Mixophyes iteratus*)	Y	Y	Y							Y	Y	Y

4.3.2.10 Reptiles

Two reptiles species were identified as candidate species for the subject land, the Pale-headed Snake (*Hoplocephalus bitorquatus*) and Stephens' Banded Snake (*Hoplocephalus stephensii*). Stephens Banded Snake has been previously recorded east of the subject land (RPS 2010).

Targeted surveys for both reptile species included active searches, pitfall trapping (over 11 trap nights) and spotlighting. Surveys undertaken in February coincided with the survey period for both species, while spotlighting in October only coincided with the surveys period for Stephens' Banded Snake (**Table 17**). Neither of these candidate reptile species were recorded within the subject land. Two reptile species, Jacky Lizard (*Amphibolurus muricatus*) and Lace monitor (*Varanus varius*), were recorded within the subject land (**Annexure 3**) and were recorded within pitfall traps and diurnal searches, respectively.

Table 17
Survey Months for Candidate Reptile Species

Candidate threatened fauna species	Survey months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pale-headed Snake (*Hoplocephalus bitorquatus*)	Y	Y	Y								Y	Y
Stephens' Banded Snake (*Hoplocephalus stephensii*)	Y	Y	Y							Y	Y	Y

5. AVOIDING AND MINIMISING IMPACTS ON BIODIVERSITY VALUES

5.1 AVOIDING AND MINIMISING IMPACTS ON NATIVE VEGETATION AND HABITAT DURING PROJECT PLANNING

In accordance with section 8.1.1.6 of the BAM, actions taken to avoid and minimise impacts through locating the Project must be documented and justified in the BDAR.

The Project would involve clearing approximately 11.59 ha of native vegetation across , with a further 0.53 ha of vegetation clearing impacting on areas identified as supporting exotic vegetation. As part of the project planning phase of this BDAR, impacts on native vegetation have been avoided through an overall reduction in the Project footprint and in particular avoidance of impacts to areas of native vegetation within the riparian buffers of Yalimbah Creek and the un-named first order tributary which traverses the south-eastern corner of the Site. During the initial phases of the preparation of this BDAR, all areas of the Site were investigated as potentially being impacted by the Project, with total vegetation clearing estimated at up to 19.43 ha. A preliminary ecology report identified that riparian buffer areas and the area of the 'Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions' EEC as being of high ecological value (**Section 3.3**). Whilst the principal components of the Project have been defined based upon the occurrence of the underlying hard rock resource and local topographic constraints, both the extraction and processing operations have been designed to optimise the recovery of the hard rock resource whilst minimising impacts to native vegetation and in particular riparian buffer areas.

The overall footprint of the operation would be kept as small as possible during all stages of operation, with vegetation and soil removed immediately prior to the progressive extension of operations. Progressive rehabilitation would be undertaken during the relevant periods of the quarry's development and operation.

5.2 AVOIDING AND MINIMISING PRESCRIBED BIODIVERSITY IMPACTS DURING PROJECT PLANNING

Prescribed biodiversity impacts are defined under clause 6.1 of the BC Reg and include impacts on biodiversity values in addition to, or instead of, impacts from clearing vegetation and/or loss of habitat. Prescribed biodiversity impacts are outlined within **Table 18** including their relevance to the site and the Project.

Impacts to water quality and hydrological processes down slope of the Site would be avoided and minimised by avoidance of impacts to the riparian buffers of Yalimbah Creek and its un-named first order tributary which occurs within the subject land. Only small areas of disturbance are proposed to riparian buffers within the subject land. Additionally, the Project has been designed to include two sediment basins (Western and Southern), each with a pre-treatment pond, to collect sediment-laden runoff from the disturbed sections of the Quarry. Perimeter drains along the toe of the Quarry infrastructure area pad would collect runoff from the batter slopes of the pad and direct it to either of these sediment basins. Two clean water diversion (CWD) drains (CWD East and CWD West) would be constructed to direct runoff from undisturbed areas upslope of the extraction area. Bunding and/or contour drains would intercept runoff from the upslope undisturbed catchments, preventing it from entering the extraction area and directing this runoff to either of the clean water diversion drains which in turn would flow towards Yalimbah Creek.

Table 18
Prescribed Biodiversity Impacts

Prescribed Biodiversity Impacts	Presence within the subject land	Additional Comments
(a) the impacts of development on the following habitat of threatened species or ecological communities: (i) karst, caves, crevices, cliffs and other geological features of significance, (ii) rocks, (iii) human made structures, (iv) non-native vegetation,	No areas of karst, caves, crevices, cliffs and other geological features of significance, rocks, human made structures or areas of non-native vegetation which support threatened species or ecological communities are present.	None.
(b) the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range,	The subject land has not been identified as providing connectivity between areas of habitat for threatened species that facilitates the movement of that threatened species across its range.	The subject land has previously been identified as providing connectivity to vegetated areas to the north of the subject land and also being part of a regional wildlife corridor (NPWS 2001) as discussed in **section 2.1.4**. It is noted that the identification of the wildlife corridor (NPWS 2001) predates much of the disturbance which is present surrounding the subject land including quarrying activities and the construction of the Karuah bypass. The Site is currently located adjacent to the cleared corridor for the Pacific Highway with disturbance associated with the Karuah Quarry and Karuah East Quarry present to the north, east and west of the subject land.
(c) the impacts of development on movement of threatened species that maintains their lifecycle,	The subject land has not been identified as providing movement of threatened species that maintains their lifecycle.	
(d) the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining or other development),	Potential impacts.	Yalimbah Creek, which flows to the east and south of the subject land (Figure 4 and Figure 5), flows south-east towards the Karuah estuary and includes water bodies and hydrological processes that sustain threatened species and threatened ecological communities. Consequently, impacts to water quality and hydrological process of Yalimbah Creek would constitute a prescribed impact.
(e) the impacts of wind turbine strikes on protected animals,	Not applicable.	
(f) the impacts of vehicle strikes on threatened species of animals or on animals that are part of a threatened ecological community.	Not applicable.	The greatest risk of vehicle strike within the Site is associated with the adjacent Pacific Highway. However, the Site is already fenced and separated from the Pacific Highway to the south

6. ASSESSING AND OFFSETTING IMPACTS

6.1 ASSESSMENT OF IMPACTS

6.1.1 Assessing Impacts to Native Vegetation and Habitat, Threatened Ecological Communities and Threatened Species Habitat

Impacts to native vegetation are anticipated through the direct clearing of the approximately 11.59ha of native vegetation, with a further 0.53ha of vegetation clearing impacting on areas identified as supporting exotic vegetation. The direct clearing and subsequent development of the subject land would represent a permanent impact, or loss, of this native vegetation and habitat. As outlined in **Section 3.5**, and in accordance with section 9.1.2.5 of the BAM, the future vegetation integrity score for all vegetation within the subject land has been assigned 0. All hollow bearing trees within the subject land, including approximately 43 hollow-bearing trees as shown in **Figure** 11. Approximately 18 hollow-bearing trees would be retained within the Site.

The overall Project life is approximately 25 years, with progressive rehabilitation to be undertaken during the relevant periods of the quarry's development and operation.

6.1.2 Assessing Indirect Impacts on Native Vegetation and Habitat

It is difficult to quantify indirect impacts associated with the Project, but these may include impacts such as noise and/or erosion associated with the construction and operational phases of the Project. Given the location of the subject land adjacent to existing quarrying activities (Karuah Quarry and Karuah East Quarry) and the Pacific Highway, it is considered unlikely that the Project would have inadvertent impacts which would reduce viability of any adjacent native vegetation or habitat due to edge effects, noise, dust or light spill, or disturbance to breeding habitats. The Project is considered unlikely to cause any increase in trampling of flora, rubbish dumping, firewood or bush rock collection or introduce any pests, weeds or pathogens to adjacent areas of native vegetation and habitat. Nonetheless, it is recommended that ongoing maintenance of retained native vegetation and fauna habitat is undertaken across the Site as detailed as part of a Biodiversity Management Plan (BMP) for the Site.

Changes to the drainage and hydrology of the subject land may have an impact on downstream habitats. The Project has been designed to include two sediment basins, each with a with pre-treatment pond, to collect sediment laden runoff from the disturbed sections of the Quarry. Two clean water diversion (CWD) drains (CWD East and CWD West) would be constructed to direct runoff from undisturbed areas upslope of the extraction area. Bunding and/or contour drains would intercept runoff from the upslope undisturbed catchments, preventing it from entering the extraction area and directing this runoff to either of the clean water diversion drains which in turn would flow towards Yalimbah Creek.

Measures to mitigate and manage indirect impacts are discussed in **Section 6.3**.

6.2 ASSESSING PRESCRIBED BIODIVERSITY IMPACTS

As outlined in **Section 5.2** of this report, no prescribed biodiversity impacts are anticipated from the Project. Impacts to water quality and hydrological processes within Yalimbah Creek could constitute a prescribed impact, however, impacts to Yalimbah Creek would be avoided through the Project location and inclusion of clean water diversions around the subject land.

6.3 MITIGATING AND MANAGING IMPACTS ON BIODIVERSITY VALUES

As described in **Section 5.1** of this report, the overall Project footprint has been reduced so as to minimise impacts to native vegetation, habitat and biodiversity values. Several measures will be implemented to mitigate and manage indirect impacts where possible, such as appropriate pre-clearance protocols and a Biodiversity Management Plan (BMP). Details are provided below.

6.3.1 Pre-clearance Protocols

One threatened fauna species (Koala) and a number of non-threatened fauna species, such as birds, arboreal mammals and amphibians, have been recorded within the subject land. Appropriate pre-clearance protocols would be put in place at the time of vegetation clearing to mitigate and avoid potential harm or injury to these individuals. These protocols should include, as a minimum, soft-felling techniques and clearing supervision where habitat trees (including hollow-bearing trees and stags) are to be removed.

Soft-felling techniques as part vegetation clearing encourage fauna to relocate outside of the disturbance footprint prior to habitat clearing or alternatively provide an opportunity to move fauna during vegetation clearing works. Soft-felling techniques should be adaptive depending on site-specific conditions but typically would include:

- marking all habitat trees to be cleared;
- removal of ground-layer and mid-storey vegetation (under-scrubbing) around the habitat trees;
- tapping/nudging of habitat trees by heavy machinery 24 hrs prior to the proposed removal of the habitat trees;
- 'Slow drop' of habitat trees, involving the gentle lowering of habitat trees with hollows intact;
- inspection of lowered habitat trees and capture and release of any fauna species present. Injured fauna are to be taken to WIRES or a veterinary clinic.
- slashing and clearing hollow-bearing trees making provision for the demarcation, ecological restoration, rehabilitation and/or ongoing maintenance of retained native vegetation habitat on the development site

These measures are to be documented and included as a component of the BMP.

6.3.2 Biodiversity Management Plan (BMP)

A best practice Biodiversity Management Plan should be prepared in consultation with OEH to describe the short, medium, and long term measures to be undertaken to manage the remnant vegetation and fauna habitat on the site. The BMP should include short, medium and long term measures to be implemented to manage remnant vegetation and habitat on site, including within any biodiversity offset areas (where adjacent land is to be used to meet offset requirements). The BMP should include as a minimum:

- the procedures for soft-felling techniques as part of vegetation removal;
- pre-clearance protocols;
- the salvage of environmental resources within the approved disturbance area including tree hollows, vegetative and soil resources, for beneficial reuse in the enhancement of any biodiversity offset areas or site rehabilitation;
- measures to protect vegetation and fauna habitat outside the approved disturbance area including Koala proof fencing along the southern boundary of the Site which would connect existing Koala proof fencing to the east and west of the Site ;
- controlling weeds and feral pests; and
- controlling erosion, sedimentation and water quality within adjacent water bodies.

- The BMP should include a program to monitor and report on the effectiveness of these measures, and progress against performance and completion criteria.

6.4 ADAPTIVE MANAGEMENT FOR UNCERTAIN IMPACTS

Impacts associated with the Project are largely certain and associated with the direct impacts associated with vegetation clearing as documented within **Section 6.1**. Uncertain impacts associated with the Project are limited to potential impacts to downstream environments, although these impacts can be mitigated through appropriate management.

As discussed, the Project has been designed to include two sediment basins (Western and Southern), each with a with pre-treatment pond, to collect sediment laden runoff from the disturbed sections of the Quarry. Perimeter drains along the toe of the Quarry infrastructure area pad would collect runoff from the batter slopes of the pad and direct it to either of these sediment basins. Two clean water diversion (CWD) drains (CWD East and CWD West) would be constructed to direct runoff from undisturbed areas upslope of the extraction area. Bunding and/or contour drains would intercept runoff from the upslope undisturbed catchments, preventing it from entering the extraction area and directing this runoff to either of the clean water diversion drains which in turn would flow towards Yalimbah Creek.

During the construction phase of the Project, the Quarry would operate in accordance with any licence issued under by the NSW Environment Protection Authority or the controls under the NSW *Protection of the Environment Operations Act (1997)*.

Excluding the need for a BMP, no additional adaptive management measures are proposed.

6.5 THRESHOLDS FOR THE ASSESSMENT AND OFFSETTING IMPACTS OF DEVELOPMENT

6.5.1 Serious and Irreversible Impacts

The *Guidance to assist a decision-maker to determine a serious and irreversible impact* (OEH 2017b) and the BioNet database identify potential SAII entities. None of the threatened species and ecological communities identified as being impacted by the Project (Koala and 'Lowland Rainforest in the NSW North-Coast and Sydney Basin Bioregions', see **sections 3 and 4**, are considered SAII entities.

6.5.2 Impacts which Require an Offset

Section 10.3.1 of the BAM outlines that the following vegetation zones require offsets:

- Vegetation zones that have a vegetation integrity score ≥15 where the PCT is representative of an endangered or critically endangered ecological community.
- A vegetation zone that has a vegetation integrity score of ≥17 where the PCT is associated with threatened species habitat or is a vulnerable ecological community.
- A vegetation zone that has a vegetation integrity score ≥20.

All vegetation zones within the subject land with the exception of the 'Exotic vegetation' have vegetation integrity scores of greater than 15 and would require offsets (**Table 19**).

Table 19
Vegetation Zones which Require Offsets

Vegetation zone	Area	Vegetation integrity score
1590 - Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest – Dense Lantana	0.58	52.6
1590 - Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest – Low Lantana	0.56	61.5
1567 - Tallowwood - Brush Box - Sydney Blue Gum moist shrubby tall open forest on foothills of the lower North Coast Lantana	7.45	63.2
1527 - Bangalow Palm - Coachwood - Sassafras gully warm temperate rainforest of the Central Coast Intact	0.47	64.9
1550 - Small-fruited Grey Gum - Turpentine - Tallowwood moist open forest on foothills of the lower North Coast Intact	2.53	62.1

6.5.3 Impacts that do not Require Further Assessment

As outlined above, impacts to those areas identified as 'Exotic vegetation' do not require offsetting.

7. CREDIT CALCULATIONS

7.1 CREDIT CALCULATIONS AND CLASSES

A biodiversity offset requirement for residual impacts of a proposed development, must be calculated in accordance with section 11.2 and section 11.3 of the BAM. The following section outlines the credit requirements for the Project in order to achieve the 'no net loss standard' as established by the BAM.

7.1.1 Ecosystem Credits

The ecosystem credits required to offset the residual impacts of the Project are provided in **Table 20**. A total of 274 credits are required to offset the development.

Table 20
Ecosystem Credit Offset Requirements

Vegetation zone	Vegetation integrity loss	Area*	Credits required
1590 - Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest – Dense Lantana	52.6	0.6	11
1590 - Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest – Low Lantana	61.5	0.6	13
1567 - Tallowwood - Brush Box - Sydney Blue Gum moist shrubby tall open forest on foothills of the lower North Coast Lantana	63.2	7.5	176
1527 - Bangalow Palm - Coachwood - Sassafras gully warm temperate rainforest of the Central Coast Intact	64.9	0.5	15
1550 - Small-fruited Grey Gum - Turpentine - Tallowwood moist open forest on foothills of the lower North Coast Intact	62.1	2.5	59
Exotic vegetation	6.3	0.5	0
Cleared land	0	4.2	0
Total		**16.36***	**274**

* Rounding errors may apply as the BAM calculator rounds the area of each PCT to one decimal place.

The following offset rules apply:

For credit class 1590

- Any PCT within the vegetation class '*Hunter-Macleay Dry Sclerophyll Forests'* (including PCTs 487, 613, 661, 684, 686, 692, 693, 694, 695, 699, 747, 748, 752, 812, 1073, 1208, 1217, 1222, 1237, 1244, 1245, 1257, 1259, 1260, 1261, 1265, 1266, 1282, 1284, 1285, 1504, 1561, 1562, 1563, 1566, 1567, 1568, 1569, 1572, 1573, 1575, 1579, 1590, 1841, 1843, 1915) AND < 50% cleared group (including Tier 7 or higher).
- In the following IBRA subregions: Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter, or any subregion within 100 km of the subject land.
- Containing hollow-bearing trees

For credit class 1527

- Any PCT equivalent to the '*Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions*' TEC (including PCT's 669, 670, 770, 845, 886, 887, 1068, 1201, 1275, 1302, 1525, 1527, 1528, 1529, 1533, 1534, 1535, 1541, 1545)
- In the following IBRA subregions: Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter, or any subregion within 100 km of the subject land.

For credit class 1550

- Any PCT within the vegetation class '*Northern Hinterland Wet Sclerophyll Forests*' (including PCT's 690, 697, 698, 755, 1092, 1262, 1267, 1268, 1281, 1385, 1548, 1549, 1550, 1556, 1557, 1558, 1564, 1565, 1580, 1582, 1584, 1585, 1845, 1846, 1847, 1914) AND < 50% cleared group (including Tier 7 or higher).
- In the following IBRA subregions: Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter, or any subregion within 100 km of the subject land.
- Containing hollow bearing trees.

For credit class 1567

- Any PCT within the vegetation class '*North Coast Wet Sclerophyll Forests*' (including PCT's 487, 613, 661, 684, 686, 692, 693, 694, 695, 699, 747, 748, 752, 812, 1073, 1208, 1217, 1222, 1237, 1244, 1245, 1257, 1259, 1260, 1261, 1265, 1266, 1282, 1284, 1285, 1504, 1561, 1562, 1563, 1566, 1567, 1568, 1569, 1572, 1573, 1575, 1579, 1841, 1843, 1915) AND < 50% cleared group (including Tier 7 or higher).
- In the following IBRA subregions: Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter, or any subregion within 100 km of the subject land.
- Containing hollow bearing trees.

7.1.2 Species Credits

A total of 345 Koala (*Phascolarctos cinereus*) species credits are required to offset the Project. These credits can be traded only with credits for this species but they can generated anywhere within NSW.

7.2 SECURING BIODIVERSITY CREDITS

The measures proposed to address the offset obligation outlined above will be determined as the Project approvals progress. Initial investigations have commenced to identify credits available for purchase, land available to purchase and enter into a Biodiversity Stewardship Agreement (BSA) and the costs of credits through payment into the Biodiversity conservation Fund (BCF). It is likely that a combination of measures will be used to retire the required credits including entering into a BSA, payment into the BCF and purchase of credits on the open market. **Table 21** outlines the costs associated with meeting offset obligations through payment into BCF, as calculated on the 18 November 2018.

Table 21
Credit Requirements and Estimated Credit Costs
as Calculated on: 14-12-2018

Ecosystem Credits				
Plant Community Type	**Baseline price per credit**	**Price per credit***	**No. of Ecosystem Credits**	**Final Credit Price (ex GST)**
1527	$1,325.37	$1,616.94	15	$24,254.07
1550	$1,325.37	$2,679.75	59	$95,399.36
1567	$1,325.37	$2,679.75	176	$284,581.14
1590	$1,325.37	$2,679.75	24	$38,806.52
			Subtotal (ex GST)	**$443,041.09**
Species Credits				
Species	**Price per credit**	**Risk Premium**	**No. of Species Credits**	**Final Credit Price (ex GST)**
Phascolarctos cinereus (Koala)	$408.16	24.8700%	345	$91,759.06
			Subtotal (ex GST)	**$534,800.15**
			Total (incl. GST)	**$588,280.17**

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Annexures

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Annexure 1 EPBC Act considerations

Annexure 2 Vegetation Integrity Data

Annexure 3 Species lists

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Annexure 1

EPBC Act Considerations

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The following section includes assessments of potential impacts to Matters of National Environmental Significance (MNES) listed under the EPBC Act. It is noted that a previous referral to the Commonwealth Department of Environment and Energy (DoEE) was made for a proposed quarry within the subject land in 2012 (EPBC Ref: 2012/6600). This referral specifically considered impacts of the current Project on the Koala (*Phascolarctos cinereus*) and Grey-headed Flying-fox (*Pteropus poliocephalus*). While the previously proposed quarry had a smaller disturbance footprint (approximately 9 ha) than the current Project, the previous referral was determined to be a non-controlled action and no further assessment and approval under the EPBC Act was required. The following assessments against the significant impact guidelines (DotE 2013) have been informed by this previous determination.

Koala (*Phascolarctos cinereus*)

A single individual Koala was recorded within the site in February 2018 and this species has previously been observed within the site (CEG 2012). Specific referral guidelines for the Koala under the EPBC Act have been prepared (DotE 2014). The following factors are defined by these guidelines and form the basis as to whether a referral is required:

- **Koala habitat**: The Site is coastal habitat for the Koala, being within the modelled distribution of the species, contains known feed trees and the species has been recorded within the site.
- **Habitat critical to the survival of the Koala**: The Site represents habitat critical to the survival of the Koala, as defined under the referral guidelines (DotE 2014) as is has a habitat score greater than 5 (habitat score of the Site is 8) which is comprised of the following:
    - Koala occurrence - high (+2): Koala was recorded on the site in February 2018.
    - Vegetation composition - high (+2): Has forest or woodland with 2 known Koala food tree species (*Eucalyptus microcorys* and *E. propinqua*).
    - Habitat connectivity - high (+2) areas is part of a contiguous landscape extending north of the Project area including an area of approximately 530 ha.
    - Key existing threats - medium (+1): Koala mortality due to vehicle strike have been recorded along the Pacific Highway.
    - Recovery value - medium (+1): The Project area is part of a large, connected area of koala habitat. However, there is uncertainty surrounding the use of the Project area to support breeding Koalas. No evidence is available on the genetic diversity or disease risk of koalas associated with the subject land.
- **Adversely affect habitat critical to the survival of the Koala:** The extent of habitat loss associated with the Project falls within the 'impacts uncertain' category in accordance with the referral guidelines (DotE 2014). Further consideration of the nature of the habitat loss, including the habitat score (8/12), extent of habitat loss (11.12 ha), Koala density (low as only single individual recorded across all surveys) and fragmentation (low, as connectivity with

adjacent areas of native vegetation will be retained), reduce the chance that impacts will adversely impact habitat critical to the survival of the species.

- **Interfere substantially with the recovery of the Koala**: In accordance with the referral guidelines, actions which may interfere with the recovery of the Koala include actions which may increase koala fatalities due to dog attacks or vehicle-strikes, facilitate the introduction or spread of disease or pathogens (including Chlamydia or *Phytophthora cinnamomi*), create a barrier to movement between or within habitat or change hydrology which degrades habitat to the extent that the carrying capacity of the habitat is reduced in the long-term.

  The Project is unlikely to cause increased Koala fatalities due to vehicle strike as Koala-proof fencing is to be installed along the southern boundary of the site where it adjoins Blue Rock Close and the Pacific Highway. The Project is also unlikely to create a barrier to movement between habitat as connectivity will be maintained through the site through retention of vegetation outside the subject land including along the southern boundary of the site. Other impacts which interfere with the recovery of the Koala, including fatalities associated with dog attack, disease introduction or habitat degradation are unlikely to result from the Project.

Conclusion for Koala

The Project is unlikely to significantly impact the Koala and a referral is not required as the Site only supports a low density of Koalas and connectivity will be maintained between areas of retained vegetation within the site and surrounding areas of native vegetation. Additionally, the habitat loss associated with the Project only represents a small increase in habitat loss compared to that which was previously referred to the DoEE and which was determined to be a non-controlled action.

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

The Grey-headed Flying-fox has been recorded foraging within the subject land (HWR Ecological 2004). In accordance with DotE (2013), an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

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

An important population is considered a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are key source populations either for breeding or dispersal; populations that are necessary for maintaining genetic diversity; and/or populations that are near the limit of the species range.

The Grey-headed Flying-fox is considered to consist of one national population due to the constant genetic exchange and movement between camps throughout the geographic distribution. Hence the individuals in the locality are part of an important population.

The proposed action is unlikely to lead to a long-term decrease in the size of an important population. There are no camps in the subject land and no camps would be indirectly impacted by the proposed action. The proposed action would not directly or indirectly cause mortality of individuals.

reduce the area of occupancy of an important population

The Grey-headed Flying-fox occupies most areas in their distribution in an irregular pattern due to seasonal and geographic variation in foraging resources. The proposed action would reduce the area available to forage for this species but would not reduce the area the species could occupy at a given time. The species would be able to continue foraging in the site in retained habitat.

fragment an existing important population into two or more populations

As the Grey-headed Flying-fox is highly dispersive and mobile, the proposed action would not fragment the existing population into two or more populations.

adversely affect habitat critical to the survival of a species

Habitat critical to the survival of the Grey-headed Flying-fox is outlined in the Draft National Recovery Plan (DECCW 2009). Foraging habitat must meet at least one of the following criteria:

- Productive during winter and spring, when food bottlenecks have been identified
- Known to support populations of >30,000 individuals within an area of 50 km radius (the maximum foraging distance of an adult)
- Productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (September to May)
- Productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes (months vary between regions)
- Known to support a continuously occupied camp

The subject land does not meet the definition as critical habitat for this species.

disrupt the breeding cycle of an important population

There are no camps in the subject land and hence the proposed action would not disrupt the breeding cycle of an important population. The removal of habitat critical to the survival of an important population would include clearing which reduces the availability of foraging resources that would be used during the breeding cycle. However, the small extent of habitat that would be removed by the proposed development is unlikely to disrupt a breeding cycle.

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

The removal and modification of foraging habitat is not likely to cause a species decline due to the small scale of the clearing. The additional fragmentation of habitat is not considered to isolate habitat patches as the Grey-headed Flying-fox is highly mobile.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposed action would not result in an invasive species becoming established in the habitat. There are invasive species that already occur in the subject land but the proposed action would not cause new species to become established.

introduce disease that may cause the species to decline, or

It is unlikely that the proposed action would introduce disease that may cause the species to decline. Due to the highly mobile nature of the species, the transportation of disease may occur through a population by individuals moving through a large geographic range. However, the proposed works would not cause a new disease to be introduced into the population.

interfere substantially with the recovery of the species. The proposed action is unlikely to interfere substantially with the recovery of the species.

Conclusion for the Grey-headed Flying-fox

A referral is not recommended for the Grey-headed Flying-fox. The small scale of clearing of vegetation in which no camps have been found, leads to a conclusion that the species is not adversely affected.

Lowland Rainforest of Subtropical Australia

In accordance with DotE (2013), an action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

reduce the extent of an ecological community

The Project will clear a small area (0.47 ha) of Lowland Rainforest of subtropical Australia ('Lowland Rainforest').

fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

The Project will result in the complete removal of a small area (0.47 ha) of Lowland Rainforest, although would not result in fragmentation of any large or interconnected patches of the ecological community.

adversely affect habitat critical to the survival of an ecological community

The occurrence of the ecological community within the site is outside the primary range of the ecological community which extends from the Clarence River north to Maryborough in Queensland. The geographic location of the Site to the south of the primary range of the ecological community, combined with the topographic and climatic conditions, have resulted in only a very small occurrence of the ecological community (0.47 ha). The habitat within the Site is considered marginal for the community and is not critical to the survival of the ecological community.

modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns

The Project would result in the clearing and loss of a small area (0.47 ha) of the ecological community within the Site. The Project would not modify or destroy abiotic factors necessary for the survival of the ecological community outside the Site.

cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting

The Project would result in the clearing and loss of a small area (0.47 ha) of the ecological community within the Site. No change in species composition, or decline in functionality important species, would occur in occurrences of the ecological community outside of the Site.

cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

> **– assisting invasive species, that are harmful to the listed ecological community, to become established, or**
>
> **– causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or**

The Project would result in the clearing and loss of a small area (0.47 ha) of the ecological community within the Site. No reduction in the quality or integrity of the ecological community would occur outside of the site.

interfere with the recovery of an ecological community.

The Project would result in the clearing and loss of a small area (0.47 ha) of the ecological community within the Site. The occurrence of the ecological community within the Site is not currently interconnected with any larger patches of the ecological community. The loss of the small area of the ecological community within the Site would not substantially interfere with the recovery of the ecological community.

Conclusion for Lowland Rainforest While the Project would result in the loss of the small area (0.47 ha) of the ecological community within the Site, given the small area of the ecological community which would be impacted by the Project and the requirements to offset these impacts in accordance with the BAM, it is unlikely that the ecological community will be significantly impacted.

Rufous Fantail

In accordance with DotE (2013), an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

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

The project would involve the removal of 11.59 ha of native vegetation representing habitat for this species. Based upon the 'Referral guideline for 14 birds listed as migratory species under the EPBC Act' (DotE 2015) important habitat for the Rufous Fantail includes moist, dense habitats, including mangroves, rainforest, riparian forests and thickets, and wet eucalypt forests with a dense understorey. The habitat within the subject land includes rainforest and wet sclerophyll forest vegetation types which are important habitat for this species, however only a small area (11.59ha) of this habitat would be impacted by the Project.

result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

Invasive species which may be harmful to the Rufous Fantail include the Black Rat (Rattus rattus) and invasive vines of riparian habitats (DotE 2015). The Project is unlikely to increase the chance of these species becoming established within the subject land.

seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species

Based upon the referral guidelines (DotE 2015), the small area of habitat which would be impacted by the Project (11.59 ha) is unlikely to support an ecologically significant portion of the species (defined as 4,800 individuals). The referral guidelines (DotE 2015) indicates that the area of important habitat for the Rufous Fantail likely to result in a significant impact if affected or the area likely to support an ecologically significant portion of the population is 750ha.

Conclusion for Rufous Fantail

The Project would result in the loss of a small area (11.59 ha) of habitat for this migratory species within the Site, however this small area is would not support an ecologically significant proportion of the species. This species would not be significantly impacted by the Project.

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Annexure 2

Vegetation Integrity Scores

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Plot	PCT	Area (ha)	Patch size (ha)	condition class	zone	easting	northing	bearing
1	1550	5.4	101	Intact	56	406834	6389125.0	60
2	1618	0.6	101	Intact	56	406949	6389205.0	240
3	1590	1.1	101	Dense_Lantana	56	406564	6389362.0	230
4	1590	1.0	101	Low_Lantana	56	406653	6389441.0	50
5	1567	7.9	101	Lantana	56	406776	6389400.0	260
6	1567	7.9	101	Lantana	56	406570	6389169.0	140
7	1567	7.9	101	Lantana	56	406802	6389261.0	220
8	1527	0.3	101	Intact	56	406647	6389260.0	315
9	1550	5.4	101	Intact	56	406742	6389052.0	125
10	1550	5.4	101	Intact	56	406581	6389048.0	280
11	1567	7.9	101	Lantana	56	406501	6389233.0	90
12	1111	0.7	101	Exotic	56	406685	6389237.0	200

Plot	Composition Tree	Composition Shrub	Composition Grass	Composition Forbs	Composition Ferns	Composition Other
1	13	10	9	7	4	12
2	7	11	11	5	0	11
3	7	10	11	14	4	13
4	8	3	11	6	3	12
5	11	8	5	9	2	18
6	4	4	1	3	3	13
7	9	7	4	5	4	15
8	9	7	3	3	4	12
9	10	12	12	9	0	10
10	7	15	12	10	3	13
11	6	9	4	7	5	14
12	0	2	3	1	1	3

Plot	Structure Tree	Structure Shrub	Structure Grass	Structure Forbs	Structure Ferns	Structure Other
1	40.8	4.8	3.2	5.7	12.3	3.4
2	31.2	9.4	53.6	0.7	0.0	1.8
3	36.0	2.0	7.2	3.0	0.9	3.4
4	31.7	0.9	5.2	0.7	0.8	7.3
5	27.4	5.1	0.6	2.2	8.1	22.8
6	25.7	8.4	0.1	0.3	5.6	9.1
7	62.3	13.2	0.8	1.7	32.0	19.1
8	41.6	23.1	0.8	1.2	32.3	42.2
9	32.4	14.0	20.9	1.0	0.0	1.9
10	23.2	4.5	33.9	1.1	2.1	1.7
11	32.6	12.7	2.2	2.6	16.3	22.9
12	0.0	2.0	2.0	1.0	0.1	0.3

Plot	Function Large Trees	Function Hollow trees	Function Litter Cover	Function Length Fallen Logs	Function Tree Stem					Function Tree Regen	Function High Threat Exotic
					5to10	10to20	20to30	30to50	50to80		
1	0	1	85.0	69.0	1	1	1	1	1	1	3.0
2	3	1	73.0	40.0	1	1	1	1	1	1	0.3
3	4	1	67.0	68.0	1	1	1	1	1	1	2.1
4	3	1	71.0	250.0	1	1	1	1	1	1	35.0
5	2	0	91.0	41.0	1	0	0	1	1	0	15.0
6	0	0	80.0	80.0	0	0	0	1	1	0	45.0
7	1	0	87.0	52.0	0	1	1	1	1	1	1.0
8	0	0	57.0	16.0	1	1	1	0	0	1	2.0
9	0	0	88.0	72.0	1	1	1	1	1	1	0.1
10	1	1	79.0	95.0	1	1	1	1	1	1	1.0
11	2	3	58.0	20.0	0	0	1	1	1	0	15.0
12	0	0	37.2	32.0	0	0	0	0	0	0	33.5

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Annexure 3

Species Lists

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Table 22
Flora Species Observed within the Site

Family	Species	KRH01	KRH02	KRH03	KRH04	KRH05	KRH06	KRH07	KRH08	KRH09	KRH10	KRH11	KRH12	Incidentals
Acanthaceae	*Brunoniella australis*		0.1	0.2						0.2	0.1			
	Pseuderanthemum variabile	0.2	0.1	0.2	0.1	0.1	0.1	0.2		0.1	0.1	0.1		
Adiantaceae	*Adiantum aethiopicum*										1			
	Adiantum formosum						0.5	3	2			0.1	0.1	
	Adiantum hispidulum			0.1	0.1							0.1		
	Pellaea falcata	0.1		0.5										
	Pellaea paradoxa			0.1	0.2	0.1						0.1		
Anthericaceae	*Arthropodium milleflorum*			0.1	0.1					0.1				
	Caesia parviflora var. *parviflora*										0.1			
Aphanopetalaceae	*Aphanopetalum resinosum*													X
Apiaceae	*Centella asiatica*									0.1				
	*Cyclospermum leptophyllum**												0.1	
	Hydrocotyle geraniifolia			0.1										
Apocynaceae	*Gomphocarpus fruticosus**													X
	Marsdenia rostrata						0.5	2						
	Parsonsia straminea		0.1			0.1				1	0.1			
	Parsonsia velutina													X
	Tylophora barbata			0.1		0.2						0.1		
Araceae	*Gymnostachys anceps*	5		0.1	0.2	1		0.5	0.1		0.1	2		
Araliaceae	*Polyscias sambucifolia*	0.3												
Arecaceae	*Archontophoenix cunninghamiana*								25					
	Livistona australis					0.2	5	0.1	2					
Asparagaceae	*Asparagus aethiopicus**													X
Aspleniaceae	*Asplenium australasicum*													X
Asteraceae	*Ageratina adenophora**												0.5	
	*Bidens pilosa**												25	
	*Cirsium vulgare**												10	
	Conyza spp.*			0.1										
	Olearia nernstii													X
	Senecio hispidulus			0.1										
	*Senecio madagascariensis**			0.1										
	Sigesbeckia orientalis subsp. *orientalis*			0.1									1	
	*Sonchus oleraceus**												0.1	
	*Tagetes minuta**												0.5	
	Vernonia cinerea	0.1												

Family	Species	KRH01	KRH02	KRH03	KRH04	KRH05	KRH06	KRH07	KRH08	KRH09	KRH10	KRH11	KRH12	Incidentals
Bignoniaceae	*Pandorea pandorana*			0.1	0.1			0.1		0.1		0.1		
Blechnaceae	*Blechnum cartilagineum*	2					5	20						
Blechnaceae	*Blechnum neohollandicum*	10		0.2	0.5	8	0.1	8			1	15		
Caryophyllaceae	*Cerastium glomeratum**													X
	Stellaria flaccida	0.1		0.2		0.1					0.1	0.1		
Casuarinaceae	*Allocasuarina torulosa*	0.1	1	0.5	0.5	0.1				2	1			
	Casuarina glauca													X
Celastraceae	*Denhamia cunninghamii*													X
	Denhamia silvestris	0.1		0.2						0.5	0.1			
	Elaeodendron australe var. *australe*							1						
Colchicaceae	*Wurmbea biglandulosa* subsp. *biglandulosa*													X
Commelinaceae	*Aneilema acuminatum*						0.1	0.5	1			0.1		
Commelinaceae	*Commelina cyanea*	0.1				0.1	0.1							
Convolvulaceae	*Dichondra repens*			0.1						0.1				
Convolvulaceae	*Polymeria calycina*		0.1							0.1				
Cunoniaceae	*Ceratopetalum apetalum*					0.1								
	Schizomeria ovata													X
Cyatheaceae	*Cyathea australis*								1					
Cyperaceae	*Carex appressa*									5				
	Carex inversa	0.1												
	Carex longebrachiata				0.1	0.1		0.1	0.2	2				
	Cyperus spp.	0.1							0.1					
	Gahnia aspera				0.1									
	Gahnia clarkei		25											
	Gahnia melanocarpa	0.1		0.2							0.1			
	Gahnia spp.				0.2	0.1				0.5		1		
	Lepidosperma laterale				0.1						0.1			
	Lepidosperma spp.			0.5										
Dennstaedtiaceae	*Pteridium esculentum*										0.1			
Dicksoniaceae	*Calochlaena dubia*	0.5				2	1	10						
Dilleniaceae	*Hibbertia aspera*		0.2											
	Hibbertia dentata	0.1		0.1		0.1					0.1			
	Hibbertia scandens	0.1	0.2											
Dioscoreaceae	*Dioscorea transversa*	1	0.1	0.1	0.1	1	0.1	0.1	0.2	0.1		1	0.1	
Droseraceae	*Drosera hookeri*													X
Dryopteridaceae	*Lastreopsis decomposita*	0.2						1				1		
	Lastreopsis microsora subsp. *microsora*								25					

Family	Species	KRH01	KRH02	KRH03	KRH04	KRH05	KRH06	KRH07	KRH08	KRH09	KRH10	KRH11	KRH12	Incidentals
Ebenaceae	*Diospyros australis*													X
Elaeocarpaceae	*Elaeocarpus obovatus*	0.1								0.1				
	Sloanea australis								2					
Ericaceae	*Leucopogon juniperinus*	0.1	0.2	0.3						1	0.2			
Euphorbiaceae	*Alchornea ilicifolia*			0.1										
	Claoxylon australe					0.2		2	0.3			1		
Eupomatiaceae	*Eupomatia laurina*					0.1	3	3						
Fabaceae - Faboideae	*Trifolium repens**													X
	*Vicia tetrasperma**													X
	Desmodium gunnii	0.1				0.1				0.1	0.1			
	Desmodium varians			0.1										
	Glycine clandestina	0.1	0.1			0.1				0.1	0.1	0.1	0.1	
	Hardenbergia violacea	0.1	0.1	0.1						0.1	0.1			
	Indigofera australis													X
	Kennedia rubicunda	0.1	0.1								0.1	0.1		
	Pultenaea paleacea		0.1											
	Pultenaea villosa		0.1											
Fabaceae (Mimosoideae)	*Acacia floribunda*										0.1			
	Acacia irrorata		5							1	0.2			
	Acacia longifolia subsp. *longifolia*		2								0.1			
	Acacia maidenii	2		0.4	0.5	0.1		0.1		0.1		0.1		
	Pararchidendron pruinosum var. *pruinosum*								5					
Flagellariaceae	*Flagellaria indica*													X
Gentianaceae	*Centaurium tenuiflorum**													X
Geraniaceae	*Geranium homeanum*			0.1										
Goodeniaceae	*Goodenia heterophylla*		0.1								0.1			
Haloragaceae	*Gonocarpus teucrioides*		0.1											
Iridaceae	*Libertia paniculata*													X
	*Sisyrinchium rosulatum**													X
Lamiaceae	*Clerodendrum tomentosum*	0.1			0.2	0.1	0.2	0.5	0.1	0.1	0.1	0.5		
	Plectranthus parviflorus			1	0.1	0.1					0.1	0.1		
	Scutellaria mollis			0.5		0.1					0.1	0.1		
Lauraceae	*Cryptocarya rigida*	2			0.7	2	0.2	5	0.2	1	0.4	10		
	Neolitsea dealbata						0.5	0.2	30			2		
Lobeliaceae	*Lobelia purpurascens*			0.1						0.1				
Lomandraceae	*Lomandra cylindrica*		0.1											
	Lomandra filiformis			0.2							0.1			

Family	Species	KRH01	KRH02	KRH03	KRH04	KRH05	KRH06	KRH07	KRH08	KRH09	KRH10	KRH11	KRH12	Incidentals
	Lomandra longifolia	0.3	8	0.2	2			0.4		5	10	1		
	Lomandra multiflora subsp. multiflora		0.1											
	Lomandra spp.									0.5				
Luzuriagaceae	*Eustrephus latifolius*	0.5	0.1	0.2	0.8	0.1	0.3	0.1			0.1	0.1		
	Geitonoplesium cymosum				0.5	0.1		0.2		0.1	0.1	0.1		
Malvaceae	*Commersonia fraseri*													X
Meliaceae	*Melia azerdach*													X
	Synoum glandulosum subsp. *glandulosum*					0.4	5	2	20		0.1			
Menispermaceae	*Sarcopetalum harveyanum*	0.1			0.5		0.1	0.1				2		
	Stephania japonica var. *discolor*				0.5	0.2	0.1	0.1	0.5		0.1		0.1	
Monimiaceae	*Daphnandra micrantha*								3					
	Wilkiea huegeliana					2		0.1						
Moraceae	*Ficus coronata*						0.2		2					
	Ficus rubiginosa													X
	Maclura cochinchinensis													X
	Streblus brunonianus								0.1					
Myrsinaceae	*Embelia australiana*								1					
	Myrsine howittiana	0.2												
	Myrsine variabilis			0.1										
Myrtaceae	*Acmena smithii*	0.5						1.5	0.2					
	Angophora costata		10											
	Angophora floribunda	8								0.5				
	Backhousia myrtifolia													X
	Callistemon salignus	0.3								4				
	Corymbia maculata		3	5	1	2								
	Eucalyptus acmenoides	1		1	15	2					1	20		
	Eucalyptus globoidea		15											
	Eucalyptus microcorys	10	1				15	25		4	10	4		
	Eucalyptus paniculata subsp. *paniculata*	2	1	25	10					0.5				
	Eucalyptus propinqua	4				5				23	10			
	Eucalyptus punctata			4	4									
	Eucalyptus saligna	1				10		6			1	6		
	Leptospermum polygalifolium		0.1											
	Lophostemon confertus	2			0.5	3	10	25						
	Melaleuca decora													X

Family	Species	KRH01	KRH02	KRH03	KRH04	KRH05	KRH06	KRH07	KRH08	KRH09	KRH10	KRH11	KRH12	Incidentals
	Melaleuca linariifolia									1				
	Melaleuca styphelioides	0.5								5	2			
	Syncarpia glomulifera	10				3				2				
	Syzygium australe								0.2					
Oleaceae	*Notelaea venosa*	0.2		0.4		0.2					0.1			
Orchidaceae	*Caladenia carnea*													X
	Caladenia catenata													X
	Calochilus paludosus													X
	Calochilus robertsonii													X
	Chiloglottis formicifera													X
	Chiloglottis trapeziformis													X
	Cymbidium suave				0.1	0.1						0.1		
	Microtis unifolia													X
	Pterostylis baptistii													X
	Pterostylis curta													X
	Pterostylis longifolia													X
	Pterostylis nutans													X
	Pterostylis pedunculata													X
	Thelymitra pauciflora													X
Passifloraceae	*Passiflora subpeltata**			0.1	0.1							0.1	0.1	
Phormiaceae	*Dianella caerulea*	0.1	0.3	0.1	0.1	0.1		0.1		0.1	0.2	0.1		
Phyllanthaceae	*Breynia oblongifolia*		1	0.1						0.1		0.1		
	Glochidion ferdinandi		0.2	0.1				2		0.1	0.1			
	Phyllanthus gunnii			0.1							0.5			
	Phyllanthus hirtellus		0.1											
	Phyllanthus spp.									0.1		0.1		
Piperaceae	*Peperomia blanda* var. *floribunda*													X
Pittosporaceae	*Billardiera scandens*		0.1									0.1		
	Hymenosporum flavum													X
	Pittosporum multiflorum	1				0.1						1		
	Pittosporum revolutum					0.1		0.1		0.1	0.1			
	Pittosporum undulatum			0.5										
Plantaginaceae	*Plantago lanceolata**													X
	Veronica plebeia									0.1				
Poaceae	*Andropogon virginicus**													X
	*Briza maxima**													X
	*Briza minor**													X
	*Bromus catharticus**													X

Family	Species	KRH01	KRH02	KRH03	KRH04	KRH05	KRH06	KRH07	KRH08	KRH09	KRH10	KRH11	KRH12	Incidentals
	Cynodon dactylon												0.5	
	Dichelachne micrantha										0.1			
	Digitaria spp.		0.1											
	Echinopogon caespitosus			0.1							0.1			
	Echinopogon ovatus	0.1								0.1				
	Entolasia marginata	0.2		0.2	0.1	0.1		0.1		0.5	0.3			
	Entolasia stricta		2											
	*Eragrostis curvula**													X
	Eragrostis spp.		0.1											
	Imperata cylindrica	0.1	15	0.1	0.2					5	2	0.1		
	Microlaena stipoides var. *stipoides*			0.5						1				
	Oplismenus aemulus				0.1		0.1		0.5	0.1	0.1		0.5	
	Oplismenus imbecillis	2	0.1	0.2	0.1	0.2		0.2		0.2		0.1	1	
	Panicum simile		0.1											
	*Paspalum ciliatifolium**												15	
	Poa labillardierei var. *labillardierei*	0.2		3	0.2	0.1				1	5			
	*Setaria sphacelata**												8	
	Sorghum leiocladum										1			
	Themeda triandra		3	2	2						15			
Polypodiaceae	*Platycerium bifurcatum*													X
Primulaceae	*Lysimachia arvensis**													X
Proteaceae	*Persoonia linearis*		0.5							0.1				
	Grevillea humilis subsp. *humilis*													X
Pteridaceae	*Pteris tremula*								0.3					
	Pteris umbrosa								5					
Ranunculaceae	*Clematis aristata*			0.1		0.1				0.1				
	Clematis glycinoides										0.1			
	Ranunculus lappaceus													X
Rhamnaceae	*Pomaderris ferruginea*										0.1			
Ripogonaceae	*Ripogonum fawcettianum*				0.1	1	0.5	0.1	0.2			4		
Rosaceae	*Rubus moluccanus* var. *trilobus*			0.1	0.1					0.1	0.3	0.1	1	
	Rubus nebulosus							0.1						
	Rubus parvifolius	0.1		0.1	0.1						0.1	0.1		
	Rubus rosifolius								0.3				1	
Rubiaceae	*Morinda jasminoides*					0.1	0.2		1					
Rutaceae	*Boronia polygalifolia*													X

Family	Species	KRH01	KRH02	KRH03	KRH04	KRH05	KRH06	KRH07	KRH08	KRH09	KRH10	KRH11	KRH12	Incidentals
Salicaceae	*Scolopia braunii*													X
Santalaceae	*Exocarpos cupressiformis*		0.1								0.1			
Sapindaceae	*Alectryon subcinereus*								0.1					
	Diploglottis australis								0.2					
	Guioa semiglauca					2		2						
Smilacaceae	*Smilax australis*	0.5	0.2	1	3	6	0.5	3	0.2		0.5			
	Smilax glyciphylla									0.1	0.1			
Solanaceae	*Duboisia myoporoides*													X
	*Physalis peruviana**												0.1	
	Solanum brownii													X
	*Solanum mauritianum**												1	
	*Solanum nigrum**			0.1									0.5	
Stylidiaceae	*Stylidium graminifolium*													X
Unknown	*Shrub indeterminate*											0.3		
Urticaceae	*Dendrocnide excelsa*								1					
Uvulariaceae	*Tripladenia cunninghamii*				0.1									
Verbenaceae	*Lantana camara**	3	0.3	2	35	15	45	1	2	0.1	1	15	8	
	Verbena spp.*												5	
Violaceae	*Viola hederacea*													X
Vitaceae	*Cayratia clematidea*			0.1	0.1	0.4	0.5	0.1	1		0.1	0.1		
	Cissus antarctica	0.1		1	0.5	10	0.1	2	0.1			5		
	Cissus hypoglauca	0.2		0.2	1	1	0.2	1	10	0.1	0.1	10		
Xanthorrhoeaceae	*Xanthorrhoea macronema*		0.6											
Zingiberaceae	*Alpinia caerulea*					0.5		0.4	0.1					

Table 23
Fauna Species Observed within the Site

Species	Common name	Status (BC Act)	Status (EPBC Act)	Record type
Amphibians				
Litoria latopalmata	Broad-palmed Frog			O
Pseudophryne coriacea	Red-Backed Toadlet			O - pifall
Litoria peronii	Peron's Tree Frog			Calling
Uperoleia laevigata	Smooth Toadlet			W
Crinia signifera	Common Eastern Froglet			W
Reptiles				
Amphibolurus muricatus	Jacky Lizard			
Varanus varius	Lace monitor			
Aves				
Acanthiza pusilla	Brown Thornbill			W
Ailuroedus crassirostris	Green Catbird			W
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo			W
Cormobates leucophaea	White-throated Treecreeper			W
Columba leucomela	White-headed Pigeon			W
Corvus coronoides	Australian Raven			Ow
Corvus mellori	Little Raven			W
Cracticus torquatus	Grey Butcherbird			W
Dacelo novaeguineae	Laughing Kookaburra			O
Dicaeum hirundinaceum	Mistletoebird			Ow
Eopsaltria australis	Eastern Yellow Robin			Ow
Gerygone olivacea	White-throated Gerygone			W
Hieraaetus morphnoides	**Little Eagle**	**V**		**O**
Malurus cyaneus	Superb Fairy-wren			W
Meliphaga lewinii	Lewin's Honeyeater			O
Neochmia temporalis	Red-browed Finch			O
Nesoptilotis leucotis	White-eared Honeyeater			O
Pachycephala rufiventris	Rufous Whistler			W
Phylidonyris niger	White-cheeked Honeyeater			Ow
Psophodes olivaceus	Eastern Whipbird			W
Ptilonorhynchus violaceus	Satin Bowerbird			Remote Camera
Ptilotula penicillatus	White-plumed			W

Species	Common name	Status (BC Act)	Status (EPBC Act)	Record type
	Honeyeater			
Rhipidura albiscapa	Grey Fantail			Ow
Rhipidura rufifrons	**Rufous Fantail**		**Migratory**	**O**
Trichoglossus chlorolepidotus	Scaly-breasted lorikeet			Ow
Mammals				
Antechinus stuartii	Brown Antechinus			O - Spotlight
Chalinolobus gouldii	Gould's Wattled Bat			Anabat - definite
Chalinolobus morio	Chocolate Wattled bat			Anabat - probable
Falsistrellus tasmaniensis / Scotorepens orion / Scoteanax rueppellii	35 - 38 khz Mixed group			Anabat – possible Calls of these species are similar and in the absence of a clear call there is uncertainty
Macropus rufogriseus	Red-necked Wallaby			O
Micronomus norfolkensis	Eastcoast Freetail Bat			Anabat – possible
Miniopterus australis	**Little Bentwing Bat**	**V**		**Anabat – definite**
Miniopterus schreibersii oceanensis	**Eastern Bentwing Bat**	**V**		**Anabat – definite**
Nyctophilus sp.	Long-eared Bat			Anabat – definite
Ozimops ridei	Eastern Freetail Bat			Anabat - probable
Perameles nasuta	Long-nosed Bandicoot			Remote Camera
Phascolarctos cinereus	**Koala+**	**V**	**V**	**Remote Camera**
Pseudocheirus peregrinus	Common Ringtail Possum			O - Spotlight
Rattus sp.	Rat			Hair analysis
Rhinolophus megaphyllus	Eastern Horseshoe Bat			Anabat – definite
Tachyglossus aculeatus	Short-beaked Echidna			Remote Camera
Trichosurus vulpecula	Common Brushtail Possum			Remote Camera
Vespadelus pumilus	Eastern Forest Bat			Anabat - probable
Vespadelus regulus	Southern Forest Bat			Anabat – possible
Vespadelus vulturnus	Little Forest Bat			Anabat – probable
Vespadelus grouped (*V. vulturnus/V. troughtoni*)				Anabat – definite
Vulpes vulpes	Fox			Remote Camera
Wallabia bicolor	Swamp Wallaby			Remote Camera

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