Proposed Extractive Industry

Sand Quarry

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Lot 1324 DP 785874
Lot 323 DP 855616

Belmore River Right Bank Road Belmore River NSW

Kempsey Shire Council Reference T6-14-122

Ecological Report prepared by Jason Berrigan

Naturecall Environmental

NATURECALL
ENVIRONMENTAL

Statutory Ecological Assessment:

Project:

Proposed Sand Quarry on Lot 1324 DP785874 and Lot 323 DP855616, Belmore River.

Client:

Townplanning and Drafting Services

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Contents

List of Figures

List of Tables

List of Photos

Executive Summary

Naturecall Environmental were engaged by Townplanning Consultants & Drafting Services to provide a statutory ecological assessment for a proposed sand quarry on Lot 1324 DP 785874 and Lot 323 DP 855616, Belmore River. This addresses limitations of the current statutory ecological assessment which supported the proponent's Environmental Impact Statement, and comments by the Office of Environment and Heritage.

The development proposal is a sand quarry over about 6.4ha of the 24.32 parent parcel of land, with material to be trucked out via a right of way across a current sand quarry operated by the proponent (nearly at the end of its lifespan and to be rehabilitated) to Belmore River Road, and associated clients across NSW.

The quarry is to be established in 10 stages over an estimated 17 year timeframe (depending on market demand). Each stage is approximately 0.5ha in extent, with the previous stage to be simultaneously rehabilitated under a rehabilitation plan (to be prepared as a condition of consent), hence a total of 1ha will be operational at a given time. A minimum of 1m of sand will be left on the floor of the quarry to avoid interacting with the watertable, but based on the soil profile in the existing quarry to the south, it is expected that 3-4m of overburden will see a higher buffer. The final landform will be undulating, matching the current local landform.

The subject land which contains the quarry adjoins Hat Head National Park to the north and east, and has two abandoned dwellings (one within the quarry footprint), which are both in states of extreme disrepair. The vegetation for a distance of 30-70m around these dwellings has been irregularly underscrubbed with limited maintenance for the last 3-5 years. Both lots are highly criss-crossed with tracks, with the widest being the main access. Historical photos show a major fire over the locality including the subject land in 2003. Historical flood mitigation and pastoralism has also significantly modified land adjacent to the western half of the haulage route.

The study area around the haulage route and quarry site encompasses a complex mosaic of vegetation types, reflecting the overlap of alluvial, swamp and Aeolian geomorphology. The quarry site lies on a dune, and is occupied by senescent dry sclerophyll forest generally dominated by Blackbutt, with less abundant species comprising Needlebark and Pink Bloodwood; with Scribbly Gum on the lower slopes. Adjacent to the east and west is sedgeland in wetlands, encircled by wet heath and swamp forests. Adjacent to the remainder of the haulage route is a mosaic of swamp forests, sedgeland, wet heath, wet meadows and improved pasture.

A complex of Coastal Floodplain EECs occur adjacent to the central section of the haulage route, but not on or around the quarry site. No threatened plants were found on the quarry site or accessible sections of the study area. Due to records in the locality in broadly similar habitat, *Phaius* orchids were considered at best only a low potential occurrence due to likelihood of being collected.

An intensive fauna survey was undertaken over the subject land and adjacent sections of the study area including along the haulage road. Previous survey had detected the Little Bent-wing Bat, Yellow-bellied Sheathtail Bat and a male Brushtailed Phascogale. OEH has requested further study to assess the significance of the site to the latter species, and correspondingly an intensive systematic survey design was employed.

This survey detected the Squirrel Glider in low density, a single male Phascogale, the Little Bent-wing Bat and the Three-toed Snake-toothed Skink on the subject land. The latter compliments an earlier record to the southwest which extended the southern range of this species into a completely different habitat type. The Green and Golden Bell Frog has also been previously recorded in the wetland to the east, but was not detected during this survey. The Wallum Froglet and another 23 (including 7 Yangochiropteran bat species) other threatened species were considered potential occurrences in the study area based on suitable habitat.

The Three-toed Snake-toothed Skink was the only EPBC Act listed species recorded on site, with the Green and Golden Bell Frog historically recorded in the wetland to the east. The Grey-headed Flying Fox, New Holland Mouse and Spotted-tail Quoll were also considered potential occurrences in the study area. No migratory species were detected, but several are expected to occur seasonally in low abundance as non-breeding birds.

The habitats on the subject land and in the study area form part of an extensive and interconnected complex of such habitats mostly in Hat Head National Park. Hence habitats for these species are not restricted to the subject land or study area, and it is not a critical part of any corridor.

The proposal will see removal of 6.4ha of dry sclerophyll forest over 17 years, comprising about 40% of this habitat on the subject land, and a somewhat lesser fraction of this habitat on adjacent land to the north, south and southeast. The rehabilitation strategy aims to utilise the resilience of the affected vegetation community to re-establish it in the short term via simultaneously rehabilitating each exhausted cell after clearing of the next operational cell over the quarry's lifetime. The current vegetation has a demonstrated capacity to recolonise after such disturbance (similar to how it does after major bushfire), hence a similar if not identical vegetation community is expected to establish in due course. Hollow-bearing trees will be the slowest habitat attribute to return, however all fallen hollow-bearing trees along with all other coarse woody debris will be used in the rehabilitation to provide habitat and other ecological values. The habitat loss is thus not permanent and eventually the disturbed area is expected to redevelop its values to the affected threatened species.

A number of mitigation measures are provided to support rehabilitation and also minimise the risk of mortality during clearing.

Assessment under the EPBC Act guidelines for the Koala determined that the site contained critical habitat, but the impact was not significant, hence the proposal does not need referral. The impact was also considered insignificant for the other fauna and flora species.

Assessment under the 7 Part Tests determined that the loss of 6.4ha of habitat would impact the following species:

- *Foraging habitat*: Square-tailed Kite, Little Eagle, Powerful Owl, Masked Owl, Varied Sittella, Little Lorikeet, Spotted-tail Quoll, Common Planigale, Eastern Pygmy Possum, Grey-headed Flying Fox, Eastern Blossom Bat, Greater Broad-nosed Bat, East-coast Freetail Bat, Yellow-bellied Sheathtail Bat, Eastern False Pipistrelle, Eastern Cave Bat, Hoary Bat, Little and Eastern Bent-wing Bats and Three-toed Snake-toothed Skink.
- *Roosting/denning/nesting/refugia*: Powerful Owl, Masked Owl, Varied Sittella, Little Lorikeet, Spotted-tail Quoll, Common Planigale, Eastern Pygmy Possum, Greater Broad-nosed Bat, East-coast Freetail Bat, Yellow-bellied Sheathtail Bat, Hoary Bat, Eastern False Pipistrelle,

Little and Eastern Bent-wing Bats and Three-toed Snake-toothed Skink, Southern Myotis, Green and Golden Bell Frog.

These impacts were however deemed insignificant in the long term to the survival of the local populations given:

- For many, the quarry site (or even the subject land or study area) is not sufficient in extent to meet the life cycle requirements of the local population.
- The quarry site is not breeding habitat eg for the Green and Golden Bell Frog.
- While hollow-bearing trees will be removed, these are demonstrated to be abundant on the subject land, with similar abundance on adjacent land, indicating this habitat component is not a critical constraint in the study area.
- The habitat loss will be spread over about 17 years, allowing not only for adjustment of home ranges but also for rehabilitated habitat to regenerate and be utilised for foraging, connectivity and refuge.
- The resilience of the affected vegetation and rehabilitation strategy will ensure the habitat loss is not permanent.
- Connectivity will remain around the disturbed area in perpetuity.
- The haulage route has minimal if any direct or indirect impacts.

Similarly, impact on the EECs is negligible given:

- No habitat to be disturbed.
- No risk of pollution.
- No impacts on Acid Sulfate Soils.
- No change to the hydrological regime.

Hence a Species Impact Statement is not considered required.

1.0 Introduction

Townplanning Consultants & Drafting Services (TCDS 2014) lodged an Environmental Impact Statement (EIS) for a proposed sand quarry on Lot 1324 DP 785874 and Lot 323 DP 855616, Belmore River with Kempsey Shire Council (KSC). The EIS is supported by a range of specialist assessments including two ecological assessments prepared by FloraFauna Consulting (2013, 2015).

The NSW Office of Environment and Heritage (OEH 2015) provided a series of comments on the proposal, detailing concerns over lack of certainty in the impact assessment, particularly on the Brushtailed Phascogale which was recorded on site by FloraFauna Consulting (FFC).

KSC engaged Naturecall to prepare a concise peer review of the ecological assessments and comment on its adequacy in supporting the conclusions of the EIS, and providing the Joint Regional Planning Panel (JRPP) with sufficient information to address all considerations.

This peer review (Naturecall 2015) identified a significant number of issues with various aspects of the ecological assessment including:

- Failure to assess all species known to occur in the study area.
- Failure to assess all potentially occurring species within habitat types found in the study area, but recorded in these habitat types in the locality and/or bioregion.
- Failure to undertake appropriate survey for the above species.
- Failure to undertake adequate and objective due diligence assessment for impacts and significance in line with DECC (2007).
- Failure to adequately identify the study area, local populations and local occurrences to be assessed; and hence inadequate assessment of impacts on the long term viability of these protected entities.
- Failure to consider impacts of the haulage route eg on the Green and Golden Bell Frog.
- Inadequate mitigation measures, including failure to justify or provide a sufficient offset to maintain or improve biodiversity.
- Failure to undertake a proper due diligence survey and assessment under the EPBC Act for a range of species known and potentially occurring in the study area.

Naturecall were subsequently requested by the proponent to address the identified deficiencies via undertaking an appropriate field survey, impact assessment and statutory assessments of the proposal.

The statutory ecological assessment for this development proposal was undertaken in accordance with the *Environmental Planning and Assessment Act 1979*, as amended by the *Threatened Species Conservation* (TSCA) *Act 1995* which in turn has been amended by the *Threatened Species Conservation Legislation Amendments Act 2002* (Seven Part Test for Significance); NSW SEPP 44 - *Koala Habitat Protection*; and the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBCA) *Act 1999* - Matters of National Environmental Significance (MNES).

The survey and assessment was performed in consideration of the draft Threatened Species Survey and Assessment – Guidelines for Developments and Activities (DEC 2004), and the Threatened Species Assessment Guidelines – Assessment of Significance (DECC 2007). The assessment has also been undertaken in accordance with the Ecological Consultants Association of NSW – Code of Ethics (2002) available at www.ecansw.org.au.

2.0 Background Information

2.1. Location of the Site

As shown in Figure 1, the approximately 24.32ha subject land is located at the end of an unnamed road (locally known as Reilly's Drain road) which branches off Belmore River Road, Belmore River, in Kempsey Shire.

2.2. Development Proposal

As shown in Figure 3, the development proposal is a sand quarry over about 6.4ha, with material to be trucked out via a right of way (see Figure 2) across a current sand quarry (nearly at the end of its lifespan and to be rehabilitated) to Belmore River Road, and associated clients.

The majority of the existing right of way has been constructed and used for over 15 years, with the remainder following an existing track to a current sand quarry operated by the client, and then onto the site. The latter is the original access to a dwelling which has been abandoned, hence minimal if any further clearing will be required to establish this road, but some grading and gravel will be required to make a trafficable surface. No widening or upgrade of the current road running adjacent to Reilly's Drain is proposed, though routine maintenance including top dressing with gravel and grading may periodically occur.

The quarry will excavate a dune approximately 10m AHD down in height to a final depth depending on the quality of material eg indurated sand is not saleable. A minimum of 1m of sand will be left on the floor of the quarry to avoid interacting with the watertable, but based on the soil profile in the existing quarry to the south, it is expected that 3-4m of overburden will see a higher buffer.

The quarry is to be established over in 10 stages over an estimated 17 year timeframe (depending on market demand). Each stage is approximately 0.5ha in extent, with the previous stage to be simultaneously rehabilitated under a Rehabilitation Plan (to be prepared as a condition of consent), hence a total of 1ha will be operational at a given time. The first stages will commence in the northern end of the quarry site which includes some of the currently disturbed land, moving progressively south to minimise ongoing disturbance to rehabilitated vegetation (TCDS 2014).

Extracted sand is to be processed on site via dry screening to filter foreign materials such as roots.

2.3. Key Definitions

The **site** is defined as the quarry access road from Belmore River to Lots 1324 and 323, and the quarry footprint (the area directly impacted by the proposal). The **study area** is defined as the limit of detectable influence of direct and indirect impacts associated with the proposal. As these impacts include edge effects such as noise associated with machinery and increased penetration of solar radiation, a nominal 100m buffer around the access road and the quarry footprint is nominated as the study area.

The **subject land** refers to Lots 1324 and 323 which contain the quarry and extension of the haulage route. The **locality** is a 10km radius around the subject land and access road to Belmore River Rd.

2.4. Soils, Topography and Geology

A detailed account of the topography, soils and geology is provided in the EIS (TCPD 2014), hence is not provided here. This account is however limited to the subject land and does not include the access road.

The access/haulage road begins on low lying and flat alluvial floodplain grading to a merge zone and eventually the rear of the coastal barrier dune system in the east. There is a gradual drop in slope moving east from the river terrace at the junction with Belmore River Rd, rising again when the dune system is reached.

Figure 4 shows the Quaternary soil landscape mapping (Troedson and Hashimoto 2008), demonstrating the complexity of the local soil landscape due to the rise and fall of sea levels and associated formation and inland migration of the barrier dune system; and infilling of the original coastal lagoon by the Macleay River and its distributaries including Belmore River and Kinchela Creek (Atkinson 1999). Soils are thus a mosaic of alluvial and swamp to Aeolian soil landscapes, with Acid Sulfate Soils known to underlain the former two (TCDS 2014, pers. obs.).

2.5. Previous Ecological Surveys

FloraFauna Consulting (FFC) were engaged by the proponent to prepare two ecological surveys and assessments for the proposal (FFC 2013, 2015)

Survey included a vegetation community and targeted threatened flora survey over the dune vegetation on Lots 1324 and 323; and a limited fauna survey including pitfalls, spotlighting, call detection and Elliot A and B trapping (restricted to the sand dune vegetation, and mostly with a contagious distribution).

Naturecall (2015) provides a detailed review of these surveys, but generally they were considered to have some key limitations which affected the assessment's outcomes eg no assessment of the habitats adjacent to the haulage route.

No threatened flora were recorded on site. The key findings of this assessment was detection of 3 threatened species:

- Brushtailed Phascogale: Recorded as a single animal in an Elliot trap.
- Yellow-bellied Sheathtail Bat: Recorded via call detection.
- Little Bent-wing Bat: Recorded via call detection.

2.6. Landuse and Disturbance History

2.6.1. Previous Rural Dwellings

The subject land has two abandoned dwellings, which are both in states of extreme disrepair. The vegetation for a distance of 30-70m around these dwellings has been irregularly underscrubbed with limited maintenance for the last 3-5 years (see Photo 1). Both lots are highly criss-crossed with tracks, with the widest being the main access.

A small well was noted on the edge of the wetland on Lot 1323. No dams occur on the subject land.

A boundary fence comprised of grid-lock fencing on the common southern boundary is the only fenceline, indicating stock have not been kept on site. No old posts were found to indicate historical use as a flood refuge by local farms.

The remainder of Lots 1324 and 323 are in a natural state.

Photo 1: Example of APZ around dwelling in quarry footprint

2.6.2. Adjacent to Haulage Road

The land adjacent to the first half of the access/haulage road is initially pasture, with the hydrological regime modified by historical artificial drains and also the height of the road formation.

A drain about 10m wide and several metres deep (Reilly's Drain) runs parallel to the access road to Belmore River, joining into a narrower (about 3-5m wide) and shallower drain where the Swamp Oak forest begins.

This drainage system is known to be subject to periodic flows of acidified water from Acid Sulfate Soils after prolonged dry conditions followed by major rain events (Berrigan 1993). This has associated impacts on the aquatic ecosystem. Some acid scalds were noted in the low lying sections of the pasture near the drain.

East of the smaller drain which runs roughly north-south, the swamp forest structure and age suggests historical clearing for pasture, with various states of regrowth especially to the south where strips of different ages are apparent in aerial photos. Weed infestation is however largely limited to the road batter due to edaphic conditions ie high watertable.

Much of the remainder of the road beyond the swamp forest is bound on at least one side by previous and active sand quarries. Some of these areas are in a state of early regeneration, as shown in the following photo. Weeds (mostly pasture grasses and associated weeds) are common in this area.

Photo 2: Sand quarry regeneration area adjacent to access road

Figure 1: Site location

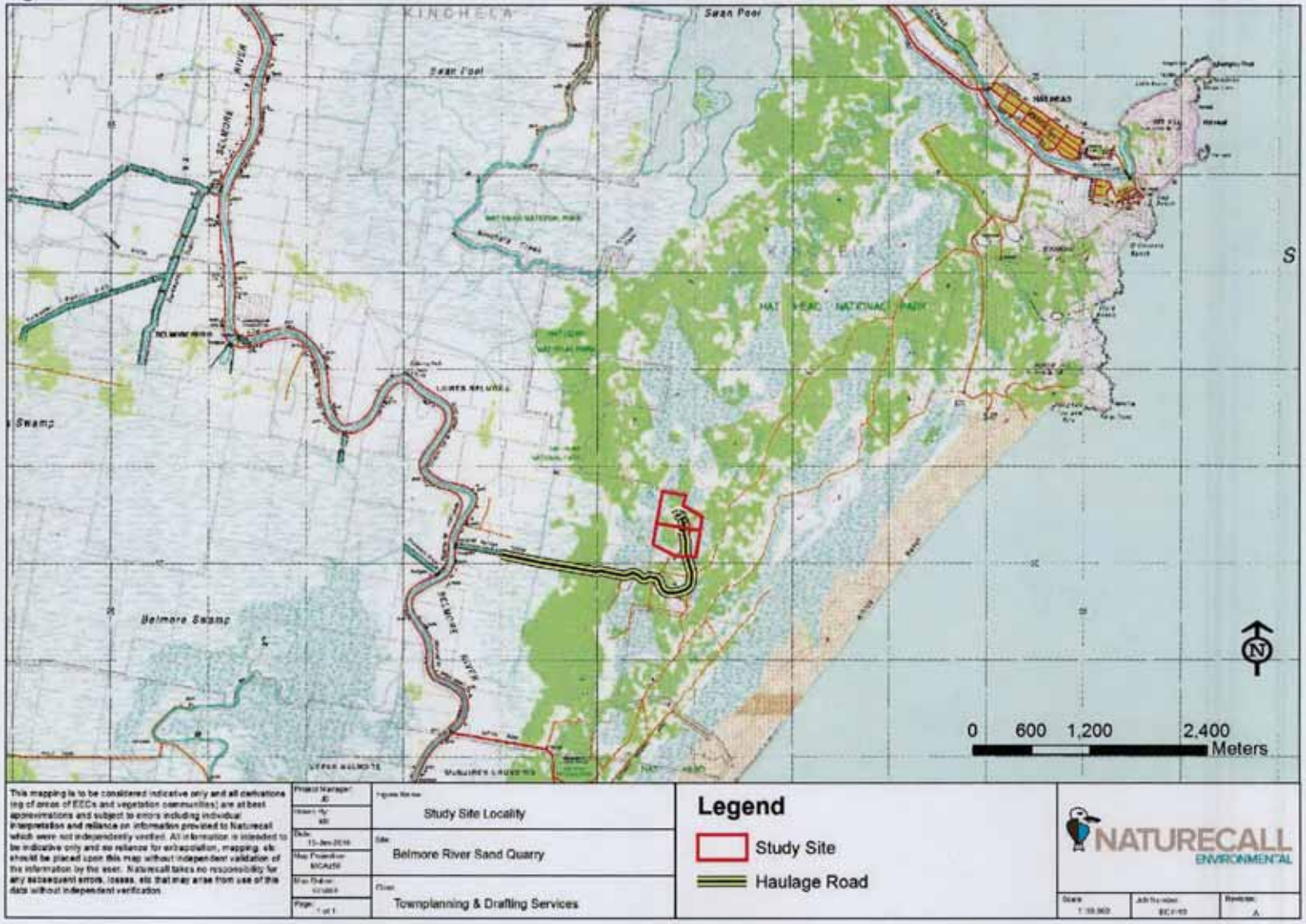


Figure 2: Proposed access and subject land

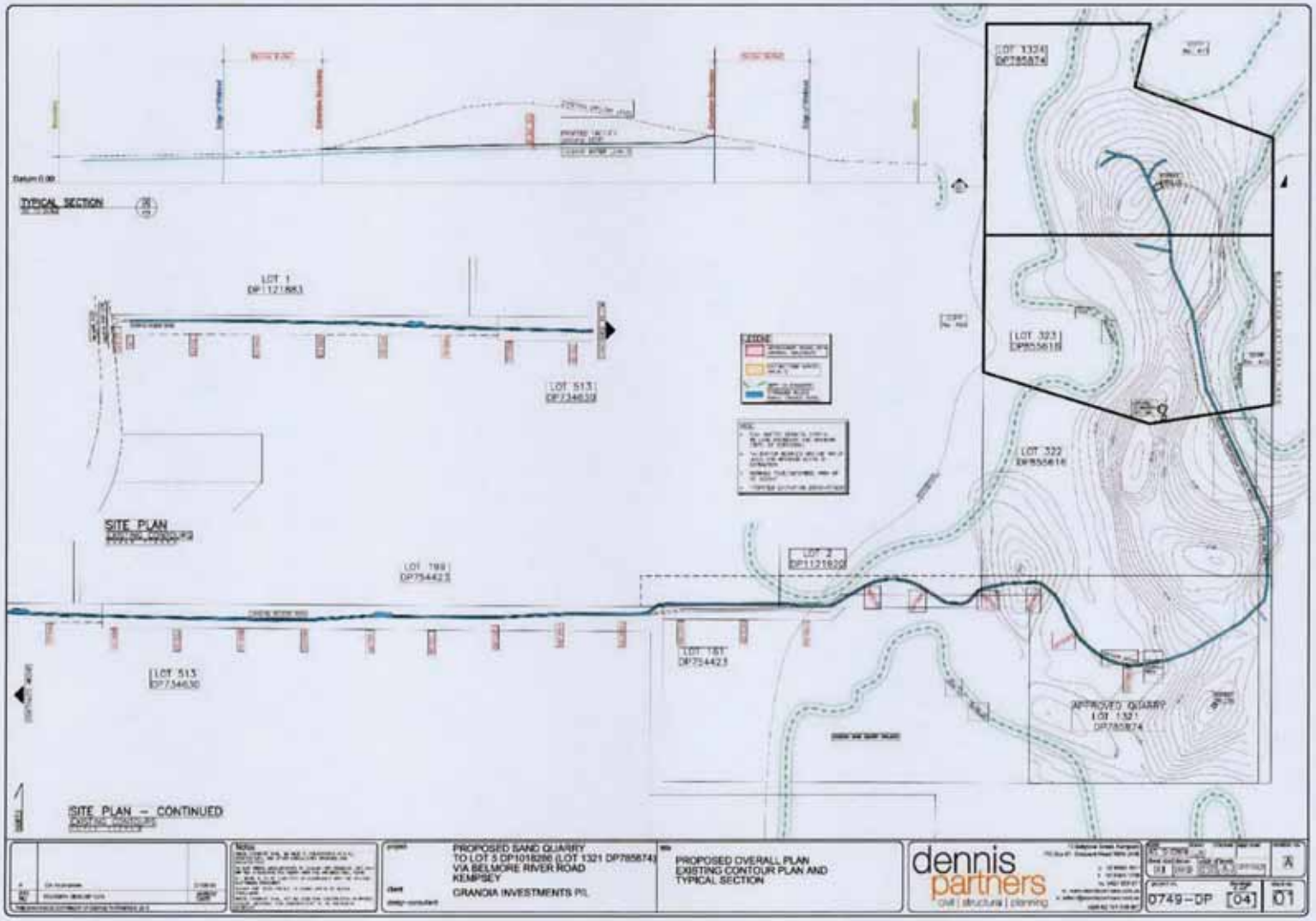


Figure 3: Quarry extent and staging

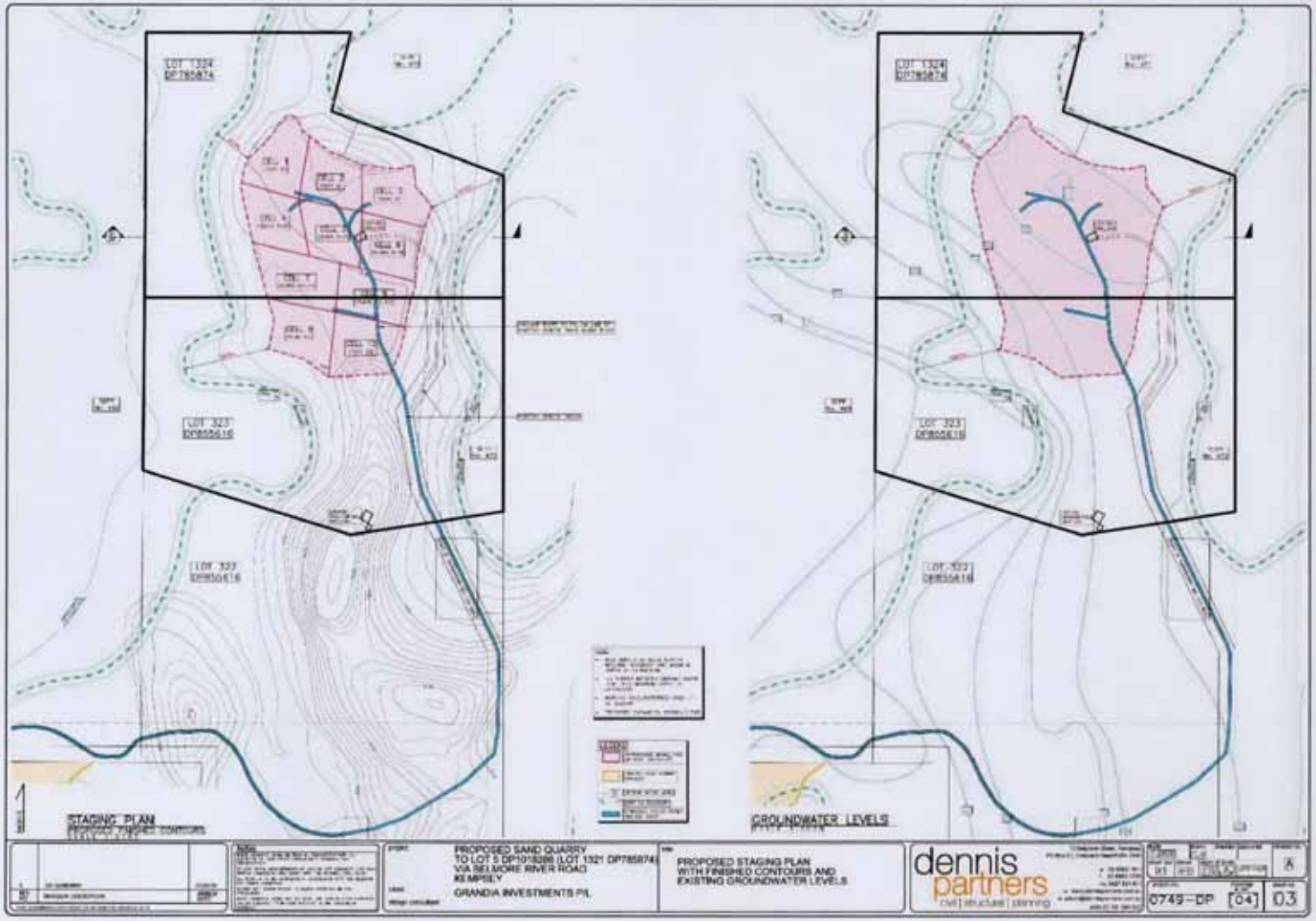
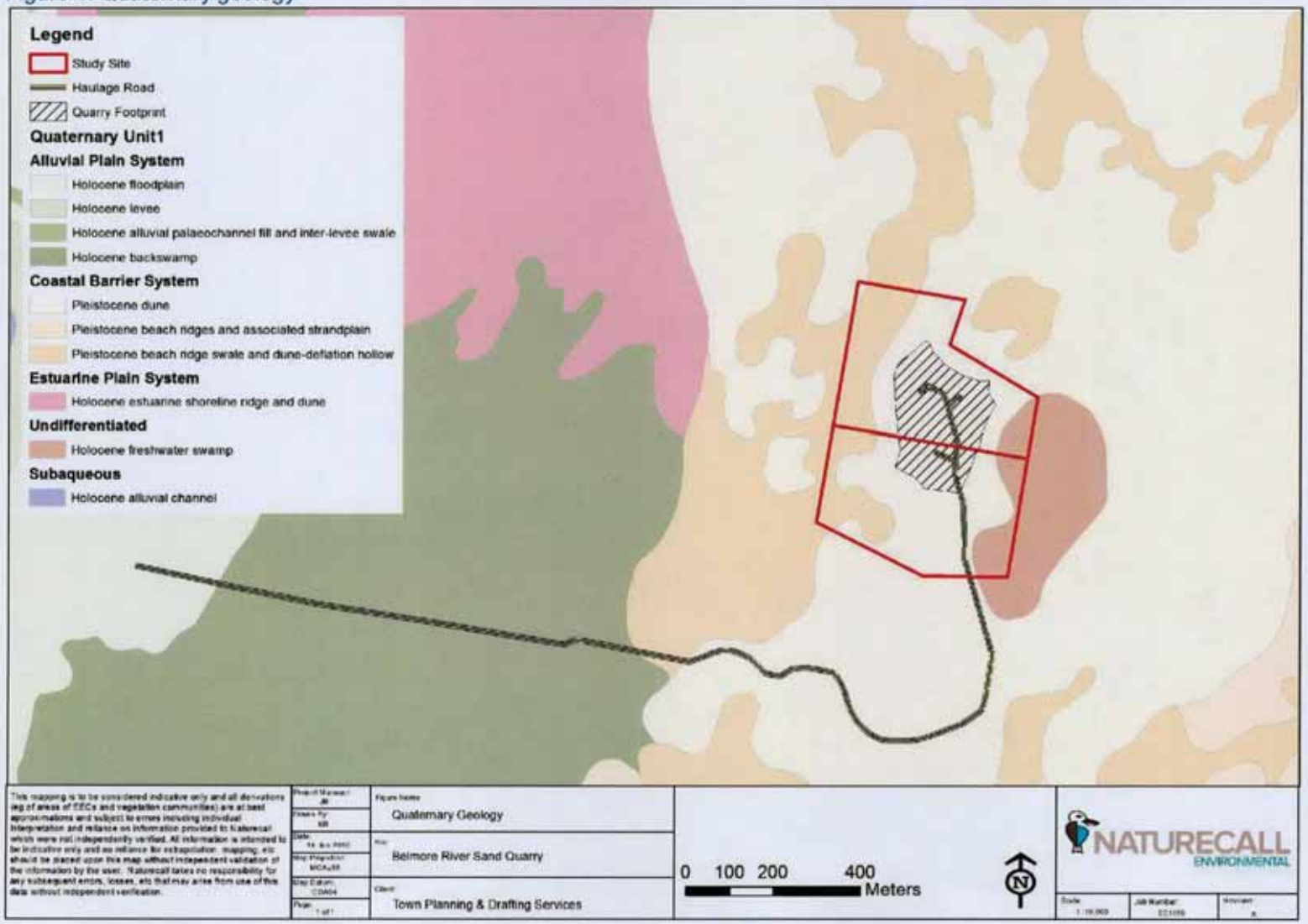


Figure 4: Quaternary geology



2.6.3. Fire History and Weed Invasion

The previous long term fire history of the site is unknown, but Google Earth shows a broad scale medium to high intensity fire occurred in 2003.

Figure 5: 2003 bushfire over the study area

Large scale and intensive fires occur periodically in Hat Head National Park as a result of lightning, escaped control burns and arson (Campbell 1998). Personal observations have noted extensive areas of the Park being burnt out between Hat Head and McGuire's Crossing, south to Crescent Head.

Weed invasion of the subject land is limited to some invasive grasses generally along the main access track and around the dwellings. This is attributed to the acidic and low fertility soils typical of a dune system (Keith 2000, Gravina *et al* 2001, Van Gorp and Erskine 2011), and the periodic high intensity fires which characterise the local ecosystems.

A variety of weed species were noted to line the batter of the access road from Belmore River, mainly on the batter and on previously sand quarried areas.

As noted above, the local floodplain has also been modified by drains constructed over the 1950-60s to improve agricultural productivity of land subject to inundation. Reilly's Drain is a union drain which runs along about half the access road, joining another drain which runs north-south. These drains have collectively reduced the length of inundation periods, leading to shifts in wetland

vegetation (eg from sedgelands to swamp forests) and displacement of former wetland habitats with pasture species eg Couch and Kikuyu.

All of the original rainforest grading to swamp forest on the fertile alluvial terraces has also been long historically cleared for dairy and beef cattle farms. These remain the dominant landuses west of the dune system.

3.0 Flora Survey

3.1. Survey and Assessment Methodology

The flora assessment consisted of the following components:

- Classification of the vegetation communities to NSW CMA/VIS vegetation community classifications (biometric).
- Database (OEH Atlas of Wildlife/Bionet, EPBCA – MNES) and literature review for local threatened species records and predicted occurrences
- Identification, mapping and condition assessment of any Endangered Ecological Communities listed under the *Threatened Species Conservation Act 1995* (TSC Act), *and Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on the site.
- Searches for and (if found) mapping of threatened species listed under the Threatened Species Conservation Act 1995 (TSCA), and Environment Protection and Biodiversity Conservation Act 1999 (EPBCA).

3.1.1. Vegetation Community Assessment

FFC (2013, 2015) previously undertook a vegetation survey and description of the dune forest on the subject land. This description is valid and hence no further formal vegetation community survey was taken of this area.

The North Coast Catchment Management Authority (CMA) VIS mapping of the remainder of the property and adjacent to the access road was reviewed in the field via a rapid assessment methodology consisting of a random meander for 100m into each community to identify dominant species.

This methodology was deemed suitable to the task given:

- None of this vegetation is to be cleared.
- No change to current ecological processes or edaphic conditions eg no lowering of the watertable via drainage, no impacts on floodwater due to levees created by new roads, etc.

3.1.2. Threatened Ecological Community Assessment

FFC (2015) assesses the EEC – "*Swamp Sclerophyll Forest on Coastal Floodplains...*" adjacent presumably to the west of the subject land in the Seven Part Test assessment, but provides no evaluation or mapping of this EEC. No assessment was provided of EECs along the proposed access road.

An assessment of TECs in the study area was undertaken based on the data collected by the flora survey, review of the relevant listings on the OEH website (www.environment.nsw.gov.au) and Department of Environment – MNES SPRAT website (DotE 2016b); and quaternary geological/soil landscape mapping by Troedson & Hashimoto (2008) and soil landscape description by Atkinson (1999).

3.1.3. Threatened Flora Species Searches and Occurrence Assessment

3.1.3.1. Searches

Searches for the locally recorded threatened flora recorded in the LGA and regionally (OEH 2015a, DotE 2015b) in similar habitats to those occurring on the site (see Appendix 1), were carried out over the survey period.

The quarry site and vegetation within 10m of the access road were survey by random meander for locally and regionally recorded threatened species by a senior ecologist. A total of 8hrs was spend on this activity.

3.1.3.2. Potential Occurrence Assessment:

Potential occurrence assessment of threatened flora species is provided in Appendix 1. This section assesses all considered threatened species listed under the TSCA 1995 and EPBCA 1999 for their potential to occur on site based on the following factors (DEC 2004, Forest Fauna Surveys 1997, DECC 2007):

- Presence/absence of suitable habitat.
- Condition and disturbance history of habitat.
- Local and regional records.
- Location of site within known distribution of the species.
- Connectivity with habitat where species is known to occur.

3.2. Flora Survey Results

3.2.1. Site Vegetation Communities

Seven broad vegetation communities were recorded in the study area, although the CMA/VIS map does not differentiate some forested wetland areas from true swamp forest. An overview of these is provided in the following table.

Photos showing the current state of these communities follow the table. The CMA/VIS vegetation map is provided in Figure 6, and is considered relatively representative of the extent of vegetation communities but not composition for the non-forest and swamp forest communities.

Table 1: Overview of study area vegetation communities

CMA Type	Coastal Sands Blackbutt	Paperbark	Paperbark
Keith (2002) Formation	Dry Sclerophyll Forest	Swamp Forest/Forested Wetland	Swamp Forest/Forested Wetland
VIS	NR 220 Pink Bloodwood open forest of the coastal lowlands of the North Coast	NR 217 Paperbark swamp forest of the coastal lowlands of the North Coast	NR 255 Swamp Oak swamp forest of the coastal lowlands of the North Coast
Location	Dominates sand dune on subject land. Also occurs on adjoining lot to south, and to east in Hat Head National Park.	Occurs mainly adjacent to access road, comprising most but not all the mapped swamp forest shown in Figure 6 (western extent dominated by Swamp Oak swamp forest). Also occurs as an unmapped narrow and discontinuous band along part of the western, northern and eastern side of the dune on the subject land, as part of an ecotone into the adjoining sedgelands.	Forms part of the CMA mapped sedgeland/rushland and swamp forest on the north and part of the southern side from the drain which Reilly's Drain joins, merging into the paperbark swamp forest occur an edaphic ecotone to the east. More extensive in northeast than shown in aerial photograph, forming complex mosaic with sedgelands and wet meadows.
General Description	Dominated by Blackbutt (*Eucalyptus pilularis*) with less common Needlebark Stringybark (*E. planchoniana*) and rare occurrence of Pink Bloodwood (*Corymbia intermedia*). Scribbly Gum becomes locally dominant on the lower slope with a different understorey. Understory is open to locally dense. Ranges from clusters of *Banksia serrata* to *Callitris rhombifolia*, and Coastal Teatree (*Leptospermum laevigatum*). Latter becomes dominant on footslope.	Varies with location. Main stands along access road consist of a tall, closely spaced forest with trunk diameter at breast height <40cm. Possibly regrowth from historical clearing. Dominated by Broad-leaved Paperbark (*Melaleuca quinquenervia*) with Swamp Oak (*Casuarina glauca*), with a patch off the northeast of the access road containing a co-dominance of Broad-leaved Paperbark with Swamp Mahogany (*E. robusta*). Understorey is generally absent, or sparse. Comprised of juvenile canopy species, to	Dominated by Swamp Oak of similar to identical age and height as the swamp forest, with at times some *Melaleuca quinquenervia* in transition zones. Limited understory generally of Swamp Oak. Groundcover is generally low (about 30cm) and varies from sedges and herbs to native grasses, to bare leaf litter.

	Shrub layer is open to well formed, generally dominated by often pungent shrubs 1-3m tall. Groundcover is mostly open, consisting of Bladey Grass and *Lomandra longifolia*, Bracken Fern and *Baloskion* spp.	Cheese Tree (*Glochidion ferdinandi*) and wattles. Minimal if any shrub layer, comprised again of same upper strata species. Groundcover varies from a dense mixture of sedges (eg *Carex* spp and *Juncus* spp with *Gahnia clarkei*) to a mix of *Gahnia clarkei*, Swamp Fern (*Blechnum indicum*), and *Baloskion* spp. Monkey Vine (*Parsonsia straminea*) is very common in the swamp forest along access road, but absent in other stands. Swamp forest either side of the dune on the subject land are very different to these other stands, and each other. Western and northern side is a semi-stunted stand of Broad-leaved Paperbark with Swamp Mahogany about 20-30m wide forming a ribbon around the foot of the dune. Trunk DBH is <20cm. This is underlain by a very dense understorey/shrub layer of *Leptospermum* spp, and dense Saw Sedge (*Gahnia clarkei*) and *Baloskion* spp. The eastern band is less continuous, and is only about 10m wide. It consists of mono-specific stand of Broad-leaved Paperbarks with trunk DBH 20-40cm. Understorey and shrub layer is generally absent, with a dense groundcover of *Lepyrodia spp* with a number of forbs, and at times a dense layer of moss.	

Condition	Good condition overall with disturbance limited to some localised asset protection zone (APZ) maintenance around the former dwellings, and numerous tracks. Minimal weed infestation.	Stands along access road generally in excellent condition although some is clearly regrowth (strips apparent in aerial photographs). Stands around subject land have never been cleared. Weed invasion is limited only to edges of the stands along the access road.	Stands along access road generally in excellent condition although some is clearly regrowth (strips apparent in aerial photographs). Stands around subject land have never been cleared. Weed invasion is limited only to edges of the stands along the access road.
Threatened plants recorded or potential habitat	None recorded and poor potential habitat.	Potential for *Phaius australis/tancarvilleae*, especially on eastern side of dune, however survey failed to detect this species which has been recorded in similar habitat in the locality (Darkheart 2010). May potentially occur in deeper sedgeland to west. Less likely in swamp forest along access road as different habitat type. Some margins and drains offer some potential for *Maundia triglochinoides*	Marginal potential for *Phaius*, but probably too acidic and appears to be subject to higher watertable. Some margins and drains offer some potential for *Maundia triglochinoides*.
Threatened Ecological Community or Endangered Population	No. Does not meet floristic and geomorphological criteria.	Yes. Where falls on alluvial soils (along access road only), qualifies as the EEC – *Swamp Sclerophyll Forest on Coastal Floodplains*.	Yes. Where falls on alluvial soils (along access road only), qualifies as the EEC – *Swamp Oak Floodplain Forest on Coastal Floodplains*.
Type	**Freshwater Wetland**	**Sedgeland/Rushland**	**Pasture and Artificial Aquatic Habitat**
Keith (2002)	Freshwater Wetlands	Freshwater Wetlands	N/A
VIS	NR 276 Wallum sedgeland and rushland of near coastal lowlands of the North Coast	NR 148 Coastal floodplain sedgelands, rushlands, and forblands	N/A

Location	Dominates the SEPP 14 wetland to the east, partially falling on the subject land.	Comprises a complex mosaic with swamp forest west of the subject land, and north and south of the access road, merging with pasture to the west.	Pasture dominates most of the adjoining land west of the swamp forest along the access road, and the access road batters. Artificial drain runs along northern side of access road before joining a smaller drain running north-south. Table drains lie along both sides of remainder of access road until sand dune is encountered.
General Description	Dominated by very dense *Lepironia articulata* and *Baumea articulata*, grading in the shallow margins to *Lepyrodia* spp. Few scattered stunted Broad-leaved paperbarks 2-3m high.	Extremely complex mix with floristics and structure varying with micro-topography, dominant parent material (eg marine sand vs alluvial), acidity and watertable. On marine sand and the mixing zone with alluvial influences, it is dominated by an extremely dense mix of *Baloskion* spp, Swamp Fern, and *Lepyrodia* spp, with margins of swamp forest becoming more wet heath with *Leptospermum* shrubs, stunted Swamp Mahogany and Broad-leaved Paperbarks, *Callistemon pachyphyllus* and *Xanthorrhoea* spp mixing over an ecotone to the swamp forest (as described in "Coastal Complex"). On alluvial substrates, the community is dominated by *Eleocharis acuta, Scirpus mucronatus, Persicaria* spp, *Juncus usitatus, Paspalum distichum* and various forbs typical of freshwater floodplain wetlands.	Pasture dominated by a gradation of Kikuyu and common pastoral weeds, to Couch and Water Couch. Road side batter is heavily vegetated with a mix of pasture grasses and range of weeds. Drains dominated by Giant Water Lilies, with Marsh Clubrush (*Boiboschoenus fluviatilis*) lining edges in deeper water; grading to *Eleocharis acuta, Scirpus mucronatus, Persicaria* spp, *Juncus usitatus, Paspalum distichum* in table drains.

Condition	Near pristine with no evidence of cattle grazing, drainage or weed invasion.	Generally in excellent condition with no evidence of cattle grazing, though historically would have been subject to grazing especially in drought periods.	Pasture is a derived community that is regularly maintained by slashing and grazing. Weeds are dominant. Drain vegetation has colonised artificial habitat. Generally low weed infestation due to edaphics. No aquatic weeds present.
Threatened plants recorded or potential habitat	Low potential for *Maundia triglochinoides* as prefers clays and silts, and too wet for *Phaius*.	Potential for *Maundia triglochinoides* but possibly too wet for *Phaius*. None found in immediate area of access road.	None recorded and poor potential habitat.
Threatened Ecological Community or Endangered Population	No. Does not meet geomorphological criteria (occurs on marine sand substrate).	Yes. Most of extent adjacent to access road falls on alluvial soils and hence these areas qualify as the EEC – *Freshwater Wetlands on Coastal Floodplains*. Area on western side of subject land occurs on marine sand, hence is not EEC.	No. Does not meet floristic or geomorphological criteria; or is artificial habitat.

Type	Coastal Complex
Keith (2002)	Heathland
VIS	NR 278 Wet heathland and shrubland of coastal lowlands of the North Coast
Location	Area mapped as "Coastal Complex" in the study area of the access road. Not mapped, but comprises an ecotone between the swamp forest and sedgeland on the western side of the dune on the subject land.
General Description	Dominated by an extremely dense mix *Leptospermum* shrubs grading over an

	ecotone to emergent Scribbly Gums or stunted Swamp Mahogany and Broad-leaved Paperbarks, *Callistemon pachyphyllus* and *Xanthorrhoea* spp. Groundcover may be absent, limited to sparse *Lepyrodia* spp, or a dense mix of *Baloskion* spp, Swamp Fern, *Lepyrodia* spp, Saw Sedge, and Bracken Fern.
Condition	Near pristine – no evidence of weed invasion.
Threatened plants recorded or potential habitat	Too wet and dense for *Phaius*.
Threatened Ecological Community or Endangered Population	No. Does not meet geomorphological criteria (occurs on marine sand substrate).

Figure 6: CMA/VIS vegetation communities of the study area

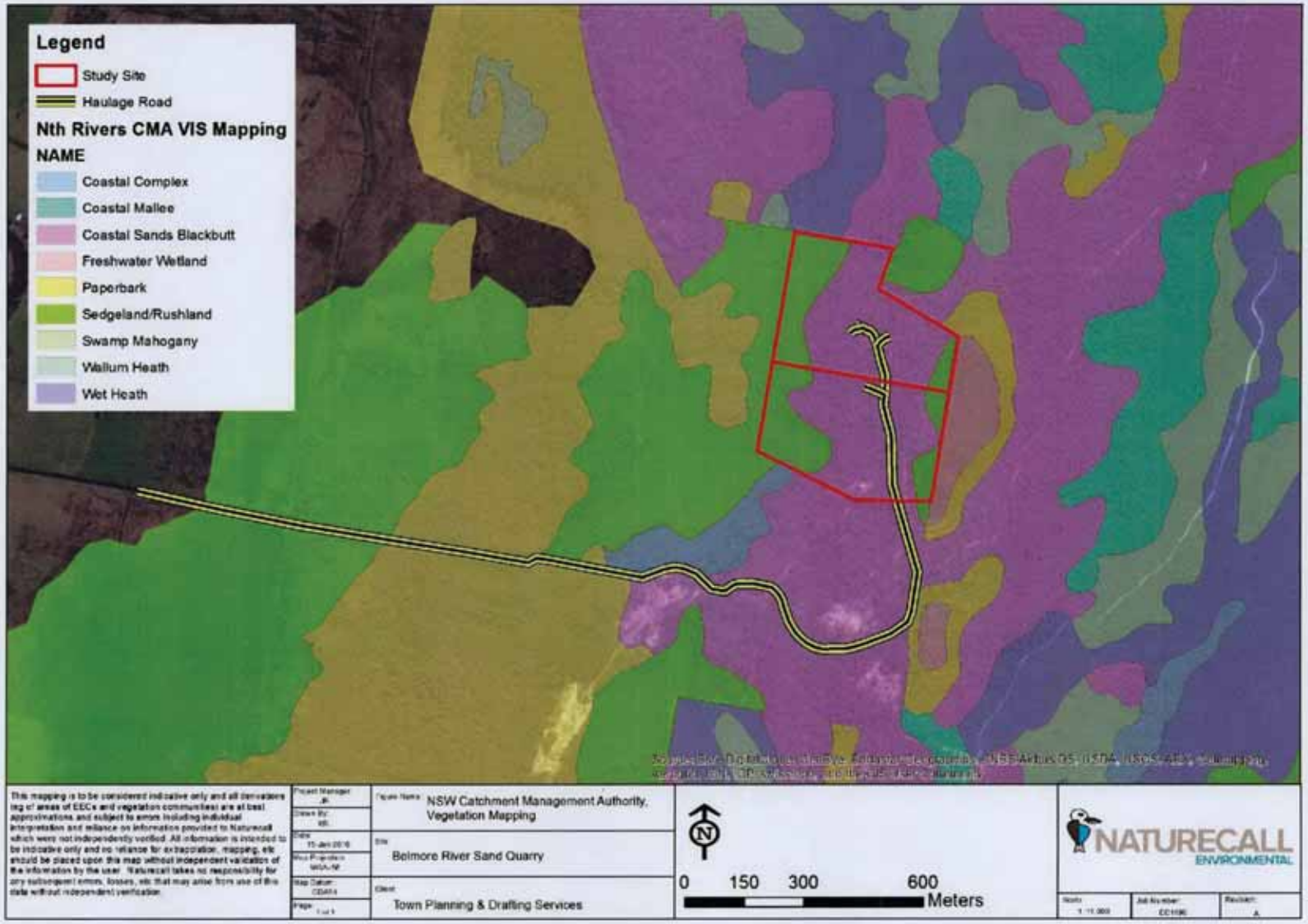


Figure 7: EECs in the study area

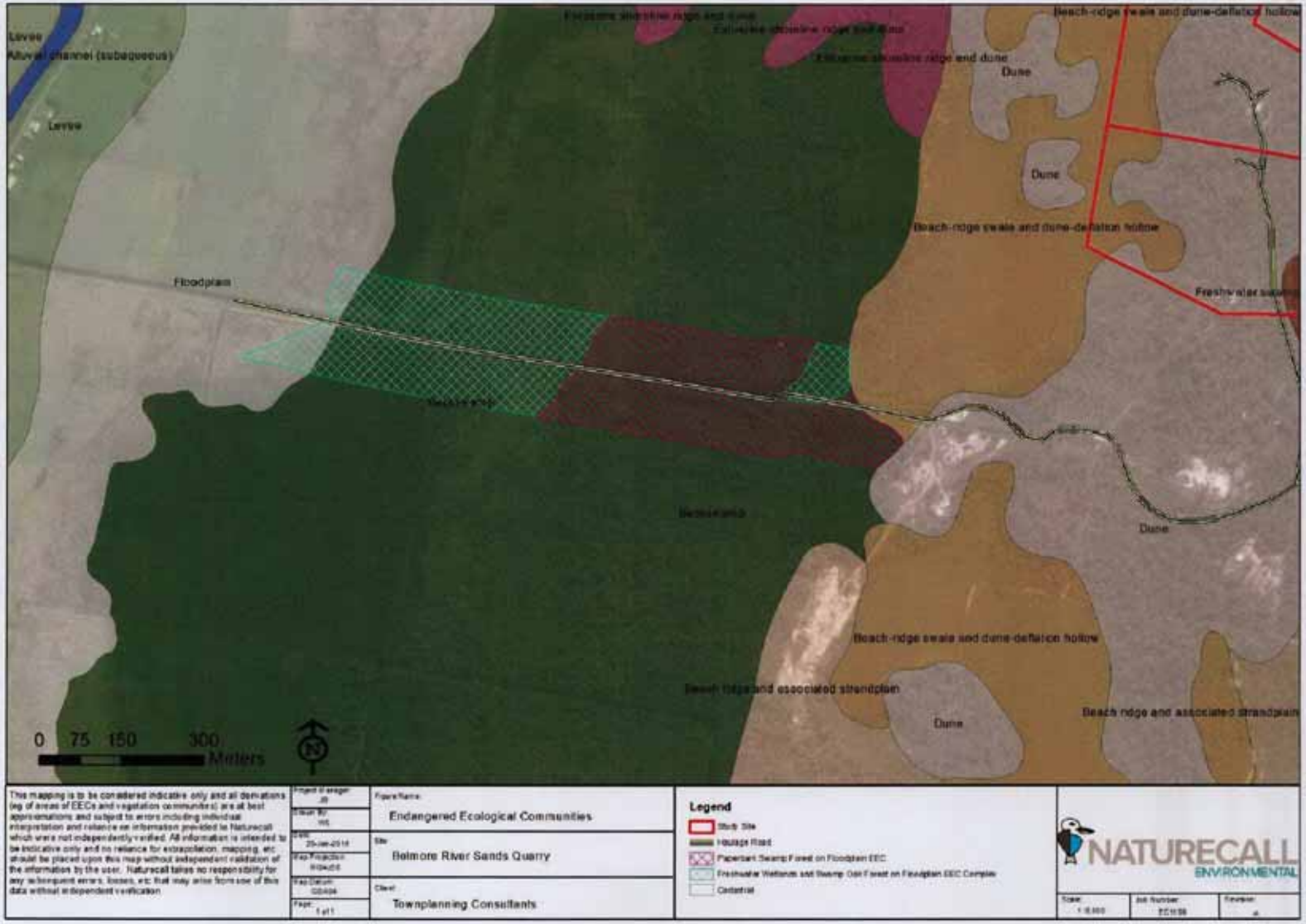


Photo 3: Dry sclerophyll/coastal sands forest

Photo 4: Paperbark swamp forest east of dune

Photo 5: Mixed swamp forest west of dune

Photo 6: Paperbark forest adjacent to access track

Photo 7. Swamp Oak forest adjacent to access track

Photo 8: Sedgeland and wet meadow adjacent to access track

Photo 9: Batter of access track grading to pasture adjacent to access track

Photo 10: Example of Coastal Complex

Photo 11. Eastern SEPP 14 sedgeland

3.3. Threatened Flora

3.3.1. Survey Results

No threatened plants were recorded on the study site during this survey or by FFS (2013, 2015). No threatened plants were detected in direct proximity to the haulage route.

No threatened plants have been recorded on adjacent lands (OEH 2016a, Darkheart 1997, Campbell 1998, EcoPro 1996).

3.3.2. Potential Occurrence Assessment

Searches of relevant literature and databases (Darkheart 2010, OEH 2016a) found records of 3 threatened flora species in the locality.

Table 2: Threatened flora species recorded in the locality

Common Name	Species	Legal Status	Distance from Study Site
Southern Swamp Orchid	Phaius australis	E- TSCA	Within locality – location not for public disclosure.
Austral Toadflax	Thesium australe	V- TSCA	Found at Hat Head, over 6km to the northeast of the study site.
Byron Bay Diuris	Diuris sp. aff. chrysantha	V-TSCA	Within locality – location not for public disclosure.

Suitable habitat for Austral Toadflax does not occur on site and hence is considered unlikely to occur within the study area.

As noted in Table 2, some of the paperbark swamp forest offers generic potential habitat for *Phaius* orchids, but survey of the best potential habitat (the edge of the freshwater wetland to the east) failed to detect the plant. It may possibly occur in more remote sections of the habitat in the study area, hence is considered a very low to low potential occurrence.

Potential habitat occurs for *Maundia triglochinoides* (V-TSCA) in the table drains adjacent to the haulage road, but this readily identifiable plant was not detected. While there is a large population on the Collombatti floodplain (PB 2011) and a population at Old Station Rd (Naturecall 2014), the species has not been detected in the Belmore area to date (OEH 2016a), hence it is not considered a likely potential occurrence.

4.0 Fauna and Habitat Survey and Assessment

In consideration of the threatened species recorded in the locality and by previous surveys of adjacent and nearby land with identical habitat (eg Darkheart 1997, 2010, OEH 2016a); available habitats on site; and potentially occurring species: the following survey methods were employed:

- Qualitative and quantitative habitat assessment
- PIR cameras (arboreal and terrestrial)
- Spotlighting and stag watching over 4 nights
- Call playback over 4 nights
- Elliot A and B trapping
- Pitfall trapping
- Harp trapping
- Yangochiropteran bat call recording
- Diurnal reptile and bird survey
- Physical searches of habitat e.g. leaf litter, etc.
- Opportunistic sightings, scratches and scats.

Including the PIR camera deployment period, the fauna survey was undertaken over 4 weeks in December 2015 to January 2016.

The fauna survey utilised a broad range of survey techniques to minimise limitations, and survey effort was generally expended well above the DEC (2004) minimum standards for species which would be at risk of the greatest impact if present eg. Squirrel Glider, New Holland Mouse, Eastern Pygmy Possum, Brushtailed Phascogale and Three-toed Snake-toothed Skink.

Survey was undertaken by Naturecall's principal ecologist and two ecologists under Naturecall's scientific license and animal research authority.

4.1.1. Habitat Evaluation

The site was surveyed to determine the available potential habitats, and the support value of these habitats for threatened species. Habitats were defined according to parameters such as:

- Structural and floristic characteristics of the vegetation e.g. understorey type and development, crown depth, groundcover density, etc.
- Degree and extent of disturbance e.g. fire, logging, weed invasion, modification to structure and diversity, etc.
- Soil type and suitability e.g. for digging and burrowing.
- Presence of water in any form e.g. dams, creeks, drainage lines, soaks.
- Size and abundance of hollows and fallen timber.
- Availability of shelter e.g. rocks, logs, hollows, undergrowth.

- Wildlife corridors, refuges and proximate habitat types.
- Presence of mistletoe, nectar, gum, seed, sap, etc. sources.

Species identification was assisted by Morcombe and Stewart (2010), Pizzey and Knight (2003), Tyler and Knight (2009), Wilson and Knowles (1992), Strahan (2008), Triggs (1996), Robinson (1996), Swan *et al* (2004) and Schodde and Tideman (1990).

4.1.2. Elliot A Trapping

Elliot A trapping was conducted over 8 nights over two separate survey periods. The first week saw 4 nights consisted of 50 traps (200 trap nights). The second week seen 100 traps set per night over 4 nights. A total of 600 Elliot A trap nights were achieved, significantly exceeding the minimum effort of 100 traps nights for a 50ha sample area (DEC 2004).

Traps were focussed on areas of dense groundcover and undergrowth throughout the subject land, which was generally limited to the lower slopes of the dune (see Figure 8). The freshwater wetland to the east was not trapped due to frog hygiene and WH&S issues, and lack of impact on this habitat. The dense swamp forest ecotone and sedgeland to the west was not trapped due to the extremely difficult physical access limitations, and associated significant WH&S issues (eye injury, trip, ticks and snake bite). Hence the edge of the ecotones of these areas were targeted due to dense cover and best potential to detect the target species.

Traps were placed between 5-15m apart depending of in-situ habitat and the presence of tracks (setback to minimise edge effects), etc. Traps were baited with rolled oats, peanut butter and sesame oil. Traps were checked each morning and cleaned or rebaited when necessary.

Target species were the Eastern Chestnut Mouse, Eastern Pygmy Possum, New Holland Mouse and Common Planigale.

4.1.3. Elliot B Trapping

Arboreal Elliot B trapping was undertaken across the subject land over 4 nights. The traps were set out over an irregular 50 x 50m grid in line with Smith and Murray (2003) to gain an estimate of population size and density. Spatial distribution of suitable trees however limited trap distance, as shown in Figure 9.

A total of 28 traps were mounted to trees at 2-3m height (see Figure 9). Specific trees within the grid were chosen according to scratchings as well as the presence of foraging habitat (eg dense Banksia) and denning habitat.

Traps were baited with a mixture of honey, oats, apple and peanut butter. In addition a honey, water and vanilla essence solution was sprayed at sunset each night above the mounting platform as a further attractant.

All traps were checked each morning and were mounted on platforms and angled slightly down so as to drain out the entrance. A total of 112 Elliot B trap nights were performed across the site (>4 times the minimum effort).

4.1.4. Spotlighting, Torch Searches and Stag Watching

Spotlighting on the subject land was conducted for at least 2 hours over separate sessions with the first within 45mins of dusk and another after 9pm. With two ecologists, this was more than sufficient to completely cover the accessible area of dry sclerophyll forest (see Figure 12) twice per night and inspect the crown of a vast majority of trees within the study area. A total of 8hrs was spent on spotlighting on the subject land. Spotlighting was conducted in a separate survey after the Elliot B trapping survey to minimise impacts on the effectiveness of the latter technique.

The swamp forest adjacent to the haulage route was similarly surveyed via a foot traverse along the road, scanning the adjacent swamp forest for fauna. A total of 3hrs was spent on surveying the haulage route.

The procedure involved walking with a hand held 50-100 watt spotlight, targeting the trunks and branches of canopy trees and understorey, and periodically scanning the ground.

Stag watching involved observing hollow-bearing trees on dusk with binoculars to watch for signs of fauna emerging from the hollows. At least 1 tree per night was watched per ecologist, and this was conducted for a total of 1 hour each night giving a total of 8 hours spent on the activity during the survey.

Torch searches for frogs was generally undertaken in conjunction with spotlighting. The focus was the edge of the wetland to the east of the subject land, the table drains adjacent to the haulage road, and opportunistically along roads during times of rain. A total of 8 hours was dedicated to this activity, including 2 hours undertaken one night and another hour on another night when heavy showers occurred and frog activity was expected to be high.

Conditions were overcast with showers on two nights of the frog survey, and clear on the other nights. Wind ranged from placid to moderate. The moon phase was full over the survey period but was obscured by clouds on the first night.

4.1.5. Call Playback

Recorded calls of the following species were routinely played on the site and study area:

- Wallum Froglet.
- Green and Gold Bell Frog.
- Green-thighed Frog.
- Wallum Sedge Frog.
- Masked, Barking, Eastern Grass Owl and Powerful Owls.
- Bush-stone Curlew.
- Squirrel Glider.
- Koala.

Calls for the birds and arboreal mammals were played through a portable MP3 player via a 30W PA system at a level approximating natural intensities of the species. The general methodology involved an initial period of listening and spotlighting; followed by playback of the calls simulating a natural

pattern. This was followed by 10 minutes of listening and 10-15 minutes spotlighting for fauna attracted by the calls (but not responding vocally), within 100m radius of the playback point. Calls were played during each spotlighting session at a different location at the southern and northern end of the site. Playback was utilised over the area over 4 nights for a total of 4 hours for these species.

Frog calls were played on the wet nights in the first week of the survey for 30mins each night. Calls were generally played at dusk, when such calls are normally heard.

4.1.6. Yangochiropteran Bat Call Detection

Anabat call detection was undertaken using 2 Anabat detectors fitted with ZCAIMs. Recording was conducted during spotlighting on 4 nights with units both stationary and carried around (see Figure 12). The units were left overnight on the two nights of the survey. This resulted in >36 hours of recording.

The recordings were forwarded to Dr Anna McConville of Echo Ecology, a bat call identification consultant, for identification of the bat species.

4.1.7. Diurnal Bird Survey

Birds were surveyed by detecting calls and searching by binoculars during area searches over the whole site and actively listening/searching for birds in the morning before 8am and in the afternoon from 4pm over a total of 12 days. Over 16hrs was spent on this activity.

Bird surveys were also conducted opportunistically during other activities (e.g. flora survey and habitat evaluation) as transects and spot surveys were redundant given the limited habitat. Binocular scans were also periodically undertaken over the adjacent saltmarsh for waders.

This information provided short-term data on bird occurrences in the area for the particular season (DEC 2004).

4.1.8. Herpetofauna and Secondary Evidence Searches

Physical habitat searches of the site were generally undertaken during the survey which involved:

- Lifting up of debris (eg logs and building materials) to search for reptiles and frogs.
- Inspection of dense vegetation for bird nests.
- Raking of leaf litter for frogs and reptiles.
- Observation of likely basking sites (i.e. reptiles and frogs).
- Searches for scats, tracks, digging, sap incisions and scratches (e.g. Koala, gliders, etc.) over the site.
- Searches for scats, owl regurgitation pellets and guano deposits.

A systematic targeted habitat search consisting of raking leaf litter, turning over and breaking up logs was also undertaken for a total of 16hrs to target the Three-toed Snake-toothed Skink. This methodology was applied at a minimum 1hr per 1ha unit of the quarry site, plus a search of the remainder of the dry sclerophyll forest. This far exceed the minimum DEC (2004) minimum effort of 1hr.

4.1.9. Hollow Bearing Tree Survey

All hollow bearing trees and stags on the study site were located and recorded via hand held GPS.

Each tree was quantified (height, trunk diameter, number of hollows, location in tree and aperture diameter), marked with pink spray paint. This provided an accurate qualification and qualification of the hollow-bearing tree component of the site's habitat.

4.1.10. PIR Camera Trapping

See Figure 10 for camera locations.

4.1.10.1. Terrestrial Camera Trapping

Ten infra-red cameras consisting of 2 Reconyx Hyperfire HC600 and 8 Scoutguard SG570s were deployed throughout the study site. Cameras were set in areas which had been identified as being regularly used either by diggings or fauna movement trails.

The cameras were set for a period of over two weeks (>140 trap nights) post-trapping over the 2015 Christmas period when the site was vacant of any human disturbance. Cameras were mounted to the base of trees <1m high opposite to bait stations which contained dry pet food or a mixture of oats, peanut butter, honey and sesame oil.

Target species were the Spotted-tailed Quoll, Long-nosed Potoroo and Rufous Bettong.

4.1.10.2. Arboreal Camera Trapping

Ten Scoutguard SG570s infra-red cameras were deployed throughout the study site. Cameras were set in areas which had been identified as high potential use by tree scratchings, foraging resources, and location of hollow bearing trees.

The cameras were set for a period of over two weeks (>140 trap nights) post-trapping over the 2015 Christmas period when the site was vacant of any human disturbance eg spotlighting, and after the initial Elliot B trapping. Traps were mounted to the trunk of trees at 2-3m height and opposite to bait stations which contained a mixture of oats, peanut butter, honey and sesame oil. In addition, the trees which supported the bait stations were sprayed with a honey, water, and vanilla essence to further entice arboreal fauna.

Target species were Squirrel Glider, Eastern Pygmy Possum and Brushtailed Phascogale.

Figure 8: Elliot A trap lines

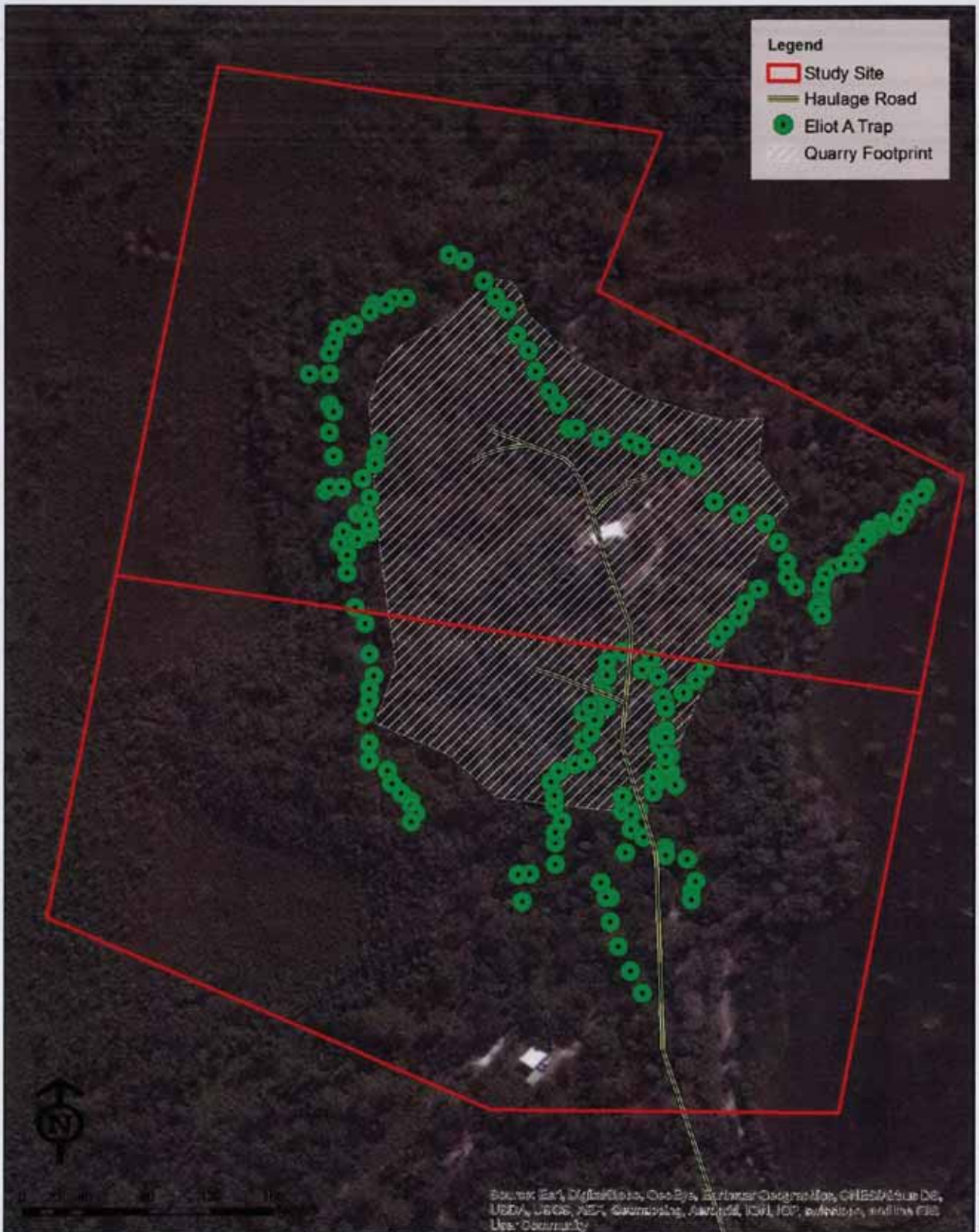
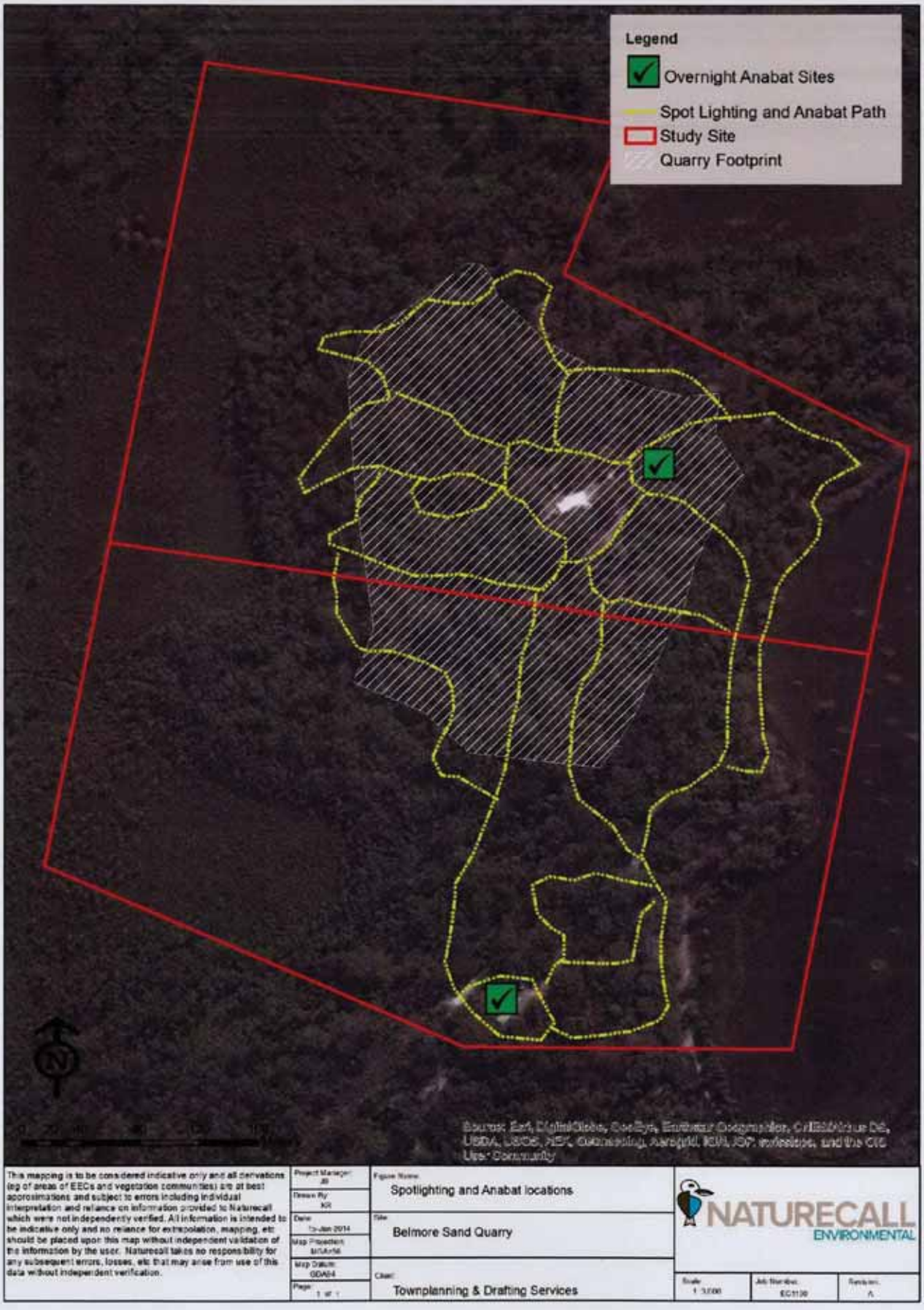


Figure 9: Elliot B trapping grid

Figure 10: PIR camera locations

Figure 11: Pitfall trap lines

Figure 12: Spotlighting and Anabat locations



4.1.11. Pitfall Trapping

Pitfall trapping consisted of 4 lines of 3-5 traps (16 traps in total) as shown in Figure 11. Each pitfall trap within a line was at least 5m apart with connecting drift fence. These were set for 4 nights (100 trap nights).

Trap lines were set where dense groundcover or undergrowth was present, avoiding the disturbed areas around the abandoned dwellings. Target species include the Common Planigale, Eastern Pygmy Possum, reptiles (specifically the Three-toed Snake-toothed Skink) and frogs. All pits were backfilled after the survey.

4.1.12. Limitations

Fauna detectability is limited by seasonal, behavioural or lifecycle characteristics of each species, and even by habitat variations (e.g. flowering periods), which can occur within a year, between years, decades, etc. (DEC 2004).

The fauna survey period fell in summer which is a period high activity for arboreal mammals, Yangochiropteran bats, birds, and also coincides with the breeding period of the target frog species (DEC 2004). Longitudinal and latitudinal migrants such as the Swift Parrot may not be present at this time of year.

Rainfall preceding and occurring during the survey significantly increased frog detection for the target species known to breed at this time of year (eg Wallum Froglet and Green and Gold Bell Frog).

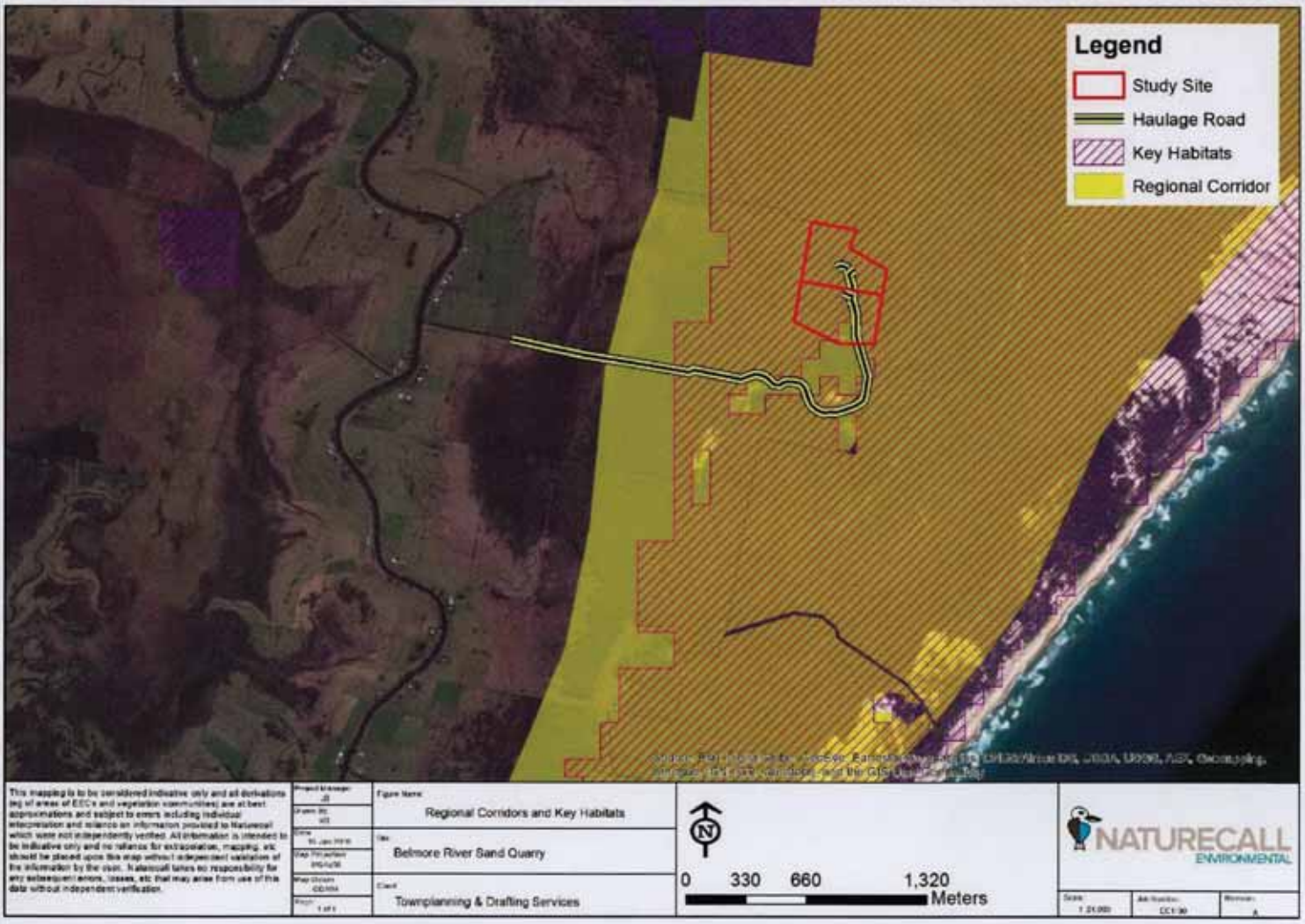
To counter any limitations, qualitative and quantitative habitat evaluation was used as well as a standard ecological field survey to assess the site's significance to threatened species. As detailed above, survey effort to target the key threatened species which could occur on the quarry site far exceeded the DEC (2004) minimum effort specifications, hence the survey results are considered highly indicative of the site's ecological assemblage.

Habitat evaluation conservatively assesses the potential occurrence of threatened species based on potentially suitable habitat and local records, providing a prediction of the likelihood of a particular threatened species occurring in the study area (DEC 2004, DECC 2007, Forest Fauna Surveys 1997). This approach is considered best practice to address the Principle of Uncertainty.

4.2. Corridors and Key Habitats

See Figure 13 showing the following:

rridors and Key Habitats



4.2.1. Regional Corridors

Regional corridors are typically >500m wide and provide a link between major and/or significant areas of habitat in the region. Ideally they are of sufficient size to provide habitat in their own right and at least twice the width of the average home range area of fauna species identified as likely to use the corridor (OEH 2016c, Scotts 2002).

The site falls within a regional corridor which generally runs along the coast including Hat Head National Park from Port Macquarie to South West Rocks. Most of this regional corridor falls over protected land hence it is quite effective, but subject to edge effects due to extensive frontage to agricultural land, and at times extensive and high intensity bushfire.

4.2.2. Sub-regional Corridors

Sub-regional corridors connect larger landscaped features and are of sufficient width to allow movement and dispersal (generally >300m), but may not provide substantial species habitat (OEH 2015c, Scotts 2002).

The site does not fall form or lie adjacent to a sub-regional corridor.

4.2.3. Local Corridors and Habitat Links

Local corridors provide connections between remnant patches of habitat and landscape features. Due to their relatively small area and width (they may be <50m), these corridors are subject to edge effects (OEH 2016c, Scotts 2002). Habitat links are evaluated in this report as links from habitat on-site directly to similar habitat on adjacent land. These would be used by fauna, which depend solely or at least partially on the site for all of their lifecycle requirements, and/or dispersal (Lindenmayer and Fisher 2006).

As evident in Figure 13, the site is part of a large remnant about habitat (mostly enclosed in Hat Head National Park) which comprises a complex of vegetation types due to the various geomorphology of the dune system and alluvial floodplain. Habitats range from extensive tracks of at times linear coastal sands dry sclerophyll forest, to wet and dry heath, sedgelands and extensive tracks of swamp forest.

The site, subject land, and study area form part of this complex mosaic, as demonstrated in Figure 6.

While ideal for fauna diversity, this complex mosaic poses challenges to species which depend on continuous forest for movement (eg gliders), hence sedgelands such as those to the east and west would be a physical barrier to Phascogales and Squirrel Gliders, but not to small terrestrial mammals, birds and bats.

In terms of habitat types, the dry sclerophyll forest on site links to similar habitat east and south, which interlinks over the dune system to extensive habitat in Hat Head National Park. Similarly, the swamp forest on the western side of the dune, and along much of the haulage route also links to

extensive tracks of this habitat type mainly on the western side of the regional corridor. Fauna using this habitat type in the study area thus have good local corridors and habitat links.

Frogs also have relatively good connectivity especially adjacent to the haulage road due to the mosaic of swamp forest and sedgeland, and the limited width of the dune forest would also not prevent movement east or west between these proximate habitats (eg due to microhabitat cover provided by leaf litter and undergrowth).

The sand quarry to the south poses a barrier to most fauna due to the current extent of the operational area, but this will eventually be covered by forest characteristic of the area and hence regain its connectivity values. Regardless, dry sclerophyll and swamp forest remains all around this quarry, and hence it is not an impermeable barrier.

4.2.4. Key Habitat

Key Habitats are areas of predicted high conservation value for forest faunal assemblages, endemic forest vertebrates or endemic invertebrates; spatially depicted as a merging of mapped assemblage hubs, assemblage hot spots and centres of endemism (OEH 2015c, Scotts 2002).

The study area and most of Hat Head National Park is mapped as key habitat.

4.3. Fauna Survey Results

4.3.1. Habitat Evaluation

The following table summarises the results of the habitat evaluation survey:

Table 3: Habitat evaluation summary

See table overleaf.

Habitat Attribute/Type	Quarry Site/Subject Land	Access Road Study Area	Potential Values to Threatened Species Occurrence
Leaf litter	Well developed on the dune due to lack of fire since 2003, especially in localised areas as bark and litter around base of larger Blackbutts and Scribbly Gums. Generally shallow and dry. Present as a layer of moist detritus in the western and eastern swamp forest ecotones, but not deep. Sedgeland to west noted to have a wet detritus layer. Sedgeland to east also has a wet layer prone to inundation.	Limited to layer of needles in the Swamp Oak forest, and patches of leaves in a shallow layer amongst most of the paperbark forest. Dense moist layer in northern sedgeland, and submerged in the south.	Potential foraging substrate for common habitat generalists such as the Garden Sun Skink and bandicoots. Good invertebrate habitat. Leaf litter also provides cover for frogs. Would be totally lost during bushfire.
Logs and debris	Logs are present but not abundant over the dune. Most are well decayed and may be destroyed in a major bushfire. Various debris occurs around the former dwelling, and some rubbish has been dumped in various locations.	No logs noted. No debris.	Logs and debris suitable for refuge for terrestrial reptiles, frogs and mammals (i.e. rodents, Blue-tongue Lizards, etc).

Groundcover	Limited density on the mid-slope to crest, often sparse or patchy. More dense on lower slopes, especially western slopes and ecotone with swamp forest. Mix of sedges and ferns offered seed source and refuge. Freshwater wetland to east consists of very tall often matted sedges >2m high. Ideal for frogs due to cover and basking, and some birds. Ecotone edge provided excellent refuge and seed source. Historical aerial photos show this may be subject to widespread burning. Sedgeland to west is extremely dense, comprising mixture of sedges with various shrubs and forbs depending on location. Extreme density offers excellent cover (runways noted), moist detritus, and grain source.	Varies from Belmore River Rd to the dune system. Adjacent pasture is low and only suited to agricultural woodland/pasture generalist birds eg Cattle Egrets. Dense cover of tall weeds and pasture grasses along road batter provides cover for small birds, reptiles, common small mammals and frogs. Wet meadows mixed with sedges on edge of Swamp Oak swamp forest offers good frog habitat, and habitat for snakes which prey on frogs. Limited potential for small mammals due to high watertable/inundation. Sedgeland to north offers same values similar values as west of the subject land. Paperbark swamp forest has at times a tall dense groundcover offering excellent refugia with foraging for seeds.	These habitat components overall provide refuge for common mammals, frogs and reptiles (i.e. rodents, dasyurids, Grass Skinks, etc.) as well as invertebrate prey. The dune forest on the subject land was considered to have at best low value for small mammals such as the New Holland Mouse, Eastern Chestnut Mouse and Common Planigale due to limited density and consistency of cover, and limited diversity of seed producing species. The relatively better habitat for these species was on the lower slopes and ecotone with the swamp forest. Most of the freshwater wetland to the east was not considered likely to support New Holland Mouse, Eastern Chestnut Mouse and Common Planigale due to predominantly high water table and limited diversity of seed sources. The margins however offered good potential, especially to the north where the topography promotes a shallower, broader ecotone. Sedgeland west of the dunes and north of the haulage road has very good to high potential for Common Planigale, and less so New Holland Mouse and Eastern Chestnut Mouse due to low fire frequency. Wet meadows to the south however were considered unsuitable for small mammals due to inundation, but were ideal for frogs.

Habitat Attribute/Type	Quarry Site/Subject Land	Access Road Study Area	Potential Values to Threatened Species Occurrence
Hollows	A total of 253 hollow-bearing tree/stags were recorded on the subject land, as shown in Figure 14. There were mostly found in living trees. Hollows apertures ranged across the entire spectrum, with large >15cm diameter) hollows being the least common. The abundance of hollows is due to the lack of agricultural value of the area (infertile soils) hence limited any historical clearing or logging has occurred; high levels of termites; and the frequent fire history.	Appear to be absent due to age and structure of the forest.	Abundance of hollows in the coastal dune forest provides denning options for small to large sized hollow obligate species such as Yangochiropteran bats, Squirrel Glider, Little Lorikeet and Masked Owl.
Caves, cliffs, overhangs, culverts, bridges, buildings	Two abandoned dwellings occur on site. One has lost its roof, the other is largely intact but infested with termites. The latter may offer some potential as refuge for rodents and snakes, and possibly roosting by bats in the roof or similar cavities. Due to the high fire risk of the area, this artificial habitat is considered temporary. No other relevant habitat features.	A wooden bridge crosses the north-south drainage line. It is considered too close to the water, structurally unsuitable and is mostly surrounded by dense aquatic vegetation to be used by bats for roosting.	Minor potential for bats such as East-coast Freetail Bat to roost in the roof of the northern house, but abundance of hollow-bearing trees suggests low potential.

Habitat Attribute/Type	Quarry Site/Subject Land	Access Road Study Area	Potential Values to Threatened Species Occurrence
Nectar Sources	Dominance of dune forest canopy and understorey by summer flowering species ie Blackbutt, Needlebark, Saw Banksia and Scribbly Gum. Pink Bloodwood and Broad-leaved Paperbark offer a late summer to autumn nectar source, with the localised Swamp Mahogany offering a minor potential winter nectar flow. No trees were flowering at the time of the survey.	Broad-leaved Paperbark is locally abundant, offering an excellent late summer-autumn nectar source. Limited and localised Swamp Mahogany offers a winter nectar source. No trees were flowering at the time of the survey	Several flowering species present providing preferred nectar resources for and Little Lorikeet, Squirrel Glider and Grey-headed Flying Fox, but predominantly in summer and autumn. This means a reliance on other nectar sources in other seasons; and lack of flowering sources during the Grey-headed Flying Fox breeding season. Patches of *Banksia serrata* offered potential foraging habitat for Eastern Pygmy Possum and Eastern Blossom Bat, but again limited to summer flowering. Limited winter flowering species limits likelihood of winter migrants such as Swift Parrot and Regent Honeyeater.
Wattles, Melaleucas, Callistemons and Banksias (shrub layer)	Wattles are present but not abundant. Leptospermums are the dominant nectar source, but small flowers suggest mainly support only very small mammals and honeyeaters but also act as insect attractant. *Xanthorrhoea* is common but not abundant in the dune forest. It is also common in the sedgeland to the west, and offers a nectar source and insect attractant.	Limited to Leptospermums with some *Callistemon pachyphyllus* in the northern sedgeland. These again offer a limited nectar source but a good insect attractant.	Flowering species would provide nectar and attract insects during flowering periods, but were not considered a key habitat component for any threatened species eg Eastern Pygmy Possum. *Callistemon pachyphyllus* is a preferred species for the Eastern Blossom Bat, but its limited abundance suggested a low likelihood of this species using this resource.

Habitat Attribute/Type	Quarry Site/Subject Land	Access Road Study Area	Potential Values to Threatened Species Occurrence
Sap and gum sources	Pink Bloodwood and Scribbly Gum are preferred sap sources for Squirrel and Yellow-bellied Gliders (NPWS 2003a, Gibbons 2002, pers. obs.). These species are common on the site, especially on the lower slope to footslopes of the dune and swamp forest ecotone. Blackbutt is less preferred. Some incisions noted on Pink Bloodwood and Scribbly Gum. No preferred wattle species for gum sources.	No preferred species.	Sufficient abundance of sap sources for Squirrel Gliders Some trees showed smaller feeding incisions typical of this glider. No evidence of Yellow-bellied Glider incisions, and this species is not found in coastal sands forests.
Primary preferred Koala browse trees	Swamp Mahogany and Scribbly Gum are listed in Schedule 2 of SEPP 44. These are common on the footslope of the dune (more so the west). The Swamp Mahogany however are spindly trees, suggesting lack of vigour due to poor soils. No other species listed in the KSC Comprehensive Koala Plan of Management present.	Locally common in a patch of swamp forest on the merge zone of the alluvial plain and dune, where they occur as trees around 30cm DBH, hence suitable for Koala browsing. No other species listed in the KSC Comprehensive Koala Plan of Management present.	Localised nature and lack of other suitable habitat in the study area suggests a Koala population is unlikely to be present unless in a very low density. History of extensive and intensive bushfire however would be a key threat and s a major limitation on occurrence.
Allocasuarinas	Absent	Absent	No preferred food species for Glossy Black Cockatoo.

Habitat Attribute/Type	Quarry Site/Subject Land	Access Road Study Area	Potential Values to Threatened Species Occurrence
Fruiting species	Absent.	Limited to a few Cheese Tree.	Overall lack of preferred species used by Wompoo Fruit-dove, Rose-crowned Fruit-dove or Barred Cuckoo Shrike.
Passerine bird habitat	Dune forest has good to very good cover over most of site provided by patchy to dense shrub layer offering cover and microhabitat for foraging, as well as range of nectar sources and decorticating bark. Sedgeland to east offers specialist habitat for small wetland bird eg Reed Warbler. Sedgeland to west offers nectar and insect sources with limited cover but good vantage point perches for birds which tolerate more open habitats. No grassy woodland habitat.	Varies with location. Pasture offers minor insect source for aerial foragers, and small common pastoral passerines such as Ground Larks, with medium sized birds more dominant. Wet meadow is similar limited. Swamp forest offers good cover and some foraging habitat, but limited structural diversity constraints diversity of microhabitats. Sedgeland to west offers nectar and insect sources with limited cover but good vantage point perches for birds which tolerate more open habitats.	May be sufficient abundance of passerine birds for site overall to form minute fraction by raptors such as the Square-tailed Kite and Little Eagle. No suitable habitat for grassy woodland specialists.

Aquatic	Limited to the freshwater wetland to east which was noted to be low at time of survey. Historical photographs show it may at times be open water with a sparse cover of emergent vegetation. At time of survey, it was completely vegetated with no open water. This habitat was considered suitable for the previously and locally recorded Green and Golden Bell Frog, and possibly also for the Wallum Froglet and Wallum Sedge Frog. Sedgeland to immediate west was too dense to have open water, but further west, the vegetation patterns suggested it may be subject to surface water with emergent vegetation for some time after flooding or local high volume rainfall due to complex micro-topography. Likely to be suitable for Wallum Froglet in these areas.	From Belmore River, which is a brackish system in the west, aquatic habitat occurs in several forms in the study area of the haulage road. Reilly's Drain is about 10m wide and >2m deep. This joins a smaller drain just before the start of the Swamp Oak forest. Water was noted to be clear to rusty-brown (presumably high dissolved iron) over the survey period. Water quality is known to widely fluctuate in this drain due to ASS. Common brackish-tolerant fish are noted to occur in this drain, with common waterbirds eg Pacific Black Duck, but the water is too deep for frogs. Common frogs may use the dense emergent reeds in the smaller drain. The western end of the adjacent pasture would be characterised by short term extensive, shallow, open water during very wet years and floods. This would suit a range of waterbirds eg Black-necked Stork, but lack of cover would preclude frogs. Tannin-stained, highly acidic water occurred in table drains west of the north-south drain along the sides of the haulage road, and was observed in the Swamp Oak forest to the north, and in the wet meadows to the south. Only acid-specialist frogs could survive in these habitats. The sedgeland to the north may contain water during inundation and local high volume rain, with	Highly suitable habitat for Green and Golden Bell Frog and Wallum Froglet in specific habitats with the study area, as evidenced by previcus records eg to the east in the wetland. The Wallum Sedge Frog has not been recorded south of Coffs Harbour, and hence is not considered a likely potential occurrence in the study area or locality. Not preferred habitat type for Green-thighed Frog. Flooded pasture and wet meadows offers potential habitat for Brolga, Black-necked Stork and migratory birds such as Great Egret and Cattle Egret. Marginal potential for bitterns to roost in swamp forest and forage in the freshwater wetlands. Black Bittern more likely to forage along Belmore River riparian zone and along Reilly's Drain. Reilly's Drain offers some generic potential for Southern Myotis.

Habitat Attribute/Type	Quarry Site/Subject Land	Access Road Study Area	Potential Values to Threatened Species Occurrence
		some local depressions likely to be ideal for the Wallum Froglet.	
Terrestrial prey	Trapping demonstrated low abundance of common terrestrial rodents, which would provide potential prey, with frogs and skinks. Relatively low abundance of medium sized arboreal mammals, but Brushtail Possums common, and bandicoots also present. These offer prey for Masked Owl and the Quoll. Passerine bird diversity would fluctuate with season (eg breeding, flowering), but was not abundant during survey. Potential to support raptors such as Square-tailed Kite.	Likely to be exotic rodents along batter of access track, with some native species in swamp forest. Swamp Rats likely to be abundant in sedgeland to north. These with bandicoots would offer prey for reptiles and perhaps raptors. Limited diversity and abundance of passerines due to habitat type, but waterfowl common, offering prey to White-breasted Sea-eagle. Low diversity and abundance of fish in drain forms small part of local habitat for Osprey. Likely abundance of frogs in sedgeland ideal for common reptiles, but also supports large wading birds eg Black-necked Stork.	Potential prey for Masked Owl, Square-tailed Kite, Black-necked Stork and Spotted-tail Quoll.

Figure 14: Hollow-bearing trees on the subject land

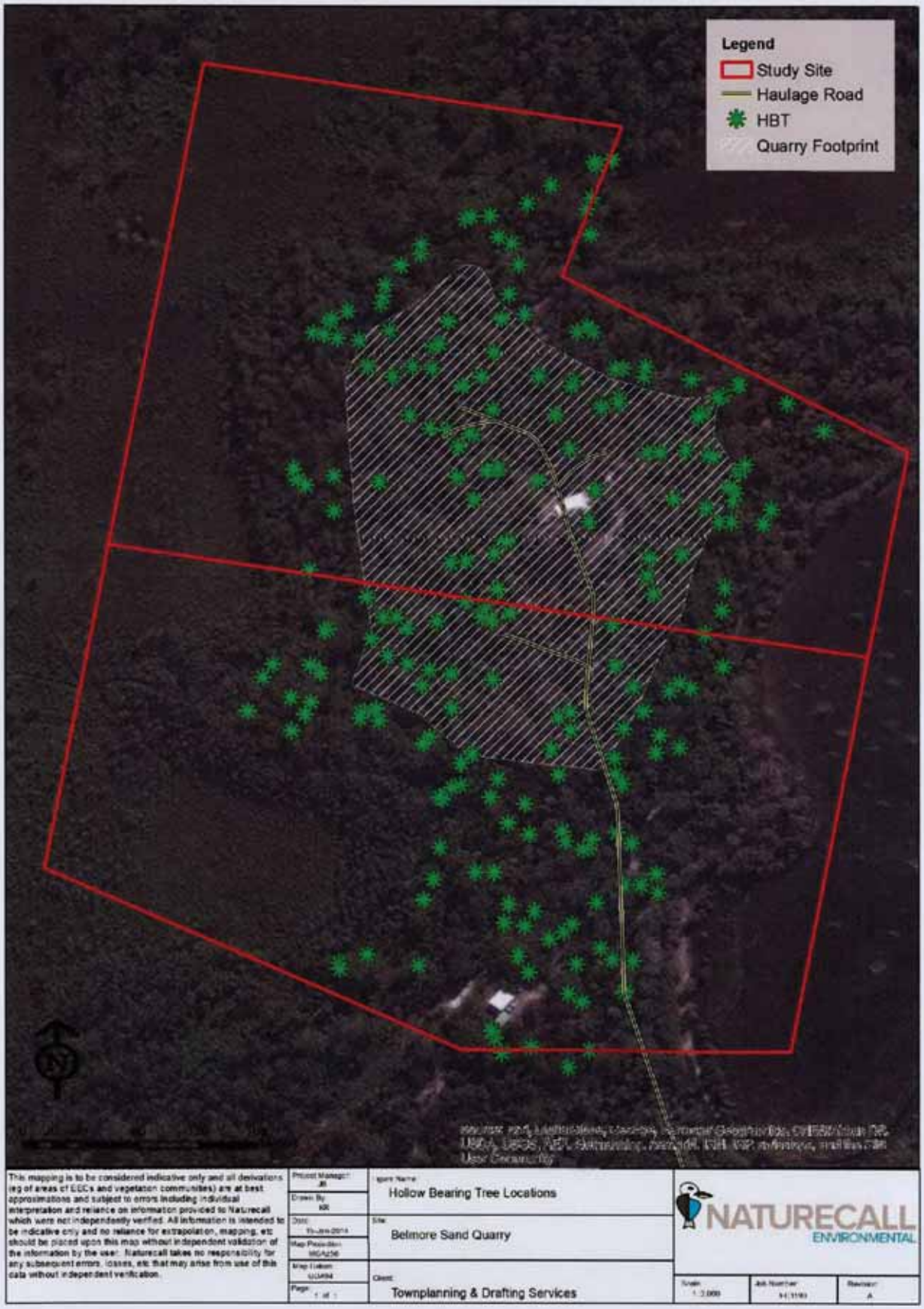


Photo 12: Table drains along haulage road.

Photo 13: Reilly's Drain

Photo 14: Dense groundcover and undergrowth on mid to footslopes

4.3.2. Call Playback, Identification and Recording

4.3.2.1. Birds

Call playback failed to gain a response from any of the target species. A number of common birds were detected by call identification (see Table 6).

4.3.2.2. Frogs

Frogs were heard calling in relatively high abundance from around the adjacent sedgeland to the east of the study site as well as along the access road. Only the following common species were heard:

- Eastern Sedge Frog (*Litoria fallax*)
- Peron's Tree Frog (*Litoria peronii*)
- Striped Marsh Frog (*Limnodynastes peronii*)
- Australian Green Tree Frog (*Litoria caerulea*).

4.3.2.3. Arboreal Mammals

No mammal species responded to call playback.

4.3.2.4. Yangochiropteran Bats

Yangochiropteran bat calls recorded during the survey were sent to Dr Anna McConville Echo Ecology, a recognised Yangochiropteran bat ecologist for identification. The results are shown in the table below (see Appendix 2).

Table 4: Yangochiropteran bat call identification

Note: # indicates species listed as Vulnerable on Schedule 2 of the TSCA Act 1995

Scientific Name	Call Identification
#Little Bent-wing Bat (*Miniopterus australis*)	Confident
Central-eastern Broad-nosed Bat (Scotorepens species 1)	Confident
Gould's Wattled Bat (*Chalinolobus morio*)	Confident
Chocolate Wattled Bat (*Chalinolobus gouldii*)	Confident
Eastern Forest Bat (*Vespadelus pumilus*)	Confident
#Miniopterus schreibersii oceanensis/Vespadelus pumilus/Vespadelus vulturnus/Vespadelus darlingtoni/Vespadelus troughtoni/#Chalinolobus nigrogriseus/#Falsistrellus tasmaniensi#s/Mormopterus (Micronomus) norfolkensis/ Mormopterus (Ozimops) ridei/Myotis macropus/ Nyctophilus geoffroyi/ Nyctophilus gouldii/#Scoteanax rueppellii/Scotorepens orion	Possible/species group

As shown in the above table, one threatened Yangochiropteran bat species was confidently identified from the data: the Little Bent-wing Bat. Some possible calls include threatened species (ie Hoary Wattled Bat, Greater Broad-nosed Bat, Eastern False Pipistrelle and East-coat Freetail Bat) hence these are considered potential occurrences as per the Precautionary Principle.

4.3.3. Trapping and PIR Camera Results

4.3.3.1. Elliot B Traps

Elliot B traps captured the same male Brushtailed Phascogale twice. Only 5 individual Squirrel Gliders were captured (one female). All but one capture of each species was outside the proposed quarry footprint.

Capture dates are presented in the table below, with location shown in Figure 15.

Table 5: Elliot B results

Species	Night 1 (15.12.15)	Night 2 (16.12.15)	Night 3 (17.12.15)	Night 4 (18.12.15)
Brushtailed Phascogale	Nil	Male	Recapture from Night 2	Nil
Squirrel Glider	Hair from tail	Nil	Male Sex unconfirmed	Male Female Male

4.3.3.2. Elliot A Traps

Elliot A traps captured only a low abundance of House Mouse (*Mus musculus*), Bush Rat (*Rattus fuscipes*), and Swamp Rat (*Rattus lutreolus*).

4.3.3.3. IR Cameras

Terrestrial

The terrestrial IR cameras recorded the following common species:

- House Mouse,
- Bush Rat,
- Swamp Rat,
- Northern Brown Bandicoot (*Isoodon macrourus*),
- Common Brushtail Possum (*Trichosurus vulpecular*),
- Dingo (Canis lupus dingo).

Arboreal

The arboreal IR cameras recorded a large number of Brushtail Possums, as well as the Squirrel Glider and Brushtailed Phascogale (see Figure 16). These appear likely to be the same animals that were trapped.

Figure 15: Locations of trapped threatened species

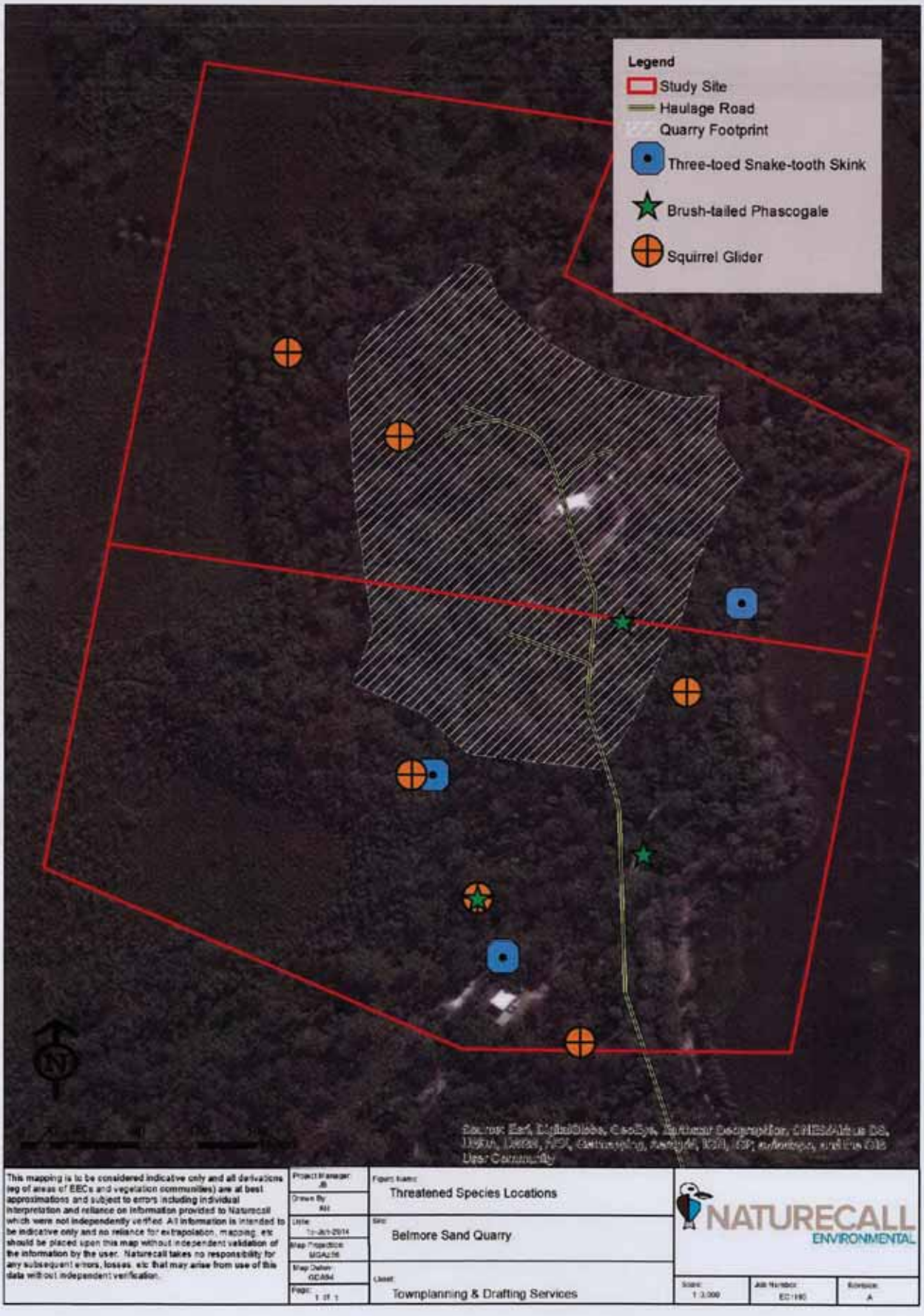
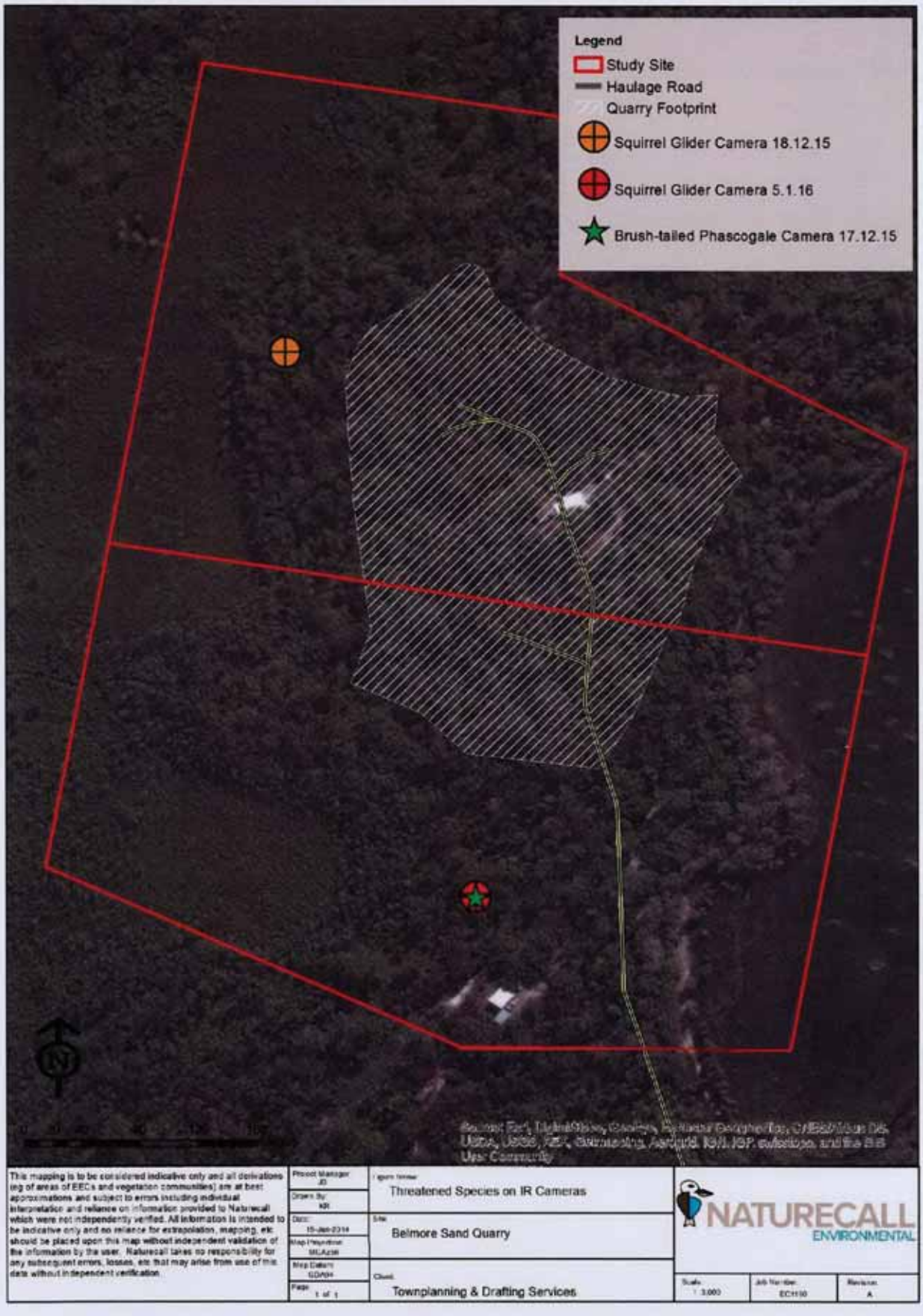


Figure 16: Location of PIR camera detected threatened species.



4.3.3.4. Pitfall Traps

Pitfall trapping successfully captured a number of common amphibian species.

The traps also successfully captured an Eastern Striped Skink (*Ctenotus robustus*). Most importantly 4 Three-toed Snake-toothed Skinks were caught (V-TSCA, V-EPBCA), complimenting a nearby record (OEH 2016a). These were all caught outside the quarry footprint.

Photo 15: Three-toed Snake-toothed Skink

4.3.4. Spotlighting and Torch Searches

Many Common Brushtail Possums were observed throughout the site, in addition, the Squirrel Glider was observed on two of the four spotlighting nights.

4.3.5. Secondary Evidence

4.3.5.1. Trunk Scratches, Tracks, Etc

Examination of tree trunks showed variable (low to very high - with well-worn trails due to Brushtail Possums noted on some trees) levels of arboreal activity depending on species.

Scratches were detected on smoothed barked trees (i.e. Scribbly Gum), though these were generally restricted to the mature trees (>40cm trunk DBH).

Large scratches were attributed to Brushtail Possum and Lace Monitor.

Tracks were found only of Eastern Grey Kangaroo.

Photo 16: Possum runway on a hollow-bearing Needlebark

4.3.5.2. Scats, Tracks and Bones

No Koala scats were observed during scat searches over the site. Scats of Eastern Grey Kangaroo were commonly observed.

The only tracks observed were from Eastern Grey Kangaroos, Wallabies and snakes. No bones or road kill were found during the survey.

4.3.5.3. Chewed Allocasuarina Cones

No chewed cones were found.

4.3.5.4. Sap Incisions

Sap incisions were recorded on a number of Pink Bloodwood and Scribbly Gum.

No tree showed the distinctive incisions of a Yellow-bellied Glider.

4.4. Total Fauna Observed

The following table lists all fauna recorded by this survey.

Table 6: Fauna recorded on and adjacent to the site

Group	Common Name	Species	Detection Method
Mammals	Dingo	*Canis lupus dingo*	IR Camera
	Northern Brown Bandicoot	*Isoodon macrourus*	IR Camera
	Eastern Grey Kangaroo	*Macropus giganteus*	Obs
	Red-necked wallaby	*Macropus rufogriseus*	Obs
	*House Mouse	*Mus musculus*	Elliot A/ IR Camera
	*Squirrel Glider	*Petaurus norfolcensis*	Elliot B/ Spotlight/ IR Camera
	*Brushtailed Phascogale	*Phascogale tapoatafa*	IR Camera/Elliot B
	Bush Rat	*Rattus fuscipes*	Elliot A
	Swamp Rat	*Rattus lutreolus*	Elliot A/ IR Camera
	Common Brushtail possum	*Trichosurus vulpecula*	IR Camera/ Spotlighting
Birds	Mistletoebird	*Dicaeum hirundinaceum*	Obs
	Little Wattlebird	*Anthochaera chrysoptera*	Obs/HC
	Pheasant Coucal	*Centropus phasianinus*	Obs
	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	Obs
	Laughing Kookaburra	*Dacelo novaeguineae*	Obs/HC
	Eastern Yellow Robin	*Eopsaltria australis*	HC
	White-throated Nightjar	*Eurostopodus mystacalis*	Obs
	Australian Magpie	*Gymnorhina tibicen*	Obs/HC
	Variegated Fairywren	*Malurus lamberti*	Obs/HC
	Noisy Miner	*Manorina melanocephala*	Obs

Group	Common Name	Species	Detection Method
	Lewin's Honeyeater	*Meliphaga lewinii*	Obs
	Nankeen Night Heron	*Nycticorax caledonicus*	Obs
	Pacific Black Duck	*Anas superciliosa*	Obs
	Crested Pigeon	*Ocyphaps lophotes*	Obs
	Australian Golden Whistler	*Pachycephala pectoralis*	HC
	Noisy Friarbird	*Philemon corniculatus*	Obs
	White-cheeked Honeyeater	*Phylidonyris niger*	Obs
	New Holland Honeyeater	*Phylidonyris novaehollandiae*	Obs
	Tawny Frogmouth	*Podargus strigoides*	Obs/HC
	Eastern Whipbird	*Psophodes olivaceus*	Obs/HC
	Willie Wagtail	*Rhipidura leucophrys*	Obs
	Rainbow Lorikeet	*Trichoglossus moluccanus*	Obs
Reptiles	Three-toed Snake-toothed Skins	*Coeranoscincus reticulatus*	Pitfall
	Eastern Striped Skink	*Ctenotus robustus*	Pitfall
	Dark-flecked Garden Sun Skink	*Lampropholis delicata*	Obs
	Red-bellied Black Snake	*Pseudechis porphyriacus*	Obs
	Eastern Brown Snake	*Pseudonaja textilis*	Obs
	Lace monitor	*Varanus varius*	Obs
Amphibians	Eastern Sedge Frog	*Litoria fallax*	HC
	Peron's Tree Frog	*Litoria peronii*	HC
	Striped Marsh Frog	*Limnodynastes peronii*	Obs/HC/ Pitfall
	Green Tree Frog	*Litoria caerulea*	Obs

Key:

Bold: Vulnerable under TSCA
* Vulnerable under EPBCA
* Indicates introduced species.

Observation Key: Obs–Observation; HC heard calling, SE – secondary evidence

4.4.1. Locally Recorded Threatened Fauna

The following table lists threatened species known to occur in the locality (OEH 2016a, FFC 2015, Darkheart 2010, 2004w, Berrigan 2004a, 2001e, Kendall and Kendall 2000, 1999, 1994, Ingersoll and Redpath 2003, personal observations). Marine/seabirds, mammals and reptiles are excluded due to lack of habitat in the study area and no impact on any potential habitat.

Table 7: Threatened species recorded in the locality

Group	Common Name	Species	Legal Status	No. Records
Mammals	Koala	*Phascolarctos cinereus*	V-TSCA	4
	Spotted-tailed Quoll	*Dasyurus maculatus*	V-TSCA, E-EPBCA	1
	Brushtailed Phascogale	*Phascogale tapoatafa*	V-TSCA	3
	Squirrel Glider	*Petaurus norfolcensis*	V-TSCA	7
	Little Bent-wing Bat	*Miniopterus australis*	V-TSCA	4
	Greater Broad-nosed Bat	*Scoteanax rueppellii*	V-TSCA	1
	Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	V-TSCA	1
	Hoary Wattled Bat	*Chalinolobus nigrogriseus*	V-TSCA	1
	Southern Myotis	*Myotis macropus*	V-TSCA	1
	Eastern Blossom Bat	*Syconycteris australis*	V-TSCA	1
	Grey-headed Flying Fox	*Pteropus poliocephalus*	V-TSCA, V-EPBCA	5
Birds	Glossy Black-Cockatoo	*Calyptorhynchus lathamii*	V-TSCA	6
	Square-tailed Kite	*Lophoictinia isura*	V-TSCA	1
	Grass Owl	*Tyto longimembris*	V-TSCA	1
	Wompoo Fruit Dove	*Ptilinopus magnificus*	V-TSCA	2
	Rose-crowned Fruit Dove	*Ptilinopus regina*	V-TSCA	1

Group	Common Name	Species	Legal Status	No. Records
	Australian Bittern	*Botaurus poiciloptilus*	V-TSCA E-EPBCA	2
	Regent Honeyeater	*Anthochaera phrygia*	E-TSCA E-EPBCA	1
	Osprey	*Pandion cristatus*	V-TSCA	7
	Black Necked Stork	*Ephippiorhynchus asiaticus*	E-TSCA	15
Reptiles	Three-toed Snake-toothed Skink	*Coeranoscincus reticulatus*	V-TSCA, V-EPBCA	1
Frogs	Stuttering Frog	*Mixophyes iteratus*	E-TSCA, E-EPBCA	1
	Green and Golden Bell Frog	*Litoria aurea*	E-TSCA V-EPBCA	26
	Wallum Froglet	*Crinia tinnula*	V-TSCA	30

The following species are considered likely to occur in the locality (excluding sea birds, etc.) due to suitable habitat and regional records in similar habitat (some have been recorded within 20km).

Table 8: Threatened fauna potentially occurring in the locality

* listed under the EPBC Act 1999.

Animal Group	Potentially Occurring Species
Mammals	Rufous Bettong, Long-nosed Potoroo*, Eastern Chestnut Mouse, Common Planigale, Eastern Pygmy Possum, Eastern Bent-wing Bat, East-coast Freetail Bat, New Holland Mouse*
Birds	Powerful Owl, Masked Owl, Barking Owl, Little Eagle, Spotted Harrier, Flame Robin, Scarlet Robin, Bush Stone-curlew, Black Bittern, Painted Snipe*, Brolga, Swift Parrot*, Regent Honeyeater*, Barred Cuckoo-shrike, Varied Sittella, Little Lorikeet.
Reptiles	Pale-headed Snake, Stephens Banded Snake
Frogs	Wallum Sedge Frog*, Green-thighed Frog

4.5. Potential Occurrence Assessment

Each of the species listed in the above two tables have been evaluated for their potential to occur on the subject land/study site/area, as well as for the likely significance of the proposal and thus their eligibility for Seven Part Test assessment, in Appendix 1.

4.5.1. New South Wales

The following species listed under the NSW *Threatened Species Conservation Act 1995* are considered to potentially occur in the study area in addition to those previously recorded:

Table 9: Threatened species potentially occurring on the subject land/site/study area

Species	Occurrence Type	Occurrence Likelihood (See Appendix 1)
Square-tailed Kite	Potential to form minute portion of large foraging territory. Generic potential nest trees.	Fair chance in study area as periodic forager.
Little Eagle	Potential to form minute portion of large foraging territory. Generic potential nest trees.	Low chance in study area as periodic forager as no local records.
Powerful Owl	Subject land contains broadly suitable foraging habitat that may form small part of a territory. Generic potential nest trees.	Low in study area – not associated with coastal sand forests.
Masked Owl	Subject land contains broadly suitable foraging habitat that may form small part of a territory. Generic potential nest trees.	>Fair chance of periodic forager in study area.
Varied Sittella	Subject land contains broadly suitable foraging habitat. Generic potential to nest.	Low in study area - no local records.
Little Lorikeet	Subject land contains preferred forage species, and potential nest sites, forming small part of large area of such habitat.	Low chance in study area foraging in peak flowering seasons as not recorded locally.
Black-necked Stork	Non-breeding pairs or individuals birds opportunistically using the wet meadows and seasonally flooded pasture adjacent to the haulage road.	High chance as non-breeding visitor.
Osprey	Potential foraging habitat in Reilly's Drain and Belmore River. No preferred potential nest sites.	Fair as part of local territory.

Species	Occurrence Type	Occurrence Likelihood (See Appendix 1)
Black-necked Stork	Potential foraging habitat in southern wet meadows, and in pasture adjacent to haulage road.	High - depending on inundation.
Black Bittern	Potential foraging habitat in wet meadows, and also along Reilly's Drain. Marginal potential in eastern wetland. Potential roosts in swamp forest. Low potential for local nesting.	Low – common bitterns recorded.
Spotted-tail Quoll	Subject land offers good potential foraging habitat forming fraction of suitable habitat in Hat Head National Park. Potential den sites in trees.	Fair in study area – using subject land as small part of territory centred in Hat Head National Park.
Common Planigale	Swamp forest and sedgeland on western side of subject land and adjacent offers very high potential habitat for resident population. Low value potential habitat on site. Similar high potential habitat in sedgeland and coastal complex north of haulage road.	Low in study area – not recorded locally.
Eastern Chestnut Mouse	Swamp forest and sedgeland on western side of subject land and adjacent offers very high potential habitat for resident population. Low value potential habitat on site. Similar high potential habitat in sedgeland and coastal complex north of haulage road.	Low– not recorded locally.
Eastern Pygmy Possum	May occur as resident populations on western and northern margins of dune on subject land where localised complex mosaic of vegetation types and dense undergrowth, and Banksias more common.	Low – no local records and intensive extensive bushfire history.
Grey-headed Flying Fox	Extensive high quality foraging habitat would see this species foraging widely over the study area; but not roosting habitat.	Highly likely using study areas as minute part of nomadic range.
Eastern Blossom Bat	Potential foraging habitat over most of study area but no roosting habitat.	Fair potential to occur using study area as part of seasonally nomadic foraging range.
Eastern Cave Bat	Potential foraging but not roosting habitat. Nearest potential caves >5km away.	Unlikely to low as transient
Eastern False Pipistrelle	Potential foraging habitat with potential to forage in roosts. Not associated with coastal sands habitats.	Unlikely to low using study area as part of seasonally nomadic foraging range
Eastern Bent-wing Bat	All areas offer potential for foraging. Potential non-breeding roosts in tree hollows	>Moderate chance foraging. Low chance of roosting in study area.

Species	Occurrence Type	Occurrence Likelihood (See Appendix 1)
Greater Broad-nosed Bat	All areas offer potential for foraging. Potential breeding roosts in tree hollows	Low to fair chance foraging. Low chance of breeding in study area.
East-coast Freetail Bat	All areas offer potential for foraging. Potential breeding roosts in tree hollows	>Moderate chance foraging. Low chance of breeding in study area.
Southern Myotis	Low value potential foraging habitat in Reilly's Drain only. Potential roosts on subject land.	Low chance of foraging and/or denning in study area.
Hoary Bat	Potential foraging habitat on site and in study area with potential roosts.	Low to fair to occur in study area
Green and Golden Bell Frog	Known to occur in freshwater wetland to east of subject land. Potential to use edge of subject land for over-wintering refuge or dispersing across site west to wetland.	>Moderate potential to occur in study area
Wallum Froglet	Potential to occur in wetland to east and west of subject land; and north and south of eastern end of haulage road adjacent to dune system.	>Fair potential to occur in study area

4.5.2. Commonwealth

The following species are considered by the DotE Matters of National Environmental Significance search tool as potential occurrences in the locality. Marine birds, mammals and reptiles and all fish listed in the search are irrelevant as the site/study area does not contain habitat and the proposal has no potential to impact these species.

4.5.2.1. Threatened Species

Table 10 summarises the species predicted by the search tool as potential occurrences, and other species with potential to occur in the locality, for their potential to occur on site, in the study area or on the property. The potential for these species to occur on the site is also reviewed in Appendix 1.

Table 10: EPBC Act threatened fauna species potential occurrence assessment
Note: Likelihood of occurrence derived from opinions of consultants in consideration of known ecology of each species (see Appendix 1); and quality of habitat on-site. * indicates listed on DotE website search.

Group	Common Name	Scientific Name	Listing Status	Recorded In Locality (10km Radius)	Suitable Habitat On Site/Study Area	Likelihood Of Occurrence
Birds	*Regent Honeyeater	*Xanthomyza phrygia*	CE	Y	Very small extent of potential foraging resources in study area in swamp forest.	Unlikely to occur due to limited preferred foraging resources, extreme rarity, and lack of recurring local records indicating regular seasonal occurrence.
	*Painted Honeyeater	*Grantiella picta*	V	N	Lack of preferred habitat.	Unlikely to occur.
	*Australian Painted Snipe	*Rostratula australis*	V	N	Some broadly potentially suitable habitat perhaps in eastern freshwater wetland and sedgelands	Unlikely to occur as no local records and scant regional records.
	*Red Goshawk	*Erythrotriorchis radiatus*	E	N	Generic potential habitat forming minute fraction of such habitat. Not	Unlikely as not seen south of Clarence River.
	*Eastern Bristlebird	*Dasyornis brachypterus*	E	N	No suitable habitat.	Unlikely to occur.
	*Australasian Bittern	*Botaurus poiciloptilus*	E	Y	Some broadly potentially suitable habitat perhaps in eastern freshwater wetland and sedgelands	Unlikely to occur as local records only in protected habitat, and scant regional records.

Group	Common Name	Scientific Name	Listing Status	Recorded In Locality (10km Radius)	Suitable Habitat On Site/Study Area	Likelihood Of Occurrence
	*Swift Parrot	*Lathumus discolor*	E	N	Very small extent of potential foraging resources on site	Unlikely to occur due to limited preferred foraging resources, extreme rarity and lack of local records indicating recurring seasonal occurrence.
Mammals	*Long-nosed Potoroo	*Potorous tridactylus*	V	N	Generically potentially suitable habitat in the dune system on the subject land and widely in Hat Head National Park.	Unlikely potential to occur – no local records and patchy coastal records throughout its distribution. Highly likely to be foxes, cats and wild dogs.
	*Koala	*Phascolarctos cinereus*	V	Y	Site has some preferred forage species which are also likely to be common on adjacent land.	Unlikely – nearest confirmed population is south and west of Crescent Head.
	*Spotted-tail Quoll	*Dasyurus maculatus*	E	Y	Generically potentially suitable habitat in the dune system on the subject land and widely in Hat Head National Park.	Fair chance as periodic forager moving through dune system as part of territory and dispersal.
	*Grey-headed Flying Fox	*Pteropus poliocephalus*	V	Y	Eucalypts, bloodwoods and Melaleucas on site suitable for seasonal nectar foraging.	Highly likely as small part of local range.
	*Dwyer's/Large Pied Bat	*Chalinolobus dwyeri*	V	N	Generic forage habitat over forest. No potential roosts in study area.	Unlikely to occur due to lack of local records or likely roosts.

Table 10: EPBC Act threatened fauna species potential occurrence assessment
Note: Likelihood of occurrence derived from opinions of consultants in consideration of known ecology of each species (see Appendix 1); and quality of habitat on-site. * indicates listed on DotE website search.

Group	Common Name	Scientific Name	Listing Status	Recorded In Locality (10km Radius)	Suitable Habitat On Site/Study Area	Likelihood Of Occurrence
Birds	*Regent Honeyeater	*Xanthomyza phrygia*	CE	Y	Very small extent of potential foraging resources in study area in swamp forest.	Unlikely to occur due to limited preferred foraging resources, extreme rarity, and lack of recurring local records indicating regular seasonal occurrence.
	*Painted Honeyeater	*Grantiella picta*	V	N	Lack of preferred habitat.	Unlikely to occur.
	*Australian Painted Snipe	*Rostratula australis*	V	N	Some broadly potentially suitable habitat perhaps in eastern freshwater wetland and sedgelands	Unlikely to occur as no local records and scant regional records.
	*Red Goshawk	*Erythrotriorchis radiatus*	E	N	Generic potential habitat forming minute fraction of such habitat. Not	Unlikely as not seen south of Clarence River.
	*Eastern Bristlebird	*Dasyornis brachypterus*	E	N	No suitable habitat.	Unlikely to occur.
	*Australasian Bittern	*Botaurus poiciloptilus*	E	Y	Some broadly potentially suitable habitat perhaps in eastern freshwater wetland and sedgelands	Unlikely to occur as local records only in protected habitat, and scant regional records.

Group	Common Name	Scientific Name	Listing Status	Recorded In Locality (10km Radius)	Suitable Habitat On Site/Study Area	Likelihood Of Occurrence
	*Swift Parrot	*Lathumus discolor*	E	N	Very small extent of potential foraging resources on site	Unlikely to occur due to limited preferred foraging resources, extreme rarity and lack of local records indicating recurring seasonal occurrence.
Mammals	*Long-nosed Potoroo	*Potorous tridactylus*	V	N	Generically potentially suitable habitat in the dune system on the subject land and widely in Hat Head National Park.	Unlikely potential to occur – no local records and patchy coastal records throughout its distribution. Highly likely to be foxes, cats and wild dogs.
	*Koala	*Phascolarctos cinereus*	V	Y	Site has some preferred forage species which are also likely to be common on adjacent land.	Unlikely – nearest confirmed population is south and west of Crescent Head.
	*Spotted-tail Quoll	*Dasyurus maculatus*	E	Y	Generically potentially suitable habitat in the dune system on the subject land and widely in Hat Head National Park.	Fair chance as periodic forager moving through dune system as part of territory and dispersal.
	*Grey-headed Flying Fox	*Pteropus poliocephalus*	V	Y	Eucalypts, bloodwoods and Melaleucas on site suitable for seasonal nectar foraging.	Highly likely as small part of local range.
	*Dwyer's/Large Pied Bat	*Chalinolobus dwyeri*	V	N	Generic forage habitat over forest. No potential roosts in study area.	Unlikely to occur due to lack of local records or likely roosts.

Group	Common Name	Scientific Name	Listing Status	Recorded In Locality (10km Radius)	Suitable Habitat On Site/Study Area	Likelihood Of Occurrence
	*Brushtailed Rock Wallaby	*Petrogale penicillata*	V	N	No suitable habitat in locality.	Unlikely to occur.
	*New Holland Mouse	*Pseudomys novaehollandiae*	E	N	Subject land contains some potential habitat in several vegetation types, forming small fraction of local abundance of such habitat, but lacks frequent fire regime preferred by this species.	Low – mostly likely in sedgeland and swamp forest ecotones, but no local records and scant regional records.
Frogs	*Green and Golden Bell Frog	*Litoria aurea*	V	Y	Known to occur in freshwater wetland to east of subject land. Potential to use edge of subject land for over-wintering refuge or dispersing across site west to wetland.	>Moderate chance of occurrence in study area.
	*Stuttering Frog	*Mixophyes balbus*	V	Y	No suitable habitat in study area.	Unlikely to occur.
	Wallum Sedge Frog	*Litoria olongburensis*	V	N	Potential to occur in wetland to east and west of subject land; and north and south of eastern end of haulage road adjacent to dune system. However site is located outside known distribution.	Unlikely to occur.
	*Giant Barred Frog	*M. iteratus*	E	Y	No suitable habitat in study area.	Unlikely to occur.

Group	Common Name	Scientific Name	Listing Status	Recorded In Locality (10km Radius)	Suitable Habitat On Site/Study Area	Likelihood Of Occurrence
	*Brushtailed Rock Wallaby	*Petrogale penicillata*	V	N	No suitable habitat in locality.	Unlikely to occur.
	*New Holland Mouse	*Pseudomys novaehollandiae*	E	N	Subject land contains some potential habitat in several vegetation types, forming small fraction of local abundance of such habitat, but lacks frequent fire regime preferred by this species.	Low – mostly likely in sedgeland and swamp forest ecotones, but no local records and scant regional records.
Frogs	*Green and Golden Bell Frog	*Litoria aurea*	V	Y	Known to occur in freshwater wetland to east of subject land. Potential to use edge of subject land for over-wintering refuge or dispersing across site west to wetland.	>Moderate chance of occurrence in study area.
	*Stuttering Frog	*Mixophyes balbus*	V	Y	No suitable habitat in study area.	Unlikely to occur.
	Wallum Sedge Frog	*Litoria olongburensis*	V	N	Potential to occur in wetland to east and west of subject land; and north and south of eastern end of haulage road adjacent to dune system. However site is located outside known distribution.	Unlikely to occur.
	*Giant Barred Frog	*M. iteratus*	E	Y	No suitable habitat in study area.	Unlikely to occur.

Group	Common Name	Scientific Name	Listing Status	Recorded In Locality (10km Radius)	Suitable Habitat On Site/Study Area	Likelihood Of Occurrence
Reptiles	Three-toed Snake-toothed Skink	*Coeranoscincus reticulatus*	V	Y	Nearby record in non-typical habitat, comprising coastal sands Blackbutt, with layer of leaf litter and good groundcover, in mosaic with heath, sedgeland and swamp forest; as on site.	Recorded on site.

4.5.3. Migratory Species

No EPBC Act migratory species recorded by the survey.

A significant number of EPBC Act 1999 listed migratory bird species are known (OEH 2016a) or considered potential occurrences in the locality (DotE 2016a). A search of the MNES website and literature review (Readers Digest 1990, DotE 2016b) also produced a list of likely occurrences. All of these species plus some considered by the consultant as potential occurrences in the LGA in similar habitat to that on the property are also shown in the following table, with an evaluation made on likelihood of occurrence based on cited ecology. Note this list excludes seabirds, etc, due to lack of habitat in the study area, as detailed above.

Table 11: EPBC Act migratory species potential occurrence assessment

Common Name	Scientific Name	Predicted Type of Occurrence	Recorded In Locality (10km Radius)	Suitable Habitat On Site/Study Area	Likelihood Of Occurrence
*White-Bellied Sea-Eagle	*Haliaetus benghalensis*	Species and/or habitat likely to occur within area	Y	Potential foraging habitat in Reilly's Drain and Belmore River. No preferred potential nest sites.	>Moderate
Osprey	*Pandion cristatus*	-	Y	As for White-Bellied Sea-Eagle.	>Moderate

Common Name	Scientific Name	Predicted Type of Occurrence	Recorded In Locality (10km Radius)	Suitable Habitat On Site/Study Area	Likelihood Of Occurrence
Latham's Snipe	*Gallinago hardwickii*	Species or habitat may occur in area	Y	Pasture and sedgelands adjacent to haulage road offer good potential habitat.	>Moderate
Australian Painted Snipe	*Rostratula benghalensis (australis)*	Species and/or habitat may occur in area	N	Some broadly potentially suitable habitat perhaps in eastern freshwater wetland and sedgelands	Unlikely to occur as no local records and scant regional records.
Great Egret	*Egretta alba*	Species/habitat may occur in area	Y	Pasture and sedgelands adjacent to haulage road offer good potential habitat.	>Moderate
Cattle Egret	*Bubulcus ibis*	Species/habitat may occur in area	Y	Pasture and sedgelands adjacent to haulage road offer good potential habitat.	>Moderate
Rainbow Bee-eater	*Merops ornatus*	Species/habitat may occur in area	Y	Suitable foraging habitat over most of subject land.	Low to fair using the study area as part of seasonal foraging range
Regent Honeyeater	*Xanthomyza phrygia*	Species/habitat may occur in area	Y	Very small extent of potential foraging resources on site	Unlikely to occur due to limited preferred foraging resources, extreme rarity and lack of local records indicating recurring seasonal occurrence.

Common Name	Scientific Name	Predicted Type of Occurrence	Recorded In Locality (10km Radius)	Suitable Habitat On Site/Study Area	Likelihood Of Occurrence
Swift Parrot	*Lathumus discolor*	Species/habitat may occur in area	N	Very small extent of potential foraging resources on site	Unlikely to occur due to limited preferred foraging resources, extreme rarity and lack of local records indicating recurring seasonal occurrence.
Rufous Fantail	*Rhipidura rufifrons*	Breeding or breeding habitat may occur in area	Y	Not preferred habitat types	Unlikely.
Satin Flycatcher	*Myiagra cyanoleuca*	Breeding or breeding habitat likely in area	Y	Not preferred habitat types	Unlikely.
Black Faced Monarch	*Monarcha melanopsis*	Breeding or breeding habitat may occur in area	Y	Not preferred habitat types	Unlikely.
Spectacled Monarch	*M. trivirgatus*	Breeding or breeding habitat likely in area	Y	Not preferred habitat types	Unlikely.
White-throated Needletail	*Hirundapus caudacutus*	Species/habitat likely to occur in area	N	Yes as part of a broader area	Moderate-high, as transient, between Dec-April
Fork-tailed Swift	*Apus pacificus*	Species/habitat may occur in area	N	Yes as part of a broader area	Fair potential, as transient, between Oct-April

5.0 Impact Identification and Assessment

5.1. Direct Impacts

5.1.1. Habitat Loss

As detailed in section 2.2, the development proposal is a sand quarry over about 6.4ha (26%) of the 24.32ha subject land, with material to be trucked out via a right of way across a current sand quarry (nearly at the end of its lifespan and to be rehabilitated) to Belmore River Road, and associated clients.

The haulage route is essentially constructed for most of its length, with the extension from the site generally following an existing track. Hence vegetation removal and earthmoving (and associated habitat loss) will largely be limited to the 6.4ha quarry footprint.

The quarry is expected to have a lifetime of >17 years depending on market demand. The quarry's operational strategy is to progressively clear 0.5ha and simultaneously rehabilitate 0.5ha, hence a total of 1ha of operational area at any given time. This allows both habitat loss and costs (including that of rehabilitation) to be spread over time.

The extraction process generally consists of initial removal of the vegetation, followed by stripping of the top stratum which contains most of the roots and other organic matter. The soil profile below is excavated and processed for sale on demand.

This will thus see eventual removal of all current vegetation on the dune from the crest down to the midslope. This will include:

- Removal of 6.4ha of the approximately 16.12ha of dry sclerophyll forest on the subject land (40%).
- Loss of 99 of the site's 253 hollow-bearing trees (39%).
- Loss of nectar sources such as eucalypts, bloodwoods and banksias.
- Loss of refugia such as dense leaf litter/decorticating bark and patches of dense groundcover.

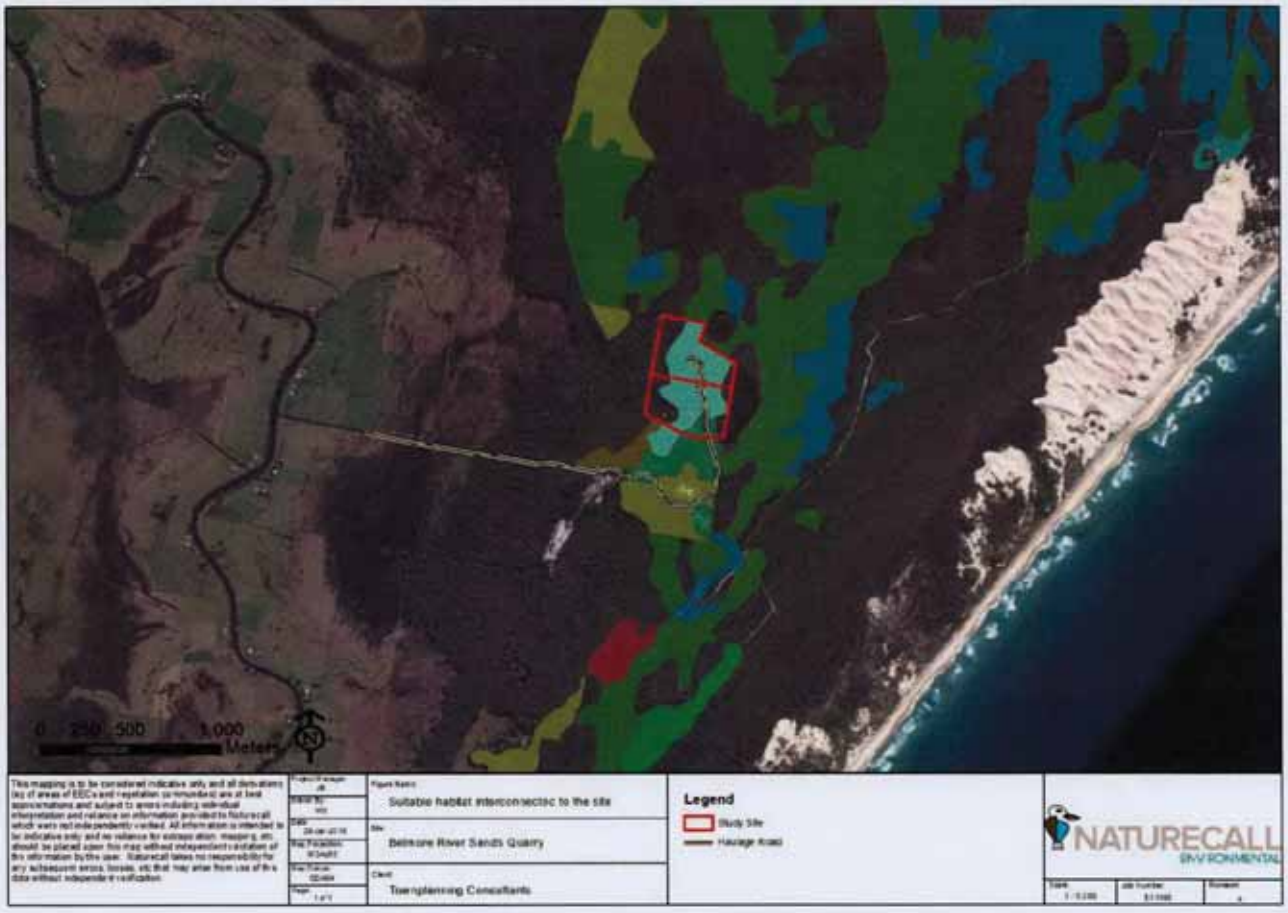
This will see direct loss of habitat for the following known and potentially occurring species.

- *Foraging habitat*: Square-tailed Kite, Little Eagle, Powerful Owl, Masked Owl, Varied Sittella, Little Lorikeet, Spotted-tail Quoll, Common Planigale, Eastern Pygmy Possum, Grey-headed Flying Fox, Eastern Blossom Bat, Greater Broad-nosed Bat, East-coast Freetail Bat, Yellow-bellied Sheathtail Bat, Eastern False Pipistrelle, Eastern Cave Bat, Hoary Bat, Little and Eastern Bent-wing Bats and Three-toed Snake-toothed Skink.
- *Roosting/denning/nesting/refugia*: Powerful Owl, Masked Owl, Varied Sittella, Little Lorikeet, Spotted-tail Quoll, Common Planigale, Eastern Pygmy Possum, Greater Broad-nosed Bat, East-coast Freetail Bat, Yellow-bellied Sheathtail Bat, Hoary Bat, , Eastern False Pipistrelle,

Little and Eastern Bent-wing Bats and Three-toed Snake-toothed Skink, Southern Myotis, Green and Golden Bell Frog.

Figure 17 shows the subject land in context of the locally available extent of dry sclerophyll forest and other habitat suitable habitat for the impacted species, most of which is protected in Hat Head National Park. In this context, the quarry site comprises a small fraction of the locally available habitat.

Figure 17: Extent of alternative habitat interconnected to the site



The following potentially occurring threatened species will not be directly impacted as potential habitat does not occur in the quarry envelope:

- *Frogs*: Wallum Froglet.
- *Birds*: Black-necked Stork, Osprey, Black Bittern.
- *Mammals*: Eastern Chestnut Mouse, New Holland Mouse.

5.1.2. Long Term Habitat Modification

The quarry will excavate a dune approximately 10m AHD, resulting in a lowering of this landform when complete. A minimum of 1m of the current *in situ* soil strata will be left on the floor of the quarry to avoid interacting with the watertable (as monitored by piezometers), but given presence of coffee

rock in some areas and unsuitability of the stratum below the root zone ("brown sand"), the final depth above the watertable is likely to be 3-4m (Steve Wink, pers. comm.).

The final landform will also be undulating not a uniform plain for a range of reasons (eg depth of excavation and overburden), with undulations running north-south mimicking the natural pattern of the dune system. This micro-topography will thus create a range of edaphic conditions (eg accumulation of moisture in the swales will promote growth of dense groundcover) and hence allow a potentially diverse vegetation assemblage to develop. This benefits fauna as it increases the diversity of potential habitat resources eg nectar producing trees and shrubs, and complexity of the habitat structure.

The excavated area is to be progressively rehabilitated as each new cell is cleared and excavated, hence provided this regime is maintained over the lifetime of the quarry, the 6.4ha envelope will contain a mosaic of seral rehabilitation stages established over the >15 year operational period. Eventually these should catch up and become relatively uniform in development, but monitoring of each cell should also form part of an adaptive rehabilitation regime to minimise the risk of stalling of recolonisation and dominance by a handful of aggressive pioneers (eg *Leptospermum laevigatum*) which may retard the development of a higher value climax community (Gravina *et al* 2001, Van Gorp and Erskine 2011).

Coastal sand dune vegetation communities generally reflect the height above the watertable, bushfire frequency and current site-specific edaphic conditions. The latter in turn are a reflection of environmental features such as the low fertility substrate; accumulation of organic matter over time (and hence establishment of micro-ecosystems and complex interactions with invertebrates, fungi and bacteria) and nutrient cycles; and maritime stresses and nutrient inputs (if close to the ocean), which have evolved over geological time (Keith 2000, Gravina *et al* 2001, Van Gorp and Erskine 2011).

Compared to sand mining where the topsoil may be mixed with the lower stratums, a sand quarry has the advantage of retaining the accumulated organic material in the upper horizons and using this as the topsoil and underlying horizon in their natural order. This maintains not only the seedbank and abiotic conditions, but also the biotic nutrient recycling components eg bacteria and fungi.

Recolonisation is thus more readily initiated and can be relatively rapid, especially in the earlier cells due to wind blow seed from adjoining undisturbed areas (as they have the highest perimeter of original vegetation). The regrowth is also diverse and representative of the original vegetation, as evidenced by the 5 year old regrowth in the following photograph.

Based on observations along McGuire's Crossing road and the subject land, it is also apparent that the current Blackbutt-dominated community can tolerate a depth to watertable that the finished landform will achieve. Hence the likely climax vegetation community is expected to be something at least very similar if not identical to that currently on the mid to lower slopes ie dry sclerophyll forest dominated by Blackbutt with Scribbly Gum. As demonstrated in the following photo in the existing quarry to the south, the regeneration includes 4-5m high Blackbutts as well as groundcover including *Baloskion tetraphyllum*.

Photo 17: 5 year old regrowth in current quarry

Hence the only long term modification will be the absence of tree hollows. These will develop >100yrs later when the trees mature, and hollow-formation forces such as fire and termites play their role (Gibbons and Lindenmayer 2002). Given 153 hollow-bearing trees will remain adjacent on the subject land, this is considered a minor ecological limitation. Trees tall enough for gliders to use will also be present within 10 years.

5.2. Indirect Impacts

The following indirect impacts are generally associated with residential to rural development. The following table evaluates the likelihood of occurrence and potential significance:

Table 12: Indirect impacts associated with the proposal

Threat	Literature Review	Assessment Of Proposal
Direct mortality via clearing and habitat destruction	Animals within hollows and fallen logs, as well as dense vegetation and leaf litter may be killed during clearing of these structures (RMS 2011). This risk increases during breeding seasons (generally spring to late autumn), and cooler season when mammals and reptiles enter torpor.	Fauna dependant on refugia such as tree hollows, leaf litter and friable soil will be vulnerable to direct mortality during clearing of the quarry area eg arboreal mammals, reptiles and frogs. About 99 hollow-bearing trees appear likely to be removed. While not all are likely to have habitable hollows (Gibbons and Lindenmayer 2002), and the survey results does not suggest a diversity and abundance of hollow-obligates; and that about 153 hollows will remain around the site, mortality is still a genuine risk. Fauna using leaf litter and decorticating bark, and burrowing in the soil are also very vulnerable to mortality during clearing. Presence of the Three-toed Snake-toothed Skink is a key issue which needs to be addressed. Clearing in winter and peak breeding seasons for most birds and bats (eg spring-summer) would also increase the risk of mortality Recommendations are made to minimise these risks.

Fragmentation and Landscape change	Fragmentation and the associated landscape changes at all scales is major factor in the decline of biodiversity, the modification of ecosystems, and alteration of ecosystem processes. Its effects vary with factors such as distance of fragments from similar habitat, their position in the landscape, the forms of habitat modification of isolates that occurs (e.g. due to edge effects), and types of surrounding land uses in the matrix, the ecology of the species affected, and how these factors influence the movement of organisms between the isolates and larger areas of habitat (Lindenmayer and Fisher 2006, OEH 2015b). Edge effects (eg microclimate change, weed invasion, nest predation, conspecific competition, etc) further add to the cumulative negative effect, resulting in impacts on biodiversity and even viability of local populations.	The proposal will incrementally and cumulatively increase fragmentation in the study area as it will eventually clear 6.4ha of dry sclerophyll forest. This will add to other clearing to the south for past sandmining which is only in the early stages of rehabilitation. The site will be rehabilitated, and especially if measures such as planting is undertaken and bushfire does not occur, will regenerate a dense shrub cover with scattered treesr within about a decade, and fully structured forest should eventually re-establish in several decades in a very similar form to the current stand. In the interim, the disturbed and early seral stages may pose a short term barrier to fauna such as gliders and less so small passerine birds that depend on some level of tree canopy connectivity, but within 5-10 years, trees tall enough to glide between will be established. The development of a shrub cover will also benefit most terrestrials, especially if mixed with a good cover of sedges and grasses. Species dependant on leaf litter may be disadvantaged for some time, but observations of formerly cleared land to the south noted extensive leaf litter blown in from adjacent vegetation. Spreading coarse woody debris over the rehabilitation areas will also offer good refugia, and dense groundcover should develop, especially if a complex micro-topography is created. Regardless, in the medium to long term after rehabilitation has been undertaken, the former quarry site will be heavily vegetated again, hence will not lead to long term fragmentation or isolation of habitat. In the interim, dry sclerophyll forest will remain all around the quarry's boundaries, providing linkage for all fauna and hence the proposal will not lead to isolation of any habitat.

Fencing	Fences have potential to obstruct the movement of threatened fauna across the site via acting as barriers eg sheet metal fencing. Some threatened fauna can be injured by collision with wire fences, particularly barbed wire eg the Yellow-Bellied Glider, owls and Squirrel Glider have been recorded being injured by barbed wire fences (Lindenmayer 2002, Berrigan 2001c, Woodford 1999).	No fencing is proposed or required hence no risk is posed.
Weed Invasion	Disturbance of soil provides the opportunity for weed invasion. Weeds may also be transported to the site from vehicle, people (e.g. on clothing), etc., who visit the development area, and via introduced fill material. New edges which have higher solar radiation inputs also provide new habitat and invasion points for weeds. Weed significance varies with the weed type eg a transformer weed can invade and modify native vegetation communities, while these and others can stall regeneration of disturbed sites. Other weeds will only persist in localised areas due to habitat constraints or ecological processes eg bushfire and drainage.	The proposal will see complete disturbance of the current soil profile and associated edaphic conditions. The regeneration areas will thus be vulnerable to weed invasion. The key transformer weed which poses a threat is Bitou Bush, which was noted in low frequency around the site. This noxious weed can readily be controlled via a weed management plan over the life of the quarry and associated post-quarrying maintenance period. More likely to occur are agricultural/environmental weeds due to their ability to readily colonise disturbed areas and efficient dispersal mechanisms. **Sporobolus* spp and Whiskey Grass (**Andropogon virginicus*) were noted to be common in disturbed former quarrying areas along the haulage road, as well as in the quarry footprint; and the batters and edges adjacent to the haulage road were completely dominated by weeds. This reservoir of weeds as well as movement of machinery in and out of the quarry area is likely to introduce a range of weeds. These will need to be controlled under the weed management plan to ensure the integrity of the rehabilitated areas is not compromised, and these weeds do not invade the adjacent National Park.

Vehicle Strike	Wildlife and particularly Koala road kills and injuries predominantly occur on high volume, high speed (60-100km/hr) streets and roads with poor visibility through sight interference (eg crests and corners) or poor visibility (eg inadequate street lighting) (Wilkes and Snowden 1998, Connell Wagner 2000, Port Stephens Council 2001, Lunney et al 1999, DECC 2008, AKF 2007). Furthermore, habitat adjacent to black spots (road sections characterised by high wildlife mortality) may also act as "sinks" to surrounding populations ie constant loss of recruits replacing previously killed individuals (Jones 2000, Gibbons and Lindenmayer 2006, Lindenmayer and Fisher 2006, AKF 2007, DECC 2008, Goldingay and Taylor 2005, Rhodes *et al* 2008).	No new road will be constructed – the existing haulage route will be extended to join the current access road. This road has a speed limit of 30km/hr. This is also limited by the condition of the route. Consequently, the risk of diurnal fauna being subject to vehicle strike is negligible. Similarly, as all activities associated with the quarry are restricted to daily only, nocturnal fauna (such as frogs which often disperse by night) are not at risk.
Noise, Vibration, and Anthropogenic Disturbances	Noise effects on fauna in Australia are relatively poorly studied (Clancy 2001, Berrigan 2001d). Most evidence presented is anecdotal, but suggests most fauna have at least a fair degree of tolerance and adaptation at least to residential noise depending on species, situation, habitat/lifecycle stage affected, habitat significance, etc. Vibration can be an issue for cave-roosting fauna, or potentially fauna in hollows. Vibration is usually associated with mining/quarrying (eg blasting), major earthworks and heavy vehicles.	The proposal will see a continuation of the current noise environment and associated anthropogenic disturbances eg periodic truck and car movements. This is generally intermittent eg a clearing event followed by a period of excavation, processing and loading. All noise and activity will also be diurnal, hence key nocturnal activities such as frog breeding and bird and mammal territorial and breeding behaviours will not be impacted. Given the current activity adjacent to the site and use of the haulage route since the late 1990s, avoidance or other altered behavioural patterns are considered likely to be established. Hence the proposal is not considered likely to see any major change.

	Some species also show a sensitivity to human presence eg nesting birds, waders, etc, and presence of pets (eg dog scats and scent marking). This can lead to avoidance of habitat interfaces, range contraction, etc. Other impacts can include increased mortality due to pest or threat perception ie risk of stock predation; collection for pets; or direct interference eg disturbing nests or roosts. This can manifest into minor short term impacts (eg temporary avoidance), to loss of key breeding animals, and the decline of diversity in spatially limited and poorly connected areas.	
Artificial Lighting	Lighting may potentially discourage particularly nocturnal native species from foraging near areas of development (ie Squirrel Gliders), especially given light may travel significant distances and it can have a similar effect to a full moon on the hunting success of predators such as owls, or a behavioural avoidance impact by potential prey species (DEC 2004a, Andrews 1990, Grayson and Calver 2004). Lighting has also been observed to delay emergence from hollows and alter Yangochiropteran bat assemblages in peri-urban habitats (Hourigan *et al* 2009). Conversely, wallabies, kangaroos, Tawny Frogmouth Owls, Kookaburras, Magpies and possums have been noted foraging under artificial lighting in residential areas eg around Lake Innes,	No artificial lighting is proposed at the quarry site, and all activities are diurnal.

	Port Macquarie and Kendall (personal observations). Artificial lighting may also be beneficial to Yangochiropteran bats by localised aggregation of insects, with these animals being observed foraging under streetlights, and even landing on lit footpaths in Horton St Port Macquarie to scamper for insects (personal observations). Squirrel Gliders have been recorded in caravan parks with all night street lighting and rural residential areas (Darkheart 2005a, 2005b 2005c, 2005d, 2005f, 2004a, 2004b), and both the Squirrel Glider and the Yellow-bellied Glider has been recorded in rural-residential to peri-urban remnants subject to light spillage (Darkheart 2011, 2010, 2008a, 2005e, 2005g2004a). These are likely to represent local adaptions via acclimatisation. Artificial lighting can also have the positive impact of increasing sight detection of fauna on roads, thus reducing risk of road kills eg Koalas (Wilkes and Snowden 1998, AKF 2007, Connell Wagner 2000, Port Stephens Council 2001, Lunney et al 1999, OEH 2015b).	
Erosion and Sedimentation	Sedimentation and erosion impacts can occur at both the construction and establishment phases. Erosion/sedimentation may occur via erosion of fill material and disturbed soils, scouring of exposed soil, earthen banks and habitats adjacent to the development area via directed flow (e.g. stormwater), or where runoff is concentrated.	This is minor if not negligible risk at the quarry site given the topography and even wind-blown sand is captured by adjacent forest. The haulage road is gravel and subject to erosion with periodic maintenance via overlay of gravel and re-grading. Some material would wash off into the batter and table drains, but overall, is not sufficient to lead to an environmental change in the terrestrial or aquatic ecosystems.

Introduction of feral/introduced species	Urban, industrial and rural developments are often associated with the introduction of non-native species i.e. rodents, cats and dogs accidentally and intentionally e.g. via creating habitat for such species (e.g. rats, Indian Myna) or as pets. Residential development is also associated with a higher density of pet cats and dogs, which has been demonstrated to contribute to biodiversity declines in peri-urban areas and urbanised remnants (White and Burgin 2004, Lunney *et al* 2007, AKF 2007, McAlpine *et al* 2006). Feral cats and foxes are significant predators of native species (NSWSC 2000a, Dickman 1996, May and Norton 1996, OEH 2015b), and domestic dogs are significant threats to species such as the Koala (Wilkes and Snowden 1998, Port Stephens Council 2001, Connell Wagner 2000b, AKF 2007, DECC 2008, OEH 2015b). The mere presence of these predators has also been shown to affect fauna behaviour e.g. avoidance and range contraction. Rodents compete with native species but also form a component of native predator diets eg forest owls, snakes and Quolls (OEH 2015b, Debus 1993).	No residences are proposed, hence cats and dogs will not pose a threat. The House Mouse was detected on site, and has been previously recorded to the south in the same habitat (Darkheart 1997). This species is likely to utilise the rehabilitation areas, where it form part of the prey base eg for snakes. It offers limited competition other than for the New Holland Mouse which was not recorded, has not been recorded in the locality, and appears only to have a low potential to occur. Feral dog/dingos were recorded, and foxes are likely to be present. The proposal is considered likely to advantage either species, although the fox's preference for more open habitats may be a benefit in the early stages of recovery. Minimising the number of tracks in the rehabilitation areas will also reduce the favourability of the habitat for the fox.

6.0 Recommendations and Mitigation Measures

6.1. Primary Recommendations

The following are recommended to be included as conditions of consent if the proposal is approved in order to mitigate the major potential ecological impacts of the proposal. The conclusions of this assessment assume these measures are implemented and effective in mitigating impacts.

6.1.1. Clearing to Minimum Required

The clearing limit at each stage of development is to be marked (eg with bunting tape) to clearly delineate the clearing area and retained vegetation. All trees/vegetation falling outside the required minimum clearing area are to remain undisturbed.

Clearing and earthworks is to avoid damage to root zones of the retained trees eg no parking of vehicles or storage of materials (including soils) under retained trees.

6.1.2. Pre-clearing Habitat Load Reduction

To minimise the risk of fauna mortality, particularly the Three-toed Snake-toothed Skink due to its crepuscular habitat, a two stage pre-clearing habitat load reduction strategy is to be implemented. The following should have high success given only 0.5ha is proposed to be cleared at any one time.

Prior to clearing, each cell is to be fenced off with barrier fencing (eg sediment fencing dug 30cm into the soil) to exclude immigration of small terrestrial fauna, and pitfalls along this fence set for 4 consecutive nights in combination with destructive habitat searches, are to be used to detect and evacuate all small terrestrial species (eg frogs and reptiles) into adjacent habitat. Clearing will also be timed to avoid the breeding period but also coincide with high activity. The priority target is the Three-toed Snake-toothed Skink.

After completion of this key activity, the understorey and all non-hollow bearing trees are to be removed. Given the limited extent of the cell, this should be undertaken in a one day hence negating the risk of re-entry of evacuated fauna.

Allowing a minimum of 1 night for arboreal fauna to evacuate, all hollow-bearing trees are to be subsequently felled as per the procedure below.

6.1.3. Hollow Bearing Tree Felling Protocol

The hollow bearing trees that may be removed could contain fauna at the time of clearing. Such fauna may be placed under stress, injured or killed during tree felling via:

- Being nocturnal or in torpor, and unable to escape prior to the tree falling.
- Collapse of the hollow when it impacts the ground.
- Collision with internal walls or via being thrown out when the tree falls.

- Being present as young eg eggs.

Any hollow bearing tree removal must be undertaken via a method that will minimise the risk of injury/mortality of potentially denning/roosting fauna within the limitations of Occupational Health and Safety (OH&S) Guidelines. Undertaken with due care, this practice can demonstrably avoid mortality of common and threatened species during felling of hollow-bearing trees, thereby substantially reducing the potential significance of development impacts. The following general guidelines are recommended:

1. Clearing should occur in two stages. Stage 1 should see removal of all non-habitat (hollow-bearing) trees and all lower stratums, with habitat trees left standing for at least 24hrs to allow voluntary evacuation of resident fauna. Stage 2 is the removal of the habitat trees. This strategy is widely employed by NSW RMS (2011), local government, and throughout Qld with high levels of success.
2. Hollow-bearing trees should be removed via a method that does not require traditional tree felling methods i.e. cut and drop with a chainsaw due to the violence of tree-ground impact and associated high risk of injury/mortality to fauna (e.g. via hollow collapse, collision with walls, etc). Options include:
    - The use of an excavator or similar machine with a pincer/harvester head attachment, which can hold the trunk while the tree base is sawn, and then the lowers the tree to the ground for inspection (preferred method).
    - Use of a crane to hold the tree while the base is sawn, and then lower the tree to the ground for inspection (preferred method).
    - Employment of an arborist to lop hollow-bearing limbs or tree sections, and lower to the ground with ropes and pulleys or crane, with the non-hollow bearing remainder of the tree later felled by traditional methods (preferred method).
    - If the above is not practical, an excavator can cut the roots and slowly push over the tree, counterbalancing the fall rate by pushing down on the root ball to minimise acceleration and final impact (least preferred method).
3. If a rip and push method is employed, the tree is to be bumped at least 3-5 times at approximately one-minute intervals to initiate evacuation of any residents. Caution will be required not to risk personal injury via falling branches.
4. An ecologist must be present during felling of the hollow bearing trees to monitor clearing, capture any resident animals injured or not evacuating, and undertake appropriate emergency actions if required e.g. transport animal to veterinary treatment (care at proponent's cost) or care by FAWNA (with a donation by proponent to cover costs). Hollows are to be immediately inspected once the tree is felled (within OH&S guidelines) for injured individuals or abandoned offspring, and appropriate measures undertaken. All rehabilitated animals are to be released in the retained habitat directly on/or adjacent to the site.
5. If hollows cannot be cleared of fauna, the fallen tree must either be allowed to sit overnight, or may be sectioned by chainsaw to clear hollows of fauna. It may then be destroyed/stacked for destruction.

A report detailing dates, personnel, qualifications, licenses and results is to be provided to Council within 14 days of the monitoring event.

6.1.4. Rehabilitation Strategy

A rehabilitation plan is to be prepared as a condition of consent (TCDS 2014). As noted in section 1.2, each former 0.5ha former quarry area is to be simultaneously rehabilitated with clearing of the next 0.5ha working area. This allows materials such as the topsoil which contains a seedbank and as well as biotic and abiotic components that have developed over millennia to be restored over the disturbed area.

Studies of sand mining and quarry regeneration (eg Gravina *et al* 2001, Van Gorp and Erskine 2011) have demonstrated that rehabilitation is more successful if:

- Topsoil to be stripped from the new stage after clearing is relocated over the last stage to maximise *in situ* seedbank and soil ecosystem (eg invertebrates and fungi) integrity, and expedite recovery. Topsoil and B horizons are to be stripped and stockpiled separately, and re-laid as per natural profile to maximise retention of edaphic and ecological conditions. Topsoil is not to be mixed with lower stratums.
- Organic matter from previous clearing in the form of coarse woody debris is to be spread over the rehabilitated area. This not only provides a potential seed source, but also enhances the re-establishment of the biotic nutrient cycling ecosystem, and helps reduce soil moisture and temperature fluctuations, as well as buffers against wind erosion and extreme exposure to solar radiation.

To enhance the success of rehabilitation, the following are thus recommended:

- The topsoil stripping is to avoid mixing of the lower stratums with the clearly organic enriched uppermost horizon with the lower stratum.
- Overburden should not be stockpiled for excessive periods if practical, but should be re-spread within a short interval after stripping over the rehabilitated areas to maximise maintenance of the soil biota.
- All leaf litter and coarse woody debris is to be stockpiled and then respread over the rehabilitation area.

6.1.5. Re-use of Hollow-bearing Trees

Hollow-bearing trees are to be stockpiled separately from other coarse woody debris during clearing. This is intended to reduce the potential for fauna to move into these trees and be at risk of mortality when the material is relocated. An example of effective re-use of a hollow log in the adjacent sand quarry is shown below.

All hollow-bearing trees are to be evenly respread over the rehabilitated area not clumped. This is to occur before any direct planting and immediately after the topsoil has been respread to minimise damage to regenerating plants.

Photo 18: Re-distributed hollow log and coarse woody debris

Clumping of coarse woody debris is to be avoided to minimise risk of bushfire destroying logs in a major bushfire event.

6.1.6. Targeted Replanting

To reduce the lag in recruitment, maximise habitat and vegetation heterogeneity, it is recommended that rehabilitation include targeted planting of the following key forage species, unless monitoring shows sufficient regeneration from the seed bank within the first 6 months of rehabilitation:

- *Banksia serrata.*
- Scribbly Gums.
- Pink Bloodwood
- Needlebark

Planting of these species is to enhance nectar and understorey to canopy development, to increase the ecological value of the regenerating area in the shortest interval.

6.1.7. Weed Control

The quarry and rehabilitation plan will contain a Weed Management Sub-plan (TPDS 2014).

The plan is to ensure:

- Key transformer weeds such as Bitou and other Noxious Weeds and Weeds of National Significance are effectively eliminated from the subject land over the quarry lifetime and post-quarry maintenance period.
- Agricultural/environmental weeds are effectively controlled especially at the loading/parking area and in the regenerating weeds via proactive control and intervention to prevent their establishment and spread.

6.1.8. Bushfire Management

Fire from adjacent areas (eg the National Park) will be difficult to control and prevented entry to the site due to connectivity with the site vegetation, and that such fires often develop into high intensity fires beyond the control of bushfire authorities.

Hence to minimise the risk of fire impacting the regeneration areas, no burning off is to be undertaken of any regeneration area. Any fires detected within the adjacent private land and National Park are to be immediately reported to the NPWS and Rural Fire Service to encourage their containment.

These measures will form part of the rehabilitation plan.

6.1.9. Green and Golden Bell Frog Management

Due to the presence of a State significant population of the Endangered Green and Golden Bell Frog in the SEPP 14 wetland (NSWSC 2002b, DECC 2005a, DECC 2008a, 2008d, DotE 2016b, NPWS 2003a, DEH 2006a, 2006b), the following measures are required.

6.1.9.1. Plant Hygiene

If earthmoving machinery has been recently used at a wet site (swamp, wetland, drains, dam, etc) prior to arriving at the site, this machinery must be decontaminated via washdown with a solution containing benzalkonium chloride, Chloramine, or Chlorhexidine as the active ingredient, as per the DECC (2008a) Hygiene Protocol, prior to commencing works or entering the property.

6.1.9.2. Wetland Entry

No one is to ever enter the wetland at any time, unless footwear has been subject to decontamination according to the DECC (2008a) Hygiene Protocol.

Former vehicle tracks around the edge of the wetland are to be closed and allowed to regenerate.

7.0 Offset Strategy

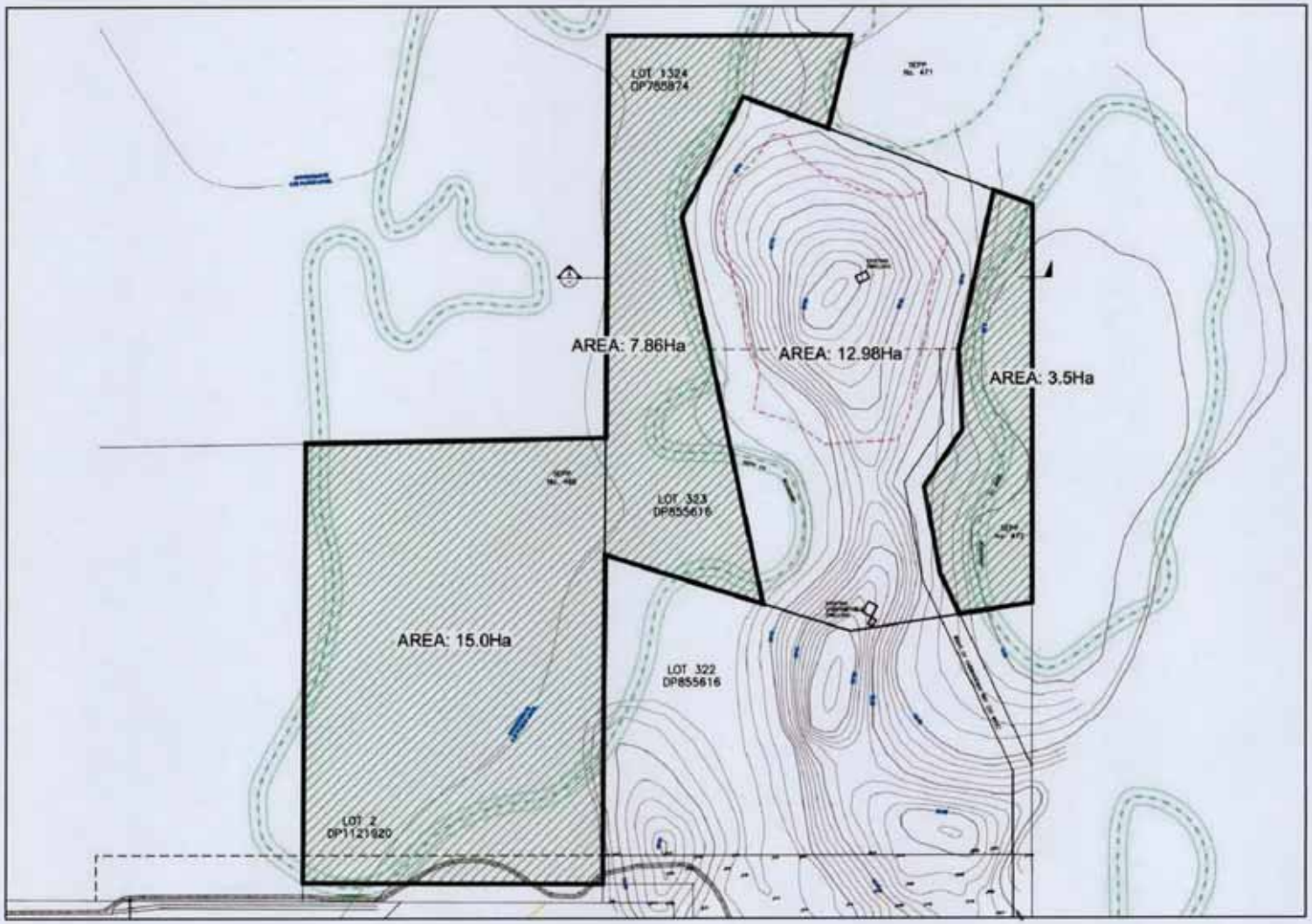
7.1. Preliminary Offset Strategy Proposal

The DGRs require consideration of a Biodiversity Offset Strategy (BOS). A formal offset strategy can be prepared and implemented as a condition of consent.

To offset the temporary loss of 6.4ha for the quarry, the proponent proposes to dedicate about 26.32ha (see Figure 18) of high value habitat comprising swamp forest, sedgeland, wet heath and swamp forest on the residual of the subject land as the offset, possibly as an extension to Hat Head National Park. This falls on the western side of Lot 1324 and 323, and Lot 2 DP 1121920 to the west. Most of this land is current zoned E2 and falls within a SEPP 14 wetland, but is not actively managed for conservation. Cattle are not currently physically prohibited from this area.

The proponent considers that no further offset is required given the rehabilitation strategy will see regeneration of native vegetation very similar if not identical to the current vegetation, with the clearing largely mimicking the disturbance and recovery after a high intensity bushfire; and that the majority of the 24.32ha property is not disturbed and will retain its ecological values and viable populations of threatened species.

Figure 18: Nominal offset area



7.2. OEH Biodiversity Offset Principles

To demonstrate the proposal can achieve an effective offset relative to the order of magnitude of the impacts associated with the proposal, the OEH Biodiversity Offset Principles are addressed as follows:

Table 13: OEH Biodiversity Offset Principles assessment

OEH Biodiversity Offset Principle:	Comment:
1. **Impacts must be avoided first by using prevention and mitigation measures.** Offsets are then used to address the remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.	As detailed in this report, the impacts associated with the proposal are considered unlikely to have a significant impact on any threatened fauna species, and no threatened flora or EECs are affected. The impacts are also considered temporary, with restoration of ecological values from the short to long term via effective rehabilitation and the demonstrated resilience of the *in situ* vegetation community to such disturbances. Measures to minimise the order of magnitude of the cumulative impact are provided in this and other reports (eg the rehabilitation plan).
2. All regulatory requirements must be met. Offsets cannot be used to satisfy approvals or assessments under other legislation, such as assessment requirements for Aboriginal heritage sites and for pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).	The offset is only intended to address the DGRs and does not duplicate the requirement of any other approvals, licenses or legislation. As the proposal is not considered to require a Species Impact Statement or approval from DotE, the offset is only proposed to meet the principles of Ecologically Sustainable Development.
3. Offsets must never reward ongoing poor performance. Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.	The proposed area of land where the offset will be located may have historically been exposed to grazing and period burning to promote green pick, but the current owners have maintained the area in a natural state eg no fencing. It is thus in very high condition requiring no additional maintenance.
4. Offsets will complement other government programs. A range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks, and incentives for private landholders.	Successful rehabilitation of the quarry area will restore its ecological value for all threatened species known or potentially occurring in the study area. This is line with Recovery Plans and Priority Action Strategies (OEH 20156) for these species. The offset area will also be protected by an effective mechanism to ensure it cannot be degraded eg dedication to the NPWS.

OEH Biodiversity Offset Principle:	Comment:
5. Offsets must be underpinned by sound ecological principles. They must: • include the conservation of structure, function and compositional elements of biodiversity, including threatened species • enhance biodiversity at a range of scales • consider the conservation status of ecological communities • ensure the long-term viability and functionality of biodiversity. Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.	The nominal offset area was proposed by the proponent on the following criteria: • Has high value for threatened species dependant on habitats which have endured a severe reduction ie coastal wetland and wet heath. • Maintain a buffer to the National Park. • Forms part of a north-south corridor of similar habitats. In addition, implementation of industry-leading rehabilitation practice of the quarry will re-establish ecological function, biodiversity and threatened species habitat in the short to long term, which will reduce and should eventually negate the negative impacts associated with the proposal. Hence the proponent considers that these total actions will more than adequately compensate for the impact of the proposal.

OEH Biodiversity Offset Principle:	Comment:
6. Offsets should aim to result in a net improvement in biodiversity over time. Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site. Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation. Offsets may include: • enhancing habitat • reconstructing habitat in strategic areas to link areas of conservation value • increasing buffer zones around areas of conservation value • removing threats by conservation agreements or reservation.	The proposed offset area can be dedicated to the National Parks and Wildlife Service via boundary adjustment to Hat Head National Park, and can be readily managed as part of dedicated reserve with minimal inputs. The latter is due to its very high condition (ie weed free and no fencing). Rehabilitation of the quarry site is intended to facilitate the restoration of a native vegetation community typical of the local edaphic conditions. This will be achieved by an adaptive rehabilitation plan monitored to achieve key performance indicators, with remediation actions if these are not met. As part of the rehabilitation management plan required to be implemented for the quarry site, the following will be addressed to ensure biodiversity outcomes are achieved: • Weed control. • Feral fauna control. • Bushfire management. • Assisted regeneration of disturbed areas.
7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs. As impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.	The offset will be secured via one of the following methods agreed to by OEH and the landowner: • Establishment of a BioBanking Agreement under the *Threatened Species Conservation Act 1995* • Dedication of land under the *National Parks and Wildlife Act 1974* (NPW Act) • A Conservation Agreement under the NPW Act • A Trust Agreement under the *Nature Conservation Trust Act 2001*; • A Planning Agreement under Section 93F of the *Environmental Planning and Assessment Act 1979*.

OEH Biodiversity Offset Principle:	Comment:
8. Offsets should be agreed prior to the impact occurring. Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval.	As detailed above, the proponent commits to preparing and implementing a formal biodiversity offset strategy as a condition of consent. The strategy will be submitted to OEH and KSC for approval, with quarry not to commence until the strategy is approved and the offset is secured. The management plan will also contain objectives and measurable milestones for implementation which KSC/OEH can monitor via reports to be submitted on a prescribed regime.
9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated. Offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset. The methodology should include: • the area of impact • the types of ecological communities and habitat or species affected • connectivity with other areas of habitat or corridors • the condition of habitat • the conservation status and/or scarcity or rarity of ecological communities • management actions • level of security afforded to the offset site. The best available information or data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets will be of greater value where: • they protect land with high conservation significance • management actions have greater benefits for biodiversity • the offset areas are not isolated or fragmented	The offset area is about 26.3ha, which is over four times the area of the quarry site. As the quarry site will be rehabilitated to support vegetation resembling that occurring on the subject land and should eventually re-develop its current ecological values, the proponent considers that no further offset is required. The rehabilitation management plan will also contain objectives and measurable milestones for implementation which KSC/OEH can monitor via reports to be submitted on a prescribed regime.

OEH Biodiversity Offset Principle:	Comment:
• the management for biodiversity is in perpetuity, such as secured through a conservation agreement. • Management actions must be deliverable and enforceable.	
10. Offsets must be targeted. They must offset impacts on the basis of like-for-like or better conservation outcomes. Offsets should be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal or greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.	The approximately 26.3ha of land comprising the proposed offset is not the same habitat as that impacted, but is of equal or higher value as it as least partially comprises EECs, whereas the impacted vegetation community is not threatened and occurs extensively in Hat Head National Park, whereas the EECs do not. As the quarry site will be rehabilitated to support vegetation resembling that occurring on the subject land and should eventually re-develop its current ecological values, the proponent considers that no targeted offset of the current vegetation community is required.
11. Offsets must be located appropriately. Wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.	As detailed above, the offset has been partly located on the same property, in the same local mosaic of sand dune/alluvial plains ecosystems. Some fauna which may use this habitat would use the quarry site eg for connectivity. As the quarry site will be rehabilitated to support vegetation resembling that occurring on the subject land and should eventually re-develop its current ecological values, the proponent considers that no targeted offset of the current vegetation community is required.
12. Offsets must be supplementary. They must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as national	The proposed offset area is partly located on the same property as the proposed development site. It is currently zoned E2, and mostly protected under SEPP 14; but no biodiversity enhancement measures funded by any source have been undertaken in this area in the past.

OEH Biodiversity Offset Principle:	Comment:
parks, flora reserves and public open space, cannot be used as offsets.	
13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or contracts. Offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.	The rehabilitation management plan will include a monitoring component over an agreed span of time to ensure the regeneration and threat control measures are implemented effectively. The plan will include measurable milestones by which compliance can be monitored via submission of monitoring reports to KSC/OEH. This will justify the proponent's view that a targeted offset for this vegetation community is not required.

8.0 Seven Parts Test Assessment

8.1. General Overview

The 7 Part Tests are used to determine whether a proposed development is likely to have a significant effect on threatened species, Endangered Ecological Communities, Endangered Populations and Critical Habitat listed under schedules of the *Threatened Species Conservation Act 1995* known or considered reasonably likely to occur in the area influenced by a development proposal. Considerations must be given to the possible significant impacts a proposed development may have on threatened species, populations, ecological communities, and their habitats (DECC 2007).

The content of the 7 Parts are specified by Section 5A of the *Environmental Planning and Assessment Act 1979*, as amended by the *Threatened Species Act 1995*, which in turn has been amended by the *Threatened Species Conservation Amendments Act 2002*.

8.1.1. Entities to be assessed

No threatened plants were found on site during this or previous surveys and none are considered potential occurrences on site, but there is low potential for a *Phaius* orchid to occur in the study area around the quarry. These species are thus subject to the assessment.

The following threatened fauna species were detected during the site and/or by FFS (2015) survey:

- Little Bent-wing Bat
- Yellow-bellied Sheathtail Bat
- Squirrel Glider
- Brushtailed Phascogale
- Three-toed Snake-toothed Skink

The above species are subject to 7 Part Test Assessment.

The following species (see Appendix 1) are also subject to the 7 Part Tests as they are considered to have at least a low potential to use some habitat in the study area at some time (e.g. now or if they were to potentially recover and expand):

- **Mammals:** Common Planigale, Eastern Chestnut Mouse, Spotted-tail Quoll, Eastern Pygmy Possum, Southern Myotis, Hoary Bat, Eastern Cave Bat, Eastern False Pipistrelle, East-coast Freetail Bat, Eastern Bent-wing Bat, Greater Broad-nosed Bat, Grey-headed Flying Fox, Eastern Blossom Bat.
- **Birds:** Powerful Owl, Masked Owl, Square-tailed Kite, Little Eagle, Varied Sittella, Black-necked Stork, Black Bittern, Osprey, Little Lorikeet.
- **Frogs:** Green and Golden Bell Frog, Wallum Froglet.

Brief ecological profiles are provided in Appendix 1 for these species. More complete profiles can be found online (DotE 2016b, OEH 2016b), and these and the references listed in this assessment were used in combination with personal knowledge when undertaking the impact assessment.

8.1.2. Local Population and Local Occurrence Definitions

The guidelines associated with the revised factors have provided definitions for key terms with the most significant being that of the "*local population*" and "*local occurrence*" as follows (DECC 2007):

"**Local population**: the population that occurs in the study area. The assessment of the local population may be extended to include individuals beyond the study area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the study area, according to the following definitions.

- The *local population* of a threatened *plant* species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area.
- The *local population* of *resident fauna* species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area.
- The *local population* of *migratory or nomadic fauna* species comprises those individuals that are likely to occur in the study area from time to time...."

The local population of the potentially occurring threatened species is thus defined as follows:

Table 14: Definition of local population

Species	Local Population
Phaius orchids	Any plants potentially occurring in the study area.
Masked Owl Powerful Owl	The local breeding pair for which the study area may constitute a minute portion of larger potential foraging territory which would extend mostly over suitable habitat in the adjacent National Park given known territory size of these birds. Local population thus requires much more habitat than found within study area to meet lifecycle requirements.
Square-tailed Kite Little Eagle	Any individuals potentially using habitat within the study area depending on prey abundance as part of larger range. Ecology of these species and limited extent of site determines that local population requires much more habitat than found within study area to meet lifecycle requirements.
Osprey	Given no habitat on the subject land or nest sites, low quality habitat in Reilly's Drain, and extensive high quality foraging habitat along Belmore River, local population clearly extends well off site and the study area.
Little Lorikeet	Due to nomadic nature of this species depending on flowering seasons and limited extent and seasonal variability of the nectar sources: the local population would be any individuals and small flocks seasonally using habitat within the study area depending on flowering incidences. Local population requires much more habitat than found within study area to meet lifecycle requirements.
Varied Sittella	The family group/s which may potentially use the site and adjoining habitat in the study area for foraging and breeding.
Black-necked Stork Black Bittern	Given ecology of the species, the local population would clearly need to utilise habitat far beyond the study area to meet all its lifecycle needs.
Grey-headed Flying Fox	Any individuals using habitat on site/in the study area depending on seasonal flowering incidences. Local population thus requires much more habitat than found within study area to meet lifecycle requirements.
Eastern Blossom Bat	Any individuals using habitat on site/in the study area depending on seasonal flowering incidences. Local population thus requires much more habitat than found within study area to meet lifecycle requirements.
Eastern Chestnut Mouse	As most likely to occur in the sedgeland in the study area of the quarry, and in the sedgeland north of part of the access road, there could be two separate local populations, but both would occur in interconnected habitat. Given limited extent of suitable habitat on fringe of study area forms edge of larger area of potential habitat, local population thus occurs on the fringe and adjacent to the fringe of the study area.

Species	Local Population
Common Planigale	The small home range of this species coupled with failure to detect it via pitfalls and Elliot trapping suggests if present, it is likely to occur outside the quarry site, and most likely in the swamp forest ecotone and sedgeland on the subject land; and in the sedgeland and coastal complex northeast of the haulage route. Similar to the Eastern Chestnut Mouse thus, there could be two local populations, but both are most likely to occur on the margins and adjacent to the study area.
Spotted-tail Quoll	Any individuals potentially using habitat within the study area depending on prey abundance as part of larger range. Ecology of these species and limited extent of site determines that local population requires much more habitat than found within study area to meet lifecycle requirements (most of which would be met in the adjacent National Park).
Brushtailed Phascogale	The local population of this species would be those animals in the study area of the quarry site as no potential habitat occurs along the haulage route to the west due to dominance by swamp forest. This local population would consist of the male captured twice on site, and any animals in adjacent habitat which would periodically utilise habitat in the study area.
Squirrel Glider	The local population would comprise the colony/ies for which the quarry site forms part of their home range, plus any other colony using habitat within the study area and adjacent habitats. Due to foraging limitations of the study site, it would not be sufficient to meet all their lifecycle needs - the study area and adjacent habitat would comprise part of these requirements.
Eastern Pygmy Possum	The local population would comprise the colony/ies for which the quarry site forms part of their home range, plus any other colony using habitat within the study area and adjacent habitats. Due to foraging limitations of the study site, it would not be sufficient to meet all their lifecycle needs - the study area and adjacent habitat would comprise part of these requirements.
Bent-Wing Bats, Hoary Bat, East-coast Freetail Bat, Greater Broad-nosed Bat, Yellow-bellied Sheathtail Bat, Southern Myotis, Eastern False Pipistrelle, Eastern Cave Bat	Any individuals/colonies which may use forest in the site/study area for foraging and roosting at some stage of their lifecycle which will see them ranging over a far wider range. Local population requires much more habitat than found within study area to meet lifecycle requirements.

Species	Local Population
Green and Golden Bell Frog	Portion of population previously recorded in the freshwater wetland to the east which occur in the study area of the quarry; and potentially a local population which occurs in the sedgeland and wet meadows around haulage road. Due to hydrological variations and lifecycle, as well as continuity with other habitat, the local population would extend beyond the study area to meet all its lifecycle requirements.
Wallum Froglet	Portion of population previously recorded in the freshwater wetland to the east which occur in the study area of the quarry; and potentially a local population which occurs in the sedgeland and wet meadows around haulage road. Due to hydrological variations and lifecycle, as well as continuity with other habitat, the local population would extend beyond the study area to meet all its lifecycle requirements.
Three-toed Snake Toothed Skink	The local population of this species would be largely limited to the dry sclerophyll forest and ecotones of the swamp forest where the groundcover and leaf litter were sufficient to provide refuge and foraging habitat for this species and its prey. The study area includes most of the likely range of the local population of this species (although other animals would occur in habitats adjacent to the study area), especially habitat to the north and east to southeast.

8.2. Seven Part Test Assessment

8.2.1. Seven Part Test Structure

To minimise repetition and superfluous information, the responses to the 7 Part Tests are structured as follows:

- In Part (a), species are grouped together based on broadly common ecology (i.e. mobile bird species such as the owls or species with similar habitats such as the Yangochiropteran bats) or similar impacts, and subject to a common 7 Part Test response to part (a).
- Parts (d) and (f) are collectively depending. Part (b) deals with Endangered Populations of which none are relevant to the proposed development. Part (c) applies specifically to EECs, which is not relevant to this study. Part (e) deals with Critical Habitat, which is not relevant to the subject proposed development.

8.2.2. Seven Part Test Responses

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

The impact of the proposal will vary in significance and context per species/species groups as follows:

***Phaius* orchids:**

Potential habitat for these species occurs on the edges of the wetland on the subject land and associated study area, and less so in the swamp forest adjacent to part of the haulage route. A limited search of the study area did not detect these species, and likelihood of occurrence is very limited given their rarity, targeting for collection, and previous land uses.

Regardless, the proposal has no potential to have a significant impact on these species as:

- No potential habitat will be removed.
- The watertable regime will not be altered.
- The bushfire regime will not be altered.
- No grazing stock will be introduced.

Osprey, Black Bittern and Black-necked Stork:

Potential habitat for the Stork occurs in the pasture and wet meadows adjacent to the haulage road, while Reilly's Drain and more so Belmore River offers foraging habitat for the Osprey. Potential habitat for the Black Bittern occurs mainly in Reilly's Drain, the wet meadows, eastern wetland and Belmore River. None of these species are known to nest locally.

Regardless, the proposal has no potential to have a significant impact on these species as:

- No potential habitat will be removed (nesting or foraging).
- The watertable regime will not be altered, hence no impact on prey habitat.
- No impact on Acid Sulfate Soils (ASS), and hence prey.
- No significant change to periodic movement of trucks and cars (anthropogenic disturbances.

Wallum Froglet:

This species is likely to occur in the sedgeland and wet meadows north and south of the central area of the existing haulage route. Potential habitat also occurs in the sedgelands to the east and west of the quarry. The species was however not recorded despite suitable breeding conditions during the survey.

Regardless, the proposal has no potential to have a significant impact on the species as:

- No potential habitat will be removed (refuge or foraging).
- The watertable regime will not be altered, hence no impact on breeding habitat.
- No impact on Acid Sulfate Soils.
- No change to the bushfire regime
- No new physical barriers to movement.

Green and Golden Bell Frog:

This species has been previously recorded in the sedgeland to the east (OEH 2016a). An important population exists in the dunal wetlands in Hat Head National Park to the east and south (OEH 2016b).

This species was not detected breeding during the survey, despite suitable conditions.

The proposal will have nil impact on the known or potential breeding habitat of this species as the quarry site is located on the dune; and the haulage route does not extend into any new wetland area.

In addition:

- The watertable regime will not be altered, hence no impact on breeding habitat.
- No impact on Acid Sulfate Soils.
- No change to the bushfire regime

The dry sclerophyll on the subject land including the quarry site has leaf litter and fallen logs which may offer potential for over-wintering refuge, or refuge for frogs dispersing east-west. Over-wintering habitat is likely to be on the mid to footslope in closer proximity to the wetland, hence the quarry footprint is unlikely to impact this habitat, and more than sufficient refugia will remain in the residual habitat on site and adjacent to the south, north and southeast.

The proposal will create a temporary barrier to movement east-west when the operational area is bare sand. This barrier however will be limited in effectiveness as:

- Only about 1ha at a time may be largely bare sand due to the progressive rehabilitation strategy. Vegetation is expected to develop rapidly, and respreading coarse woody debris will establish refugia. Hence any barrier posed by disturbed land will be short to at most medium term.
- Regardless of the above, the 6.4ha quarry will be surrounded by forest identical to that on site, with the same refugia, hence ensuring habitat is never isolated.

The risk of vehicle strike is considered negligible as all activity will be daily, and the species mostly moves at night to avoid predation. Similarly, predation success of native and exotic predators is not considered likely to increase given the site is already criss-crossed with numerous tracks and hence ambush points.

Considering the above, the proposal is thus incapable of placing a local viable population at risk of extinction.

Grey-headed Flying Fox and Eastern Blossom Bat:

These bats would only use the study area for foraging, with no potential for roosting.

For the Grey-headed Flying Fox, the quarry site only represents a minute fraction of the local extent and diversity of foraging resources. It does not contain species which support spring breeding of the species. Given this, and that these resources will regenerate within a decade to a point where they

may start to be used again; and in the medium to long term, regain most if not all of their current status: it is clear that the proposal does not have the capacity to have an impact of sufficient order of magnitude to place a local viable population at risk of extinction.

The Eastern Blossom Bat has a smaller range, but also moves depending on flowering incidence. The local complex mosaic of vegetation types which contains many potential nectar species (eg Swamp Bottlebrush, Needlebark Stringybark and Broad-leaved Paperbark) is ideal for this species. However, the lack of roosting habitat suggests the species may not regularly use the study area.

Regardless, in context of the local extent and diversity of foraging habitat; and that rehabilitation will restore a similar or potentially more diverse community; and that no roosting habitat is impacted nor new threat created (eg entanglement risk): it is clear that the proposal does not have the capacity to have an impact of sufficient order of magnitude to place a local viable population at risk of extinction.

Yangochiropteran Bats: Little Bent-wing Bat, Eastern Bent-wing Bat, East-coast Freetail Bat, Greater Broad-nosed Bat, Yellow-bellied Sheathtail Bat, Eastern False Pipistrelle, Eastern Cave Bat, Southern Myotis, Hoary Bat.

Survey of the site to date has confirmed the presence of the Little Bent-wing Bat and Yellow-bellied Sheathtail Bat. Several of the other species were considered 'possible' call detections due to call identification limitations (McConville 2016).

All of these species except the Eastern Cave Bat have potential to roost in tree hollows on the subject land. All but the Bent-wings and the Eastern Cave Bat also have potential to breed in tree hollows.

The nearest known caves suiting the Bent-wings and the Eastern Cave Bat for roosting are at Hungry Head (<7km) and Big Hill (>18km), which are likely to be too far away for regular visitation of the study area, with ample foraging habitat around these caves in Hat Head National Park and Limeburners Creek Nature Reserves. Hence the Eastern Cave Bat is not considered a significantly likely potential occurrence in the study area.

All of the subject species require seasonably variable ranges that far exceed the property/study area/property (Dwyer 1966, 1968, OEH 2016b, ABS 2016, Smith *et al* 1995, Churchill 2000, 2009, etc). Hence ecologically, while an individual/s may use the property/study area for foraging, etc, at some time, any known/potentially occurring local population of these species would have to extend well beyond the study area to meet their full lifecycle requirements (as detailed in Appendix 1).

As shown in Figure 14, there is an abundance of tree hollows on the subject land. With similar condition and floristics, as well as disturbance history (ie bushfire and no clearing for timber or agriculture), is it also reasonable to surmise that a similar abundance of this key habitat component occurs in the study area. Consequently, the probability of a critical breeding roost occurring on site is very low.

All of these species also range over extensive areas depending on life cycle, hence the quarry site only comprises a relatively small to minute part of their seasonal range.

The proposal will see loss of 6.4ha of potential foraging and roosting habitat for all but the Southern Myotis (potential roosting habitat only), and loss of only potential foraging habitat for the Eastern

Cave Bat. The foraging potential will eventually be restored in the short to long term provided rehabilitation is effective. Roosting habitat will however take >100 years to restore. While the latter is a negative impact, the abundance of hollows on the remainder of the property and in the study area clearly demonstrates this is not a key limitation.

The proposal will have nil impact on potential foraging habitat of the Southern Myotis as:

- No potential habitat will be removed (refuge or foraging).
- The watertable regime will not be altered, hence no impact on breeding habitat.
- No impact on Acid Sulfate Soils.
- No change to the bushfire regime

Considering the ecology of the species and the above, it is evident that that the proposal does not have the capacity to have an impact of sufficient order of magnitude to place a local viable population at risk of extinction.

Spotted-tail Quoll

This species was not recorded by the survey. Due to its large home ranges, this species is seldom detected by short term surveys (DEC 2004, Belcher 2000, Claridge *et al* 2005, Kortner *et al* 2004). Given local records (OEH 2016a), records in Limeburners Creek Nature Reserve in identical habitat (Bernard Whitehead Saltair Flora and Fauna pers. comm./ELA 2010), presence of prey species, habitat connectivity along the coast from Port Macquarie north to South West Rocks, and linkages to forest above the floodplain (eg west of Crescent Head): it is considered highly likely that a population of Quolls occur in the ribbon of habitat between Hat Head and Crescent Head, which incorporates the study area.

The study area offers potential prey species ranging from terrestrial mammals, frogs, reptiles and invertebrates, to a relative abundance of arboreal mammals, and birds. Potential den sites occur in a limited number of tree hollows in the dry sclerophyll. Due its limited extent, the development envelope/property/study area only has potential to form a minute to fraction of a single Quoll's potential territory (Belcher 2000, Claridge *et al* 2005, Kortner *et al* 2004, OEH 2016b, DotE 2016b). Hence ecologically, the local population of this species would extend well beyond the site/study area to meet their full lifecycle requirements (as detailed in Appendix 1).

The proposal will impact this species via loss of some potential den sites and prey habitat. While a negative impact, it is evident that that the proposal does not have the capacity to have an impact of sufficient order of magnitude to place a local viable population at risk of extinction due to the following:

- Ecology of the species qualifies the site as only potentially providing a minute fraction of its foraging requirements.
- Potential den sites are not restricted to the quarry footprint – hollows are abundant on the subject land and in the study area.

- The foraging value of the site will be largely restored via rehabilitation in the medium to long term.
- Re-use of fallen hollow logs will provide potential den sites from the very early stages of regeneration.
- Competitive feral species such as foxes will be controlled if required under the rehabilitation plan.

Varied Sittella

This small passerine bird was not detected on the subject land or study area, but has been recorded in the locality (OEH 2016a). This species may have territories (9-20ha) which the subject land/study area is sufficient in extent to support at least a single breeding pair (OEH 2016b, NSWSC 2010e, Noske 1998, 1985). Hence a local population could largely depend on habitat within the subject land/study area for its lifecycle processes. Continuity with adjoining and similar habitat north, east and south suggests ready genetic exchange with other populations, and hence viability.

As the species was not found and it is territorial, the subject land including the quarry site is not currently likely to be represent breeding habitat. The proposal will see removal of 6.4ha of potential habitat, comprising a relatively minute fraction of such habitat in the locality, most of which is protected in Hat Head National Park. This habitat will also be restored to much of its current value for this species in the medium term, and essentially to its current potential value to this bird in the long term. No new threat or barrier to movement will be created.

Given the above, it is clear that the proposal does not have the capacity to place a local viable population at risk of extinction.

Square-tailed Kite and Little Eagle:

These species were not recorded in the study area by the survey, but local records of the Square-Tailed Kite and coastal records of the Little Eagle (OEH 2016a) suggest they could potentially incorporate the study area as a minute part of a very large territory (OEH 2016b, Smith *et al* 1995, Debus and Czechura 1989, NSWSC 2010b, etc). Hence ecologically, while a local breeding pair may use the study area for foraging, etc, at some time, the local population (the breeding pair) of these species would extend well beyond the study area to meet their full lifecycle requirements (as detailed in Appendix 1).

No nests occur on site for these species hence known nesting habitat will not be impacted. The proposal will this predominantly impact these species via loss of prey habitat. This will be offset in the short to long term via the progressive rehabilitation of the former quarried areas. Over the short to medium term, this will create a series of seral stages of potential prey habitat, which may benefit these species via increasing the diversity and abundance of prey options. In the long term, the current foraging values of the quarry site are expected to be restored.

Given the above, it is clearly evident that the proposal does not have the capacity to place a local viable population at risk of extinction.

Little Lorikeet:

This small passerine bird was not detected, but has been recorded in the locality (OEH 2016a). This species may potentially occur in the general area during seasonal flowering periods, particularly of Blackbutt which is a preferred species (OEH 2010a). Broad-Leaved Paperbark and Swamp Mahogany are also significant as they may flower during seasonal shortages in nectar flows.

Nesting may also potentially occur in tree hollows, depending on local flowering incidences and extent of habitat in the adjacent National Park.

Due to its dependence on flowering incidence and the unreliability of flowering seasons (Law *et al* 2000), a local population would have to range far beyond the property to meets its lifecycle processes.

The proposal will impact this species via loss of about 6.4ha of potential summer-early autumn foraging habitat and a number of hollow-bearing trees which could be structurally suitable for nesting. While this is a negative impact recognised as a threatening process to the species (OEH 2010a), the loss of foraging habitat will be replaced in the medium to long term provided rehabilitation is effective. The loss of nesting habitat will be more long term, with replacement over >100 years as trees senesce and hollow formation processes occur (Gibbons and Lindenmayer 2002). While the latter is a more detrimental impact, the demonstrated abundance of hollow bearing trees on the subject land and likely in the study area evidence that potential nest sites are not likely to be a critical limitation on the species local occurrence and hence viability.

Considering the above, it is evident that the proposal does not have the capacity to place a local viable population at risk of extinction.

Brushtailed Phascogale and Squirrel Glider:

The Brushtailed Phascogale was recorded over the dry sclerophyll forest on site including in the quarry, with trapping suggesting only a resident male is present. In contrast, survey of a similar complex mosaic of habitat south of McGuires Rd recorded 5 captures of both sexes, including 2 females (one lactating) and sub-adults (Darkheart 2010). Both results suggest the subject land only supports a low density of the species, and it not natal habitat, or likely to be maternity habitat given females often establish within or adjacent to their natal range (OEH 2016b, Soderquist 1993a, 1993b, 1994, Trail and Coates 1993, Rhind 1998).

This and the ecology of the species evidences that the local population is not restricted to the quarry site, subject land or even the study area.

The Squirrel Glider was recorded only as two males and a female (in contrast to 25 captures in nearby habitat), despite a high intensity survey intended to estimate the population size. This indicates the subject land supports a low density of this species for this kind of habitat (Smith & Murray 2003). Given this result, habitat connectivity, distribution of preferred nectar sources, and varying flowering seasons of vegetation within the mosaic of dry sclerophyll and swamp forest habitats in the study area: it is clear that the subject land contains only part of the home range of the local population.

The proposal will see removal of known potential foraging habitat for these species, comprising about 40% of that available on site, but somewhat less than that occurring in the study area. In addition, about 99 hollow-bearing trees will be removed, comprising 39% of the resource on the subject land.

This loss will occur over about 17 years at a rate of about 0.5ha. This will thus disperse the impact over time, potentially allowing for home range adjustment. More importantly, the potential for the disturbed areas to be re-used as foraging habitat will be gradually restored in the short (for the Phascogale) to medium (for the Squirrel Glider) term via rehabilitation and regeneration of native vegetation typical of the locality. Hence the proposal will not lead to a permanent reduction of the current carrying capacity of the study area.

The recruitment of hollow-bearing trees will be a long term process, but should eventually eventuate as the disturbed areas are intended to be regenerated into a vegetation community typical of local floristics, structure and edaphic conditions. For the Phascogale, this will be mitigated to an extent by the re-distribution of hollow trees as logs in the rehabilitated areas, given this species has been recorded using logs. The fact that at least 153 hollow-bearing trees will remain on the subject land on all sides of the ultimate disturbed area, in addition to a similar abundance of hollows on adjoining land in the study area, also ensures that the den-swapping ecology of both species is likely to be met over the short to long term.

Dispersal and mating encounters will also not be significantly impacted given the fact the disturbed area will be encircled by suitable habitat over its lifetime and each cell will be progressively rehabilitated. Feral predators will also not benefit from the disturbance given control requirements.

Given the above, it is evident that while the proposal will have a negative impact, this is not permanent, and given the extent of adjacent supporting habitat, the proposal is not considered likely to have an impact of sufficient order of magnitude to place a local viable population at risk of extinction.

Eastern Pygmy Possum:

This animal was not detected by the survey, but is considered difficult to capture (Buckley 2003, Bowen and Goldingay 2000). The dry sclerophyll (especially on the lower slopes and footslopes where Banksia is locally dominant) and swamp forest vegetation (especially to the west and southwest on the margins of the wetland) is considered to offer the best potential habitat for this species due to a good abundance and distribution of hollows, and complex mosaic of forest types and floristic associations offering a source of nectar in both the understorey and canopy in a localised area (Buckley 2003, Bowen and Goldingay 2000, Law *et al* 2000, Evans and Bunce 2000, Laidlaw and Wilson 1995).

This habitat also occurs extensively to the north and east (generally within Hat Head National Park), southwest, southeast and less to the south (underscrubbed >10 years ago), suggesting the wider area is generally high quality potential habitat for this species. The complex mosaic of habitat types and ecology of this species (OEH 2016b, Buckley 2003, Bowen and Goldingay 2000, Evans and Bunce 2000, Laidlaw and Wilson 1995) suggests that a local population could fulfil much of its lifecycle requirements within the study area, with other animals whose home range would overlap with the study area and other adjacent interconnected habitat. Continuity with adjoining and at least

similar habitat north and south suggests ready genetic exchange with other populations, and hence long term viability.

The dominant current threat to this species is extensive intensive bushfire which sees total loss of all stratums. To survive such events, this species would need to be present in refugia eg edges of wetlands and other unburnt habitat.

The proposal will mimic this natural threat to which the species has adaptation mechanisms. The proposal will see removal over about 17 years of 6.4ha of potential foraging habitat for the species, comprising about 40% of that available on site, but substantially less than that occurring in the study area. In addition, about 99 hollow-bearing trees will be removed, comprising 39% of the resource on the subject land. Its key preferred food species, *Banksia serrata*, is also more common outside the quarry, hence only lesser quality potential habitat is impacted.

This loss will also occur over about 17 years at a rate of about 0.5ha per annum. This will thus disperse the impact over time, potentially allowing for home range adjustment. More importantly, the potential for the disturbed areas to be re-used as foraging habitat will be gradually restored in the medium term via rehabilitation and regeneration of native vegetation typical of the locality. Hence the proposal will not lead to a permanent reduction of the current carrying capacity of the study area.

The recruitment of hollow-bearing trees will be a long term process, but should eventually eventuate as the disturbed areas are intended to be regenerated into a vegetation community typical of local floristics, structure and edaphic conditions. This species has been recorded denning in fence posts to grass trees, hence there may be potential to den in re-distributed hollow trees as logs in the rehabilitated area. The fact that at least 153 hollow-bearing trees will remain on the subject land on all sides of the ultimate disturbed area, in addition to a similar abundance of hollows on adjoining land in the study area, also ensures that the den-swapping ecology of the species is likely to be met over the short to long term.

Conversely, the quarry footprint and also the regenerating areas will also provide a fuel-reduced short for some time, possibly providing an interim refuge and buffer to adjoining habitat from a severe fire event.

Dispersal and mating encounters will also not be significantly impacted given the fact the disturbed area will be encircled by suitable habitat over its lifetime and each cell will be progressively rehabilitated. Feral predators will also not benefit from the disturbance given control requirements.

Given the above, it is evident that while the proposal will have a negative impact, this is not permanent, and given the extent of adjacent supporting habitat, the proposal is not considered likely to have an impact of sufficient order of magnitude to place a local viable population at risk of extinction.

Three-toed Snake-toothed Skink:

This species was recorded by pitfall trapping within locally very dense undergrowth on the subject land. This is predominantly located on the mid to lower slopes. With the quarry site being partially

underscrubbed and highly fragmented with tracks, it is thus of relatively lower potential habitat value than the remaining habitat on the property and over a significant proportion of the study area.

As noted above, the records of this species on the subject land compliments an earlier record in identical interconnected habitat to the west. Not only are these records in completely different habitat to its northern range (DotE 2016b), but they also represent the southern limit of the species. Review of Figure 17 shows that there is a relative abundance of interconnected potential habitat for this species in the complex mosaic of interconnected vegetation types. The overwhelming majority of this habitat is protected in Hat Head National Park. This species is thus highly unlikely to be exclusively restricted to the study area.

The current key threat to this species' long term viability is intensive and extensive bushfire, which could lead to extinction over the landscape of this species. As shown in Figure 5, a large scale bushfire burnt most of the local area (including the subject land and adjacent wetlands) in 2003. The species has clearly persisted possibly via burrowing into the sandy soil or being present in unburnt refugia and dispersing after habitat has naturally regenerated.

However, this species is particularly vulnerable to bushfire as dense groundcover, logs, leaf litter and accumulations of decorticating bark would be completely removed in such events; and this habitat component used for refuge and foraging would take several years to re-generate. It thus must persist via utilising unburnt habitats (eg edges of the sedgelands and swamp forests, or interconnected dry sclerophyll forest until sufficient regeneration occurs. Its presence on the subject land indicates it has survived the extensive 2003 fire via such adaptive mechanisms/strategies.

Fire appears to have remained absent from the site since 2003, as indicated by the current high fuel load. Vegetation on Lot 322 to the south was underscrubbed >10 years ago, but now has a very well-developed groundcover and shrub layer, with an identical cover (compared to the subject land) of leaf litter and decorticating bark from *in situ* and adjacent sources. This indicates a timeframe for habitat (including prey) to recolonise disturbed areas.

The proposal will have an adverse impact on this cryptic fossorial species via removal of about 6.4ha of potential foraging and refuge habitat. Direct mortality during clearing is to be mitigated by a targeted survey and evacuation strategy.

This habitat loss will gradually occur over about 17 years. This dispersal of habitat loss over this time has the advantage of allowing time for home ranges to adjust, but also as each cell is progressively rehabilitated via re-spreading coarse woody debris and supporting re-vegetation by the original vegetation, this will support the early return of the species to the disturbed area. This process will thus be similar to the impact of an intensive bushfire in the study area, hence the proposal's impact and the associated response of the animal thus should mimic a natural disturbance to which this species has a demonstrated capacity to survive.

The quarry footprint and the regenerating areas will also provide a fuel-reduced short for some time, possibly providing an interim refuge and buffer to adjoining habitat from a severe fire event.

Feral predators will also not benefit from the disturbance given control requirements.

Given this; that the most optimal habitat will remain on the subject land ie the mid to footslopes where habitat complexity is greatest; and all current connectivity to other potential habitat in all directions will be retained: is it is considered that the viability of the population on the subject land, study area and in interconnected habitats where other animals are highly likely to occur, will not be undermined.

Given the above, it is evident that while the proposal will have a negative impact, this is not permanent, and given the extent of adjacent supporting habitat, the proposal is not considered likely to have an impact of sufficient order of magnitude to place a local viable population at risk of extinction.

Eastern Chestnut Mouse and Common Planigale:

These species were not detected by a thorough survey of the dune forest on the subject land via Elliot A traps, PIR cameras and pitfalls. Neither has been recorded in the locality, hence potential to occur is limited.

The best potential habitat for these species on the subject land is the sedgeland to the west, and the associated ecotone of swamp forest. This is due to the very dense and diverse groundcover which provides excellent refuge and well as foraging habitat (OEH 2016b, Smith *et al* 1995, Luo *et al* 1994, Luo and Fox 1995, Luo and Fox 1994, Fox 2000, Fox *et al* 2003, *Garrett v Freeman (No. 4) [2007] NSWLEC 389,* Darkheart 2004g, 2008d, Berrigan 2002c). Similar habitat occurs in sedgeland and coastal complex north of the mid-section of the haulage route, but most of the route passes by unsuitable habitat. The patchy and generally open cover of the mid to upper dune is less suitable for both species, especially the Eastern Chestnut Mouse due to very limited potential preferred forage species, lack of regular low intensity fire, and lack of groundcover density and continuity.

If present, habitat within the most suitable portions of the study area would be capable of supporting a number of individuals meeting all their lifecycle requirements *in situ* ie within the high quality sedgeland and swamp forest to the west; but the population would not be limited to the study area due to limited extent of captured habitat. Continuity with adjoining and at least similar habitat west, north, southeast and south suggests genetic exchange with other populations, and hence viability.

The proposal will see temporary loss of 6.4ha of potential foraging habitat for these species. This loss will occur at a rate of about 0.5ha p.a. over about 17 years, hence allowing for range adjustment. This timeframe is also advantageous for rehabilitation which is to be undertaken simultaneously, and may benefit the Eastern Chestnut Mouse due to its dependence on a disturbance regime which promotes fresh regrowth to the disadvantage of its conspecific, the Swamp Rat (which was recorded in low abundance). Effective rehabilitation including re-distribution of coarse woody debris and regeneration of vegetation characteristic of the local area which will provide potential refugia and foraging habitat is expected to restore the current habitat values of the site. The complex micro-topography of the new landform may also lead to a greater floristic and structural diversity which would also benefit these species.

Feral predators will also not benefit from the disturbance given control requirements.

Furthermore, as the disturbed area will progressively revegetated in the short term and natural habitat will remain encircling this area at all times, there is no barrier to potential dispersal.

Hence given the above, it can be concluded that the proposal is unlikely to have an impact of sufficient order of magnitude to place a local viable population at risk of extinction.

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

No Endangered Population occurs on site or in the study area, hence none are affected by the proposal.

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

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

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

EECs occur adjacent to the central section of the existing haulage road (see Figure 7). These comprise a complex of *Freshwater Wetlands on Coastal Floodplains*, *Swamp Oak Floodplain Forest on Coastal Floodplains* and *Swamp Sclerophyll Forest on Coastal Floodplains*.

No clearing is required of these EECs as the existing section of the haulage route is not to be altered. There is also no change to the current hydrological regime nor are ASS impacted. Hence the proposal will have no indirect impact.

Hence the proposal will have nil impacts on any EEC.

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

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

The proposal will see 6.4ha of dry sclerophyll forests removed over about 17 years at a rate of 0.5ha p.a. This comprises about 40% of this habitat type on the subject land. This will also see eventual removal of about 99 hollow bearing trees, with 153 remaining on the subject land.

The quarry's operational plan is to simultaneously rehabilitate the former operational cell when the next cell is opened. This not only reduces storage requirements for overburden, but also maintains the biotic values of the topsoil which is to be stripped first and stockpiled separately to avoid mixing with lower stratums. The overburden is to be replaced in the reverse order it was extracted to maintain abiotic conditions and ensure the seedbank and stored organic matter is replaced as the topsoil. Cleared coarse woody debris including all hollow-bearing trees is then respread over the rehabilitated cell to provide refugia and nutrient sources, and the area encouraged to rehabilitate with weed maintenance and infill planting as required. Given landform, edaphics and buffer to the

watertable, a community very similar if not identical to the previous and adjacent vegetation is expected to redevelop over the short to medium term (barring a major disturbance such as bushfire).

The rehabilitation strategy is intended to largely mimic a natural disturbance such as bushfire and initiate the associated adaptive mechanisms of native flora and fauna, hence the vegetation is expected to mature over a series of seral stages to the climax community, just as it would after a high intensity fire.

The marketable sand is to be carted out via trucks along a mostly existing haulage route. This will be extended onto the site via utilising an existing track and then an existing road, hence minimal if any further clearing will be required to establish this infrastructure.

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

The proposal will eventually see about 6.4ha of currently fragmented dry sclerophyll cleared, with a fraction of this area comprising operational land at any given time. This will happen over about 17 years, hence allowing for gradual adjustment to changes in vegetation connectivity.

At all times, this entire disturbed area will be surrounded by this same habitat type. Hence no area of habitat is at risk of being fragmented or isolated.

Furthermore, the rehabilitated areas are expected to become fully vegetation via natural regeneration and infill planting in the short term. Combined with refuge provided by respread coarse woody debris, the disturbed areas will soon become crossable by all but gliders. Direct connectivity for gliders will occur in the short to medium term as trees in the disturbed envelope mature to a sufficient height to attract gliders to cross over not around the envelope.

This disturbance is considered to mimic an intensive bushfire event, hence fauna are considered to have adaptive mechanisms to accommodate the temporary disturbance. The quarry footprint and also the regenerating areas will also provide a fuel-reduced short for some time, possibly providing an interim refuge and buffer to adjoining habitat from a severe fire event.

The haulage route will utilise an existing road and only during the day, hence will not create a new physical or behavioural barrier to any threatened species or the EECs which is bisects. This route will be extended onto the site, but generally follows an existing trail and needs little if any widening. Given the existence of the route over most of its length and existing fragmentation by trails on the subject land, this has no potential to create an impermeable barrier and hence isolate or fragment any habitat.

Given this, it is considered that the proposal will not lead to long term fragmentation or isolation of habitat.

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

As detailed in (a), for the following species, the quarry site only forms a minute to small part of the local population's life cycle requirements or does not form any part of their habitat; and hence is of no or low importance to the long term survival of these species in the locality:

- Square-tailed Kite and Little Eagle
- Osprey, Black Bittern and Black-necked Stork
- Yangochiropteran bats
- Spotted-tail Quoll.
- Wallum Froglet.
- *Phaius* orchids.

The site may or is known to form part of the home range or seasonal range of the following species, but due to the limitations and/or their ecology, is not critically important to their survival:

- Varied Sittella
- Little Lorikeet
- Eastern Chestnut Mouse
- Common Planigale
- Green and Golden Bell Frog.

As detailed in part (a), the site is known foraging and probably denning habitat for the Squirrel Glider and Brushtailed Phascogale. Both species however appear to occur in low density, suggesting carrying capacity limitations. The loss of habitat associated with the proposal; while an incremental and cumulative loss to the study area's carrying capacity and contributing to threatening processes responsible for the species' decline and negatively affected the site colony's current viability: is not considered likely to be sufficient to undermine the local population's ability to obtain sufficient food or denning requirements due to the extent of remaining habitat in the study area/locality (ie remaining habitat on the subject land alone includes 153 hollow-bearing trees). Furthermore, both species are expected to recolonise the 6.4ha disturbance envelope in due course. Hence the important of the quarry area is not sufficient to place the long term survival of the species in the locality at significant risk.

The subject land supports a population of Three-toed Snake-toothed Skink, but the quarry site appears to be relatively lower in quality due to the extensive fragmentation by trails, previous APZs, and patchier groundcover compared to adjacent areas where the species was detected. Given this limitation, that all known habitat is retained, connectivity will remain, and the habitat loss is temporary; and the extent of habitat interconnected to the site suitable for this species (and likely to be occupied), it is considered that the 6.4ha envelope is not critical to the survival of the species in the locality.

The proposal does not impact any EEC directly or indirectly, hence does not impact any important habitat.

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

No relevant areas of critical habitat have been declared, as yet, under Part 3 of the TSCA.

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

Draft/final recovery plans have only been prepared for the Forest Owls and Grey-headed Flying Fox (DEC 2006, DECCW 2009). Priority actions have been identified for all of the other species, and the EECs (OEH 2016b).

For the Forest Owls and Grey-headed Flying Fox, the proposal generally conflicts with their Recovery Plans objectives in terms of loss of habitat. However, this will be offset in the long term via rehabilitation back to forest characteristic of the area, and no breeding or otherwise significant habitat is impacted by the proposal.

The other species are now addressed under a Species Action Statement (SAS). The following table shows the management streams for the new Saving our Species threatened species conservation funding program and the subject species that fall into each category. As shown, the recovery actions identified have limited relevance to the proposal and generally relate to the actions of government authorities

Table 15: Management streams and recovery actions for the subject species

Management stream	Species	Actions
Site managed species	East-coast Freetail Bat	No relevant local conservation projects have been developed for this species to date.
	Eastern Chestnut Mouse	No relevant local conservation projects have been developed for this species to date
	Green and Golden Bell Frog	Site falls into the Crescent Head management area. The objectives of this site is to secure the species at the site and ensure the population's viability in the long term. Four actions have been proposed: 1. Investigate presence/susceptibility/effects of Chytridiomycosis. 2. Determine area of occupancy of the species. 3. Increase understanding of the species ecological requirements. 4. Track species abundance / condition over time.

Management stream	Species	Actions
		None of these actions apply to the proposal.
Landscape managed species	Spotted-tailed Quoll, Squirrel Glider, Brushtailed Phascogale, Grey-headed Flying Fox, Bent-wing bats, Greater Broad-nosed Bat, Yellow-bellied Sheathtail Bat, Eastern False Pipistrelle, Eastern Cave Bat Powerful Owl, Masked Owl, Square-tailed Kite, Little Eagle, Glossy Black Cockatoo, Little Lorikeet, Varied Sittella, Three-toed Snake-toothed Skink, Eastern Osprey, Eastern Pygmy Possum, Black Bittern	These species are generally managed by: 1. Broadscale vegetation and habitat management programs, e.g. replanting or weeding 2. Land clearing controls regulated through the *Native Vegetation Act 2003* and the *Environmental Planning and Assessment Act 1979* 3. Water sharing plans for riparian and floodplain ecosystems and species that depend on them 4. Programs to manage coasts, estuaries and coastal wetlands 5. The management of national parks and reserves under the *National Parks and Wildlife Act 1974.* Proposal has no long term conflict with these actions.
Partnership Managed Species These species: • have less than 10% of their distribution in NSW • are either common in other states or territories or	Common Planigale	OEH is currently developing a targeted approach for managing Partnership species. In the interim, the following management actions have been identified for this species. • DEC to provide information for education programs for Catchment Management Authorities, Local Councils and landholders to prioritise protection and restoration of its habitat. • Forest management activities that include logging, grazing, burning, and feral predator control needs to consider this species across all tenures.

Management stream	Species	Actions
programs for their management are coordinated by other jurisdictions.		• The modelling requires refinement to implement more recently derived predictor variables, including current vegetation mapping, and new records for the species. • Research into habitat use at all spatial scales (local, landscape, regional) should be encouraged. Investigations into dispersal capability, use of corridors, preferred habitats, fire ecology, and impacts of feral animal control measures. • Foxes, cats and cane toads should be controlled in known and potential Planigale habitats. • Protect and enhance ground cover and understorey structure, especially near water. Stock removal and fencing, protection and enhancement of understorey cover and feral predator control are measures that should be encouraged. • Fire planning within reserves should be undertaken so as to promote diverse understories and ground cover structure. • Investigations into dispersal capability, use of corridors, preferred habitats, fire ecology and impacts of feral animal control measures would be highly valuable to land managers. The proposal will disturb potential habitat, but this will be restored in the short to medium term. Hence the proposal does not significantly conflict with these actions.
	Black-necked Stork	No identified action but likely to be similar to Brolga as follows: OEH is currently developing a targeted approach for managing Partnership species. In the interim, the following management actions have been identified for this species. • Retain or reintroduce water flows to wetlands, soaks, swamps, etc. • Educate all rural landholders about the importance of Brolgas and encourage them to retain wetland areas on their properties for these magnificent birds.

Management stream	Species	Actions
		• Establish and implement a system of monitoring and reporting to identify whether Brolgas are being persecuted by landholders. • Conduct an annual, region- or state-wide, community/volunteer/landholder-based Brolga census. Advertise & educate prior to and send out census forms for landholders to complete & send back. • Identify at least 25 currently inhabited sites across the species range for management or recovery actions. • Establish a comprehensive monitoring program across the 25 sites in order to determine the success or otherwise of recovery actions and to guide future actions. • Encourage landowners to fence off stock from wetland areas (or parts of) in order to retain or restore some habitat for the Brolga. • Encourage landowners with suitable wetlands to enter into a VCA or other form of site protection for the Brolga. • Provide support, advice and assistance to bushcare groups for the restoration of wetlands (through brochures, field days, funds, resources, advice on locations or species for planting, weed removal, etc.). The proposal does not conflict with any of these actions.
	Phaius australis	OEH is currently developing a targeted approach for managing Partnership species. In the interim, the following management actions have been identified for this species. • Improve awareness of legislative requirements for picking and harming threatened species. Provide signage on site. • Identify location of populations. Minimise further loss of habitat by clearing and fragmentation associated with urban and rural development

Management stream	Species	Actions
		• Develop and implement strategies to reduce impacts of urban and rural runoff. • Implement appropriate fire management practices. • Identify locations of populations. Raise landholder awareness of compatible land management techniques. Implement feral pest control at priority sites. • Control priority weeds The proposal does not conflict with these actions.
Keep Watch Species	Wallum Froglet	No actions specified.

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

The TSCA 1995 defines a "*threatening process*" as "a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities". Loss and fragmentation of habitat due to urban, residential and rural development is a recognised threat to these species (Smith *et al* 1995, Lindenmayer and Fisher 2006, Johnson *et al* 2007, Smith *et al* 1995, Gibbons and Lindenmayer 2002, OEH 2016b, NPWS 1999b, Watson *et al* 2003, Gilmore and Parnaby 1994, NPWS 2003b, etc.). The proposal thus generically qualifies as a class of activity that is considered a threatening process. However, as the vegetation and associated habitats will eventually regenerate, the effect is not considered permanent.

For all of the subject species, the proposal will or may contribute (to varying extents) to the following Key Threatening Processes:

Table 16: Key threatening processes

KTP	Extent/Manner Which Proposal Affects KTP	Mitigable?
Clearing of native vegetation (NSWSC 2001c).	An estimated 6.4ha of open forest and woodland will be removed.	The 6.4ha envelope is to be regenerated to restore vegetation characteristic of the locality.
Loss of hollow-bearing trees (NSWSC 2007)	Likely loss of about 99 hollow-bearing trees	As above and hollow-bearing tree removal protocol recommended to reduce impacts on fauna during clearing. Fallen hollow-bearing trees to be re-used as hollow logs.
Human caused climate change (NSWSC 2000d).	As above and generation of greenhouse gasses by machinery during construction.	The 6.4ha envelope is to be regenerated to restore vegetation characteristic of the locality. No material to be burnt – all wood to be reused for rehabilitation.
Removal of dead wood, dead trees and logs (NSWSC 2004f).	Some logs and log piles will be removed.	Structurally sound hollow logs are to be relocated to the rehabilitation areas. All other coarse woody debris to be re-distributed over the rehabilitation area to provide nutrient inputs and refugia.

9.0 Matters of National Environmental Significance

9.1. General Assessment Overview

The provisions of the EPBCA 1999 require determination of whether the proposal has, will or is likely to have a significant impact on a "*matter of national environmental significance*". These matters are listed and addressed in summary as follows:

1. **World Heritage Properties**: The site is not listed as a World Heritage area nor does the proposal affect any such area.
2. **National Heritage Places**: The site is not listed as a National Heritage Place nor does the proposal affect any such area
3. **Ramsar Wetlands of International Significance**: A Ramsar wetland does not occur on the site, nor does the proposal affect a Ramsar Wetland.
4. **EPBCA listed Threatened Species and Communities:** The Grey-headed Flying Fox (Vulnerable) has been recorded on site and the Koala (Vulnerable) is considered a potential occurrence. As detailed in section 9.3, none are considered at risk of a significant impact.
5. **Migratory Species Protected under International Agreements**: No Migratory species is likely to be significantly affected by the proposal as assessed below.
6. **The Commonwealth Marine Environment (CME)**: The site is not within the CME nor does it affect such
7. **The Great Barrier Reef Marine Park:** The proposal does not affect the Great Barrier Reef Marine Park.
8. **Nuclear Actions**: The proposal is not a nuclear action.
9. **A water resource, in relation to coal seam gas development and large coal mining development**: The proposal is not a relevant mining development.

The proposal thus is not considered to require referral to Department of Environment (DotE) for approval under the EPBCA.

9.2. Koala Referral Assessment

The habitat on site has been assessed using the Koala habitat assessment tool from the EPBC Referral Guidelines (DotE 2014). To qualify as critical habitat, it must score 5 or more. This is shown in the following table:

Table 17: Koala habitat assessment

Attribute	Score	Reason	
Koala occurrence	0	Desktop	OEH Bionet has no records of Koalas within 2km of the site within the last 5 years. EPBC PMST report identified the Koala as 'known to occur' in the study area.
		On-ground	No evidence of Koalas found on site.
Vegetation structure and composition	1	Desktop	Quarry is mapped by KSC as Secondary Class A, however no species listed as browse species in the KSC CKPoM (Biolink 2011) occur here – they occur on the edge of the dune system. Hence this mapping is inaccurate.
		On-ground	On ground surveys found Swamp Mahogany and Scribbly Gum only in very localised occurrence and abundance in the study area of the haulage road and quarry site, not on the quarry site.
Habitat connectivity	2	Site is part of a contiguous landscape >500ha	
Key existing threats	1	Desktop	OEH Bionet has no records of Koala road kill in local area.
		On-ground	No risk of vehicle strike as all roads <30km/hr by conditions. No dogs on site – wild dogs/dingos present.
Recovery value	1	Site and study area not capable of supporting a population, and is not essential to maintain corridors due to Hat Head National Park. No long term barrier to movement created. However, forms part of a corridor linking Crescent Head Koala population to small, isolated population at South West Rocks. Potential thus for value in long term recovery.	
Total	**5**	Site just **qualifies** as critical habitat	

As per the Koala habitat assessment tool, the site just qualifies as critical habitat. An assessment has been undertaken to determine if the proposal will adversely affect this habitat and/or interfere substantially with the recovery of the Koala and require referral to the Minister.

The following table derived from the Koala Referral Guidelines (DotE 2014) assesses whether the proposal is likely to adversely affect habitat critical to the survival of the Koala.

Table 18: Critical habitat assessment

Factor	Y/N	Reason
Does impact area contain habitat critical to the survival of the Koala	N	These trees occur outside the quarry site. No Koala food trees to be removed. These are proposed to be planted in the rehabilitation area due to suitable edaphic conditions.
Do the areas proposed to be cleared contain known Koala food trees	N	No preferred or used Koala food trees in impact area.
Are you proposing to clear<2ha of habitat containing known Koala food trees in an area with a habitat score of ≤5	N	No preferred or used Koala food trees in impact area.
Are you proposing to clear >20ha of habitat containing known Koala food trees in an area with a habitat score of ≥8	N	Proposal will remove an estimated 6.ha of forest which does not contain Koala food trees.
Outcome	Impact is clearly insignificant. Referral not required.	

The assessment of significance for the Koala has determined that the proposal is unlikely to lead to a significant impact. Thus a referral to DotE is not required.

9.3. EPBCA Threatened Species

9.3.1. Protected Species Assessments

The following EPBCA threatened species require assessment:

- Spotted-tail Quoll (Endangered)
- *Phaius australis/tancarvilleae* (Endangered)
- Grey-headed Flying Fox (Vulnerable)
- Three-toed Snake-toothed Skink (Vulnerable)
- New Holland Mouse (Vulnerable)
- Green and Golden Bell Frog (Vulnerable)

9.3.1.1. Factors to be Considered for a Vulnerable or Endangered Species:

The guidelines to assessment of significance to this Matter, define an action as likely to have a significant impact on a Vulnerable/Endangered species, if it will:

- Lead to a long-term decrease in the size of an important population (Vulnerable) or population (Endangered) of a species, or:
- Reduce the area of occupancy of an important population (Vulnerable) or population (Endangered), or:

- Fragment an existing important population (Vulnerable) or population (Endangered) into two or more populations, or:
- Adversely affect habitat critical to the survival of a species, or:
- Disrupt the breeding cycle of an important population (Vulnerable) or population (Endangered), or:
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or:
- Result in invasive species, that are harmful (by competition, modification of habitat, or predation) to a Vulnerable or Endangered species, becoming established in the Vulnerable and/or Endangered species' habitat, or:
- Introduce a disease that may cause a species to decline, or:
- Interferes substantially with the recovery of the species.

An *important population* is one that is necessary for a species' long-term recovery. This includes such populations as:

- Key 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

9.3.1.2. Assessment of Significance

This section addresses each of the previous points listed.

For the purposes of discussion, the "*important population*" of the Vulnerable species is defined as follows:

- **Grey-Headed Flying Fox**: Given the ecology of this species (Eby 2000a, 2000b, 2002, DotE 2016b, OEH 2016b), for the purposes of discussion, the "*important population*" of Grey-Headed Flying Foxes is defined as that population of the species likely to depend on colonial roosts in the locality eg Crescent Head. Given this species ecology, it is evident than the important population is not restricted to the subject land or the study area.
- **New Holland Mouse**: This species has a small home range, but is most likely to occur in the less disturbed portions of the subject land ie the footslopes of the dune, swamp forest ecotone and adjacent sedgeland. If present, the study area has potential to support over a dozen individuals. This habitat interconnects to extensive potential habitat especially to the west, north northeast, south and southeast. This species was not detected by survey, and has not been detected in the locality to date (OEH 2016a, Campbell 1998). Hence an important population has not yet been identified, with the study area only providing potential habitat at this time for such an entity, hence the important population is not likely to be restricted to the subject land or the study area.

- **Three-Toed Snake-Toothed Skink**: This species was recorded in the lower part of the dune system on the subject land but not in the quarry footprint which is partially underscrubbed and highly dissected by tracks. This record is in the same dune system as a previous record <500m southwest, which established a southern extension of this species range into a different kind of habitat compared to its northern range. The local records are thus considered indicative of an important population due to representing the southernmost record which is disjunct from other records in northeast NSW (DotE 2016b, OEH 2016b). As shown in Figure 17, the site habitat is part of a large local extent of this habitat, hence the important population is not likely to be restricted to the subject land.
- **Green and Golden Bell Frog**: This species was been previously recorded in the wetland dominating the eastern side of the subject land. This wetland mostly falls into Hat Head National Park, and forms part of an extensive system of dune swamps which are known habitat of a key NSW population (DECC 2005a). As per the DEWHA (2009b) assessment guidelines for this species, the adjacent wetland is considered an important population.

a) Lead to a long-term decrease in the size of an important population (Vulnerable) or population (Endangered) of a species, or:

Grey-Headed Flying Fox

In the context of the species ecology, vulnerability to variations in flowering phenology and its seasonal requirements, the 6.4ha quarry envelope and even the subject land provides a relatively minor area of potential foraging habitat compared to the full lifecycle needs of this species (Eby 2000a, 2000b, 2002, DotE 2015c, OEH 2015b).

The quarry and study area are not known nor considered suitable as roosting habitat for the species, thus no such areas are affected by the proposal.

The proposed works will result in the loss of approximately 6.4ha of forest vegetation which offers potential forage when flowering for this species, hence the proposed development will reduce the study area's current foraging carrying capacity for the species.

Relative to the amount of habitat available on the remainder of the subject land, in the study area and more so the locality over which the important population would have to forage to meet its lifecycle requirements, this is considered a relatively minute area of potential habitat. Given this, that the remainder of the subject land/study area habitat will be retained, that rehabilitation will see at least a similar vegetation type (ie Blackbutt-dominated dry sclerophyll forest) return, and the ecology of the species; the short to at most medium term habitat reduction is not considered capable of directly resulting in an inevitable long term decline of an important population.

In addition, sufficiently abundant alternative known/potential habitat within its local range occurs extensively in the locality. Hence sufficient forage will remain within its local range to sustain the local population, and the proposal will thus not lead to a long-term decrease in the size of an important population.

Spotted-tail Quoll

The proposal may require the removal/modification of approximately 6.4ha of generic potential foraging and denning habitat, forming at most, a miniscule part of the wider foraging range of a local individual.

The loss of this habitat will impact on the occurrence/abundance of prey within the quarry footprint via loss of habitat for small terrestrial animals, arboreal mammals, and passerine birds, as well as incrementally increase anthropogenic impacts (e.g. human presence, etc) – though the latter will only be over the lifetime of the quarry. This habitat loss and impacts on prey habitat are not permanent. The final landform will be rehabilitated via respreading hollow-bearing trees to provide potential dens and other ecological values, and the original vegetation encouraged to revegetate. Within a decade, each cell is expected to be fully vegetated and hence offer potential habitat for the quoll. In the long term, hollows should also eventually be restored.

Hence given the ecology of the species; that the quarry footprint only potentially forms a small part of this species potential territory; that the vast majority of habitat on the subject land (including the majority of potential den sites) will be retained; that the habitat will be restored in the medium to long term at most; and that the Quoll has been recorded moving through more disturbed habitats: the negative impacts induced by the proposal are considered unlikely to significantly affect the viability of any population in the area.

Green and Golden Bell Frog:

This species has been previously recorded in the adjacent wetland to the east, which forms part of a larger series of wetlands in Hat Head National Park which supports a key NSW population (DEC 2005a). This population is currently threatened by the risk of intense and extensive fire (DEC 2005a, NPWS 2003a, DEWHA 2009b). Under the DEWHA (2009b) guidelines, this population is also a nationally important population.

The proposal has no direct impact on the breeding habitat of this species, but will remove/modify buffering and potential over-wintering habitat within 200m. This reaches the 2nd threshold of the significance assessment guidelines for this species (DEWHA 2009b).

While this threshold is met, the quarry footprint is centred on the top of the dune which is charactered by numerous tracks and APZs associated with a former dwelling, hence the more optimal potential wintering habitat is on the lower slopes which are not impacted.

The proposal will see fragmentation of forest which could offer a link between known habitat to the east and potential habitat to the west, hence Threshold 3 of the DEWHA guidelines may also be triggered. Notwithstanding this, the quarry envelope will remain surrounded on all sides by forest with a very dense undergrowth. This will retain more than sufficient potential linkages and over-wintering habitat. Compared to most of the quarry footprint, the lower slope and ecotones with the wetlands are also considered the better potential over-wintering habitat.

The quarry footprint is also to be progressively rehabilitated cell by cell over the quarry's lifetime, thereby ensuring that any potential fragmentation is only short term, and the re-spreading of coarse

woody debris will also provide potential refuge for dispersing or over-wintering frogs. The quarry footprint and also the regenerating areas will also provide a fuel-reduced short for some time, possibly providing an interim refuge and buffer to adjoining habitat from a severe fire event.

The proposal poses a very low risk of Chytrid, potentially via personnel entering the wetland or via contaminated machinery being brought to the site during the occupational phase. This can be mitigated by ensuring no entry to the wetland or the perimeter swamp forest by any vehicles or personnel; decontamination procedure; and the fact that all machinery will operate within the 'catchment' of the quarry area hence no runoff will leave the site and potentially enter the wetland.

No change to the current bushfire regime is proposed, and any wild fires will be reported on detection to the Rural Fire Service and NPWS.

Feral predators will also not be advantaged as the vegetation removal is only short term, and a pest control plan forms part of the rehabilitation plan.

Overall thus, the proposal is not likely to lead to a long term decrease in an important population.

Three-Toed Snake-Toothed Skink:

As noted above, the records of this species on the subject land compliments an earlier record in identical interconnected habitat to the west. This and the subject land habitat forms part of a complex mosaic of interconnected vegetation types which offer potential habitat for this cryptic animal.

The current main threat to this species is intensive and extensive bushfire. As shown in Figure 5, a large scale bushfire burnt most of the local area in 2003, and the species has persisted possibly via burrowing into the sandy soil or populations in unburnt refugia. This species is particularly vulnerable to bushfire as dense groundcover, leaf litter and accumulations of decorticating bark would be completely removed in such events; and this habitat component would take several years to re-generate. It thus must persist via utilising unburnt refuge habitats (eg edges of the sedgelands and swamp forests) until sufficient regeneration occurs.

The proposal will have an adverse impact on this cryptic fossorial species via removal of about 6.4ha of potential foraging and refuge habitat. Direct mortality during clearing is to be mitigated by a targeted survey and evacuation strategy.

This habitat loss will gradually occur over about 17 years. This dispersal of habitat loss over this time has the advantage of allowing time for home ranges to adjust, but also each cell is to be progressively rehabilitated via re-spreading coarse woody debris and supporting re-vegetation by the original vegetation. The impact and recovery will thus be similar to the impact on the species of an intensive bushfire, hence the proposal's impact, habitat recovery and the associated response of the animal thus should mimic a natural disturbance.

The quarry footprint and also the regenerating areas will also provide a fuel-reduced short for some time, possibly providing an interim refuge and buffer to adjoining habitat from a severe fire event.

Given this, and that the most optimal habitat will remain on the property ie the mid to footslopes where habitat complexity is greatest; and all current connectivity to other potential habitat in all

directions will be retained: the viability of the population on the subject land and in interconnected habitats where other animals are highly likely to occur, is unlikely to be undermined by the proposal.

Hence the proposal is unlikely to lead to the long term decline of an important population of this species.

New Holland Mouse:

This species has not been recorded in the locality, and has a very sparse NSW distribution, with the nearest record south of Taree in Kiwarrak State Forest and in the upper Macleay/Hastings in Werrikimbee and Oxley Wild Rivers National Parks (OEH 2016a).

The best potential habitat for this species in the study area is the heathland and swamp forest to the west of the quarry site on and adjacent to the subject land, as well as some denser parts of the dry sclerophyll on the lower slopes (Prosser *et al* 2007, Wilson and Laidlaw 2003, DSE 2003, Fox *et al* 1993, 2003, DSEWPC 2010c, 2010d). This species was not detected by the survey, but it difficult to detect with population size and density varying with disturbance (ie fire) history, and is easily confused with the House Mouse (DSE 2003, Fox *et al* 1993, DotE 2016c, 2016d).

The proposal will impact on this omnivore via removal of about 6.4ha of generally relatively lower quality potential foraging and refuge habitat from the study area, comprised of dry sclerophyll with a patchy groundcover and high level of dissection with tracks.

Given the extent of potential habitat remaining on the 24.32ha subject land and directly interconnected in all directions, this habitat loss is unlikely to be sufficient to place an important population at risk of long term decline.

This habitat loss will also be spread over a period of up to 17 years, with removed habitat replaced in the short to medium term via rehabilitation. As demonstrated on the nearby quarry site, the retention and re-spreading of topsoil readily promotes regeneration of the original dominant species as they are adapted to bushfire which has a similar effect, and eventually the original vegetation type or a complex of surrounding types will develop. The habitat loss thus is only temporary, similar to a major bushfire event, and well within the species' capability to tolerate. The seral progression may also benefit this species, given its preference for a periodic disturbance regime.

Given only about 1ha may be disturbed at any given time, and at all times this area will be surrounded by forest, the quarry will also not isolate any population. Feral predators will also be controlled as part of the rehabilitation plan, and no change to the current bushfire regime is proposed.

Overall, it is clearly evident that the proposal will not lead to a long term decline in an important population of the New Holland Mouse.

***Phaius* orchids:**

These species were not detected on site, but have been recorded in low paperbark swamp forest with a very high watertable in the locality. Similar habitat to the local known occurrence does not occur on the subject land or in the study area – only vegetation types which offer potential in general

terms ie wet heath and swamp forest on the margins of the wetlands to the east and west of the quarry sites, and swamp forests adjacent to the haulage route.

The proposal has nil impact on these species as:

- No known plants or potential habitat is to be removed.
- No change to the current watertable or hydrological regime.
- No change to the bushfire regime ie no increase in fire frequency.
- No introduction of grazing stock.

Hence the proposal has no potential to place a population of this species at risk of extinction.

b) Reduce the area of occupancy of an important population (Vulnerable) or population (Endangered), or:

The proposal has no impact on the area of occupancy of the *Phaius* orchids as no habitat is impacted.

The proposal will remove some potential over-wintering habitat and corridor vegetation for the Green and Golden Bell Frog. However this is only temporary, with respreading of coarse woody debris coupled with rehabilitation to re-establish a native vegetation community typical of the locality to be achieved. Hence the proposal will not lead to permanent reduction of the area of occupancy of an important population.

Similar applies to the Three-toed Snake-toothed Skink, Spotted-tail Quoll, New Holland Mouse and Grey-headed Flying Fox. While the proposal will see removal of 6.4ha of potential or known habitat for these species, the loss is only temporary, with rehabilitation intending to see restoration of a vegetation community with habitat components capable of providing forage and refuge within 10-20 years. In the long term, the disturbed area should regain all its current habitat potential. Hence the proposal will not lead to a permanent reduction of the area of occupancy.

c) Fragment an existing important population (Vulnerable) or population (Endangered) into two or more populations, or:

***Phaius* Orchids:**

These species have not been recorded in the study area, and only have at best a low potential to occur given its rarity and the area's previous human settlement, and the vulnerability of the orchids to collection.

Potential habitat on the subject land is currently separated by natural barriers, and the haulage road currently bisects potential habitat. Given there will be no significant change to these natural barriers and hence dispersal vectors, the proposal has no capability of fragmenting an existing population.

Grey-Headed Flying Fox:

Foraging habitat of this species is measured in terms of hundreds of thousands of hectares, hence it has exceptional mobility, moving widely longitudinally and latitudinally, across cleared rural and

urban landscapes. The small and short term fragmentation associated with the proposal has no capacity to affect its movements (OEH 2016b, DotE 2016b, Eby 2000a, 2000b, 2002).

Quoll:

For the Quoll, the loss (6.4ha) is also only a minute fraction of a potential territory of a single animal, let alone an entire population (Belcher 2000, 1994, NPWS 1999a, WWF 2002, OEH 2016b, Claridge *et al* 2005, Kortner *et al* 2004), and as noted above, the overwhelming majority of the individual and population's area of occupancy will remain as is.

The active working area and the regenerating habitat will remain encircled by forest at all times, hence the proposal has no potential to fragment or isolate any populations. Within a few years, the regenerating habitat in the former working area will also be usable for connectivity.

Green and Golden Bell Frog, New Holland Mouse and Three-Toed Snake Toothed Skink:

These species all have small home ranges, and make less significant movements across the landscape, although the Green and Golden Bell Frog has been recorded moving 5km (DEWHA 2009b).

The active working area and the regenerating habitat will remain encircled by forest at all times, hence the proposal has no potential fragment or isolate any populations. Within a few years, the regenerating habitat in the former working area will also be usable for connectivity by these species, especially due to the re-distribution of coarse woody debris to provide refugia. Hence while 6.4ha of habitat offering potential for linkage will be cleared over about 17 years, this is not permanent, hence no permanent barrier will remain.

In addition to the above, the haulage road is existing and does not pose any barrier.

d) Adversely affect habitat critical to the survival of a species, or:

According to the MNES guidelines, "*critical habitat*" refers to areas critical to the survival of a species or ecological community and may include areas that are necessary for/to:

- Activities such as foraging, breeding, roosting or dispersal.
- Succession.
- Maintain genetic diversity and long term evolutionary development, or
- Reintroduction of populations or recovery of the species/community.

***Phaius* Orchids:**

The proposal has no impact on potential or known habitat of these species, hence has no capability of impacting critical habitat.

Grey Headed Flying Fox:

The proposal will remove about 6.4ha of potential foraging habitat which forms a minute fraction of locally available habitat and required by the important population to meet lifecycle needs. It is not

roosting or maternity habitat. Given this, and that the habitat will be regenerated to a level where it can be begin to be used within about a decade, and to a significant degree within the medium term (eg 50 years) and much of its current capacity within the long term (>100 years), it is clear that the proposal will not have a significant effect on critical habitat.

Spotted-tail Quoll:

As for the Grey-headed Flying Fox, the quarry site only has generic value to form a small fraction of the population in the locality, given its ecology and limited extent of the site. Some potential den sites may be lost, but these will be restored as fallen logs. Prey habitat will also regenerate within the short to medium term, and in the long term, the current values should be largely if not all redeveloped if rehabilitation is successful. Given this, it is clear that the proposal will not have a significant effect on critical habitat.

Green and Golden Bell Frog:

A State significant and important population of this species occurs in the adjacent wetland which forms part of a complex of wetlands in the dune system which support this overall population.

The proposal does not directly impact breeding habitat, but will temporarily remove about 6.4ha of potential over-wintering and dispersal habitat. This loss will be offset in the short to medium term via rehabilitation which includes re-spreading coarse woody debris to provide shelter and prey habitat, and regeneration of the current vegetation community via utilising in situ soil seed banks supplemented by in-blown propagules and direct planting.

Other threats such as the risk of introducing Chytrid will also be mitigated.

Given this, it is clear that the proposal will not have a significant effect on critical habitat.

Three-Toed Snake-Toothed Skink and New Holland Mouse:

The proposal will also see loss of generally lesser quality habitat for these species, with known habitat of the Skink (predominantly on the lower slopes) not impacted. The gradual clearing of 6.4ha of this habitat over about 17 years is expected to mimic a bushfire disturbance, with the adjacent undisturbed refuge/critical habitat retained, and the species recolonising the rehabilitated areas over time.

Given this, it is clear that the proposal will not have a significant effect on critical habitat.

e) Disrupt the breeding cycle of an important population, or:

***Phaius* Orchids:**

The proposal has no capability to impact the breeding cycle as:

- No loss of potential habitat.
- No barrier to dispersal vectors.
- No introduction of any grazing stock.

Grey-headed Flying Fox:

The quarry site is not a roost, nor does it contains species likely to reliably flower during the maternity season. Given this, and that the habitat will eventually be restored and hence carrying capacity reinstated for recruitment, the proposal has no capacity to disrupt the breeding cycle of an important population.

Spotted-tail Quoll:

While the proposal will see gradual removal of potential den sites which may be used for breeding, hollows are clearly locally abundant, hence this critical habitat component is not a limiting factor. These will also be replaced by use of fallen hollow-bearing trees as habitat logs in the rehabilitated area. The impact on prey abundance and diversity is also inconsequential given the relatively minute area affected relative to the range of the species and extent of available high quality habitat in the locality. Furthermore, this loss of foraging habitat is only short term, with much and eventually all of its current potential to be restored via rehabilitation.

Given this, the proposal has no capacity to disrupt the breeding cycle of a population.

Green and Golden Bell Frog:

The proposal has no capability to impact the breeding cycle of this species as:

- No removal or indirect impacts on breeding habitat.
- No noise during calling sessions which could impact breeding success.
- No change to the bushfire regime and hence alteration of cover and hence refugia for tadpoles from predators eg Plague Minnow.
- No risk of pollution.

New Holland Mouse:

This species prefers a disturbance regime which creates a complex mosaic of seral stages. In such habitats, populations peak. The subject land was last burnt in 2003, and is currently in high fuel load state, and hence exposed to another high intensity fire. This may promote a short term 'boom' cycle for this species, if it occurs locally.

The proposal will in essence mimic a bushfire disturbance, via removing the current vegetation incrementally over about 17 years. This will thus create a series of seral stages which may offer potential for breeding. Regardless if it does not, the higher quality adjacent habitat will retain this potential, and the fact that forest will encircle the site at all times, and that rehabilitation will be progressive, no barrier to dispersal or mating encounters is likely.

Given this, and that the habitat will eventually be restored, the proposal has no capacity to disrupt the breeding cycle of an important population.

Three-toed Snake-toothed Skink:

The quarry could potential remove some breeding habitat of this species, but this could be mitigated by avoiding clearing in the likely breeding season. The risk is also very small given only about 0.5ha may be cleared per year. Similar to a major bushfire event which would have much the same impacts, this loss is also not permanent, with rehabilitation aiming to restore a vegetation community close to if not identical to the current, and re-spreading of coarse woody debris will both provide refuge, breeding habitat and prey habitat.

The proposal will also not pose a key barrier to dispersal at any time given the retention of the best quality habitat around the site in all directions, and the progressive rehabilitation strategy.

Given the above, the proposal is considered unlikely to disrupt the breeding cycle of an important population, and place it at risk of long term decline.

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

The proposal has no impact on the habitat of *Phaius* orchids.

As detailed previously, while the proposal will eventually clear 6.4ha of habitat over about 17 years, this will be replaced in the short to long term via rehabilitation to restore a community characteristic of the locality, with similar or potentially more optimal habitat values (eg due to seral stages and more complex micro-topography). Hence no fauna species will see a permanent loss of habitat.

During this time, connectivity will also be retained by both the remaining encircling vegetation, and via the progressive regrowth of native vegetation in the rehabilitation zones. Hence no area of habitat will be isolated.

In addition to the above, there is more than sufficient habitat for the important population and populations to remain adjacent to the quarry footprint

Hence there will be no long term decrease in availability or quality of habitat, and no species is likely to decline as a result of loss of habitat.

g) Result in invasive species, that are harmful (by competition, modification of habitat, or predation) to an Endangered species, becoming established in the Vulnerable and/or Endangered species' habitat, or:

No new invasive species that affects any of the subject species is likely to be introduced as a result of the proposed quarry.

The House Mouse is known to be present and could be a competitor with the New Holland Mouse. As this species is already part of the current ecology, its eradication is not a viable option.

Foxes may also be present, and while this species prefers disturbed areas, the progressive rehabilitation coupled with controls on this feral predator should ensure this species does not establish a population capable of leading to long term declines.

h) Introduce disease that may cause a species to decline, or:

Chytrid is the key disease which poses a major threat to the Green and Golden Bell Frog

This risk can be mitigated by measures included into the quarry's environmental management plan such as:

- Decontamination of imported machinery.
- All activities confined to the quarry area, hence no risk of runoff entering the wetland
- No entry by personnel to the wetland.

i) Interferes substantially with the recovery of the species.

Ideally, the goal in threatened species recovery is to increase the abundance and range of the threatened species, so that it is not in risk of becoming extinct. One major means of achieving this is to avoid habitat loss which is the principal cause of threatened species decline (Eby and Lunney 2002, Eby 2000a, 2000b, Richards 2000, Smith 2002, DECC 2007a, OEH 2016b, DotE 2016b).

The proposal has no impact on the *Phaius* orchids, hence poses no impact on their recovery.

The proposal has only very limited impact on the Green and Golden Bell Frog in terms of the short term loss of connective vegetation and over-wintering refugia. This will be restored, with the medium term seeing these values largely restored. Hence the proposal is unlikely to interfere substantially with the recovery of the species.

Due to the ecology of Spotted-tail Quoll and Grey-headed Flying Fox (especially the very large areas of habitat required throughout their lifecycle), the habitat loss is inconsequential. This loss will also be offset in the short to long term due to the rehabilitation strategy.

The New Holland Mouse and the Three-toed Snake-toothed Skink are more detrimentally impacted, especially the Skink given it has been confirmed to occur on the subject land, due to their smaller home range requirements and limited mobility. However, with measures to mitigate the risk of mortality during clearing; that the disturbance will largely mimic a natural disturbance to which they have evolved adaptive mechanisms to; and that the habitat will be restored for at least connectivity and refuge in the short term and foraging in the medium term: the proposal is not considered to substantially interfere with the recovery of these species in the long term.

9.3.2. Conclusion

The proposal is not considered likely to have a significant impact on any Vulnerable or Endangered species.

9.4. Migratory Species

No migratory species were observed in the study area during the survey. The study area however offers potential habitat for a number of species such as the Great Egret, Cattle Egret, Fork-tailed Swift and Rainbow Bee-eater. These species are collectively assessed below.

9.4.1. Factors To Be Considered

The guidelines to assessment of significance to this Matter, define an action as likely to have a significant impact on a migratory species, if it will:

a) Substantially modify (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or;

b) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species, or;

c) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

An important area of habitat is:

1. Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or:
2. Habitat utilised by a migratory species which is at the limit of the species range, or;
3. Habitat within an area where the species is declining.

9.4.2. Assessment of Significance

This section addresses each of the previous points listed.

The site is not considered likely to constitute an important area of habitat on the basis of the following:

1. The quarry site and study area is not of sufficient extent to support an ecologically significant proportion of any of the above listed species (at most, only a small group or transient individuals). This value of the habitat is as a fraction of a significant extent of similar habitat not only in the LGA, but the North Coast Bioregion.
2. While some migratory species occurring in the locality may be at the limits of their range, no such species were recorded in the survey area.
3. If the site/study area was located at the limits of a species whose abundance and range is declining, it would not be considered significant as such habitat is locally abundant in the area, and habitat with greater capability occurs within 10km e.g. National Park, State Forest, etc.

In regards to point (**a**): The proposal does not affect important habitat (as detailed above). Occurrence of the subject species on site/study area is considered most likely to be as a short term seasonal forager with the site/study area constituting a small part of their large seasonal nomadic range. The value of habitat on the site/study area is as a minor fraction of the significant area of potential habitat in the LGA and the North Coast Bioregion.

In regards to point (**b**): An invasive species is one that may become established in the habitat, and harm the migratory species by direct competition, modification of habitat, or predation. The proposal will not introduce any such invasive species.

In regards to point (**c**): No disruption of the lifecycle of any migratory bird is likely as:

- Habitat affected is locally abundant eg. pasture and dry sclerophyll forest, and no permanent loss of habitat will occur.
- No significant nesting/breeding habitat is affected.
- No significant extent of foraging habitat will be affected.

In view of the above, no migratory bird is considered likely to be significantly affected by the proposal.

10.0 Conclusion

The proposal will see removal of 6.4ha of dry sclerophyll forest over 17 years, comprising about 40% of this habitat on the subject land, and a somewhat lesser fraction of this habitat on adjacent land to the north, south and southeast.

The rehabilitation strategy aims to utilise the resilience of the affected vegetation community to re-establish it in the short term via simultaneously rehabilitating each exhausted cell after clearing of the next operational cell over the quarry's lifetime. The current vegetation has a demonstrated capacity to recolonise after such disturbance (similar to how it does after major bushfire), hence a similar if not identical vegetation community is expected to establish in due course. Hollow-bearing trees will be the slowest habitat attribute to return, however all fallen hollow-bearing trees along with all other coarse woody debris will be used in the rehabilitation to provide habitat and other ecological values. The habitat loss is thus not permanent and eventually the disturbed area is expected to redevelop its values to the affected threatened species.

A number of mitigation measures are provided to support rehabilitation and also minimise the risk of mortality during clearing.

Assessment under the EPBC Act guidelines for the Koala determined that the site contained critical habitat, but the impact was not significant, hence the proposal does not need referral. The impact was also considered insignificant for the other fauna and flora species.

Assessment under the 7 Part Tests determined that the loss of 6.4ha of habitat would impact the following species:

- *Foraging habitat*: Square-tailed Kite, Little Eagle, Powerful Owl, Masked Owl, Varied Sittella, Little Lorikeet, Spotted-tail Quoll, Common Planigale, Eastern Pygmy Possum, Grey-headed Flying Fox, Eastern Blossom Bat, Greater Broad-nosed Bat, East-coast Freetail Bat, Yellow-bellied Sheathtail Bat, Eastern False Pipistrelle, Eastern Cave Bat, Hoary Bat, Little and Eastern Bent-wing Bats and Three-toed Snake-toothed Skink.
- *Roosting/denning/nesting/refugia*: Powerful Owl, Masked Owl, Varied Sittella, Little Lorikeet, Spotted-tail Quoll, Common Planigale, Eastern Pygmy Possum, Greater Broad-nosed Bat,

East-coast Freetail Bat, Yellow-bellied Sheathtail Bat, Hoary Bat, Eastern False Pipistrelle, Little and Eastern Bent-wing Bats and Three-toed Snake-toothed Skink, Southern Myotis, Green and Golden Bell Frog.

These impacts were however deemed insignificant in the long term to the survival of the local populations given:

- For many, the quarry site (or even the subject land or study area) is not sufficient in extent to meet the life cycle requirements of the local population.
- The quarry site is not breeding habitat eg for the Green and Golden Bell Frog, Wallum Froglet, Square-tailed Kite and waterfowl.
- While hollow-bearing trees will be removed, these are demonstrated to be abundant on the subject land, with similar abundance on adjacent land, indicating this habitat component is not a critical constraint in the study area.
- The habitat loss will be spread over about 17 years, allowing not only for adjustment of home ranges but also for rehabilitated habitat to regenerate and be utilised for foraging, connectivity and refuge.
- The resilience of the affected vegetation and rehabilitation strategy will ensure the habitat loss is not permanent.
- Connectivity will remain around the disturbed area in perpetuity.
- The haulage route has minimal if any direct or indirect impacts.

Similarly, impact on the EECs is negligible given:

- No habitat to be disturbed.
- No risk of pollution.
- No impacts on Acid Sulfate Soils.
- No change to the hydrological regime.

Hence a Species Impact Statement is not considered required.

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12.0 Appendix 1: TSC Act – Seven Part Test Eligibility

A1.0 Potential Occurrence Assessment

The following tables are used as a summary to address threatened species (as detailed below) in terms of potential occurrence, and likelihood of being significantly affected by the proposal, and hence requiring formal 7 Part Test assessments. Threatened species have been assessed if it is:

a) Recorded on-site;

b) Not recorded on site, but recorded within a 10km radius (the locality), and may occur to some degree on-site or in the study area (land within 100m of site) due to potential habitat, key habitat component, etc.;

c) Not recorded in the locality as yet, but recorded in the bioregion, and thus may occur in the locality, and possibly to some extent, may occur on the site, due to potential habitat.

The "*habitat requirements*" column is derived from the previously listed references. Likelihood of occurrence is based on the probability of occurrence in terms of:

- Habitat extent (e.g. sufficient to support an individual or the local population; comprises all of home range; forms part of larger territory, etc.); quality (i.e. condition, including an assessment of threats, historical land uses on and off-site, and future pressures); interconnectivity to other habitat; and ability to provide all the species life-cycle requirements (either the site alone, or other habitat within its range);
- Occurrence frequency (i.e. on-site resident; portion of larger territory; seasonal migrant or transitory opportunist and thus when and how often, etc.)
- Usage ie breeding or non-breeding; opportunistic foraging (e.g. seasonal, migratory or opportunistic); marginal fringe of core range; refuge; roosts; etc.

An indicative 1-5 scale used by the author to indicate the likelihood of the species to potentially occur in the habitat on the study sites (if they have not been recorded in the locality) is as follows:

- 0: *Unlikely* (<1% probability) - no potentially suitable habitat; too disturbed; or habitat is very poor. No or few records in region or records/site very isolated eg by pastoral land, urbanisation, etc.
- 1: *Low* (1-10%)- few minor areas of potential habitat; highly modified site/habitat; or few habitat parameters present, but others absent or relatively insignificant (sub-optimum habitat). Usually very few records in locality.
- 2: *Fair* (11-25%) - some significant areas of potential habitat, but some habitat parameters limited. Potential for occasional foraging eg from nearby more optimal areas or known habitat. Records at least within 10-15km radius of site.

- 3: *Good* (26-50%) - significant abundance of habitat parameters/areas of habitat, and more locally e.g. adjacent. Potential part of larger territory, but probably unable to support breeding in isolation. Recorded within 10km in similar habitat/environs.
- 4: *Moderate* (51-75%) - quite good potentially suitable habitat on and adjacent to the site, and/or good quality and abundance of some vital habitat parameters. Records within <10km, or adjacent to site, or adjacent to high quality habitat where species likely to occur.
- 5: *High* (>75%) - very good to optimum habitat occurring on or adjacent to the site (support breeding pair or population). Recorded within 5-10km of site in same or similar habitat.

The "*Assessment of Significance*" column is based on consideration of the habitat on-site, likelihood of occurrence, and consideration of the DECC guidelines for assessment under the 7 Part Tests (DECC 2007). Recognising that some species with very large ranges or varying tolerances to habitat modification, some species which may have low potential to occur in the study area and will obviously not be significantly affected by the proposal will not be formally assessed to avoid production of superfluous information. Rather these species are assessed in the final column with justification for this assessment. However, recognising that significance is open to interpretation, the decision on whether a species is formally assessed or not by the 7 Part Tests in this assessment is based on the following rules:

a) If there is *any* justifiable risk, based on consideration, of a significant impact as a result of direct or indirect impacts, a 7 Part Test is required (ie the Principle of Uncertainty is applied).

b) Any threatened species recorded on-site or in the study area, or of at least fair chance of occurrence on-site in terms of potential habitat, is **automatically** selected for the 7 part Tests, unless the proposal has no effect (justification provided).

A1.1 Flora

Searches of relevant literature and databases (OEH/Bionet 2016a) found records of 3 threatened flora species in the locality. These species and species found in similar habitat to that in the study area are assessed for their potential to occur in the following table:

Table 19: Eligibility for Seven Part Test Assessment - Flora

Species	Status	Habitat Requirement	No. of records	Likelihood of Occurrence and Impact Significance	7 Part Test Required?
Scented Acronychia (Acronychia littoralis)	E-TSCA, E-EPBCA	A small understorey tree to 6m in height found in littoral rainforest on sand, generally within 2km of the coast. This species occurs coastally from Fraser Island to Port Macquarie.	0	Site/study area does not contain suitable habitat for this species. No significant impact is therefore likely.	NO
Diuris sp. aff. chrysantha	V-TSCA	A terrestrial orchid which grows from a tuber, and has no parts visible above ground during Summer and Autumn. In late Winter, a single stem and two grass-like leaves emerge. Found grassland and low heathland on stony clay, clay loam, sandy-clay loams. Previously only known from a single population of 100 plants at Byron Bay in low grassy heath on clay. Distributed from Crowdy Head to Yamba.	1	Site/study area does not contain suitable habitat for this species. No significant impact is therefore likely.	NO
Sand Spurge (Chamaesyce psammogeton)	E-TSCA	A herb that grows on fore dunes and exposed sites on headlands. Recorded on Bare Point, Kempsey, Hastings, Nambucca, Coffs Harbour, Port Stephens and Bulahdelah LGA databases.	0	Site/study area does not contain suitable habitat for this species. No significant impact is therefore likely.	NO

Species	Status	Habitat Requirement	No. of records	Likelihood of Occurrence and Impact Significance	7 Part Test Required?
Maundia triglochinoides	V-TSCA	An aquatic herbaceous plant found in swamps or shallow fresh water on heavy clay on the north and central NSW coast. Recorded on Hastings and Kempsey databases	0	Generic potential habitat along Reilly's Drain and in table drains and sedgelands, but not observed. No records on Belmore River floodplain to date. Appears unlikely to occur.	NO
Phaius tancarvilleae and P. australis	V-TSCA V-EPBCA	Large terrestrial orchids that generally grow in Melaleuca quinquenervia swamps on the coast or at sea level, as well as littoral rainforest, dunes (including stabilised dunes), riparian forests (including gallery rainforests), swamp forests, swamps (including marshes and intermittent wetlands), mainly at low altitudes. Sandy alluvium is the favoured geology and sandy, damp to humic soils are favoured. Flowers September-October. Recently combined into one species.	1	Swamp forest on east of eastern wetland offers best potential habitat but not found on subject land by survey. Generic potential in other sedgeland and swamp forest habitats but at best low given only 1 local record and extreme rarity.	YES
Austral Toadflax (*Thesium australe*)	V-TSCA	A parasitic herb commonly associated with Kangaroo Grass, and has been recorded on coastal headlands at Coffs Harbour, Hat Head, Crescent Head, Diamond Head and Perpendicular Point in Kangaroo Grass areas.	1	No suitable habitat on site or study area and not found during survey. Unlikely to occur.	NO

A number of other species (see table below) are known or considered potential occurrences within the locality. However due to a number of factors, these species were not considered potential occurrences on site. Thus the proposal is not considered to have a significant impact on the viability of any local population of the subject species and Seven Part Test evaluation was not required.

Table 20: Threatened flora unlikely to occur

Preferred Habitat	Species	Site considered unsuitable habitat	Disturbance history likely to have excluded this species	Lack of local records
Dry Sclerophyll Open Forest Woodland	Acacia ruppii	X		X
	Ancistrachne maidenii	X		X
	Angophora inopina	X		X
	Angophora robur	X		X
	Babingtonia prominens	X		X
	Banksia conferta subsp. Conferta	X		X
	Bertya sp.(Chambigne NR, M Fatemi 24)	X		X
	Bertya ingramii	X		X
	Bertya sp. Cobar-Coolabah	X		X
	Boronia hapalophylla	X		X
	Caesia parviflora var. minor	X	X	X
	Chiloglottis anaticeps	X		X
	Cynanchum elegans	X		X
	Diuris venosa	X	X	X

Preferred Habitat	Species	Site considered unsuitable habitat	Disturbance history likely to have excluded this species	Lack of local records
	Diuris disposita	X		X
	Diuris pedunculate	X	X	X
	Diuris praecox	X	X	X
	Dillwynia tenuiflora		X	X
	Eucalyptus tetrapleura	X	X	X
	Grevillea banyabba	X		X
	Grevillea beadleana	X		X
	Grevillea caleyi	X	X	X
	Grevillea quadricuada	X		X
	Hakea archaeoides	X		X
	Hakea trineura	X		X
	Hibbertia superans	X		X
	Leucopogon confertus	X		X
	Lindsaea incisa	X		X
	Macrozamia johnsonii	X		X

Preferred Habitat	Species	Site considered unsuitable habitat	Disturbance history likely to have excluded this species	Lack of local records
	Melichrus hirsutus	X		X
Rainforest Wet Sclerophyll Forest Riparian	Olax angulata	X		X
	Philotheca obovatifolia	X		X
	Polygala linariifolia	X		X
	Corybas dowlingii	X		X
	Dracophyllum macranthum	X		X
	Acacia chrysotricha	X	X	X
	Acalypha eremorum	X	X	X
	Arthraxon hispidus	X		X
	Arthropteris palisotii	X		X
	Boronia umbellata	X		X
	Calophanoides hygrophiloides	X		X
	Corynocarpus rupestris subsp. Rupestris	X		X
	Dendrocnide moroides	X		X
	Desmodium acanthocladum	X		X

Preferred Habitat	Species	Site considered unsuitable habitat	Disturbance history likely to have excluded this species	Lack of local records
	Diospyros mabacea	X		X
	Diploglottis cambelli	X		X
	Eidothea hardeniana	X		X
	Endiandra floydii	X		X
	Endiandra hayesii	X		X
	Eucalyptus tetrapleura	X	X	X
	Gingidia montana	X		X
	Grammitis stenophylla	X		X
	Grevillea guthrieana	X	X	X
	Haloragis exalata subsp. velutina.	X		X
	Harnieria hygrophiloides	X		X
	Lindsaea brachypoda	X		X
	Macadamia tetraphylla	X		X
	Olearia flocktoniae	X	X	X
	Peristeranthus hillii	X	X	X

Preferred Habitat	Species	Site considered unsuitable habitat	Disturbance history likely to have excluded this species	Lack of local records
	Phyllanthus microcladus	X		X
	Plectranthus nitidus	X		X
	Pomaderris queenslandica	X		X
	Psilotum complanatum	X		X
	Quassia sp. Moonee Creek	X		X
	Sarcochilus dilatatus	X		X
	Sarcochilus fitzgeraldii	X		X
	Sarcochilus hartmannii	X		X
	Siah's Backbone (Streblus pendulinus/brunonianus)	X	X	X
	Syzygium paniculatum	X		X
	Tinospora smilacina	X		X
	Tinospora tinosporoides	X		X
	Triplarina imbricata (formerly Baeckea camphorata)	X	X	X
Swamp Forest Aquatic Freshwater	Oberonia titania	X		X
	Typhonium sp. aff. brownii	X		X

Preferred Habitat	Species	Site considered unsuitable habitat	Disturbance history likely to have excluded this species	Lack of local records
Wetland Estuarine	Uromyrtus australis	X		X
	Cyperus aquatilis	X		X
	Eleocharis tetraquetra	X		X
	Phaius tancarvilleae		X	X
	Phaius australis		X	X
	Melaleuca biconvexa			X
	Melaleuca tamariscina ssp irbyana	X		X
Heathland Shrubland Grasslands	Allocasuarina defungens	X		X
	Allocasuarina simulans	X		X
	Sophora tomentosa subsp. australis	X		X
	Babingtonia silvestris	X		X
	Centranthera cochinchinensis	X		X
	Chamaesyce psammogeton	X		X
	Diuris sp. aff. chrysantha	X		X
	Lindernia alsinoides			X

Preferred Habitat	Species	Site considered unsuitable habitat	Disturbance history likely to have excluded this species	Lack of local records
	Rotala tripartita	X		X
	Elyonurus citreus	X		X
	Eucalyptus approximans	X		X
	Glycine clandestina (Broad leaf form)	X		X
	Pimelea spicata	X	X	X
	Rutidosis heterogama	X		X
	Zieria prostrata	X		X
Various Habitats, Miscellaneous, Other.	Pultenaea maritima	X		X
	Cryptostylis hunteriana (Leafless Tongue Orchid)		X	X
	Galium australe (Tangled Bedstraw)	X	X	X
	Zieria prostrata	X		X
	Hibbertia hexandra	X	X	X
	Neoastelia spectabilis	X		X
	Zieria lasiocaulis	X		X

Preferred Habitat	Species	Site considered unsuitable habitat	Disturbance history likely to have excluded this species	Lack of local records
	Kennedia retrorsa	X		X
	Tetratheca juncea	X	X	X
	Prostanthera spnosa	X		X
	Senecio spathulatus	X		X
	Styphelia perileuca	X		X

A1.2 Fauna

As previously noted in section 4, a significant number of threatened fauna have been recorded in the locality, and a number of others are considered potential occurrences by the consultant. In the table below, these species are evaluated for their potential to occur on the site; significance of the proposal to this potential occurrence; and thus their eligibility/requirement for Seven Part Test assessment.

Table 21: Eligibility for Seven Part Test Assessment – Fauna

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
BIRDS	Glossy Black Cockatoo (*Calyptorhynchus lathamii*)	6	V-TSCA	Dry sclerophyll forest and woodland containing Allocasuarina and Casuarina, and large tree hollows. Preferred regional forage species are *A. littoralis* and *A. torulosa*. Requires sufficient extent of forage within home range to support breeding. Breeds Mar-Aug, takes 90 days to hatch and fledge (Lindsey 1992).	No potential food species. Some potential nest trees in broad terms but very high risk of Brushtail Possum predation. Remote from potential foraging habitat – unlikely to be used for breeding. Unlikely to occur. No foraging habitat or likely nest trees to be removed. No risk of impact and unlikely to unlikely to occur. Seven Part Test not required.
	Black Bittern (Dupetor flavicollis)	0	V-TSCA	Coastal waterways, estuaries, swamps with densely wooded edges, Swamp Oak, Mangroves. Secretive, partly nocturnal. Roosts in trees overhanging water or in dense reeds. Critical breeding habitat is mangrove belts (Lindsey 1992). Breeds Dec-Mar, nests in trees over water. (NSW NPWS 2000, DEC 2005a)	Potential foraging habitat along Reilly's Drain and Belmore River. Generic potential roosting habitat in swamp forest adjacent to haulage route. Lesser quality potential habitat in eastern freshwater wetland and sedgeland to west of subject land. Low chance to occur in study area of quarry, but fair chance along Reilly's Drain or Belmore River. Proposal has no impact on foraging or roosting habitat of this species – and given existing traffic, not likely to be impacted by truck movements. No risk of significant impact, however as fair potential to occur, **7 Part Tests required,**

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
	Australasian Bittern (Botaurus poiciloptilus	2	V-TSCA E-EPBCA	Wetlands, preferably with dense sedges, rushes, reeds. Prefers freshwater, but also uses densely vegetated saltmarsh and flooded grasslands. Roosts on the ground, forages in shallow water from a platform of trampled vegetation, nests above water on similar platform. Single or groups to 12. Usually sedentary, but nomadic in response to flood, drought.	Wet meadows adjacent to haulage road and less so the sedgeland may offer potential habitat. Freshwater wetland to east also may offer potential but may be too heavily vegetated. Better habitat in locality in dune swale wetlands. Only very low to unlikely to occur in study area as transient forager. Proposal has no impact on foraging or roosting habitat of this species – and given existing traffic, not likely to be impacted by truck movements. No risk of significant impact, hence 7 Part Tests not required.
	Comb Crested Jacana (Irediparra gallinacean)	0	V-TSCA	Inhabit permanent freshwater wetlands, either still or slow-flowing, with a good surface cover of floating vegetation, especially water-lilies, or fringing and aquatic vegetation. Forage on floating vegetation, walking with a characteristic bob and flick. They feed primarily on insects and other invertebrates, as well as some seeds and other vegetation.	Marginal potential habitat in Reilly's Drain which has some water lily cover. Other wetlands too sedge-dominated for this species. Unlikely to occur. No potential habitat impacted and unlikely to occur, hence no risk of impact. Seven Part Test not required.
	Black-Necked Stork/Jabiru (*Ephippiorhynchus asiaticus*)	15	E-TSCA	Wetlands, mudflats, mangroves, floodplains, irrigated fields, farm dams. Forages in shallow water for small vertebrates. Shuns cover, prefers extensive open shallows. Nests in a tree, often above water in a	Wet meadows and periodically flooded pasture along haulage route offers very good potential habitat. Sedgeland and freshwater wetland considered too dense

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
				secluded swamp. Eggs laid Aug-Nov in NSW. Adults resident, juveniles dispersive.	unless recent fire. >high chance of occurrence depending on flooding. Proposal has no impact on foraging or roosting habitat of this species – and given existing traffic, not likely to be impacted by truck movements. No risk of significant impact, however high chance of occurrence, hence **7 Part Tests required** to demonstrate.
	Brolga (Grus rubicunda)	1	V-TSCA	Inhabits coastal and inland wetlands, shallow lakes, grassland, saltmarsh, farm and dry open land. Forages for large invertebrates, frogs, fish, seeds, green shoots and bulbs. Breeding occurs predominantly in tropical wetland and large inland swamps and irrigated grasslands at inland and central northern Australia (eg Queensland and Northern Territory), though has been recorded in the northwest and north-eastern corner of NSW and Victoria.	Recorded in 1980s on Belmore River floodplain as non-breeding southern nomads foraging in flooded pasture. Potential to occur in flooded pasture adjacent to haulage route but only very low to unlikely as not seen for >20 years. Proposal has no impact on foraging or roosting habitat of this species – and given existing traffic, not likely to be impacted by truck movements. No risk of significant impact, hence 7 Part Tests not required.
	Osprey (Pandion haliaetus)	7	V-TSCA	Wetlands, mudflats, mangroves, floodplains, irrigated fields, farm dams. Forages in shallow water for small vertebrates. Shuns cover, prefers extensive open shallows. Nests in a tree, often above water in a secluded swamp. Eggs laid Aug-Nov in NSW. Adults	Likely to forage along Belmore River as part of local territory, but not nests known within >1km. At least fair chance as overfly in study area.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
				resident, juveniles dispersive (DEC 2005a, Lindsey 1992).	Proposal has no impact on foraging or nesting habitat of this species. No risk of significant impact, hence 7 Part Tests not required.
	Powerful Owl (*Ninox strenua*)	0	V-TSCA	Wet and dry sclerophyll forests. Nests in tree hollows. Requires high diversity and abundance of medium-sized arboreal prey. Very large territory (500-5000ha).	Not preferred habitat – not normally found in dune systems. Potential prey present but no preferred glider species. Potential nest sites in large hollows. At best low chance of local pair utilsing subject land as small part of territory mainly centered in Hat Head National Park. Loss of 6.4ha of potential foraging habitat and potential nest trees (generic only), but only low potential to occur. **Seven Part Test required** to demonstrate unlikely to be significant.
	Masked Owl (Tyto novaehollandiae)	0	V-TSC Act	Eucalypt forest and woodlands with sparse understorey. Nests in tree hollows. Requires high diversity and abundance of prey 200-600g weight. Large territory.	As for Powerful Owl but does occur in coastal dune systems, hence >fair chance to occur using subject land as small part of large territory centred on Hat Head National Park. **Seven Part Test required**.
	Barking Owl (Ninox connivens)	0	V-TSC Act	Well-forested hills and flats, eucalypt savannah (especially), and riverine woodland in coastal and subcoastal areas. Prefers hunting in more open country for mammals (rabbits, rats, mice, small bats and small	Some generic potential habitat in study area no local records, sparse NSW distribution, hence unlikely to occur.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
				marsupials) and birds (small up to Frogmouths and Magpies). Large territories. Nest in hollows.	No risk of significant impact given ecology and extent of identical habitat, hence 7 Part Test not required.
	Grass Owl (Tyto capensis)	1	V-TSC Act	Inhabit coastal and inland grasslands, coastal heath, agricultural crops and swamp margins. Dependant on good numbers of rodent prey. Highly mobile.	Some generic potential in sedgeland to west of subject land but may be too dense and prone to inundation. Similar to east. Very low to unlikely to occur on fringes of study area. Proposal has no impact on this species directly or indirectly, and only very low potential to occur. No risk of significant impact, hence 7 Part Tests not required.
	Square-tailed Kite (*Lophoictinia isura*)	1	V-TSC Act	Open forests and woodlands in coastal and sub-coastal areas. Forages low over, or in, canopy for eggs, nestlings, passerines, small vertebrates and invertebrates. Large home range (>100km^2). Observed foraging in residential areas of Port Macquarie. Large stick nest in high fork of living tree. Breeds July-December. Lays 2-3 eggs with 1-2 birds fledging after 100days. Appears to be adapting to an abundance of passerines in well-vegetated outer fringes of cities. Probably migrates to northern Australia in winter. (Debus 1998, NSW NPWS 2000)	Study offers some generic potential habitat, and foraging opportunities. Considered fair chance of occurrence as opportunistic forager in study area. **7 Part Test required** as fair potential to occur.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
	Little Eagle (Hieraaetus morphnoides)	0	V-TSC Act	Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland, sheoak or acacia woodlands and riparian woodlands of interior NSW are also used (Marchant and Higgins 1993; Aumann 2001a). For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring. It eats birds, reptiles and mammals, occasionally adding large insects and carrion (Marchant and Higgins 1993; Aumann 2001b; Debus et al. 2007). It is distributed throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment (Marchant and Higgins 1993). It occurs as a single population throughout NSW.	Generally as for Square-tailed Kite however no local records. Low chance of occurrence. **Seven Part Test required.**
	Spotted Harrier (*Circus assimilis*)	0	V-TSC Act	Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods) (Marchant and Higgins 1993; Aumann 2001a). It is found mostly commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. The species builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months. Diet includes terrestrial mammals, birds and reptiles, occasionally large insects and rarely carrion (Marchant and Higgins 1993; Aumann 2001b). Many of	General area including site largely unsuitable in structure and no local records. Unlikely to occur. No risk of impact, hence 7 Part Test not required.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
				the remaining key prey species (e.g. terrestrial grassland birds such as quail, button-quail, pipits, larks and songlarks) require ground cover and are sensitive to habitat degradation from grazing (Marchant and Higgins 1993).	
	Regent Honeyeater (*Anthochaera phrygia*)	1	E-TSC Act. CE-EPBC Act	Nomadic, may move coastwards in late summer. Inhabits temperate eucalypt woodlands and open forest, including forest edges, woodland remnants on farmland and urban areas. Also uses *Casuarina cunninghamiana* gallery forests. Requires reliable and ample nectar supplies to support semi-permanent (core breeding) habitat. Favoured nectar sources are *E. sideroxylon, E. albens, E. melliodora, E. leucoxylon, E. robusta, E. planchoniana*, and heavy infestations of mistletoe. Also take insects and orchard fruits. Coastal forests of Swamp Mahogany or Spotted Gum an important drought refuge. Preference for large emergent trees. Breeds in pairs or small colonies in open woodland/forest and occasionally more disturbed woodland near housing and farmland, depending on food availability, from August-January. Breeding less likely to occur if nectar flows are low or unreliable, or heavy competition with more aggressive honeyeaters eg Noisy Miner, Red Wattlebirds and Noisy Friarbirds. (Menkhorst *et al* 1999).	General area unlikely to be a preferred non-breeding locality due to lack of records indicating regular season occurrence. At best rare/opportunistic foraging event due to local flowering. Proposal highly unlikely to impact as unlikely to occur and no loss of potential foraging resources. Seven Part Test not required.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
	Little Lorikeet (Glossopsitta pusilla)	0	V-TSCA	Gregarious, usually foraging in small flocks, often with other species of lorikeet feeding primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including, melaleucas and mistletoes. Mostly occurs in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. In south-east Queensland (Smyth *et al.* 2002), were more likely to occupy forest sites with relatively short to intermediate logging rotations (15–23 years) and sites that have had short intervals (2.5– 4 years) between fires.	Site and study area contains preferred forage species as well as numerous potential nest sites. No local records, but subject to seasonal movements, hence potential to forage on site as part of local range. At least low chance of occurrence as periodic transient. Proposal will see loss of 6.4ha of potential foraging and nesting habitat. **Seven Part Test required** even though no local records and low potential to occur given preferred forage species common and abundance of potential nest sites to demonstrate unlikely to be significantly impacted.
	Swift Parrot (Lathumus discolor)	0	E-TSC Act, E-EPBC Act	Breeds in Tasmania and winters on mainland, from Victoria to southern Queensland. Feeds mostly on pollen and nectar of winter flowering eucalypts and banksias, but also on fruit, seeds, lerps and insect larvae (Schodde and Tideman 1990). Favoured species are *E. robusta, Corymbia gummifera, E. globulus, E. sideroxylon, E. leucoxylon, E. labens, E. ovata, E. maculata, Banksia serrata* and *B. integrifolia.* In coastal NSW, Swamp Mahogany, Spotted Gum and Bloodwood forests are important foraging habitats and larger trees may be selected. Disperse according to changing local food resources.	Small stand of Swamp Mahogany in study area provides potential nectar resources, however no local records to indicate locality is a seasonally significant area for non-breeding migrations, and large areas of higher quality habitat occur locally. Unlikely to occur. Proposal highly unlikely to impact given limited habitat loss. Impact clearly insignificant, Seven Part Test not required.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
	Wompoo Fruit Dove (Ptilinopus magnificus)	2	V-TSCA	Sub-tropical, littoral, warm temperate and dry rainforest, and wet sclerophyll with rainforest understorey. Preference for large areas of undisturbed forest. Feeds on fruit, usually high in canopy. Locally nomadic following fruit resource. Nests in rainforest, 3-10m above ground. Known to feed on Camphor Laurel and Lantana.	No suitable foraging or nesting habitat in study area, hence not a potential occurrence Unlikely to occur, no habitat affected, hence 7 Part Test not required.
	Rose-Crowned Fruit Dove (P. regina)	1	V-TSCA	Inhabits dense rainforest or vegetation containing fruit bearing trees, feeding on fruit. Recorded in small areas of habitat (2ha). Locally nomadic and migratory, following fruiting patterns, with northward movement in winter.	No suitable foraging or nesting habitat in study area, hence not a potential occurrence Unlikely to occur, no habitat affected, hence 7 Part Test not required.
	Varied Sittella (*Daphoenositta chrysoptera*)	0	V-TSC Act	Sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands, with a nearly continuous distribution in NSW from the coast to the far west (Higgins and Peter 2002; Barrett *et al.* 2003). It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree	Generic potential habitat in forest on subject land but no local records and no usually associated with dune systems. Given this and no local records, only low chance of occurrence. If present would be a resident colony occupying habitat on the subject land and adjacent habitat. Loss of potential but not known habitat, and only low potential to occur, however territorial species, hence **7 Part Test required** to assess significance.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
				canopy, and often re-uses the same fork or tree in successive years.	
MAMMALS	Spotted-tailed Quoll (*Dasyurus maculatus*)	5	V-TSC Act, E-EPBC Act	Various forested habitats with preference for dense forests. Requires tree hollows, hollow logs or caves for nesting. Large home range (>500ha) and may move over several kilometres in a few days. Tends to follow drainage lines.	Subject land offers good potential foraging habitat forming fraction of suitable habitat in Hat Head Nationa Park. Potential den sites in trees. Fair chance of occurrence in study area – using subject land as small part of territory centred in Hat Head National Park. Loss of potential habitat, and fair potential to occur, hence **7 Part Test required** to assess significance.
	Common Planigale (Planigale maculata)	0	V-TSCA	Wide variety of habitats. Preference for areas of dense groundcover due to heat/dehydration problems. May prefer ecotones of dry/wet habitats (Denny 1982). Preys on arthropods, small vertebrates, shelters in nest under/in fallen timber or rock (Strahan 1995). Home range about 0.5ha. Breeds Oct-Jan (NSW NPWS 2000).	Generic potential habitat in dune forest where intact groundcover and other undergrowth, but higher potential in ecotones and sedgeland to west where very dense cover and excellent invertebrate habitats. Some limited potential to occur in coastal complex and sedgeland north of haulage track. No local records but difficult to detect. Considered low chance in study area. Loss of 6.4ha of low quality habitat for this species and some short term fragmentation, **Seven Part Test**

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
					undertaken due to small home range and edge effects.
	Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*)	0	V-TSCA	Appears to prefer heathland especially dense wet heath and swampy areas usually occupied by Swamp Rat (AMBS 1996). Also recorded from mid-elevation grasslands, open dry and wet sclerophyll woodland. In the Port Macquarie area, associated with heathland with dense shrub layer of *Banksia ericifolia*, *B. serratifolia*, *Xanthorrhoea* spp, *Dillwynia floribunda*, *Boronia spp*, *Leptospermum flavescens* and *Melaleuca nodosa*. Requires specific fire regime, greatest density 3-4 years after fire. Omnivorous, seeds, fungi, green stem, arthropods. Home range <0.5ha (NSW NPWS 2000).	Swamp forest and sedgeland on western side of subject land and adjacent offers very high potential habitat. Low value potential habitat on site. Lesser potential habitat in sedgeland and coastal complex north of haulage road. Low potential to occur as depends on specific fire regime and competes with Swamp Rat which was found on site. Habitat loss on site considered insignificant to this species as not likely potential habitat, however as low potential to occur in study area, due diligence **7 Part Test required**.
	Eastern Pygmy Possum (*Cercartetus nanus*)	0	V-TSCA	Found in rainforest, sclerophyll forest, woodland and tree heath. Predominantly nectivorous (opportunistically insectivorous and also eats fruits during flowering lulls) feeding on Banksias, Leptospermum, Melaleucas, Eucalypts and Callistemons. Nest in very small hollows, or within bark/leaf nests in tree forks (eg Melaleucas and Banksias), Myrtaceous shrubs, abandoned bird nests or under loose eucalypt bark. Often Winters in torpor.	Subject land contains potential habitat in dune forest, swamp forest and heathy sections of sedgeland to west. Some potential perhaps also in coastal complex adjacent to haulage road. No local records but hard to detect. At least low potential to occur perhaps in localised areas where complex mosaic of nectar sources. Loss of 6.4ha of low quality habitat for this species and some short term

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
					fragmentation, **Seven Part Test undertaken** due to small home range and edge effects.
	Yellow-Bellied Glider (Petaurus australis)	0	V-TSCA	Moist and dry mature eucalypt forest and woodland. Tree hollows, diversity of winter-flowering and suitable sap-feeding eucalypt species required. Large territory.	Not associated with dune forest as prefers tall forests. No local records. Considered unlikely to occur. No loss of potential habitat, hence no risk of impact. Seven Part Tests not required.
	Long-Nosed Potoroo (Potorous tridactylous)	0	V-TSCA E-EPBCA	Coastal heath and shrublands; paperbark forest; woodland with dry heathy understorey; high elevation rainforest or moist hardwood forest; moist shrublands with dense or moderately dense understoreys and sedge-dominated groundcover; wet or dry sclerophyll forests where average annual precipitation exceeds 760mm. Requires thick groundcover for refuge, while foraging in open areas on ridges, slopes or gullies, typically on ecotones, and prefers sandy soils for digging. Eats roots, tubers, fungi, fleshy fruits, leaves, insects and other soil invertebrates. Optimum habitat generally considered a mosaic of regenerating dense understorey vegetation as result of patchwork of periodic low to medium intensity fires. Home range 2-5ha (NSW NPWS 2000).	Generic potential habitat on subject land and throughout Hat Head National Park, but no local records or records along coast from Coffs Harbour to Forster strongly suggests unlikely to occur. Unlikely to occur, and rehabilitated habitat will eventually be suitable for this species, hence no risk of a significant impact. Seven Part Test not required.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
	Koala (Phascolarctos cinereus)	4	V-TSCA, V-EPBCA	A large arboreal marsupial to 12kg for males and 8kg for females. Spends most of its time in trees and has large claws adapted for climbing. Largest populations in NSW occur on the central, mid-north and north coast with scattered populations on the south coast, tablelands and western districts. Koalas inhabit eucalypt forests and woodlands where they feed on the leaves of a wide range of eucalypts and will select preferred browse species in an area. Home range size varies depending on quality of habitat, ranging from two to several hundred hectares in size (DECC 2008 Van Dyck and Strahan 2008).	Only limited primary browse trees occur on western side of dune, and adjacent to haulage route, but no records in proximity, and no Koalas detected. Local area is poor Koala habitat. Considered unlikely to occur even as a transient as no nearby source population- nearest is Crescent Head and Dulconghi. No loss of potential habitat and no new threats or barriers, hence no risk of impact. Seven Part Test not required.
	Grey-Headed Fruit-Bat/Flying Fox (Pteropus poliocephalus)	5	V-TSCA, V-EPBCA	Nomadic frugivore and nectivores on rainforest, eucalypt, melaleuca and Banksia. Recorded flying up to 45km from roost (generally max. of 20km). Roosts colonially with short term individual or small groups. Spring or Summer roosts are maternity sites. Dependant on winter flowering species eg *E. robusta* and *E. tereticornis*.	Study area contains preferred forage species which form fraction of local extent. No known or likely potential roosts on site but known in locality. Highly likely to forage in study area during suitable flowering periods. Loss of 6.4ha of high quality habitat for this species hence **Seven Part Test required.**
	Common/Eastern/ Queensland Blossom Bat (*Syconycteris australis*)	1	V-TSCA	Roosts in rainforest and wet sclerophyll forest. Feeds in heathlands and paperbark swamps up to 4km from roost. Key food species include Banksia, Melaleucas, Callistemons and Bloodwoods.	Potential habitat provided by canopy and understorey species in dune forest, swamp forest and heathy edges of sedgeland west of quarry. Fair potential to occur using study

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
					area as part of seasonally nomadic foraging range. Loss of 6.4ha of moderate quality habitat for this species hence **Seven Part Test required.**
	Common/Eastern/Large Bent Wing Bat (Miniopterus schreibersii)	0	V-TSCA	Habitat generalist - forages above well-forested areas. Roosts in old buildings, caves, mines etc and in tree hollows. Dependant on nursery caves and communal roosts. Recorded foraging along vegetated roadside verges; along tracks in forest, and interfaces of forest and pasture.	Site and surrounding habitat may provide generic foraging habitat. Potential roosts in tree hollows. >moderate chance of foraging within forest canopy on the site **7 Part Test required** due to potential to occur.
	Eastern False Pipistrelle (Falsistrellus tasmaniensis)	0	V-TSCA	A large vespertilionid which feeds on moths and insects. Known to roost in caves, abandoned buildings, but mostly in trees hollows higher rainfall forested areas. It is suspected that some populations migrate in Winter from higher altitudes to coastal areas, or may simply enter torpor. Prefers tall forests (>20m high) and extensive movements (eg 12km recorded between foraging and roost sites).	Site and surrounding habitat may provide generic foraging habitat but not associated with coastal sands forests. Potential roosts in tree hollows. Unlikely to low chance of foraging within forest canopy on the site **7 Part Test required** due to potential to occur.
	Eastern Cave Bat (Vespadelus troughtoni)	0	V-TSCA	Rare and poorly known bat. Cave dwelling bat roosting in small (5-50) to large (500) groups in sandstone overhang caves, boulder piles, mines, tunnels and sometimes buildings. Tend to roost in well-lit portions of caves in avons, domes, cracks and crevices. Occasionally found along cliff lines in wet eucalypt	Lack of preferred roosting habitat within range of site and only single record in locality suggests unlikely to low to occur. **Seven Part Tests required due to potential to occur.**

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
				forest and rainforest on the coast and dividing range, but extend into drier forest on western slopes.	
	Hoary Bat (Chalinolobus nigrogriseus)	1	V-TSCA	Occurs in a range of habitats, such as monsoon forest, tall open forest, open woodland, vine thickets, coastal scrub, sand dunes, grasslands, floodplains, watercourses and dams. Roosts in eucalypt tree hollows, as well as rock crevices. Breeding colonies have been recorded in roofs of buildings. Preferred prey is beetles and moths, but also spiders, mantids, crickets, grasshoppers, cicadas, bugs, diving beetles, flies and ants (thus may land and forage).	Site and surrounding habitat may provide generic foraging habitat. Potential roosts in tree hollows. Low to fair chance of foraging **Seven Part Test required** due to potential to occur.
	Dwyer's Bat/ Large Eared Pied Bat (Chalinobus dwyeri)	0	V-TSCA V-EPBCA	Found in moderately wooded habitats such as dry sclerophyll forest, tall open eucalypt forests, woodlands, and sub-alpine woodlands, edge of rainforest and wet sclerophyll forest. Roosts in caves, mines and abandoned bottle-shaped mud nests of Fairy Martins. In caves and mines, tend to roost in twilight sections near entrance. Insectivorous but habits poorly known. Fly relatively slowly, direct and manoeuvrable, low to ground or 6-10m above ground.	Lack of preferred roosting habitat within range of site and no record in locality suggests unlikely to occur. Seven Part Tests not required.
	Greater Broad Nosed Bat (Scoteanax rueppellii)	0	V-TSCA	Forages over range of habitats including rainforests and moist forests, but prefers ecotones between riparian forest, woodland and cleared land. Requires sparse understorey and will forage over water. Roosts in tree hollows. Feeds on larger insects, small	Site and surrounding habitat may provide generic foraging habitat. Potential roosts in tree hollows. Low to fair chance foraging. Low chance of breeding in study area.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
				vertebrates and perhaps other bats. Recorded foraging in rural residential areas and on edge of large forest remnants and pasture.	**Seven Part Test required** due to potential to occur.
	Large-Footed Mouse-Eared Bat/Southern Myotis (Myotis adversus/ macropus)	1	V-TSCA	Tunnel, cave, bridges, old buildings, tree hollow and dense foliage roosting bat which prefers riparian habitat over 500m long with nearby roosting habitat. Key habitats are streams, rivers, creeks, lagoons, lakes and other water bodies. Feeds on aquatic insects and small fish. Has recently been observed foraging in small bodies of water.	Potential roost sites on subject land, with potential foraging habitat in Reilly's Drain and Belmore River. Low potential to occur as only 1 local record. **Seven Part Tests required** to assess.
	Beccari's Freetail Bat (Mormopterus beccarii)	0	V-TSCA	Wide range of habitats from rainforest, floodplains, tall open forest, savannah woodlands, arid shrublands and grasslands. Commonly caught along watercourses, over water and over canopy as prefers areas free of obstructions due to low manoeuvrability. Feeds above canopy in fast flight but agility on ground suggests ability to forage on flightless insects. Very few records in NSW – sporadic and possibly Summer nomadic.	Generic potential foraging and roosting habitat, but not confidently recorded this far south. Unlikely to very low potential to occur as rare seasonal transient. Given habitat will regenerate and numerous alternative roost sites, clearly no risk of significant impact, hence 7 Part Tests not required.
	Eastern Freetail Bat or Eastern Little Mastiff-Bat (Mormopterus norfolkensis)	0	V-TSCA	Specific habitat requirements of this species are poorly known. Has been recorded in habitats ranging from rainforest to dry sclerophyll and woodland, with most recorded in the latter (State Forests 1995, Allison 1991). Roosts in small colonies in tree hollows and under loose bark; has been found under house eaves, in roofs and metal caps on telegraph poles. Recorded	Site and surrounding habitat may provide generic foraging habitat. Potential roosts in tree hollows. >Moderate chance foraging. Low chance of breeding in study area. **Seven Part Test required** due to potential to occur.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
				roosting in roof in Hat Head village. Probably forages above forest or woodland canopy, and in clearings adjacent to forest. Most records are of single individuals, and is likely to occur at low densities over its range.	
FROGS	Green and Golden Bell Frog (Litoria aurea)	26	E-TSCA V-TSCA	Found in permanent swamps and ponds. Prefers water bodies which are: still; shallow; unshaded; ephemeral; unpolluted; generally isolated; and free of native fish species or Plague Minnow (Gambusia holbrooki) and little macro-algae. Requires emergent vegetation, grass tussocks or rocks for shelter. May use disturbed sites opportunistically - may depend on several stages. Eats insects and other frogs. Summer breeder. (Hero et al 2004).	Previously recorded in freshwater wetland to east but not recorded by this survey. Some limited potential to occur in sedgeland to west of dune, and also around the haulage road north and south. No impact on breeding habitat, but proposal will see loss of potential wintering habitat, and fragment a potential corridor on the dune between known habitat to the east, and potential habitat to west. Seven Part Test required to evaluate.
	Olongburra Sedge Frog (Litoria olongburensis)	0	V-TSCA V-EPBCA	Apparently restricted to marshes and swamps with emergent vegetation, and often associated with tannin-stained, acidic water. Not recorded south of Yuraygir National Park, north of Coffs Harbour.	Freshwater wetland to east of dune, and less so the sedgeland to the west, and wet meadows and sedgeland north and south of haulage road offers potential habitat, however well south of known range. Unlikely to potentially occur.

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
					No risk of significant impact as no impact on potential habitat, hence Seven Part Test not required.
	Wallum Froglet (Crinia tinnula)	30	V-TSCA	Predominantly confined to acidic paperbark swamps of coastal areas (Cogger 1992). Also found in wet heathland and Melaleuca sedgelands. Recorded breeding in flooded pasture adjacent to paperbark swamps.	Freshwater wetland to east of dune, and less so the sedgeland to the west, and wet meadows and sedgeland north and south of haulage road offers potential habitat. >Fair potential to occur in study area No risk of significant impact as no impact on potential habitat, however >fair chance to occur in study area, hence **Seven Part Test required.**
	Giant Barred Frog (M. iteratus)	1	E-TSCA E-EPBCA	Moist hardwood forest, Antarctic Beech and rainforest near flowing streams. May also occur in coastal riverine rainforest and riparian vegetation. Forages in areas adjacent to riparian zones. Males call from under leaf litter or rocks by flowing streams. Eggs laid at streamside to await washing into stream by rainfall.	No suitable habitat in study area. Unlikely to occur. No risk of impact hence 7 Part Tests not required.
	Green-thighed Frog (*Litoria brevipalmata*)	0	V-TSC Act	Poorly known. Found in range of habitats such as warm temperate open forest, rainforest, wet sclerophyll, paperbark swamp forest, to forestry dams and ephemeral drainage lines in dry open forest; breeding aggregations around oxbow lakes, ditches, flooded paddocks, overflows, ephemeral creeks and drainage lines, and grassy semi-permanent ponds. Males call	Some broadly generic potential habitat perhaps in swamp forest and sedgeland, but not associated with coastal dune environments. Not detected despite suitable breeding conditions, and no local

Animal Group	Common Name (Scientific Name)	Local Records	Legal Status	Habitat/Ecology Profile	Likelihood Of Occurrence? Risk of Significant Impact? Seven Part Test Required?
				only for few days after spring and early summer rains. Possibly a lowland forest ground-dweller. Seeks refuge in dense groundcover, leaf litter and cavities such as cicada nymph burrows.	records, hence considered unlikely to occur. No risk of significant impact as no impact on potential habitat hence 7 Part Tests not required.

A number of other species (see table below) are known or considered potential occurrences within the locality. However due to a number of factors, these species were not considered potential occurrences on site. Thus the proposal is not considered to have a significant impact on the viability of any local population of the subject species and Seven Part Test evaluation was not required.

Table 22: Fauna unlikely to occur on site

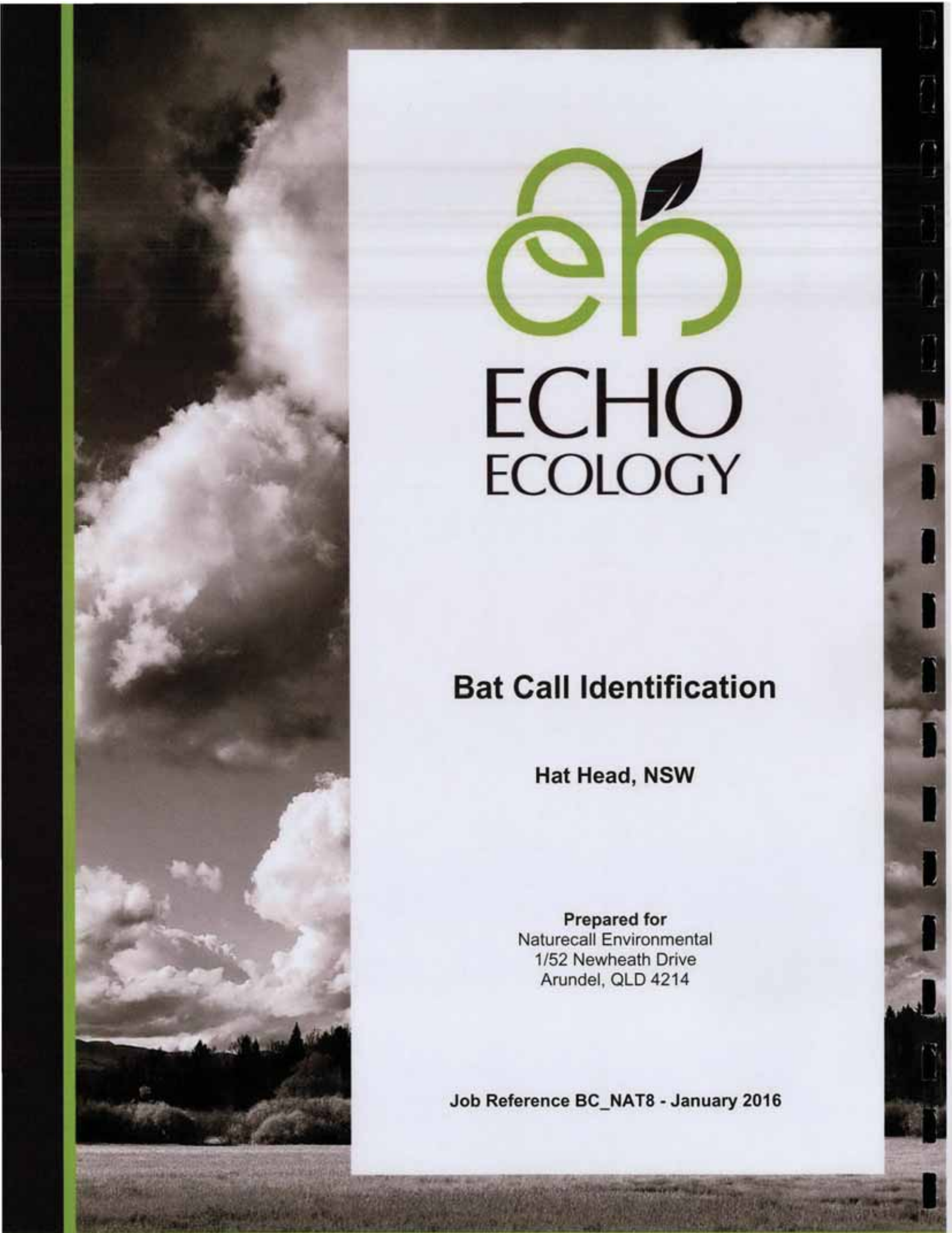
Preferred Habitat	Species	Site considered unsuitable habitat	Presence of predators likely to have excluded the species	Disturbance history likely to have excluded this species	Lack of local records
Dry Sclerophyll/Open Woodland/Grassy Open Woodland	Painted Honeyeater (*Grantiella picta*)	X		X	X
	Black-chinned Honeyeater (*Melithreptus gularis gularis*) eastern subspecies				X
	Scarlet Robin (Petroica boodang)	X			X
	Flame Robin (Petroica phoenicea)	X			X

Preferred Habitat	Species	Site considered unsuitable habitat	Presence of predators likely to have excluded the species	Disturbance history likely to have excluded this species	Lack of local records
	Hooded Robin (Melanodryas cucullatacucullata) southeastern form	X			X
	Bush-stone Curlew (*Burchinus grallaris*)	X	X	X	X
	Diamond Firetail (Stagonopleura guttata)	X			X
	Grey-crowned Babbler (*Pomatostomus temporalis*) eastern subspecies	X		X	X
Rainforest/Wet Sclerophyll Forest	Olive Whistler (Pachycephala olivacea)	X			X
	Sooty Owl (Tyto tenebricosa)	X			X
	Superb Fruit Dove (P. superbus)	X			X
	Barred Cuckoo Shrike (Coracina lineata)	X			X
	Parma Wallaby	X	X	X	X

Preferred Habitat	Species	Site considered unsuitable habitat	Presence of predators likely to have excluded the species	Disturbance history likely to have excluded this species	Lack of local records
	(Macropus parma)				
	Pale-Headed Snake (Hoplocephalus bitorquatus)	X		X	X
	Stephens Banded Snake	X			X
	White-Crowned Snake (Cacophis harriettae)	X		X	X
	Red-Legged Pademelon (Thylogale stigmatica)	X	X	X	X
	Stuttering Frog (Mixophyes balbus)	X		X	X
	Blue-Billed Duck (*Oxyura australis*)	X			X
	Freckled Duck (Stictonetta naevosa)	X			X
	Magpie Goose (Anseranas semipalmata)	X			X
	Painted Snipe (Rostratula benghalensis)	X			X

Preferred Habitat	Species	Site considered unsuitable habitat	Presence of predators likely to have excluded the species	Disturbance history likely to have excluded this species	Lack of local records
	White-fronted Chat (*Epthianura albifrons*)	X			X
	Ground Parrot (Pezoporus wallicus wallicus)	X	X	X	X

Appendix 2: Yangochiropteran bat call data



ECHO ECOLOGY

Bat Call Identification

Hat Head, NSW

Prepared for
Naturecall Environmental
1/52 Newheath Drive
Arundel, QLD 4214

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This report has been prepared to document the analysis of digital ultrasonic bat echolocation calls received from a third party. The data was not collected by the author and as such no responsibility is taken for the quality of data collection or for the suitability of its subsequent use.

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Contents

List of Tables

List of Figures

1.0 INTRODUCTION

This report has been commissioned by Naturecall Environmental to analyse bat echolocation call data (Anabat, Titley Electronics) collected from Hat Head, NSW. Data was provided electronically to the author. This report documents the methods involved in analysing bat call data and the results obtained only.

2.0 METHODS

The identification of bat echolocation calls recorded during surveys was undertaken using AnalookW (Version 4.1z) software. The identification of calls was undertaken with reference to Pennay *et al.* (2004) and through the comparison of recorded reference calls from north-eastern NSW. Reference calls were obtained from the NSW database and from the authors personal collection.

Each call sequence ('pass') was assigned to one of five categories, according to the confidence with which an identification could be made, being:

- Definite - Pass identified to species level and could not be confused with another species
- Probable - Pass identified to species level and there is a low chance of confusion with another species
- Possible - Pass identified to species level but short duration or poor quality of the pass increases the chance of confusion with another species
- Species group - Pass could not be identified to species level and could belong to one of two or more species. Occurs more frequently when passes are short or of poor quality
- Unknown - Either background 'noise' files or passes by bats which are too short and/or of poor quality to confidently identify.

Call sequences that were less than three pulses in length were not analysed and were assigned to 'Unknown' and only search phase calls were analysed. Furthermore, some species are difficult to differentiate using bat call analysis due to overlapping call frequencies and similar shape of plotted calls and in these cases calls were assigned to species groups.

The total number of passes (call sequences) per unit per night was tallied to give an index of activity.

It should be noted that the activity levels recorded at different sites may not be readily able to be compared. Such comparisons are dependent on many variables which need to be carefully controlled during data collection and statistically analysed. Influential variables include wind, rain, temperature, duration of recording, season, detector and microphone sensitivity, detector placement, weather protection devices etc.

2.1 Characteristics Used to Differentiate Species

Miniopterus australis was differentiated from *Vespadelus pumilus*, by characteristic frequency or the presence of a down-sweeping tail on pulses. Call sequences which had a majority of pulses containing an up-sweeping tail were assigned to *Vespadelus pumilus*.

Chalinolobus gouldii was differentiated from other species by the presence of curved, alternating call pulses.

Chalinolobus morio calls were differentiated from those of *Vespadelus* sp. by the presence of a down-sweeping tail on the majority of pulses.

Scotorepens species 1 was differentiated from *Chalinolobus nigrogriseus* by short pre-characteristic section.

3.0 RESULTS

A total of 300 call sequences were recorded, of which 254 call sequences were able to be analysed (ie were not 'noise' files or bat calls of short length). Of the bat calls, 84 call sequences (33 %) were able to be confidently identified (those classified as either definite or probable identifications) to species level (Table 3-1). Species recorded confidently within the site include:

- *Chalinolobus gouldii* (Gould's wattled bat)
- *Chalinolobus morio* (Chocolate wattled bat)
- *Miniopterus australis* (Little bentwing bat)
- *Scotorepens* species 1 (Central-eastern broad-nosed bat)
- *Vespadelus pumilus* (Eastern forest bat)

Additionally, the following bat species potentially occurred within the site, but could not be confidently identified (those calls classified as possible or as a species group):

- *Chalinolobus nigrogriseus* (Hoary wattled bat)
- *Falsistrellus tasmaniensis* (Eastern falsistrelle)
- *Miniopterus schreibersii oceanensis* (Eastern bentwing bat)
- *Mormopterus (Micronomus) norfolkensis* (East coast free-tailed bat)

- *Mormopterus (Ozimops) ridei* (Eastern free-tailed bat)
- *Myotis macropus* (Large-footed myotis)
- *Nyctophilus geoffroyi* (Lesser long-eared bat)
- *Nyctophilus gouldi* (Gould's long-eared bat)
- *Scoteanax rueppellii* (Greater broad-nosed bat)
- *Scotorepens orion* (Eastern broad-nosed bat)
- *Vespadelus darlingtoni* (Large forest bat)
- *Vespadelus regulus* (Southern forest bat)
- *Vespadelus troughtoni* (Eastern cave bat)
- *Vespadelus vulturnus* (Little forest bat)

It should be noted that additional bat species may be present within the site but were not recorded by the detectors and habitat assessment should be used in conjunction with these results to determine the likelihood of occurrence of other bat species.

Table 3-1 below summarises the results of the bat call analysis.

Table 3-1: Results of bat call analysis (number of passes per site per night)

IDENTIFICATION	Anabat 7/01/2016	Anabat 10/01/2016
DEFINITE		
Chalinolobus gouldii	-	11
Chalinolobus morio	-	2
Scotorepens species 1	1	6
Vespadelus pumilus	1	3
PROBABLE		
Chalinolobus gouldii	-	2
Miniopterus australis	1	6
Scotorepens species 1	3	47
Vespadelus pumilus	-	1
POSSIBLE		
Scotorepens species 1	1	5
Vespadelus darlingtoni	1	-
SPECIES GROUPS		
Chalinolobus gouldii / Mormopterus (Micronomus) norfolkensis / Mormopterus (Ozimops) ridei	-	11
Chalinolobus gouldii / Scoteanax rueppellii	1	4
Chalinolobus morio / Vespadelus pumilus / Vespadelus vulturnus / Vespadelus troughtoni	26	7
Chalinolobus nigrogriseus / Falsistrellus tasmaniensis / Scotorepens species 1	-	5
Chalinolobus nigrogriseus / Scotorepens greyii / Scotorepens species 1	-	12
Chalinolobus nigrogriseus /Scotorepens species 1	1	43
Falsistrellus tasmaniensis / Scotorepens orion	2	3
Falsistrellus tasmaniensis / Scotorepens orion / Scoteanax rueppellii	-	6

IDENTIFICATION	Anabat 7/01/2016	Anabat 10/01/2016
Miniopterus australis / Vespadelus pumilus	5	32
Miniopterus schreibersii oceanensis / Vespadelus darlingtoni / Vespadelus regulus	1	2
Myotis macropus / Nyctophilus geoffroyi / Nyctophilus gouldi	-	1
Vespadelus pumilus / Vespadelus vulturnus / Vespadelus troughtoni	1	-
UNKNOWN		
'Noise' files	-	5
Unknown	2	39
TOTAL	**47**	**253**

4.0 SAMPLE CALLS

A sample of the calls actually identified from the site for each species is given below.

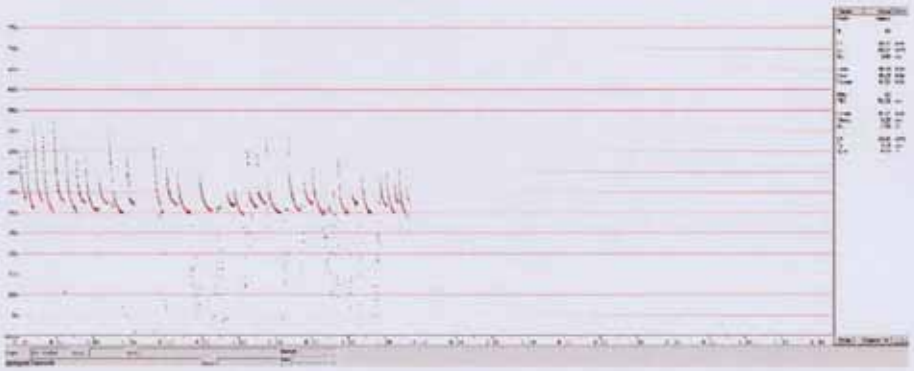

Figure 4-1: *Chalinolobus gouldii* definite call

Figure 4-2: *Chalinolobus morio* definite call

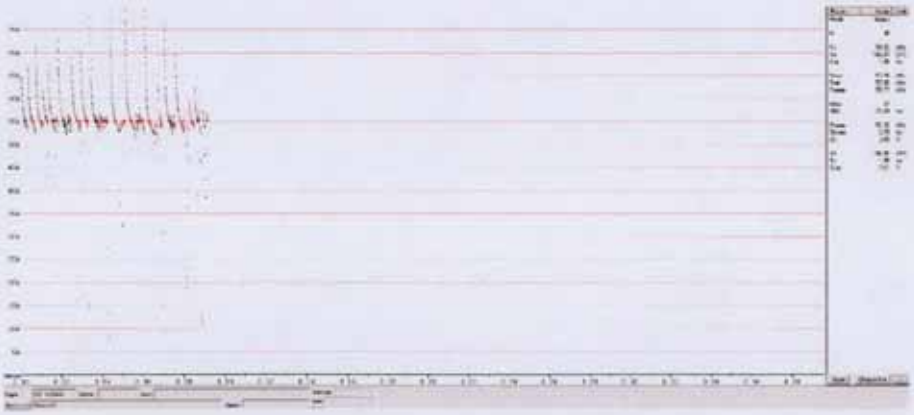

Figure 4-3: *Miniopterus australis* probable call

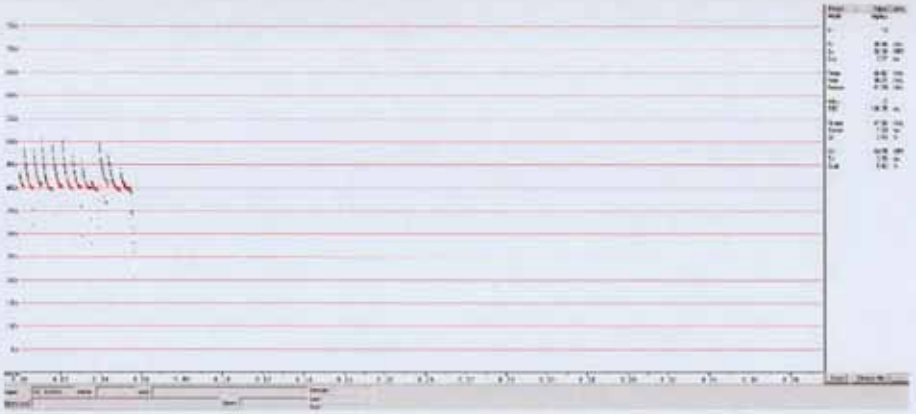

Figure 4-4: *Scotorepens* species 1 definite call

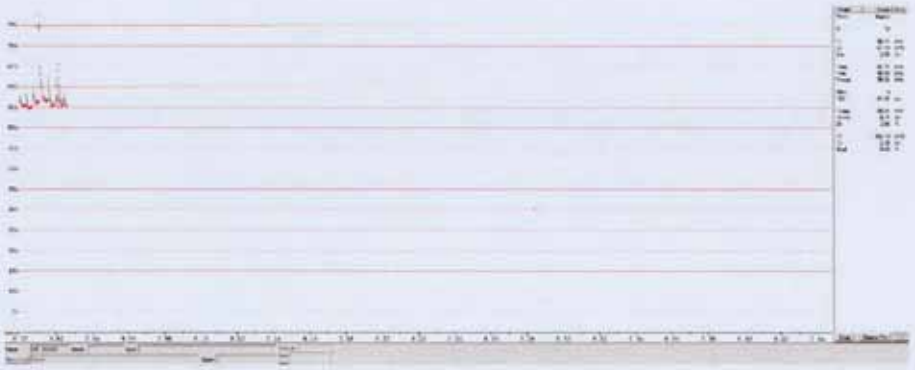

Figure 4-5: *Vespadelus pumilus* definite call

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