APPENDIX E: ECOLOGICAL RESPONSE

E2 - Biolink Koala and NHM Studies

Deep Creek Quarry

Response to Submissions Report

Supplemental surveys for koalas and new holland mice at the site of the proposed Deep Creek quarry, Allworth NSW.

Final report to Ironstone Developments Pty. Ltd.

December 2022

Acronym	Expanded meaning
ARKS	Area of Regional Koala Significance
BCD	Biodiversity and Conservation Division (of DPE)
BDAR	Biodiversity Development Assessment Report
CKH	Core Koala Habitat
DBH	Diameter at Breast Height
DPE	Department of Planning and Environment
EoO	Extent of Occurrence
GDA	Geodetic Datum of Australia
GP	Generational Persistence
EIS	Environmental Impact Statement
KPoM	Koala Plan of Management
LGA	Local Government Area
MCC	MidCoast Council
NHM	New Holland Mouse
PKFT	Preferred Koala Food Tree
SAT	Spot Assessment Technique

Citation:

Biolink (2022). *Supplemental surveys for koalas and new holland mice - proposed Deep Creek quarry, Allworth NSW*. Report to Ironstone Developments Pty. Ltd. Biolink Ecological Consultants, Pottsville, NSW.

Cover photo: female New Holland Mouse *Pseudomys novaehollandiae*, trap station 55, 29th April 2022 (Photo: Steve Phillips).

Summary

Ironstone Developments Pty. Ltd are seeking approval to establish a hard rock quarry on properties located off the Bucketts Way near Deep Creek, Allworth, towards the southern boundary of the MidCoast Council (MCC) Local Government Area (LGA).

In response to submissions received from MCC and the Biodiversity and Conservation Division (BCD) of the now Department of Planning & Environment (DPE) following exhibition of the Environmental Impact Statement (EIS) and amongst other things, further field survey was required to gather supplemental ecological data enabling a response to matters concerning the potential of the proposed development to impact on koalas and new holland mice (NHM), both of which had been recorded on the site of the proposed development for purposes of a related Biodiversity Development Assessment Report (BDAR).

The use of habitat by koalas in the major area to be impacted – the proposed quarry pit – was assessed by way of Spot Assessment Technique (SAT) sampling at 250 m intervals, and in areas proposed for linear infrastructure, specifically the proposed haul road, by foot-based traverses along the intended alignment. A review of recent studies was also included to place the local koala population into a broader landscape context.

The site of the proposed quarry is located within the Wang Wauk State Forest *Area of Regional Koala Significance* (ARKS) and at its eastern end directly adjoins a known area of koala generational persistence (*vis-a-vis* Core Koala Habitat). Preferred Koala Food Tree (PKFT) species within the area proposed for the development are known to be forest red gum, grey gum and tallowwood. Koala activity was detected by SAT survey at two locations within the proposed quarry pit, in both instances at levels of low use / transient movement rather than use by individuals with established home range areas. The indicative activity gradient resulting from the SAT activity we recorded implies the presence of higher activity levels to the south of the proposed quarry pit. Evidence of koalas in the form of scats was also observed in areas to the west of the proposed quarry pit and in other locations to the southwest and southeast of the proposed quarry pit.

The NHM population was surveyed over two events using a series of trap stations comprising five type-A Elliot traps, each station located at ~ 150 m intervals, initially across and adjoining the proposed quarry pit, and secondarily in several other locations within the proposed offset areas. One thousand, one hundred and eighty-six (1,186) trap nights at 60 trap stations were collectively accumulated during the two sampling events. Capture rates varied from 1.28 – 1.96 NHM / 100 trap nights between the

two surveys. Nineteen (19) NHM comprising 16 known individuals were recorded from 10 trap stations. The maximum number of known NHM individuals captured at any single station was six.

NHM trapping data enabled a minimum definable Extent of Occurrence (EoO) for the species of at least 77.02 ha. to be identified, within which NHM density was estimated at 15.01 individuals ha^{-1}. Extrapolation of the NHM density estimate across the EoO implies the presence of a local population of more than 1,000 individuals. The northern extent of the EoO extends into the proposed quarry pit, density data implying that approximately 160 NHM, or 13.84% of currently known population size estimate, would be directly impacted / displaced by habitat removal for the proposed quarry pit.

Individuals of an unidentified species of murid rodent captured during the initial survey at a single trap station located proximal to the northern boundary of the proposed quarry pit were recaptured at the same site and at another location during the second trapping event. These animals were subsequently confirmed as a member of the Genus *Rattus* based on the mammary formula, and likely belong to a thus far undescribed species within the *Rattus tunneyi* complex.

Amongst recommendations arising from the assessments include revision of the existing Koala Plan of Management (KPoM) to include stadia-metric mapping of PKFTs along the proposed haul road, the outcomes of which should be used to inform a final alignment to minimise loss of any PKFTs > 300 mm DBH. The haul road alignment should also incorporate exclusion fencing, koala-grids and underpasses to reduce potential for vehicle-strike, maintain connectivity and minimise impacts of fragmentation. The potential for impacts on the resident NHM population support referral for assessment as a controlled action and/or consideration of the need for an approved NHM management plan that would see the capture and translocation of all or the majority of the NHM population occupying habitat in the proposed quarry pit and adjoining buffer to be impacted into nearby areas of otherwise suitable but otherwise unoccupied habitat, or elsewhere if determined by the responsible agency.

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Introduction

Ironstone Developments Pty. Ltd are seeking development approval to establish a hard rock quarry (hereafter referred to as the proposed Deep Creek Quarry) on properties located off the Bucketts Way, Allworth, near the southern boundary of the MidCoast Council (MCC) LGA. Amongst other things, the proposed development requires construction of a new access (haul) road approximately 2 km in length, and the progressive removal of vegetation from an area of approximately 18.27 ha to create the quarry pit.

Amongst threatened species confirmed to be on the proposed quarry site for purposes of the Biodiversity Development Assessment Report (BDAR) prepared by Kleinfelder (2021) were the koala and the new holland mouse (NHM). In response to public exhibition of the Environmental Impact Statement (EIS), submissions were received from MCC and the (now) Department of Planning and Environment's (DPE) Biodiversity and Conservation Division (BCD). In terms of koalas, the MCC submission communicated concerns about matters of occupancy and connectivity and was further of the opinion that the Koala Plan of Management (KPoM) accompanying the BDAR was inadequate. For the NHM, additional information was requested by both the MCC and BCD submissions regarding the potential quantum of impact. To this end, the need for further assessment work on the site was identified to provide further data on key population parameters for both koala and NHM, as well as related matters such as fragmentation and connectivity.

This report has been prepared for Ironstone Developments Pty. Ltd. specifically with a view to addressing the concerns raised by submissions, better informing the statutory assessment process, and notionally improve on-site conservation / management outcomes for both koala and NHM.

Methods

Study area

The study area is in the south-western corner of the MCC LGA. The proposed development extends over seven Lot plans: 30/DP753176, 472/DP1162208. 48/DP753178, 551/DP1238818, 11/DP1277150, 12/DP1277150 and 1/DP615302. The area adjoins the Bucketts Way on the eastern side and Karuah National Park in the south-east (**Figure 1**)

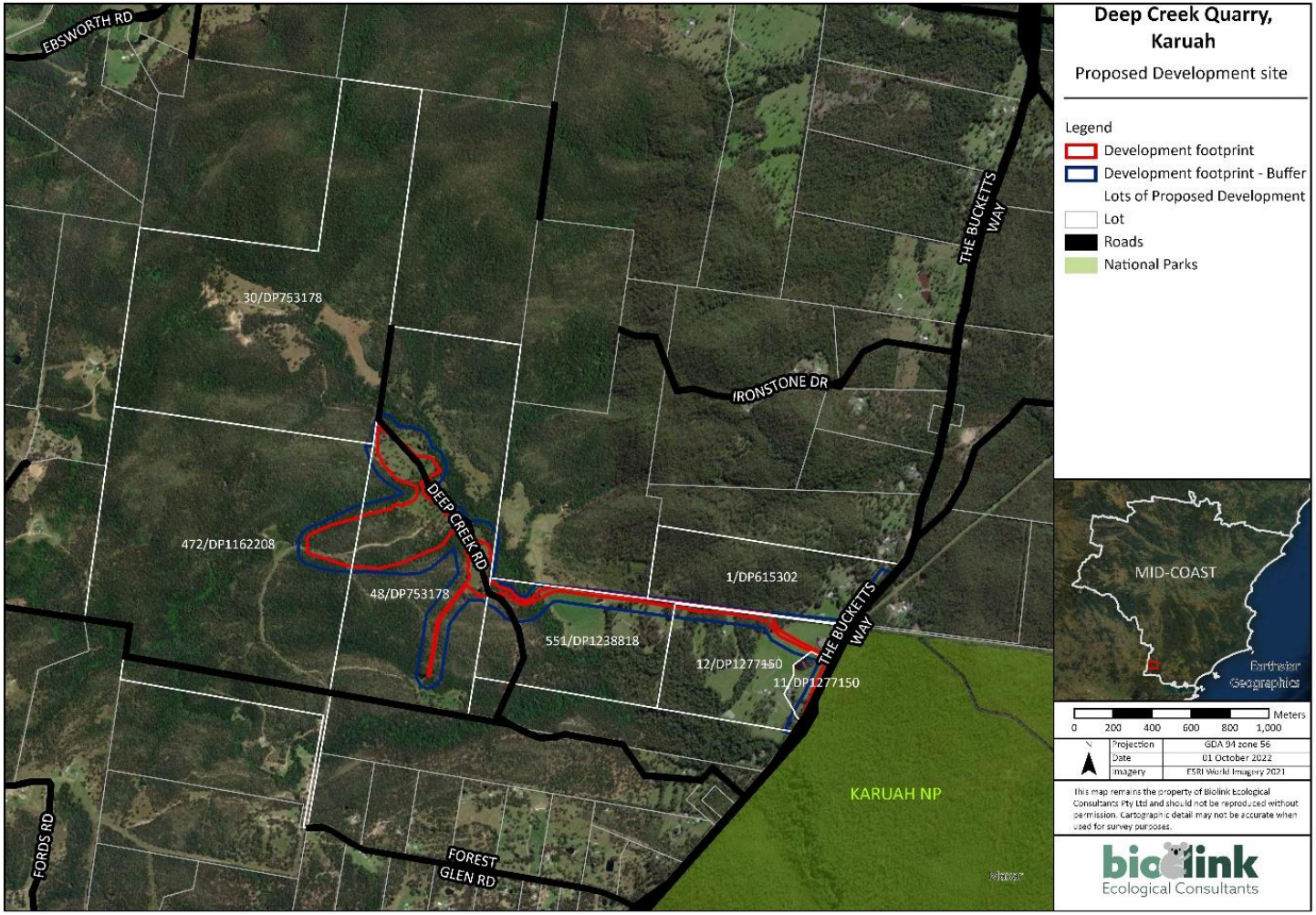

Figure 1. Location of proposed development footprint (red line) and associated buffer area (blue line) in the broader context of the seven proposed development lots (labelled and white line).

Formal survey effort was initially focussed on the area with the greatest potential for negative impact, that being the proposed quarry pit, the peripheral buffer area and immediately adjoining areas of habitat. To assist survey design, we overlayed this area with a 125 m grid projected in GDA 2020 and used the associated grid-cell intersections to create a series of potential sampling points. As outlined below, selection of this grid-cell size as a base underlay was intended to offer flexibility in design by offering a capacity to sample at different scales of resolution, while also contributing towards longer-term biodiversity management by offering a series of survey points for subsequent monitoring if required. Using this grid, survey effort for both koalas and NHM within this area was undertaken as follows:

a) Koala

We deployed the Spot Assessment Technique (SAT) of Phillips and Callaghan (2011) at 250 m intervals across the proposed quarry pit and immediately adjoining areas of habitat to assess the extent of habitat utilisation by koalas. Sites corresponding to this sampling intensity were subsequently selected from the 125 m grid, and coordinates for each of the resulting SAT sites were uploaded to handheld GPSs to assist location in the field. It was envisaged that koala activity within the focal area would be interpolated using regularised, thin-plate splining to model the extent of any habitat use.

Areas potentially impacted by the alignment of the proposed haul road were visually inspected for habitat use / elements such as the presence of the Preferred Koala Food Tree species (PKFTs) forest red gum *E. tereticornis*, tallowwood *E. microcorys* and grey gum *E. punctata*[1].

b) New Holland Mouse

To answer questions relating to NHM EoO, occupancy, and population density we deployed a grid-based survey design over two sampling events. As for koalas, the first event focussed on the proposed quarry pit and addressed the question of NHM abundance and occupancy therein, whereas the second event was based on a habitat-informed survey[2] that explored potential NHM occurrence in proposed offset areas. On both occasions locations for trapping stations were selected from the 125 m grid in an offset fashion to provide sampling intervals at ~ 150 m intervals. Universal Transverse Mercator coordinates for each trap station were uploaded to handheld GPSs to assist location in the field.

Trap stations comprised five Type A Elliot traps that were arranged by placing a centrally located trap at the site coordinates with outliers thereafter placed at distances of approximately 10 m along

[1] Includes taxonomically allied species *E. propinqua* and *E. canaliculata*

[2] Areas with similar habitat to that of NHM capture locations of the initial survey event, supported by those reported by the BDAR.

cardinal compass bearings (*i.e*. North, South, East and West) from the central trap to create an effective census area for each trapping station[3] of ~ 393 sq. m. Traps were baited with a combination of rolled oats, honey, peanut butter and white truffle oil. Trapping was undertaken over four consecutive nights, all captured animals being identified to species prior to immediate released at the point of capture. While the ears of some NHM were marked using a permanent marker, this proved to be unreliable in the damp field conditions; we consequently used the minimum number of known individuals known to be present at a given trapping station to calculate NHM population metrics.

The second survey event was timed to replicate as best as possible weather and lunar conditions of the first survey event, being a waning crescent immediately preceding a full moon. Because site occupancy by *Pseudomys* spp. is known to be negatively associated with the presence of species such as *Rattus fuscipes* (Pereoglou *et al*. 2016), we optimised the potential for NHM trap success by removing any trap that had captured a *Rattus* spp. or *Mus* and replacing it *in situ* with a clean trap. All traps were rebaited after the second night of trapping had been completed.

Results

Survey work was undertaken over the period 27/04/22 – 01/05/2022, and again for NHM over the period 22 – 26/08/22. Weather and lunar conditions over the period of the two survey events are summarised in **Table 1**.

Table 1. Weather and lunar conditions at Clarence town (Mill Dam Falls) during survey period.

	Wed (27/04)	Thu (28/04)	Fri (29/04)	Sat (30/04)	Sun 1/05)
1st survey					
Rainfall (mm)	-	1.00	-	-	1.8
Max temp (°C)	24.4	25.3	28.1	20.8	19.7
Min temp (°C)	13.9	16.2	15.6	16.6	10.5
Moon rise (hrs EST)	0229	0330	0430	0529	0628
	Mon 22/08	Tue 23/08	Wed 24/08	Thu 25/08	Fri 26/08
2nd survey					
Rainfall (mm)	-	-	2.4	1	1
Max temp (°C)	21.7	22.4	17.2	18.7	17.8
Min temp (°C)	4.7	10.5	7.6	6.1	10.5
Moon rise (hrs EST)	0257	0350	0437	0520	0557

a) Koala

[3] Assumes a 5 m radial catchment around each trap.

Seven SAT sites were assessed, five of which were located directly within the footprint of the proposed quarry pit, and two within the proposed quarry pit buffer. Floristic data, notably the presence of spotted gum *Corymbia maculata* and red bloodwood *C. gummifera* confirmed the presence of an overlaying low nutrient soil landscape across the greater proportion of the proposed quarry pit.

PKFTs were present in four of the seven sites that were assessed. Two of the seven sites contained evidence of habitat utilisation by koalas in the form of diagnostic faecal pellets, both returning measures of habitat utilisation indicative of transient use (*i.e.*, both returned koala activity levels of less than 10%) based on the activity thresholds[4] in Table 2 of Phillips and Callaghan (2011). The presence of a south-easterly trending koala activity gradient implied the likelihood of significant levels of habitat use by resident animals immediately to the south of the peripheral buffer area adjoining the quarry pit in the south.

Inspection along the alignment of the proposed haul road revealed a relatively sparse distribution of PKFTs such as grey gum and tallowwood (**Figure 2**). The locations of these tree species (and other PKFTs) should ideally inform final alignment of proposed haul road with a view to demonstrably maximising their retention.

Figure 2. Vegetation in that area of Deep Creek identified as for crossing by the proposed haul road. Note presence of individual tallowwoods (*E. microcorys*) in both images.

The locations and activity status of the sampled SAT sites are illustrated in **Figure 3**, including the results of interpolation, while the associated data summaries for each of the sites are provided in **Appendix 1**. Koala scats were observed opportunistically at two locations during the initial survey event, 240 m due west of SAT site 24 and 150m south-east of SAT site 43.

[4] The minimum activity threshold indicative of occupancy by resident populations in the East Coast Low category is now 10%.

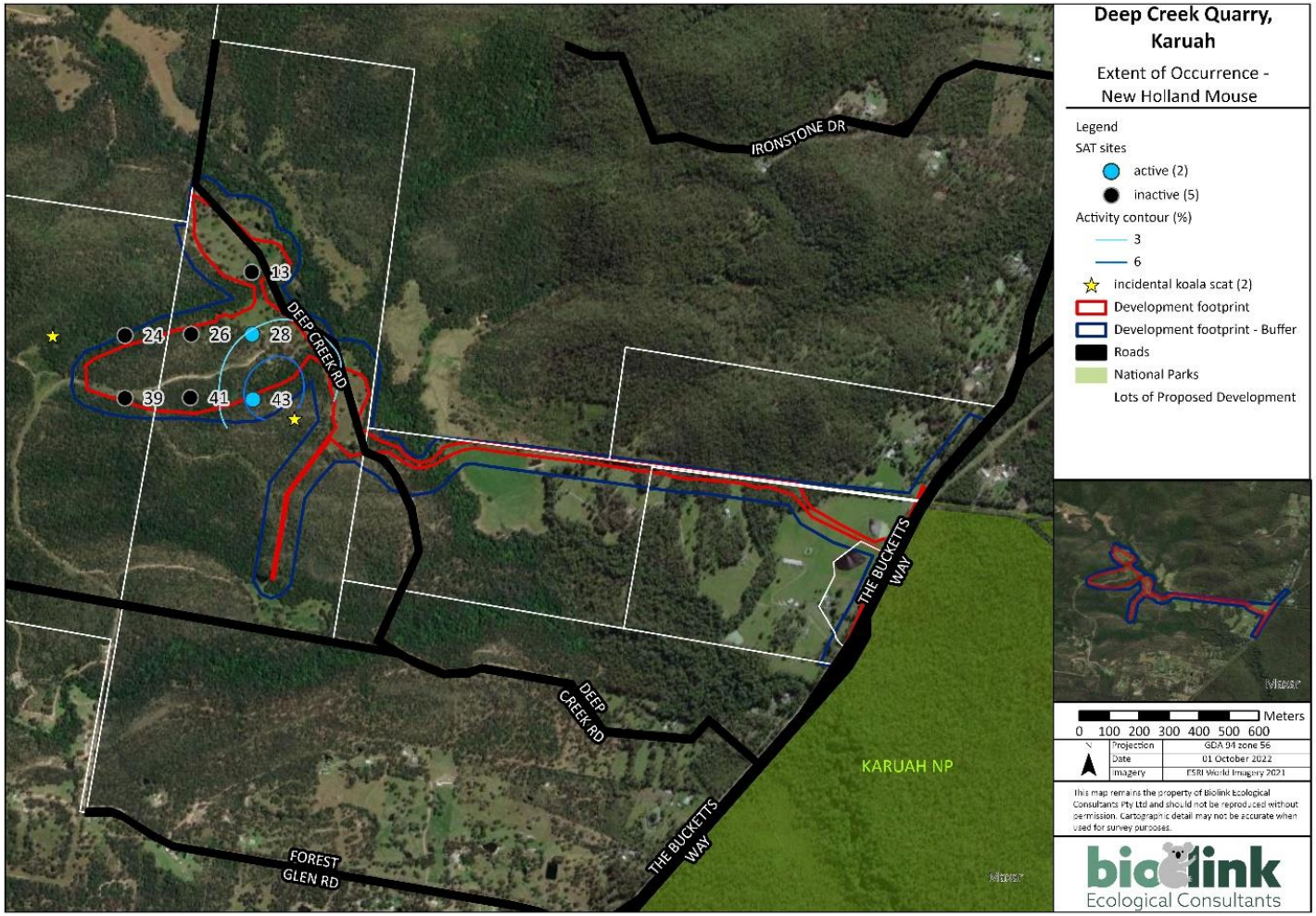

Figure 3. SAT survey outcomes from the proposed Deep Creek quarry pit, classified as inactive (black circles) (*n* = 5) or active (blue) (*n* = 2), based on the presence of diagnostic koala scats. Interpolated activity contours are also illustrated. Incidental scat locations (*n* = 2) recorded in the in the vicinity of the proposed quarry pit are denoted by yellow stars.

b) New Holland Mouse

Six hundred and twenty-six (626) trap nights were completed at 32 trap stations primarily distributed across the face of the proposed quarry pit during the initial survey event. Five hundred and sixty (560) trap nights were completed at 28 trap stations during the second survey event. Six species of terrestrial small mammal – brown antechinus *Antechninus stuartii*, new holland mouse *Pseudomys novahollandiae*, house mouse *Mus musculus*, *Rattus sp*., bush rat *R. fuscipes* and swamp rat *R. lutreolus* were captured over the period of the survey program.

Eight NHM captures of five known individuals were obtained during the initial field survey to yield a capture rate of 1.28 NHM captures / 100 trap nights. Eleven individual NHM captures were obtained during the second survey event to yield a capture rate of 1.96 captures / 100 trap nights. While trending higher, differences in the NHM capture rate between the two survey events were not statistically significant (t = -0.54512; 47_{df}; P (two-tailed) = 0.588).

Figure 4 illustrates the *smallest definable NHM Extent of Occurrence*[5] (hereafter referred to as the EoO) of 77.02 ha that can be identified based on the capture data from the two survey events; it is arguable that the on-site EoO is larger than what has been identified given the absence of systematic, grid-based survey effort across other areas of the site.

[5] A Minimum Convex Polygon connecting the outermost capture points that also includes a 75 m buffer to accommodate sampling uncertainty arising from the grid-based design.

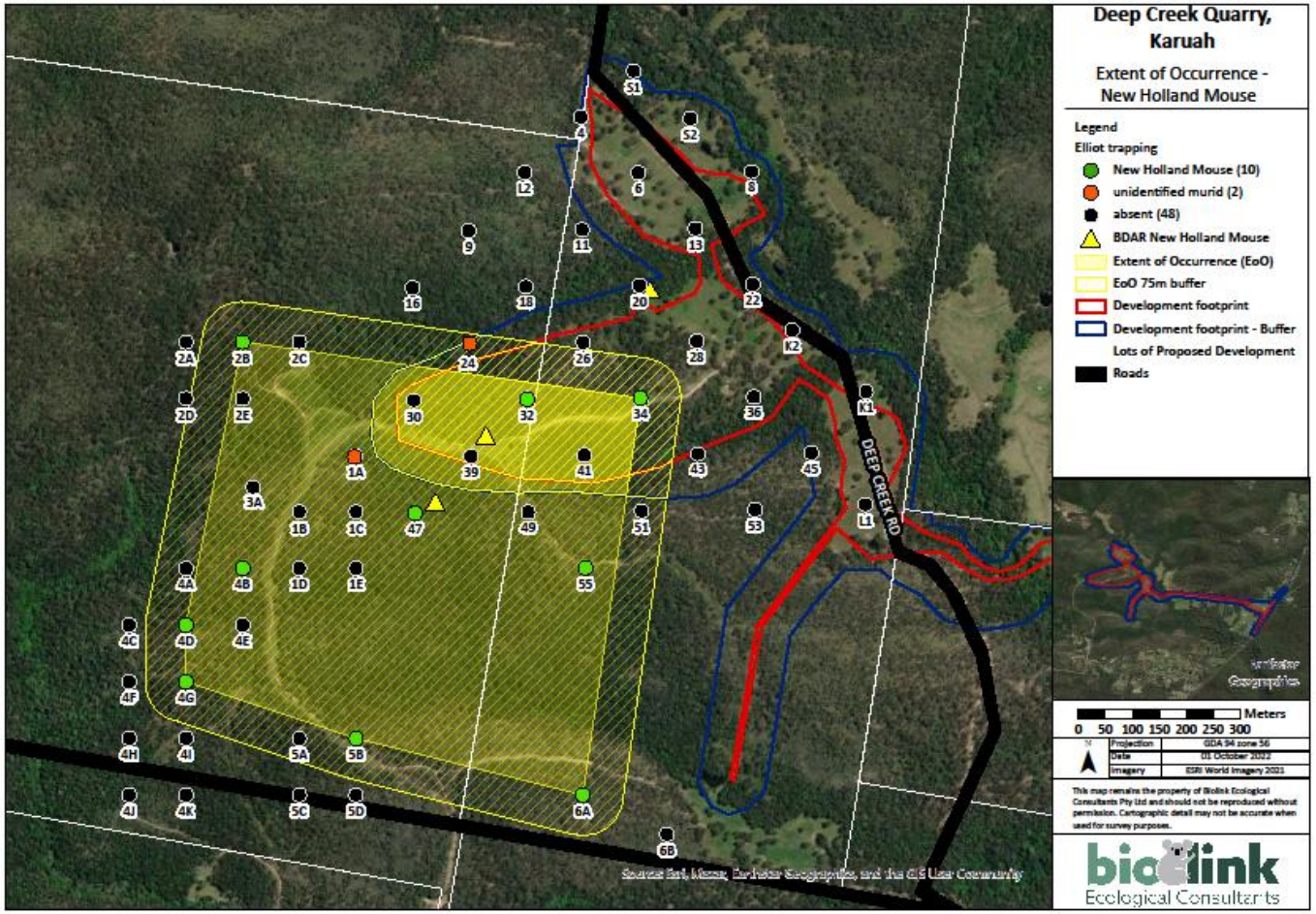

Figure 4. NHM trapping results in the area of the proposed Deep Creek Quarry pit and adjoining areas of habitat to the south, coded as NHM absent (black circles) (*n* =50) or present (green circles) (*n* = 10). The NHM Extent of Occurrence (yellow polygon) and associated buffer (yellow hatching) based on the two survey events is indicated. NHM records reported by the BDAR (yellow triangles) of Kleinfelder (2021) are also illustrated for context. The two sites at which the *Rattus sp*. were captured (orange circles) are also indicated.

Three individuals of an unidentified species of murid rodent were captured on two consecutive nights at trap station 24 near the northern western edge of the proposed quarry pit during the initial survey. This site was again surveyed during the second survey event and the same animals recaptured for further assessment. A further individual with similar features, including small size for a sexually mature female *Rattus* and a white blaze along the ventral surface, was captured at trap station 1A near the western boundary of the proposed quarry pit on the final night of trapping (26/08) (**Figure 4** refers). Attributes of the species include a body weight of approximately 60 gm, a strongly annulated tail the length of which was slightly greater than body length, silky fur and a mammary formula of 5:5. The annulated tail and mammary formula are generally consistent with members of the Genus *Rattus*. One of the individuals captured at trap station 24 is shown in **Figure 5**.

Figure 5. *Rattus sp*. from trap station 24. Note chestnut pelage, white vibrissae, white feet and larger body size (relative to NHM) (Photos: Kirsten Wallis). Refer to discussion for further information on the likely identity of this specimen.

Appendices 2 & **3** provide trap station coordinates and summaries of the small mammal capture data.

NHM density

NHM density data from the 27 trap stations within the EoO ranged from 0 – 6 NHM / trap station (0.393 sq. m.) and was not approximately normally distributed. Central tendency measures in the following calculations were thus determined using a Bernoulli-based approach whereby:

95% Confidence Interval of sample (CI) = 1.96 x sq. root of *pq*/*n* where

p = NHM density / trap station

q = 1 – p, and

n = sample size.

Number of trap stations	60
Effective trap station census area	393 sq. m.
Total area sampled by trap stations	2.36 ha
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NHM Extent of Occurrence	77.02 ha
Number of trap stations within EoO	27
Total area sampled by trap stations in EoO	1.06 ha
Number of known NHM individuals captured	16
NHM density / trap station within EoO	0.59 (95% CI: 0.40 – 0.78)
NHM density / ha within EoO	15.01 (95% CI: 10.18 - 19.85)
NHM population size within EoO	1156.07 (95% CI: 784.06 – 1528.85)

Numbers of NHM potentially impacted

EoO proposed quarry pit intersect	10.62 ha x 15.01= 159.41 (30 – 210.81)
EoO proposed quarry pit intersect + buffer	14.05 ha x 15.01 = 210.89 (143.03 – 278.89).

Discussion

Further survey work on the site of the proposed Deep Creek Quarry development has resulted in additional information regarding habitat use by koalas in addition to NHM population metrics.

As detailed in the BDAR by Kleinfelder (2021) evidence of koalas was detected across the proposed development area, including in the vicinity of the proposed haul road (opportunistic sighting, SATs and camera trap) and towards the southern edge of the proposed quarry pit (SAT). In terms of koalas, and as already acknowledged in the BDAR, the proposed development site is located within a known ARKS (Rennison & Fisher 2019; Biolink 2021); while it's eastern extent immediately adjoins an area of known koala generational persistence (Biolink 2017). For these reasons alone it is important that koala management actions on the site reflect best practice as befitting an area of Core Koala Habitat.

Preferred koala food trees represent a finite food resource for free-ranging koalas, more so in low nutrient / low koala carrying capacity habitat landscapes where larger individual koala home range areas reflect larger distances between individual PKFTs. This knowledge mandates a requirement for measures that can function to maintain connectivity by minimising fragmentation, maximise retention of PKFTs > 300 mm DBH and reduce to the maximum extent possible any potential for increase in vehicle-strike arising from the proposed haul road. Such measures that we would propose to be required are detailed further below as potential amendments to the KPoM that is currently provided as Appendix 10 of the BDAR by Kleinfelder (2021).

The NHM EoO determined by this study only captures two of the three NHM captures reported by Kleinfelder (2021). The outlier capture occurred near our trap station 20 which, as our capture data confirms by way of the presence of *R. fuscipes* (**Appendix 2** refers), presents with a mesic mid-stratum and sparse ground cover that would otherwise be considered atypical NHM habitat. For this reason, we are inclined to discount the earlier capture as perhaps an indication of transient use by NHM more than evidence of occupancy by a resident population cell, more so given that we did not capture NHM at this location despite the coincidental presence of a trap station at approximately the same locality at which the species was originally captured.

Notwithstanding the recent rediscovery of NHM in 2021 in Tasmania, the entire mainland Australia population of NHM has been estimated to be less than 10,000 individuals (Menkhorst *et al*. 2008). If this is true, then our reporting by way of this survey of a local NHM population of more than 1,000 individuals is significant but also warrants further discussion because of the challenge it presents to this earlier estimate. Other work by us (Biolink 2016) elsewhere in the MidCoast LGA also reported statistically identical NHM densities of 19 ± 9.8 (95% CI) NHM ha^{-1} on a 70-ha site near Forster. Because of this and given the widespread distribution of NHM records across the MidCoast LGA generally, we speculate that a population estimate for just this LGA alone will likely approximate or even exceed that of the Menkhorst *et al*. (2008) estimate, while also challenging some other long-standing paradigms about NHM ecology.

New Holland Mice are social animals that live in burrows (Kemper 1980; Lazenby *et al*. 2008), and because of this the species arguably requires greater consideration than may be afforded other larger and more widely distributed species. Contrary to statements in the originally submitted BDAR, neither are NHM a highly mobile species, nor do they appear to be uniformly distributed in areas of otherwise suitable habitat. The relatively large numbers of NHM likely to be impacted suggest that four management solutions are potentially available in the event that the development proceeds, the first being a significant modification of the proposed development footprint to effectively avoid the known

NHM EoO, or at least reduce the size of the proposed quarry pit to reduce to potential for negative impact to a level that is regarded as more sustainable at the local population level, the second to do nothing and seek approval based on an argument of progressive displacement of a relatively small proportion of the larger population, the third being development and approval of an on-site re-homing program that would see most of the affected NHM population moved to an alternative area of suitable but otherwise unoccupied habitat elsewhere in the immediate area, ideally within those areas currently proposed as offsetting / stewardship sites. The fourth option would see animals removed from the area to be impacted and translocated with a view to establishing a new population elsewhere within the region.

Regardless of which of the preceding four alternatives are adopted, the size of the NHM population inhabiting the proposed quarry pit and the potential impacts upon the species of development works in this area further supports the earlier referral to the Commonwealth for consideration as controlled action, as well as informing decisions relating to on-site management and/or future conservation assessments of this species. If development is to be approved and presuming that the first two options floated above are unacceptable (the first likely makes the proposal economically unviable, while the second contradicts a priority management action for NHM), we thus foresee either a well-informed on-site relocation or an approved translocation of the greater proportion of the impacted NHM population to alternative, unoccupied habitat areas elsewhere as the only ethical management responses. The success of such relocation or translocation as may be approved would be assisted by the relatively large numbers of NHM currently occupying the area to be impacted. In the context of translocation, we note that some precedent exists for this course of action given recent translocations of the species from the NSW central coast to the ACT in 2013[6].

The formerly unidentified murid rodent from trap station 24 is also of interest. Prior to this survey, we have captured an almost identical animal during field work in the Dalby area of south-eastern Queensland. Genetic profiling of the Dalby animal based on a tissue sampled collected during a subsequent survey event unambiguously placed it within the *Rattus tunneyi* (pale field rat) complex, but not aligned with either of the two currently recognised subspecies *R. tunneyi tunneyi* and *R. tunneyi culmorum* (unpub. data). We thus consider the anomalous individuals captured during this survey to be this same taxon (albeit currently undescribed), the results implying a potentially wide distribution that potentially extends from SE Qld. south to the Hunter River. Because of its similarity

[6] http://www.environment.act.gov.au/cpr/conservation-research/new_holland_mouse_-_returning_to_the_act

to sub-adult *R. fuscipes*, it is likely that specimens of this animal may have been more widely sampled but otherwise misidentified.

Recommendations

The following recommendations are proposed for consideration and further discussion:

1. Koala

- Stadia-metric survey of PKFTs along the proposed alignment of the haul road (*i.e*., currently proposed alignment and 20 m either side) should be provided so as to demonstrate that the loss of PKFTs > 300 mm DBH on non-alluvial soils, and all PKFTs > 100 mm DBH on alluvial soils has been minimised. Any unavoidable loss of PKFTs should be addressed via revegetation.

- Infrastructure along any final haul road alignment should include fauna exclusion fencing along the vegetated section of the straight road which is anticipated to run from the Bucketts Way to the base of the incline within the development footprint (between approx. UTH coordinates 398783 / 6397533 and 399673 / 6397416). This exclusion fencing should incorporate koala-grids at fence ends to enforce the exclusion area and the use of three dry box-culverts of sufficient dimensions (minimum 1.2 m x 1.2 m) to facilitate the under-road passage of koalas and other wildlife. Planting PKFT either side of the underpasses will enhance their long-term utility. Fencing, underpass and koala-grid specifications are provided in **Appendix 4**. The remainder of the straight road, which runs through cuttings in the vegetation, should be fenced with rural fencing at a minimum. It is anticipated that the section of road which follows the steep incline / decline in the development footprint is unlikely to sustain vehicles travelling at high speeds and therefore requires rural fencing at a minimum and the incorporation of wide speed humps and fauna signage.

- PKFTs represent a finite food resource for free-ranging koalas. As such, we recommend addressing the reduction in carrying capacity of the landscape which will result from the loss of PKFTs within the development area by focusing on increasing the extent of PCT 1567. This PCT has a higher carrying capacity than other PCTs, especially in alluvial landscapes.

2. New Holland Mouse

- The current BDAR will likely require redrafting to better reflect outcomes of this field survey, including acknowledgement that the NHM population may qualify as an important population for assessment purposes.

- Prior to any construction work on the site, an approved onsite relocation or offset translocation plans should be prepared as an appropriate response to longer-term management and monitoring of NHM on the site.

- High-resolution floristic / pedological and landscape data from the 10 NHM capture sites should be used to develop an optimum NHM habitat model to assist identification of potential sites for relocation / translocation

3. Conservation Areas

- Of the vegetation that will be remaining within any area approved for development, that classified as offset should be set aside in perpetuity using an accepted mechanism, while outside of such areas, remaining onsite native vegetation will require protection from indirect impact.

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Appendix 1

Koala SAT data

Site	Easting[7]	Northing	*Allocasuarina torulosa*	*Angophora costata*	*Casuarina glauca*	*Corymbia maculata*	*C. gummifera*	*Eucalyptus acmerniodes*	Eucalyptus punctata	*E. carnea*	*E. crebra*	*E. microcorys*	*E. resinifera*	*E. sideraphloia*	*E. tereticornis*	*Lophostemon confertus*	*Melaleuca nodosa*	Rainforest sp	A Stringybark	*Syncarpia glomulifera*	Scats	A/level	A/cat
13	397700	6398156		1			5			1		10	5	1					7		N	0	low
24	397276	6397944			11				3						3	1	1	11			N	0	low
26	397498	6397948	1	7		3	5			1			3						9	1	N	0	low
28	397701	6397948		11			15			1									3		Y	3.33	low
39	397276	6397735	5			4		3		6	1		1						3	7	N	0	low
41	397495	6397736	11			3		2	6	1	1	3		2					1		N	0	low
43	397704	6397730	6		1	2		2	5			1	2	7					1	3	Y	6.67	low

[7] UTM coordinates are GDA 2020

Appendix 2

Small mammal trapping program 27/04/2022 - 01/05/2022: field survey results

(Astu = *Antechinus stuartii*; Mmus =- *Mus musculus*; Pnov – *P. novaehollandiae*; Rfus = *Rattus fuscipes*; Rlut = *R. lutreolus*; Unid = unidentified species).

Site No.	Easting[8]	Northing	TN	Astu	Mmus	Unid	Pnov	Rfus	Rlut
4	397488	6398366	20						
6	397595	6398262	20		X				
8	397805	6398264	20	X	X			X	
9	397279	6398153	20					X	
11	397490	6398156	20	X					
13	397701	6398158	20		X				
16	397175	6398047	20						
18	397386	6398050	20	X				X	
20	397597	6398052	20	X				X	
22	397808	6398054	20	X				X	
24	397281	6397944	20	X		X		X	
26	397492	6397946	20	X					
28	397703	6397948	20	X					
30	397177	6397838	20	X					
32	397388	6397840	15	X			X		
34	397599	6397842	20	X			X		X
36	397810	6397844	20	X				X	
39	397284	6397734	20	X					
41	397494	6397736	21	X				X	
43	397705	6397738	20	X				X	
45	397916	6397740	20	X	X			X	
47	397179	6397628	20				X		
49	397390	6397630	20		X				
51	397601	6397632	20	X					
53	397812	6397634	20						
55	397497	6397526	20	X			X		
K1	398018	6397854	20						
K2	397881	6397969	20						X
L1	398017	6397644	15	X	X				
L2	397383	6398262	15						
S1	397586	6398452	20	X	X				
S2	397691	6398363	20	X					

Total Survey Effort	**626**

[8] UTM coordinates are GDA 2020.

Appendix 3

Small mammal trapping program 22/08/2022 - 26/08/2022: field survey results

(Astu = *Antechinus stuartii*; Mmus =- *Mus musculus*; Pnov – *P. novaehollandiae*; Rfus = *Rattus fuscipes*; Rlut = *R. lutreolus*; Rspp = unidentified *Rattus* sp.).

Site no	Easting[9]	Northing	TN	Astu	Mmus	Rspp	Pnov	Rfus	Rlut
1A	397070	6397736	20	x		x		x	
1B	396964	6397630	20		x				
1C	397070	6397630	20						
1D	396964	6397525	20					x	x
1E	397070	6397525	20	x				x	
2A	395066	6395627	20	x				x	
2B	396859	6397947	20				x		
2C	396964	6397947	20					x	
2D	396753	6397841	20						
2E	396859	6397841	20	x				x	
3	397280	6397946	20	x				x	x
4A	396753	6397525	20	x				x	
4B	396859	6397525	20	x			x		x
4C	396648	6397419	20	x				x	
4D	396753	6397419	20	x			x	x	
4E	396859	6397419	20	x				x	
4F	396648	6397314	20					x	
4G	396753	6397314	20	x			x		
4H	396648	6397208	20	x				x	
4I	396753	6397208	20	x					x
4J	396648	6397103	20	x				x	
4K	396753	6397103	20						
5A	396964	6397208	20	x				x	
5B	397070	6397208	20	x			x		x
5C	396964	6397103	20	x					
5D	397070	6397103	20	x				x	x
6A	397492	6397103	20	x			x	x	x
6B	397645	6397034	20	x					x

Total Survey Effort	**560**

[9] UTM coordinates are GDA 2020

Appendix 4

Exclusion fencing, underpass and koala-grid specifications

The following minimum measures are proposed based on management plans and associated monitoring programs we have undertaken.

1. Exclusion fencing

Chain mesh fencing with uprights at 3 metre intervals, minimum height of 1.5 m without 60 cm anti-climb sheeting at ground level.

2. Underpasses

If under-road traverse required of koalas is < 35m, reinforced box culvert dimensions of 1.2 m x 1.2 m (larger if possible) will suffice.

3. Koala grids

Koala-grids are constructed based on a typical cattle-grid design but otherwise use 50mm round pipe at 100mm centres. Provision should be made to install koala-grids at the end of each exclusion fence section and on any fence breaks required to afford access to properties adjoining the final haul road alignment.

A typical fence / koala-grid array is illustrated below: