Newcombe Road Sand Quarry: Ecology Report

Prepared for
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Executive summary

RS Sand Ltd (RS Sand) is applying to the Waikato Regional Council and Waipā District Council to establish and operate a sand quarry on a rural property at 77 Newcombe Road, Cambridge (the Site).

The quarry is proposed to extract and process up to 400,000 tonnes of sand from the pit area per year (depending on demand) for approximately 25 years.

This report provides an assessment of the ecological values of the site, the potential effects of the proposal on terrestrial and wetland ecological values, and measures required to address these effects.

The report is based on desktop and field investigations of the ecological values onsite. The assessment of effects has been undertaken in accordance with the Ecological Impact Assessment Guidelines (EcIAG) (EIANZ 2018). Guidance on the residual effects management measures likely to achieve No Net Loss (NNL) or Net Gain (NG) outcomes for indigenous biodiversity is provided through the application of Qualitative Biodiversity Models (QBMs).

In broad terms the site includes alluvial terrace, gully and floodplain habitats. Intensively grazed pastureland is the predominant vegetation type on alluvial terraces though mature stands of exotic trees are also present. Several gully systems incise the upper main terrace of the property. These gullies include exotic-dominated forest, exotic pine plantation forestry, exotic-dominated scrub and rank pasture grassland. Most gullies include gully seepage wetlands, and gully streams on site range from ephemeral to permanent in nature. The floodplain at the base of the gullies is dominated by exotic and rank pasture grasses but also includes riparian floodplain wetlands and a large gully basin wetland. All terrestrial vegetation types and wetland and stream habitats onsite support or may support nationally 'Threatened', nationally 'At Risk' or 'Regionally uncommon' species, most importantly the nationally 'Threatened' long-tailed bat.

None of the terrestrial vegetation or wetland habitats on the site are classified as Significant Natural Areas (SNAs). However, the Waipa District Significant Natural Area (SNA) assessment[1] has ranked two significant natural areas (SNAs) in close proximity. Moreover, the terrestrial vegetation types and wetland and freshwater habitat types with the highest ecological values are located outside the proposed project footprint. Nevertheless, the project is expected to have effects on a range of terrestrial and wetland ecological values, most importantly on long-tailed bats, the collective native forest fauna assemblage, and gully seepage wetlands.

Effects on these and other ecological values will be further avoided, remedied and mitigated through a range of measures. These measures centre on minimising the project footprint; undertaking vegetation clearance and earthworks outside of bird breeding season; adopting a bat roost tree felling protocol; salvaging and relocation operations for lizards and invertebrates; and providing bunding or native mitigation plantings.

Residual adverse effects that cannot be avoided, remedied or mitigated include the loss of 24.43 ha of variable quality habitat for long-tailed bats (most of which is low quality improved pasture), 3.06 ha of variable quality habitat for native terrestrial fauna and approximately 0.309 ha of gully seepage wetland habitat assessed as having 'Moderate' ecological value. The type and quantum of habitat loss corresponds to a 'High' level of residual effects for long-tailed bats, and a 'Moderate' level of residual effects for both native forest fauna and wetland habitat. Effects on all other terrestrial and wetland values were assessed as either 'Low' or Very Low'.

[1] Waipa District Plan 1 November 2016

Measures proposed to offset or compensate for residual effects on bats, wetlands and indigenous forest fauna include approximately 12.5 ha of habitat restoration and enhancement within terrestrial floodplain and gully habitat. Proposed revegetation will:

- Create additional habitat and ecological connectivity for bats and other native forest fauna along approximately 2 km of riparian margin, linking up two Significant Natural Areas; and
- Provide buffering and ecological connectivity for approximately 3.73 ha of floodplain and gully seepage wetlands through the native revegetation of associated wetland margins.

Proposed revegetation will begin in the first winter planting season following consent approval and well in advance of impacts, which will occur from 1 – 25 years following consent approval depending on staging.

To improve the likelihood that native plantings will persist in the long-term, the plantings should be protected from livestock browsing through stock exclusion fencing and a 20-year weed control programme. Infill planting is also recommended as required, as is felled log deployment into revegetation sites.

In conclusion, we consider all potential adverse effects to be adequately addressed. A NNL / NG outcome for key biodiversity values is expected to be achieved within 10 years of project impacts within each location.

1 Introduction

1.1 Background

RS Sand Ltd (RS Sand) is applying to the Waikato Regional Council and Waipā District Council to establish and operate a sand quarry on a rural property at 77 Newcombe Road, Cambridge (the Site).

The Site is located on three records of title which have a total area of 134.67 hectares, although the quarry is only proposed on approximately 27 hectares in the western portion of the properties. The quarry is made up of a 23 hectare pit area towards the western boundary and a 4 hectare plant area (for processing and stockpiling) to the east of the pit.

1.2 Project description

1.2.1 Overview

The pit area is estimated to contain 7,409,700 tonnes (4,116,500m3) of sand resource, comprising a mixture of pit sand and concrete sand. The quarry is proposed to extract and process up to 400,000 tonnes of sand from the pit area per year (depending on demand) for approximately 25 years, based on the following stages:

- Stage 1. Years 1 to 1.7 2.7ha 495,000 tonnes (275,000m^3).
- Stage 2. Years 1.7 to 6.1 3.4ha 1,327,500 tonnes (737,500m^3).
- Stage 3. Years 6.1 to 13.9 6.6ha 2,346,300 tonnes (1,303,500m^3).
- Stage 4. Years 13.9 to 20.7 5.2ha 2,049,300 tonnes (1,138,500m^3).
- Stage 5. Years 20.9 to 25 5.1ha 1,191,600 tonnes (662,000m^3)

Excavations of the pit area will begin 10-15m from the Karapiro Stream and move towards Newcombe Road. The stages are approximately 120m wide and will excavate approximately 35m below the existing ground level of the existing terrace. The bottom floor of the pit area will be approximately 10m above the level of the Karapiro Stream bank. An internal haul road will link the pit and plant areas.

The proposed plant area includes a processing plant (approximately 6m high and 20m wide) towards the middle of the area and a water recycling pond towards the north. The plant building will use and discharge water to and from the recycling pond to grade the sand with spirals, screens, conveyors, and pumps on multiple levels. Graded sand will be stockpiled around the plant area. The southwestern portion of the plant area will contain an office and breakroom building, maintenance workshop, car parking, weighbridge, and wheel wash facility.

These project activities are expected to have effects on terrestrial and wetland ecological values. While permanent and intermittent streams are present onsite, direct impacts on these streams and associated freshwater ecological values have been avoided.

1.2.2 Access

Access from Newcombe Road to the quarry will be provided via a new vehicle crossing approximately 150m to the west of the Site's existing access and 660m from the Newcombe Road – Tirua Road intersection.

For Stages 1–4 (Years 1–20.2), a 20m wide internal road will be constructed from the new vehicle crossing to the weighbridge and stockpiling area. The road will initially be positioned over Stage 5 to limit the impact on the existing dairy farm and dwelling on the Site. For Stage 5 (Years 20.2–25), the internal road will be realigned to the south to provide access to the sand beneath Stage 5.

1.2.3 Establishment

To establish the quarry, the top 2m of ground of the plant area will be stripped to form a level and stable platform, while the top 7.5m of Stage 1 will be stripped to access the sand beneath. Excavations to strip the plant area will be a minimum of 6m from the Transpower pylon. The stripped material is assumed to comprise of 50% overburden and 50% pit sand.

Overburden from the plant area will be used to form bunding along the western and southern boundaries of the pit area, the eastern boundary of the plant area and the internal access road from Newcombe Road to screen the activities. The bunds will be approximately 3m high in relation to existing ground level (5m above the stripped base of the plant area) and 8m wide and will be planted with vegetation capable of growing up to 2-3m high.

Topsoil and some overburden from Stage 1 will be placed along the northern boundary of Stage 2 up to 5m high (in relation to existing ground level) and re-grassed for screening and storage for the future reinstatement of Stage 1.

Pit sand excavated to form the land area and Stage 1 will be (where necessary) processed and stockpiled at the processing area and sold.

1.2.4 Operation

The quarry is proposed to operate for up to 50 weeks of the year on the following basis:

- Monday to Friday – 7:00am and 5:00pm.
- Saturday – 7:00am and 12:00pm.
- Sundays and public holidays – Closed.

A 30-50 tonne excavator will be used to extract sand from the pit area, while 30-40 tonne articulated dump trucks will transport the sand to the plant area via the internal pit road.

An average of 71 trucks per weekday and up to a maximum of 200 trucks could visit the site on the busiest day (depending on the demand for sand).

Quarry Management, Dust Management, Erosion and Sediment Control, and Traffic Management plans will be used to avoid, remedy, and mitigate the operational effects of the quarry.

The following maintenance plan will be undertaken on Newcombe Road for 3 years.

- Rut filling and pothole repairing (Annually).
- Flushing of the chip seal and localised watercutting.
- Rehab proposal based on 25 year design life.

1.2.5 Water Take

Extraction of groundwater is required to operate the plant and suppress dust associated with the proposed quarry. The required daily take is likely to be a maximum of 1,2001,100m3, which results in an annual groundwater take of 290,000m3.

The groundwater take sought considers the percentage of areas expected to open at any one time and comprises of the following:

- 600m^3 water per day at 29 litres per second for the plant building.

- 500m^3 water per day for dust suppression of the plant area (Stage 4 and internal roads being the greatest area open).

1.2.6 Rehabilitation

As excavations progress through the stages, the floor (beyond a working area of approximately 50m wide) and faces of the pit will be reinstated with overburden and topsoil and re-grassed. The eastern pit faces of Stages 2 and 3 will be temporarily re-grassed as they will be excavated to access Stage 5.

1.2.7 Ecological Mitigation and Compensation

- 1.2 ha of native mitigation planting will be undertaken along the northern boundary of the site which is aimed to reduce the potential for adverse effects on adjacent wetlands.
- 12.5 ha of habitat restoration and enhancement will be undertaken within the Karapiro stream floodplain and associated gully slopes along the northern boundary of the site to:
  - Create additional habitat and ecological connectivity for bats and other native forest fauna.
  - Link two Significant Natural Areas.
  - Provide buffering and ecological connectivity of floodplain and gully seepage wetlands through the native revegetation of associated wetland margins.
- The restoration, enhancement and planting areas will be fenced to exclude livestock and managed to control pest species (both fauna and flora).

1.3 Report Purpose and Scope

Alliance Ecology Ltd has been engaged by RS Sands[2] to prepare an ecological assessment of effects associated with the proposed sand quarry to inform the Assessment of Environmental Effects (AEE) and accompany the resource consent applications. To this end, the report:

- Describes the existing terrestrial, wetland and freshwater ecological characteristics and values
- Describes ecological effects on these values that are expected to result from construction and operation after recommended measures to avoid, remedy or mitigate effects are undertaken
- Provides recommendations for addressing residual effects (where required)
- Presents an overall conclusion on the level of actual and potential ecological effects of the project after all recommended effects management measures have been undertaken.

The overarching objective and intended outcome for this project is to address adverse effects on indigenous biodiversity that cannot be avoided, remedied or mitigated, to a No Net Loss (NNL) or preferably Net Gain (NG) standard. This approach broadly aligns with Waikato Regional Council's objectives and policies for indigenous biodiversity as set out in the Waikato Regional Policy Statement[3].

[2] This report has been prepared in accordance with the terms and conditions set out in the proposed Offer of Service dated 11 January 2021.
[3] The Waikato Regional Policy Statement. Waikato Regional Council May 2016 (updated December 2018).

2 Methods

2.1 Desktop investigations

A desktop review was undertaken to inform the methodology and approach to the ecological assessment and to determine the wider ecological context of the site. The review included published and unpublished reports and papers, and records from the following databases:

- Waikato Regional Council biodiversity layer (2012) and aerial imagery of the site to assess habitat suitability for terrestrial fauna;
- Waipa District Council intramaps;
- NZ Herpetofauna Atlas Webmap;
- Historical records of bat presence from the New Zealand bat distribution database (DOC);
- New Zealand Plant Conservation Network Database (NZPCND); and eBird database; (https://ebird.org);
- New Zealand freshwater fish database (NZFFD, NIWA, 2018); and
- Ministry for the Environment (MFE), 2020. Wetland delineation protocols (WDP).

2.2 Field investigations

2.2.1 Overview

General field investigations were undertaken on 13 and 14 January 2021 to characterise and map terrestrial, wetland and freshwater values within the project footprint and surrounds. These investigations included:

- Characterisation of plant species dominance and composition within terrestrial and wetland vegetation types including the application of Wetland Delineation Protocols (MFE 2020) (see Section 2.2.2 below for further detail).
- Biodiversity condition assessments associated with potential impacts such as browsing pressure and weed infestation.
- Habitat assessments for forest and wetland birds, lizards, and invertebrates with a focus on the presence or potential presence of nationally 'Threatened' or 'At Risk' species. Specific long-tailed bat surveys using Automatic Bat Monitors (ABMs), were undertaken by Blue Wattle Ecology Ltd from December 2019/January 2020 and from May to June 2020 prior to the field investigations described above. The associated Bat Report, including a description of survey methods, is provided in Appendix B.
- Classification of streams based on the Waikato Regional Plan definitions for farm canals, ephemeral streams, perennial streams and permanent streams.
- Assessment of options and recommendations for effects avoidance and mitigation.
- Assessment of options and recommendations for addressing any residual effects that cannot be avoided or mitigated, through habitat restoration and enhancement.

2.2.2 Wetland assessments

All areas of potential wetland within or potentially affected by the proposed project footprint were assessed in accordance with the WDP (MfE, 2020) to determine the presence and extent of wetlands.

The WDP sets out the methods for classifying and delineating freshwater wetlands based on vegetation, soil and hydrological characteristics. This document refers to Clarkson et al. (2014) and Fraser et al. (2018) respectively for vegetation and wetland (hydric) soil assessment methods. The protocol notes that the hydrology tool is currently under development, but many of the main hydrology indicators of the US system (e.g., observation of surface or ground water) are directly applicable. In accordance with the WDP the presence and relative abundance of all species was estimated, within all potential wetlands.

All areas were assessed as wetlands where plant species that are associated with wetland soils were common. The wetland plant categories in Clarkson *et al*. (2014) used within this assessment were:

- Obligate (OBL): species that occur almost always in wetlands (estimated probability > 99 % in wetlands);
- Facultative Wetland (FACW): species that occur usually in wetlands (67 – 99 %);
- Facultative (FAC): species that are equally likely to occur in wetlands or non-wetlands (34 – 66%);
- Facultative Upland (FACU): species that occur occasionally in wetlands (1 – 33 %); and
- Upland (UPL): species that rarely occur in wetlands (< 1%).

Where the vegetation present within the defined wetland area across all strata[4] was dominated by species that are classified as OBL or FACW species, the area was confirmed to be a wetland.

If the wetland was not exclusively dominated by OBL or FACW species then a further dominance test was applied. To pass the dominance test, the most abundant plant species that immediately exceed 50% of the total cover for each stratum (plus any additional species comprising 20% or more of the total cover for the stratum) must be OBL, FACW, or FAC. If the most dominant species were OBL or FACW then the dominance test was satisfied and the presence of a wetland was confirmed. Conversely if all or most of the dominant species were FAC then further testing was required to determine if the area was a wetland.

In such instances and as per the WDP, we used the Prevalence Index (PI) test. The Prevalence Index (PI) is a plot-based algorithm derived from the unique combination of OBL–UPL plants and their percentage cover. For the PI, OBL species are assigned a score of 1, FACW species a score of 2, FAC species a score of 3, FACU species a score of 4 and UPL species a score of 5. Correspondingly an area with a PI <3.0 is deemed to be a wetland and an area >3.0 is not. Additionally, if prevalence assessment was required, hydric soil testing and a hydrological assessment was also undertaken in accordance with protocol set out in Fraser et al. 2018 and the US Army Corp of Engineers (1987), respectively.

Following confirmation of 'wetland' status, further assessment was undertaken to confirm the status of the wetlands as 'natural' as defined under the National Policy Statement for Freshwater Management 2020 (NPS FM). Specifically, if it was apparent that the wetland was constructed for a specific function in accordance with the latest guidance from the Ministry for the Environment (MfE)[5], then it was deemed to be a constructed wetland. Natural wetlands included all wetlands that

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[5] Essential Freshwater Interpretation Guidance: Wetlands Definitions as set out in the Ministry for the Environment's exposure draft dated 7 April 2021 (MfE 2021).

did not meet the definition of a constructed wetland as set out in this MfE guidance, irrespective of the degree of modification or inducement through anthropogenic land use activities.

In addition to the wetlands that were expected or likely to be affected by the proposed project, wetlands that were present onsite but unlikely to be adversely affected by Project activities were identified through aerial imagery and a rapid site assessment. This approach likely underestimated the number and spatial extent of wetlands present on the site, as smaller wetlands were likely to be missed, as were those unable to be detected on aerial imagery. This is expected to be inconsequential to the overall assessment of effects because the worst-case scenario is that the benefits to wetlands associated with the proposed offset/compensation package will be understated.

2.3 Assessment of Ecological Effects

An assessment of ecological effects was undertaken in accordance with the Ecological Impact Assessment Guidelines (EcIAG) (EIANZ, 2018)[6]. These guidelines provide a systematic, consistent and transparent framework for undertaking assessment of effects, while also providing for professional judgement and flexibility where appropriate.

As outlined in the following sections, the guidelines have been used to determine:

- **Step 1**: 'Ecological value'
- **Step 2**: The 'Magnitude of Effect' of the proposed activity on the environment
- **Step 3**: The overall 'Level of Effect' after recommended efforts to further avoid, remedy or mitigate for effects.

2.3.1 Step one: Assigning ecological value

'Ecological values' were assigned on a scale of 'Negligible' to 'Very High' based on species and habitat values, using criteria in the EcIAG (see Appendix C, Tables 1 – 3).

2.3.2 Step two: Assessing the magnitude of effects

The 'Magnitude of Effect' is a measure of the extent or scale of the effect of an activity and the degree of change that it will cause after measures to avoid, remedy or mitigate for effects.

The 'Magnitude of Effect' after efforts to avoid, remedy or mitigate for effects was scored on a scale of 'Negligible' to 'Very High' (Appendix C, Tables 4– 5) and was assessed in terms of:

- Spatial scale of the effect;
- Duration and timescale of the effect;
- The relative permanence of the effect;
- Timing of the effect in respect of key ecological factors; and
- Level of confidence in understanding the expected effect.

2.3.3 Step three: Assessing the level of effects

An overall 'Level of Effect' (after efforts to avoid, remedy or mitigate for effects) was identified for each habitat/fauna type using a matrix approach. This approach combines the ecological values with the magnitude of effects resulting from the activity (Appendix C, Table 6).

[6] Environment Institute of Australia and New Zealand Inc. (2018). Ecological Impact Assessment (EcIA). EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd Edition.

The matrix describes an overall ‘Level of Effect’ after efforts to avoid, remedy or mitigate effects on a scale from ‘Very Low’ to ‘Very High’. This ‘Level of Effect’ is then used to guide the extent and nature of measures to demonstrably offset and/or compensate for residual effects.

These offsetting or compensation measures are considered necessary where the level of effects is assessed as ‘Moderate’ or higher. However, a level of effects deemed to be ‘Very High’ may not comply with the ‘Limits to offsetting’ principle (Section 5.6 below).

3 Ecological Characteristics and Values

3.1 Ecological context

The site is situated just east of Cambridge, which lies within the Eastern periphery of the Hamilton Ecological District (approx. 160,000 ha) (Appendix A, Figure 1).

The geological characteristics and soils in the Hamilton ED are largely influenced by the presence of the Waikato River and associated tributaries. Evidence from soil core samples and pollen analysis suggests that historically, most of this area was once covered in conifer-broadleaf forest (Newnham *et al.*, 1989) with the ranges to the west dominated by broadleaf forest and podocarp forest to the east of the Hamilton basin. In the steeper and hillier regions, rimu/tawa forest with emergent hardwood, broadleaf species formed the second tier and a ground cover of ferns would have been typical. Kahikatea semi-swamp forest would have been dominant in the wetter, low-lying areas with extensive wetland and peat bog systems (Clarkson *et al.,* 2007). Mixed conifer-broadleaf forest would have grown on the slightly elevated mounds and ridges. The well drained terraces adjacent to the Waikato River and associated tributaries would once have been totara-matai-kowhai forest.

Large areas of forests have been cleared and wetlands drained both pre- and post-European settlement (Newnham *et al.*, 1989). Much of the area has been converted to farmed pasture and residential property with only a handful of original forest and wetland habitats remaining. Most of these remaining areas of indigenous vegetation are small and fragmented. Leathwick *et al.* (1995) calculated the decline in indigenous vegetation since 1840 and current percentage cover. Since 1840, the Hamilton ED has had a 97.77 % reduction in indigenous vegetation. Percentage cover of indigenous vegetation in 1995 was about 1 % forest and less than 1 % scrub and wetland for the entire Hamilton ED.

Multiple threatened species are found within the Hamilton ED. The nationally threatened long-tailed bat (*Chalinolobus tuberculatus*) has been recorded throughout the area. Threatened lizard species include the Pacific sticky-toed gecko (*Hoplodactylus pacificus*), Auckland green gecko (*Naultinus elegans*) and speckled skink (*Oligosoma infrapunctatum*), which have been recorded near the western margins. Mobile bird species such as the ‘At risk’ North Island kaka have been recorded near the south-eastern margins, near Cambridge and the southern suburbs of Hamilton city. Multiple threatened bird species, as classified in Robertson *et al.* (2016), are found in lake, wetland and peat bog habitats within the district. The Hamilton ED is also home to numerous threatened fish species as identified in Allibone *et al.* (2009).

The NIWA FFDB indicates the presence of shortjaw kokopu (*Glaxias postvectis*) and lamprey (*Geotria australis*), both classified as ‘Threatened-nationally vulnerable’, and longfin eel, inanga, giant kokopu (*Galaxias argenteus*), torrentfish and black mudfish (*Neochanna diversus*), all classified as ‘At risk-declining’ within 20 km of the site.

The Hamilton ED has multiple protected areas that are managed by private landowners, local district councils and the Department of Conservation (DOC). Significant habitats for indigenous fauna also exist outside of areas of indigenous vegetation (e.g. long-tailed bats in exotic tree stands; black mudfish populations in highly modified drains and willow wetlands).

3.2 General site description

The 134.67 ha Site is situated at 77 Newcombe Road, Cambridge and is approximately 3 km due East of the Cambridge town (Appendix A, Figure 1).

The site is situated on alluvial terrace and flood plains of the Karapiro Stream, which is likely a former tributary of the Waikato River. None of the habitats on the site are classified as Significant

Natural Areas (SNAs). However, the Waipa District Significant Natural Area (SNA) assessment[7] has ranked two significant natural areas (SNAs) in close proximity (Appendix A, Figure 1):

- **SNA WP366**: Karāpiro Stream, Thornton Road riparian willow wetland (unprotected) (20m from the northwestern site boundary)
- **SNA WP379**: Karāpiro - Cambridge, Waikato River riparian shrubland remnants (unprotected) (120m from the northeastern site boundary).

These two SNAs are characterised by the riparian protection values they provide for a number of nationally at risk and threatened fauna species, including native fish species and long-tailed bat (Deichmann & Kessels 2013)[8]. Long-tailed bats are a nationally threatened species with the highest threat category assignment of 'nationally critical' (Townsend et al. 2008).

Intensively grazed pastureland is the predominant vegetation type on the alluvial terrace of the site with three stands of mature exotic trees found along the entrance driveways and around buildings near Newcombe Road.

Several gully systems incise the upper main terrace of the property, leading to the lower flood plain through which the Karapiro Stream flows along the northern boundary of the site (Appendix A, Figure 1). These gullies include exotic-dominated forest, exotic-dominated scrub and rank pasture grassland but also include small pockets of native terrestrial vegetation to varying degrees. Most gullies include gully seepage wetlands (Appendix A, Figure 1) and most gully streams on site are ephemeral in nature. Several gullies to the East of the footprint include permanent streams.

Broad habitat descriptions of these gullies (see Appendix A, Figure 1 and Appendix F for representative site photographs) are as follows:

Gullies within or immediately adjacent to the project footprint (West to East)

- Gully A is dominated by exotic plantation forest, exotic-dominated forest and exotic scrub. The exotic-dominated forest also includes small patches of native tree fern. Gully A is also likely to include wetland seeps. At the toe of this forested area, situated between the forest and the Karapiro Stream, is a relatively large basin, dominated by a mosaic of willow and rough pastureland, also including wetland habitat with patches of native sedges[9].
- Gully B includes pasture, exotic-dominated forest, and gully wetland seeps with a small stretch of intermittent or ephemeral stream between these seeps. An overland flow path is present at the bottom of the gully.
- Gullies C and D are both in pasture but include a gully wetland seep. Both gullies included evidence of an overland flow path/ephemeral stream.
- Gully E includes pasture and exotic-dominated forest. There was no permanent stream or evidence of a defined stream channel within this gully though there was evidence of an overland flowpath/ephemeral stream.
- Gully F is well vegetated and dominated by mixed native/exotic forest with a smaller proportion of exotic-dominated forest. The gully is heavily impacted by invasive weeds, It includes a permanent stream and is also likely to include wetland seepages. Gully F is outside but immediately adjacent to the project footprint).

A steep bank which drops from the main upper farm terrace some 40-50m down to the Karapiro Stream is in pasture, aside from vegetation contained within the gullies.

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[7] Waipa District Plan 1 November 2016

[8] Deichmann, B & Kessels, G. 2013. Significant Natural Areas of the Waipa District: Terrestrial and Wetland Ecosystems. Kessels & Associates Ltd for Waikato Regional Council: Technical report 2013/16

[9] Part of Gully A could not be accessed due to dominance of dense blackberry

The floodplain area at the bottom of the gully is dominated by rank and improved pasture grassland but also includes a large willow-dominated gully basin wetland and several exotic dominated floodplain wetlands. Whilst dominated by exotics, both the gully basin wetland and floodplain wetlands include smaller native-dominated patches. The Karapiro stream sits within the floodplain and is approximately 3-5 metres in width.

All terrestrial and wetland habitat types are subject to the effects of livestock, invasive weeds and introduced mammalian predators and browsers.

3.3 Vegetation/habitat characteristics

Specific vegetation/habitat types and recorded plant species within each of these habitat types are provided in Table 3.3 below. Representative landscape and habitat photos are provided in Appendix F.

Table 3.3. Vegetation/habitat types within or immediately adjacent to the project footprint (see Appendix F for representative site photos).

Habitat/vegetation type	Areal extent/ location	Description of habitat/vegetation types and identified plant species (no threatened plants were identified[10])
Mixed native/exotic forest	Gully F only	Even mix of native and exotic dominated forest habitat. Patches of native forest dominated by mahoe, treefern (mamaku and silverfern) but also includes cabbage tree and karamu (*Coprosma robusta*) and patches of exotic-dominated forest. Mixed exotic forest dominated by crack willow, poplar or grey willow. Also includes English privet, Eastern buckthorn, and hawthorn.
Exotic pine plantation forest	Gully A only	Exotic pine is approximately 20 – 25 years old with sparse understory. Ground cover dominated by bare earth and pine needles and several exotic species, most notably tradescantia.
Exotic dominated forest	Gully, A, B, E, and F	Exotic forest dominated by crack willow, poplar or grey willow. Also includes English privet, Eastern buckthorn, and hawthorn. In Gully A, exotic dominated forest also includes small patches of native treefern (mamaku and silverfern) that comprise approximately 7% of the exotic dominated forest in this gully. Other native species recorded in exotic-dominated forest type include cabbage tree, *Muehlenbeckia australis*, karamu, waterfern, shaking brake fern and rasp fern.

[10] A number of plant species in the Myrtaceae family are potentially present onsite but outside the project footprint (most likely in Gully B). This includes common species such as kanuka, manuka and several species of climbing rata. These species have been assigned a threat status in accordance with the New Zealand Threat Classification System based on the potential impact of myrtle rust, a serious fungal disease that affects plants in the myrtle (Myrtaceae) family.

Habitat/vegetation type	Areal extent/ location	Description of habitat/vegetation types and identified plant species (no threatened plants were identified[10])
Exotic dominated scrub	Gully A only	Mixed exotic scrub is dominated by blackberry, Chinese privet, exotic bindweed, gorse, pampas, Himalayan honeysuckle, Japanese honeysuckle raspberry, inkweed, exotic broom. Native species present include *Coprosma robusta, Muehlenbeckia australis*, rasp fern and bracken fern.
Pasture	Terrace, floodplain and gullies	Improved and rank exotic pasture grassland
Gully seepage wetlands	All gullies	Dominated almost exclusively by native *Carex geminata* but may also include crack willow, grey willow or pampas and *Juncus effusus*. See Appendix D for WDP assessments.
Gully basin wetlands	Gully A (*outside but adjacent to the project footprint*)	Most of this wetland is dominated by grey or crack willow but in wetter areas at the toe of the gully the wetland is dominated by native *Carex virgata* and *Carex geminata* These low stature native-dominated wetland areas make up around 20 – 25% of the wetland area (see Appendix D for WDP assessments). See Appendix D for WDP assessments.
Floodplain wetlands	Along Karapiro Stream (*outside but adjacent to the project footprint*)	Floodplain wetlands are dominated by native *Carex geminata* and exotic *Juncus effusus, mercer grass, Yorkshire fog and willow weed*. See Appendix D for WDP assessments.
Permanent streams	Gully B (*outside but adjacent to the project footprint*)	This stream was not assessed for instream values as it was considered highly unlikely to be impacted by the project due to catchment topography
Likely ephemeral streams or overland flowpaths	All gullies	Not applicable

3.4 Fauna

The presence, likely presence or potential presence of native birds, lizards, invertebrates and fish that are classified as nationally 'Threatened' or 'At Risk', regionally uncommon or that are otherwise legally protected under the Wildlife Act (1953) was assessed based on a combination of field observations and assessments of habitat suitability for a range of species.

Importantly, the site is known to support long-tailed bats (Appendix B), which are classified as 'Threatened- Nationally Critical'. The site may also support up to six nationally 'Threatened', 'At Risk' or regionally uncommon birds, two species of regionally uncommon invertebrates and two species of nationally 'At Risk' or 'Regionally Uncommon' fish (Table 3.4).

Table 3.4. Nationally 'Threatened' 'At Risk', 'Regionally Uncommon' or common legally protected species that are likely or known to be present on site

Species	Threat status (NZ Classification system)	Habitat suitability and likely population characteristics of the site.
Long-tailed bat	Threatened (Nationally Critical)	See bat report, Appendix B. In summary, based on habitat assessments and survey results: The site includes a variety of structural and ecosystem traits that provide habitat for bats, including mature linear stands of trees and deeply incised gullies. It lies close to the Karapiro Stream and the Waikato River, where insects tend to aggregate at dusk and dawn, and where mature trees with cavity- bearing qualities for roost are situated in relative shelter from wind. The most important of these habitat features are likely to be the vegetated gullies leading to the Karapiro Stream and the mature exotic trees left in clusters or rows. Pasture, while being utilised, is likely to be less important because bats are an edge-adapted species so open grassland is not preferred habitat. The mature stands of exotic trees and vegetated gullies on the property may also be used by bats as roosting habitat. Within this vegetation, long-tailed bats may roost in cavities, splits and loose bark in both native and exotic trees (including standing dead trees), as well as in large hollow tree stumps and hollow tree ferns. The data indicates that bats use, or are likely to use, the site and its surrounding locality as follows: • **Commuting:** The mature shelterbelt trees at the site access, all of Gully F and the margin of the Karapiro Stream are likely to be used as regular commuting corridors across and along this site. Bats are likely to fly over the entire site on a regular basis, but likely favour the gullies and shelterbelts. • **Foraging:** The stream in Gully F, the margins of the Karapiro Stream and the wetland areas at the bottom of Gully A alongside the Karapiro Stream. The open pastures are also likely to be used occasionally for foraging. • **Roosting:** The mature trees within Gullys are possibly used for roosting by solitary bats or as an occasional communal roost by bats. The mature trees found in the shelterbelts, as well as the isolated trees within the pastureland, are less likely to be used as communal roost trees, but roosting may still occur in these trees
New Zealand pipit	At Risk (Declining)	Possibly present in exotic scrub and floodplain wetland habitats and pasture

New Zealand Falcon	At Risk (Declining)	Possible occasional use of forested habitats
Kaka	At Risk (Recovering)	Possible occasional use of forested habitats
Bellbird	Regionally Uncommon	Possible occasional use of forested habitats
Kereru	Not Threatened	Present in forested habitat types onsite
Tui	Not Threatened	Present in forested habitat types onsite
Australasian bittern	Threatened (Nationally Critical)	Possibly present on occasion in the floodplain wetland habitats. These wetlands provide only low-quality habitat due to their relatively small size, low habitat diversity and ongoing browsing pressure
Spotless crake	At Risk (Declining)	Likely present within Basin wetland in Gully A (outside the project footprint), particularly in areas dominated by carex species. Unlikely to be present in gully wetland seepages due to poor habitat suitability or in floodplain wetlands due to browsing pressure from livestock.
Copper skink	Not Threatened	Likely present in all terrestrial habitat types except improved pasture
Auckland tree weta	Regionally Uncommon	Likely present in all forested vegetation
Peripatus novaezelandiae	Regionally Uncommon	Likely present in all forested vegetation
Black mudfish[11]	At Risk (Declining)	Possibly present in the gully basin wetland and potentially present in some of the floodplain wetlands (both of these wetland types are outside the project footprint)

[11] Other freshwater fish species will be present in the Karapiro Stream and Gully B outside of the project footprint

4 Assessment of ecological effects

Key terrestrial and wetland ecological values[12] onsite include the long-tailed bat and associated terrestrial and wetland vegetation/habitat types that provide important habitat for this species.

Outside the project footprint, the site also includes the Karapiro stream, two permanent streams, a large gully comprising mixed native/exotic forest (Gully B), and a moderately-sized gully basin wetland at the bottom of Gully A that includes native wetland vegetation. These features support or may support a range of 'Threatened' or 'At Risk' terrestrial, wetland and freshwater species.

This section assesses the potential effects of the project on all terrestrial and wetland ecological values using the methodology in the EcIAG (EIANZ, 2018).

4.1 Potential for adverse effects

Construction and operational activities associated with the Newcombe Road Sand Quarry have the potential to result in a range of adverse effects on terrestrial and wetland values.

Potential adverse effects on ecological values relating to construction include:

- Approximately 27.09 ha of terrestrial and wetland vegetation/habitat loss through staged vegetation clearance and earthworks, which will be undertaken over a period of 25 years. Specifically:
  - 23.72 ha of pasture grassland
  - 1.55 ha of exotic pine plantation forest
  - 0.98 ha of exotic dominated scrubland
  - 0.53 ha of mature exotic-dominated forest
  - 0.309 ha of native gully seepage wetland (this is based on the 0.109 ha of gully seepage wetlands delineated within the footprint in Gullies B-F and assumes that there is approximately 0.2 ha of native gully wetland seepage habitat within Gully A that cannot be accessed due to dominance of dense blackberry).
- The creation of habitat edge effects, altering the composition and health of adjacent vegetation (i.e. habitat degradation), which may affect habitat suitability for flora and fauna.
- Direct mortality or injury to species, for example all plants and most of the smaller, less mobile species (e.g. native lizards and invertebrates) may be harmed during vegetation clearance or earthworks activities. Likewise, roosting bats could potentially be harmed during vegetation clearance activities. Outside of bird breeding season, bird mortality would be low; however, during breeding season, vegetation removal has the potential to result in the destruction of nests, eggs and fledglings.
- Habitat fragmentation and isolation due to the loss and reduction of available habitat types, and severance of habitat which reduces the ability for plants and animals to disperse across the landscape for food, shelter, and breeding purposes.
- Noise, vibration or dust effects related to construction and operations.
- For wetlands, sediment runoff to wetlands and watercourses that may affect the quality of aquatic habitats, and potential changes in hydrology.

Potential long-term adverse effects after construction may include:

[12] Direct impacts on these streams and associated freshwater ecological values have been avoided as discussed in Section 1.1.

- Ongoing habitat degradation associated with edge effects and fragmentation, which permanently affect movement of some species.
- Ongoing disturbance effects, particularly on habitat margins/edges, through noise, dust and lighting.
- Ongoing degradation of aquatic habitat quality through:
  - contaminated stormwater discharge into aquatic receiving environments
  - increased risk of spills of potential toxins (for example, oil or chemicals) from cartage vehicles.

The potential adverse ecological effects described above will vary in scale and extent and can change over time. The following section sets out the measures required to avoid, remedy or mitigate them.

4.2 Overview of proposed measures to avoid, remedy or mitigate effects

Potential adverse effects on terrestrial and wetland values associated with the construction and operation of the project will be avoided, remedied or mitigated through:

- Further refinement of the project footprint to ensure that the vegetation clearance and earthworks footprint is kept to a minimum.
- Seasonal constraints on vegetation clearance. The vegetation clearance programme will be affected by specific timing restrictions to avoid or minimise effects on fauna that are legally protected under the Wildlife Act (1953). This includes avoidance of vegetation clearance:
  - outside of earthworks season (i.e., should not be undertaken from 1 May – 1 October) due to the need for erosion and sediment controls to be in place in accordance with the relevant management plan;
  - during colder months when bats are less active and when roosting bats are less likely to be detected through standard bat tree felling protocol methods
  - during peak bird breeding season to reduce harm to eggs or chicks (August to December inclusive); and
  - in accordance with seasonal constraints for salvaging and relocating lizards and invertebrates.
- Vegetation clearance protocols which will include:
  - physical delineation of vegetation to be cleared to avoid inadvertent clearance and to minimise potential damage to branches and roots; and
  - directional felling to prevent damage to vegetation immediately adjacent to the footprint.
- Sediment control measures will be undertaken to avoid or minimise effects on wetlands and the aquatic receiving environment.
- Vegetation/habitat clearance salvage and relocation operations for nationally 'Threatened', 'At Risk', Regionally uncommon or legally protected species present or potentially present onsite. This will include:
  - best practice bat tree felling protocol to reduce the risk of harming roosting bats
  - copper skink salvage and relocation to mitigate for effects on this species
  - redeployment of dead standing wood or fallen logs into native revegetation sites to mitigate for potential effects on regionally uncommon invertebrates that may be present, e.g. Auckland tree weta and peripatus.
- The use of bunding and mitigation plantings to primarily reduce potential effects on surrounding habitats associated with general disturbance. This will include:

- 2.5m high western bunds planted with low-stature native vegetation;
- 5m high southern and eastern bunds planted with low-stature native vegetation;
- Native mitigation plantings of approximately 1.2 ha:
  - 20m width between the Project footprint and the Gully A basin wetland (380m length, 0.76 ha); and
  - 10m width along the northern boundary between the Karapiro floodplain and Gullies B to F (440 m length, 0.44 ha).

These measures to avoid, remedy or mitigate potential adverse effects will be detailed in the respective ecological management plans as mandated through proposed consent conditions set out in the AEE.

4.3 Level of effects assessment

Table 4.3 below sets out the potential 'Level of Effects' for terrestrial and wetland values after efforts to avoid, remedy or mitigate for effects. This 'Level of Effects' assessment is based on the more detailed Ecological Values assessment in Section 4.3.1 (Table 4.2) and the Magnitude of Effects Assessment in Section 4.3.2 (Table 4.4). Of key importance:

- The level of residual effects on bats is expected to be 'High' due to the loss of long-tailed bat habitat;
- While effects on other native terrestrial fauna on an individual species basis are assessed as being 'Very Low' or 'Low', on a cumulative basis the overall level of residual effects on the native fauna assemblage is considered to be 'Moderate'; and
- The level of residual effects on gully seepage wetlands is assessed as being 'Moderate'.

Residual effects on habitat values, individual species or species assemblages that are assessed as being 'Moderate' or higher warrant habitat restoration or enhancement measures to offset or compensate for these effects as set out in Section 5.

Table 4.3: Level of effects after measures to avoid, remedy or mitigate for effects (Appendix C, Table 6)

Ecological value	Ecological value category	Magnitude of effects category	Level of effects category
Habitat/vegetation type			
Mixed exotic native (outside the project footprint)	Moderate	Negligible	Very Low
Exotic pine plantation (Gully A)	Low	Moderate	Low
Exotic dominated forest	Low	Moderate	Low
Exotic dominated scrub	Low	Moderate	Low
Pasture	Negligible	Low	Very Low
Gully seepage wetlands	Moderate	Moderate	Moderate
Gully basin wetland (outside the project footprint)	High	Low	Low
Floodplain wetlands (outside the project footprint)	Moderate	Negligible	Very Low
Native terrestrial fauna species			

Ecological value	Ecological value category	Magnitude of effects category	Level of effects category
Long-tailed bats	Very High	Moderate	High
Pipit	High	Low	Low
Kārearea (New Zealand Falcon)	Moderate	Low	Low
Kaka	Moderate	Low	Low
Bellbird	Moderate	Low	Low
Kereru	Moderate	Low	Low
Tui	Moderate	Low	Low
Shining cuckoo	Low	Low	Very Low
Fantail	Low	Low	Very Low
Grey Warbler	Low	Low	Very Low
Silvereye	Low	Low	Very Low
Copper skink	Low	Moderate	Low
Auckland tree weta	Moderate	Low	Low
Peripatus	Moderate	Low	Low
Collective forest fauna assemblage (all species excluding bats[13])	Moderate	Moderate	Moderate
Native wetland birds			
Australasian bittern (Matuku hūrepo)	Very High	Negligible	Low
Spotless crake (Pūweto)	High	Low	Low

4.3.1 Ecological values assessment

The ecological values associated with each habitat type and for nationally 'Threatened' or 'At Risk species that help inform the overall Level of Effects assessment are assessed below in Tables 4.3.1 and 4.3.2.

Table 4.3.1: Ecological values assessment for terrestrial vegetation and wetland habitat types based on tables in Appendix C

Ecosystem types	Value of terrestrial vegetation and wetland habitat types (as per Ecological Impact Assessment guidelines (EcIAG (EIANZ 2018 guidelines))	'Ecological Value' (EcIAG)
Terrestrial ecosystem types		
Mixed exotic-native secondary forest **(Gully B)**	Representativeness: **Moderate** • Indigenous species common but exotic species also common with an abundance of invasive weeds, also grazed by stock in the more	**'Moderate':** Moderate for all matters.

[13] Includes all bird, herpetofauna and invertebrate species

Ecosystem types	Value of terrestrial vegetation and wetland habitat types (as per Ecological Impact Assessment guidelines (EcIAG (EIANZ 2018 guidelines))	'Ecological Value' (EcIAG)
	accessible areas and indigenous biodiversity is compromised by the full suite of introduced mammalian browsers Rarity/distinctiveness: **Moderate** • Not a threatened ecosystem type but forest with a high proportion of native plant species is locally uncommon in the landscape. Diversity and Pattern: **Moderate** • A number of indigenous plant species are present but diversity is compromised by livestock browsing and predation and browsing from introduced mammalian pests and from the abundance of invasive weeds Ecological context: **Moderate** • Relatively large tract of forest that provides ecological connectivity in the landscape	
Exotic pine plantation forest) **(Gully A)**	Representativeness: **Very Low** • Not representative of an indigenous ecosystem type Rarity/distinctiveness: **Very Low** Diversity and Pattern: **Very Low** • Low native diversity and pattern Ecological context: **Moderate** • Relatively large tract of forest that provides ecological connectivity in the landscape	**'Low':** Habitat type rates 'Moderate' for one matter and ''Very Low' for the remainder**.**
Exotic-dominated forest (**Gully, A, B, C, F and G**)	Representativeness: **Very Low** • Not representative of an indigenous ecosystem type Rarity/distinctiveness: **Very Low** • Not a Threatened or uncommon ecosystem/habitat type Diversity and Pattern: **Low** • Low native diversity and pattern Ecological context: **Moderate** • Relatively large tract of forest that provides ecological connectivity in the landscape	**'Low':** Habitat type rates 'Moderate' for one matter and 'Low' or 'Very Low' for the remainder**.**
Exotic-Dominated scrub (**Gully A**)	Representativeness: **Very Low** • Not representative of an indigenous ecosystem type Rarity/distinctiveness: **Very Low** • Habitat type is not threatened. Diversity and Pattern**: Very Low** • Very Low native diversity and pattern Ecological context: **Moderate** • Relatively large tract of forest that provides ecological connectivity in the landscape	**'Low':** Habitat type assessed as 'Moderate' for one matter and 'Very Low' for the remainder**.**
Pasture	Representativeness: **Very Low** • Not representative of an indigenous ecosystem type Rarity/distinctiveness: **Very Low**	**'Very Low':** 'Habitat type assessed as 'Very Low' for all matters

Ecosystem types	Value of terrestrial vegetation and wetland habitat types (as per Ecological Impact Assessment guidelines (EcIAG (EIANZ 2018 guidelines))	'Ecological Value' (EcIAG)
	• Not a Threatened or uncommon ecosystem/habitat type Diversity and Pattern: **Very Low** • Native biodiversity and Ecological context: **Very Low** • Does not provide a notable buffering or connectivity function for native biodiversity	
Wetland ecosystem types		
Gully seepage wetlands	Representativeness: **Moderate** • Representative species composition but indigenous biodiversity compromised by livestock browsing and trampling as well as browsing and predation pressure from introduced mammalian pests Rarity/distinctiveness: **High** • Wetlands are a nationally threatened ecosystem type Diversity and Pattern: **Low** • A number of indigenous plant species are present but diversity is compromised by livestock browsing and predation and browsing from introduced mammalian pests and from the abundance of invasive weeds Ecological context: **Moderate** • Small size so limited value for ecological buffering or ecological connectivity but do provide hydrological function in the landscape	'**Moderate**': 'High' for one matter, and 'Moderate' or 'Low' for the remainder
Gully Basin Wetland (bottom of Gully A outside the footprint)	Representativeness: **Moderate** • Representative species composition but indigenous biodiversity compromised by livestock browsing and trampling as well as browsing and predation pressure from introduced mammalian pests Rarity/distinctiveness: **High** • Wetlands are a nationally threatened ecosystem type • Possible that one of more nationally "Threatened' or 'At Risk' wetland bird species are present Diversity and Pattern: **Moderate** • A number of indigenous wetland plant species are present but diversity is compromised by livestock browsing and predation and browsing from introduced mammalian pests and from the abundance of invasive weeds Ecological context: **High** • Small size so limited value for ecological buffering or ecological connectivity but do provide hydrological function in the landscape	'**High**': 'High' for two matters and 'Moderate' for other matters
Floodplain wetlands (Floodplain – outside the project footprint)	Representativeness: **Low** • Representative species composition but indigenous biodiversity compromised by livestock browsing and trampling as well as browsing and predation pressure from introduced mammalian pests Rarity/distinctiveness: **High**	'**Moderate**': 'High' for one matter, and 'Moderate' or 'Low' for the remainder

Ecosystem types	Value of terrestrial vegetation and wetland habitat types (as per Ecological Impact Assessment guidelines (EcIAG (EIANZ 2018 guidelines))	'Ecological Value' (EcIAG)
	• Wetlands are a nationally threatened ecosystem type • Possible that one of more nationally "Threatened' or 'At Risk' wetland bird species are present Diversity and Pattern: **Low** • A number of indigenous wetland plant species are present but diversity is compromised by livestock browsing and predation and browsing from introduced mammalian pests and from the abundance of invasive weeds Ecological context: **Moderate** • Moderate size so limited value for ecological buffering or ecological connectivity but do provide hydrological function in the landscape	

Table 4.3.2: Ecological values assessment for species based on tables in Appendix C

Fauna	Conservation status (based on the most recent report issued for each fauna group)	Observed within, or close to the Project footprint	'Ecological Value' of species (as per EIANZ guidelines)
Bats that are present or potentially present within the Project footprint			
Long-tailed bat	Threatened - Nationally Critical	Yes	'Very High'
Native forest birds that are present or potentially present within the Project footprint			
Pipit	At Risk – Declining	No but expected to be present	‘High’
Kārearea (New Zealand Falcon)	At Risk - Recovering	No but possibly present	'Moderate'
Kaka	At Risk - Recovering	No but possibly present on occasion	'Moderate'
Bellbird	Regionally Uncommon and a “Keystone species”, (i.e., is critical to seed dispersal of native species and the ecological integrity of native forests)	No but assumed present in low numbers	'Moderate'
Kereru	Not Threatened (but is a “Keystone species”, (i.e., is critical to seed dispersal of native species and the ecological integrity of native forests)	No but assumed present in low numbers	'Moderate'
Tui	Not Threatened (but is a “Keystone species”, (i.e., is critical to seed dispersal of native species and the ecological integrity of native forests)	Yes	'Moderate'
Shining cuckoo	Not Threatened	Yes	'Low'
Fantail	Not Threatened	Yes	‘Low’
Grey Warbler	Not Threatened	Yes	‘Low’

Fauna	Conservation status (based on the most recent report issued for each fauna group)	Observed within, or close to the Project footprint	'Ecological Value' of species (as per EIANZ guidelines)
Silvereye	Not Threatened	Yes	'Low'
Native wetland birds that are present or potentially present within the Project footprint			
Australasian bittern (Matuku hūrepo)	Threatened - Nationally Critical	No but assumed present on occasion in floodplain wetlands	'Very High'
Spotless crake (Pūweto)	At Risk - Declining	No but possibly present in Gully basin wetland	'High'
Native lizards that are present or potentially present within the Project footprint			
Copper skink (moko)	Not Threatened	No but assumed present based on known presence in the vicinity	'Low'
Native terrestrial invertebrates that are present or potentially present within the Project footprint			
Auckland tree weta	Regionally uncommon	No but assumed present	'Moderate'
Peripatus	Regionally uncommon	No but assumed present	'Moderate'

4.3.2 Magnitude of effects assessment

The magnitude of effects on ecological values is assessed based on the extent, intensity, duration and timing of effects associated with the project. This 'Magnitude of Effects' assessment (Table 4.3.2.1) is completely independent of the 'Ecological Value' assigned to each habitat/vegetation type and species.

Table 4.3.2.1: 'Magnitude of Effects' assessment (Appendix C, Tables 4 – 5)

Biodiversity value	Project effects	Efforts to avoid, remedy or mitigate effects)	Magnitude of Effect (EcIAG 2018)
Vegetation/habitat type (associated species values are addressed below)			
Mixed native/exotic regenerating forest (Gully B)	Outside the project footprint but potential for indirect effects due to proximity	Native mitigation plantings to buffer potential indirect effects	Negligible
Exotic plantation forest (Gully A)	Permanent loss of 1.55 ha, which equates to a moderate proportion of what is available within the immediately surrounding landscape and a negligible proportion of what is available in the Ecological District.	Further refinement of project footprint Vegetation clearance protocols Native mitigation plantings to buffer potential indirect effects	Moderate
Exotic dominated forest (gullies A, B C, F, G)	Permanent loss of 0.53 ha, which equates to a moderate proportion of what is available within the immediately surrounding landscape and a negligible proportion of what is available in the Ecological District.	Further refinement of project footprint Vegetation clearance protocols Native mitigation plantings to buffer potential indirect effects	Moderate
Exotic dominated scrub	Permanent loss of 0.98 ha, which equates to a moderate proportion of what is available within the immediately surrounding landscape and a negligible proportion of what is available in the Ecological District.	Further refinement of project footprint Vegetation clearance protocols Native mitigation plantings to buffer potential indirect effects	Moderate
Pasture	Permanent loss of 23.72 ha, which equates to a Low proportion of what is available within the immediately surrounding landscape and a negligible proportion of what is available in the Ecological District.	None	Low
Gully seepage wetlands	Permanent loss of an expected 0.309 ha, which equates to a Moderate proportion of what is available within the immediately surrounding landscape and a Negligible proportion of what is available in the Ecological District.	Further refinement of project footprint Vegetation clearance protocols Native mitigation plantings to buffer potential indirect effects	Moderate
Gully basin wetlands	Low potential for indirect negative effects relating to hydrological changes associated with sand quarrying and the potential for water quality degradation	Further refinement of project footprint Vegetation clearance protocols Native mitigation plantings to buffer potential indirect effects	Low
Floodplain wetlands	No adverse effects anticipated as well away from the Project footprint	None required	Negligible
Native species			

Bats that are present or potentially present within the Project footprint			
Long-tailed bats	Permanent loss of up to 23.72 ha of variable quality habitat that includes pasture, exotic dominated forest, exotic plantation forest, exotic dominated scrub and gully seepage wetlands, which collectively equates to a low proportion of what remains available in the surrounding landscape and a negligible proportion of what remains in the Ecological District. In addition to direct effects, loss of these habitat types may also have localised indirect negative effects associated with general disturbance and potential effects on ecological connectivity.	Further refinement of project footprint Avoidance of clearance during bat breeding season when detection of roost sites is less likely Implementation of bat tree felling protocols to reduce the potential for harm to roosting bats	Moderate
Native forest or grassland birds that are present or potentially present within the Project footprint			
Pipit	Permanent loss of up to 24.70 ha of habitat that includes pasture and exotic dominated scrub, which collectively equates to a low proportion of what remains available in the surrounding landscape and a negligible proportion of what remains in the Ecological District.	None	Low
Kārearea (New Zealand Falcon), kaka, bellbird, kereru, tui, shining cuckoo, fantail, grey warbler and silvereye	Permanent loss of up to 3.06 ha of variable quality habitat, which includes exotic dominated forest, exotic plantation forest and exotic dominated scrub. Loss of these habitats may also have localised indirect negative effects associated with general disturbance.	Further refinement of project footprint Vegetation clearance protocols Seasonal constraints on vegetation clearance during peak bird breeding season	Low
Wetland birds that are present or potentially present within the Project footprint			
Australasian bittern (Matuku hūrepo)	Potential habitat outside project footprint	None required	Negligible
Spotless crake (Pūweto)	Potential habitat outside project footprint	Vegetation clearance protocols in proximity to potential habitat in the Gully Basin wetland (Gully A)	Low
Lizards that are present or potentially present within the Project footprint			
Copper skink	Permanent loss of at least 3.06 ha of variable quality habitat, which constitutes a low proportion of what is available in the surrounding	Further refinement of project footprint Salvage and relocation protocols	Moderate

	landscape and a negligible proportion of what is available in the Ecological District.		
Notable invertebrates that are present or potentially present within the Project footprint			
Auckland tree weta	Permanent loss of at least 3.06 ha of variable quality habitat, which constitutes a low proportion of what is available in the surrounding landscape and a negligible proportion of what is available in the Ecological District.	Further refinement of project footprint Salvage and relocation protocols	Low
Peripatus	Permanent loss of at least 3.06 ha of low quality habitat, which constitutes a low proportion of what is available in the surrounding landscape and a negligible proportion of what is available in the Ecological District.	Further refinement of project footprint Habitat salvage and relocation protocols	Low

5 Residual effects management

5.1 Residual effects to be addressed

As assessed in Section 4, the project is expected to have residual adverse effects of ‘Moderate’ or higher (after efforts to avoid, remedy or mitigate effects) on several habitats and species. Specifically:

- The ‘Level of Effects’ on long-tailed bats after measures to avoid, remedy or mitigate effects was assessed as ‘High.’
- The ‘Level of Effects’ on native-dominated gully seepage wetlands was assessed as ‘Moderate’ after measures to avoid, remedy or mitigate effects, as were cumulative residual effects on the native forest fauna assemblage.

5.2 Objectives and intended ecological outcomes

The overarching objective of the residual effects management package is to achieve likely NNL/NG outcomes for residual effects on bats, wetlands and native forest fauna within 10 year of impacts occurring at a given location. To this end, we have focused on the following ecological outcomes:

- A substantive net increase in the areal extent of native habitat types that were historically present within floodplains and gully slopes in the landscape and wider Hamilton Ecological District (above and beyond what is currently present) and/or the quality of existing habitats in terms of indigenous biodiversity and ecological integrity/function;
- Improved ecological connectivity for native flora and fauna and buffering of native habitats through:
  - Providing riparian connectivity between existing SNAs in close proximity to the site
  - Creating greater connectivity between wetlands and terrestrial ecosystem habitat types including between gully basin wetland, wetland floodplain habitats, and mixed podocarp-broadleaved habitats on gully slopes;
  - The linking of smaller habitat fragments to create larger contiguous habitat; and
  - Linking different habitat types (i.e. terrestrial, wetland, and freshwater streams).

The approach taken also addresses residual effects that were assessed as ‘Low’ and is additionally expected to provide biodiversity benefits for some values that are not likely to be affected.

5.3 Biodiversity offsetting versus compensation

For this project, all proposed habitat restoration and enhancement measures are defined as forms of compensation. The proposed measures do not meet the definition of offsetting because:

- Neither impacts within the footprint, nor benefits associated with the proposed restoration and enhancement, can be quantifiably measured with an adequate degree of precision or certainty. Long-tailed bats are difficult to monitor with adequate precision and have extensive home ranges which obscure site-specific cause and effect.
- ‘Like for like’ offsetting is not desired (e.g. offsetting effects on exotic dominated vegetation is better achieved through native habitat restoration, which constitutes a ‘trade-up’)
- ‘Like for like’ offsetting is not possible, (e.g. addressment of the loss of gully seepage wetlands with the re-creation of gully wetland seepage habitats elsewhere).

5.4 Determining compensation requirements: Qualitative Biodiversity Models

Qualitative Biodiversity Models (QBMs) were used as a decision support tool to provide guidance on the type and amount of compensation required to achieve expected NNL/NG outcomes for long-tailed bats, the native forest fauna assemblage and wetlands (see Appendix E; Baber et al 2021; Tonkin & Taylor 2021). These models:

- Provide additional transparency, process and rigour to the process of addressing residual adverse effects through compensation measures at proposed habitat restoration/ enhancement site(s);
- Provide guidance on whether NNL/NG outcomes are expected to be achieved. Expected Net Gain outcomes are sought, rather than No Net Loss (NNL) outcomes, to provide more confidence that NNL is actually achieved; and
- Operate at the 'as close to offset as possible' end of the compensation continuum. This is termed 'biodiversity compensation' in the Proposed National Policy Statement for Indigenous Biodiversity (NPSIB).

In broad terms, the QBMs are based on:

- Available information and expert assessment of the amount and quality of habitat that will be adversely affected at the impact sites;
- Available information and expert assessment of the quality of habitat that will be subject to habitat restoration and enhancement at the compensation sites; and
- Assessment of the potential biodiversity benefits associated with proposed habitat restoration and enhancement measures.

5.5 Proposed compensation package

As guided by QBM outputs, to achieve NNL/NG outcomes for key biodiversity values in each location within 10 years of project impacts will require approximately 12.5 ha of habitat restoration and enhancement within the existing Karapiro stream floodplain and associated gully slopes along the northern boundary of the property (Appendix A, Figure 2). This is in addition to the approximately 1.2 ha of native mitigation planting along the northern boundary of the project footprint which is aimed to reduce the potential for adverse effects on adjacent wetlands. This 12.5 ha of habitat restoration and enhancement will:

- Create additional habitat and ecological connectivity for bats and other native forest fauna along approximately 2 km of riparian margin, linking up two Significant Natural Areas; and
- Provide buffering and ecological connectivity for approximately 3.73 ha of floodplain and gully seepage wetlands through the native revegetation of associated wetland margins.

Native revegetation will be staged over a five-year period commencing in the first winter planting season following consent approval. To improve the likelihood that native plantings will persist in the long-term, the plantings will be protected from livestock browsing through stock exclusion fencing and will also include a 20-year weed control programme. It is expected that this weed control programme will be relatively resource intensive until canopy-cover is achieved (between 5 – 10 years) given the diversity and abundance of invasive weeds in the landscape. Infill planting and control of mammalian browsers (e.g. rabbits and hares) will be undertaken as required.

All native plants will be eco-sourced and plant composition will include species that:

- Were historically present onsite
- Have a high chance of survival and establishment within planted areas due to the appropriateness of site conditions for associated species

- Provide a diversity and early supply of resources for fauna (e.g., year-round availability of fruits and flowers for native birds)
- Provide good roosting habitat for bats and other indigenous terrestrial fauna in the longer term
- Are supported by iwi partners through iwi consultation and inputs.

Felled trees and fallen logs in various states of decomposition are ecologically important to forest regeneration processes and as habitat for a wide range of flora and fauna. Felled native (preferably) or exotic log deployment into revegetation sites should be undertaken. A minimum of 20 m / ha of cut up stockpiled logs should be deployed into restoration sites. These log materials should be placed in locations where they cannot move or enter streams. Long-term protection of all sites where restoration and habitat enhancement is undertaken will be required through protective covenants.

5.6 Assessment against biodiversity compensation principles

We consider all biodiversity compensation principles[14] to be met through the proposed measures to address adverse residual effects on biodiversity values that cannot be adequately avoided, remedied or mitigated. Specifically:

- Adherence to the effects management hierarchy, noting that as described in Section 5.3 above, biodiversity offsetting cannot be achieved so it is necessary to default to biodiversity compensation because:
  - neither impacts within the footprint nor benefits associated with the proposed restoration and enhancement can be quantifiably measured with an adequate degree of certainty
  - 'Like for like' offsetting is not desired (e.g. offsetting effects on exotic-dominated vegetation is better achieved through native habitat restoration, which constitutes a 'trade-up')
  - 'Like for like' offsetting is not possible (e.g., recreation of gully wetland seepage habitats).
- Adherence to the 'limits to offsetting' principle. Importantly, there are no instances in which the residual effects on biodiversity values[15] are considered so high that they are likely to result in a notable loss of ecological values (e.g. a particular habitat type or local population).
- Adherence to NNL or NG outcome objectives for biodiversity, noting that in the long-term NNL/NG outcomes are expected with a high degree of confidence for indigenous terrestrial and wetland vegetation and associated biodiversity.
- Landscape context has been considered through the focus on addressing effects in close proximity to the impact site, and on increasing and enhancing landscape and ecological connectivity.
- The principle of 'additionality' will be achieved because none of the proposed restoration or habitat enhancement activities would have otherwise occurred.
- The principle of long-term outcomes (preferably in perpetuity) will be achieved on the basis that native revegetation will remain onsite and will be protected through covenanting.

[14] As set out in the Draft National Policy Statement for Indigenous Biodiversity (NPSIB) (December 2019)
[15] After measures to avoid, remedy, mitigate, offset or compensate for effects

6 Conclusion

In conclusion, the adoption of the proposed effects management measures will ensure that adverse ecological effects on biodiversity values within a given location will be addressed to an expected Net Gain standard within 10 years of impact.

The proposed residual effects management package will need to be enacted through consent conditions and the development and implementation of ecological management plans. These plans will need to include biodiversity outcome monitoring at impact and habitat restoration sites to verify that intended ecological outcomes have been achieved (where feasible). The plans should also include contingency measures to be enacted if these intended ecological outcomes are not met within the specified timeframes.

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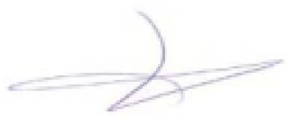
8 Applicability

This report has been prepared for the exclusive use of our client RS Sands Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Report prepared by:



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Matt Baber

Principal Ecologist/ Director

Alliance Ecology Ltd

Appendix A: Figures

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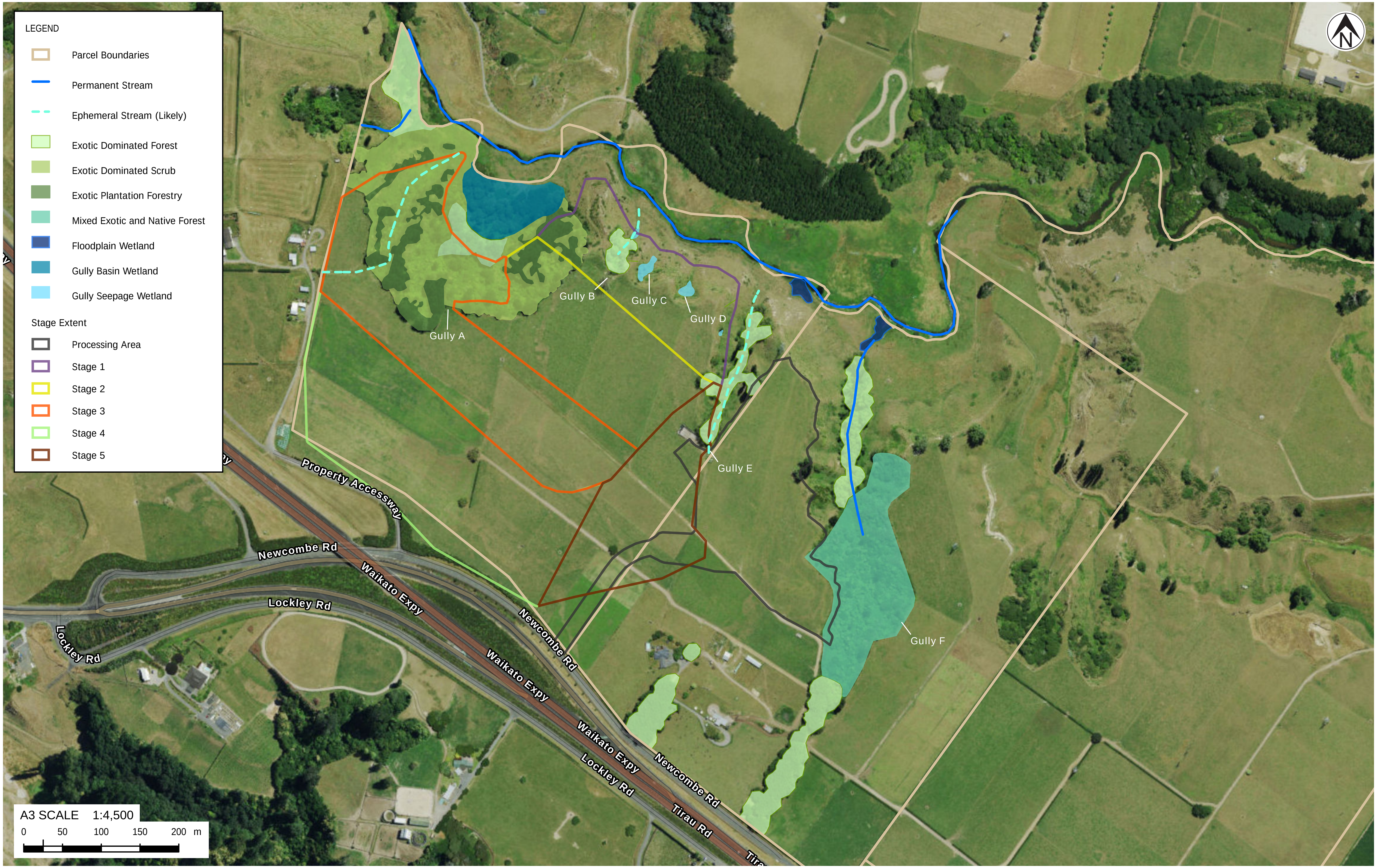

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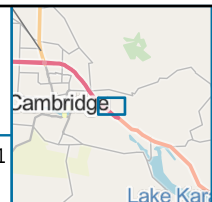

LOCATION PLAN

PROJECT No.	1016543	
DESIGNED	JORB	AUG.22
DRAWN	JORB	AUG.22
CHECKED	CHSA	AUG.22
APPROVED		DATE

CLIENT **ALLIANCE ECOLOGY LTD**

PROJECT **RS SANDS QUARRY**

TITLE HABITAT/VEGETATION MAP NEWCOMBE ROAD SAND QUARRY

SCALE (A3) 1:4,500 FIG No. FIGURE 1. REV 0

Document Set ID: 11016218
Version: 1, Version Date: 22/05/2023

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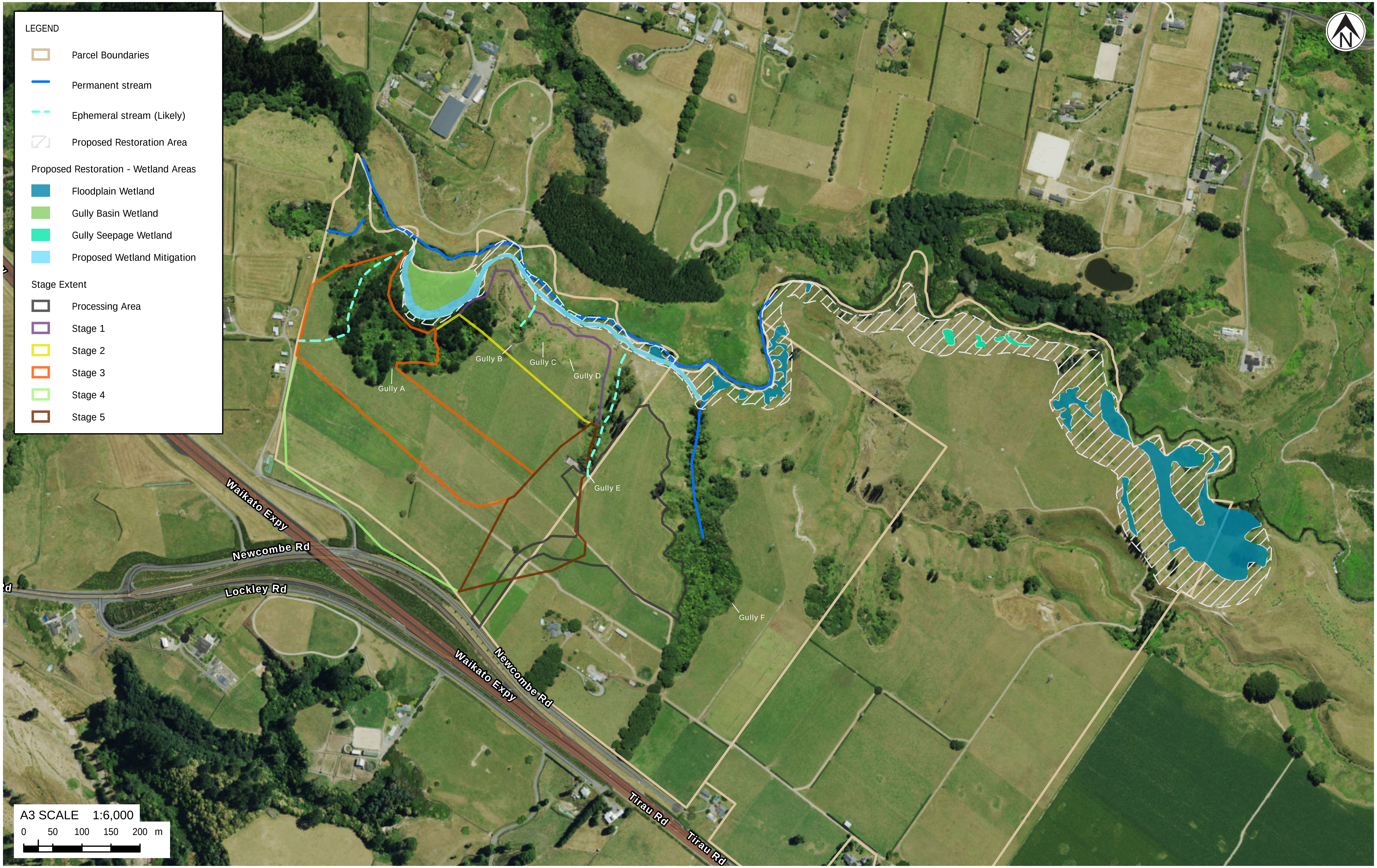

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REV	DESCRIPTION	GIS	CHK	DATE
0	First version	JORB	CHSA	20/01/20

LOCATION PLAN: Cambridge, Lake Karapiro

PROJECT No.	1016543	
DESIGNED	JORB	AUG.22
DRAWN	JORB	AUG.22
CHECKED	CHSA	AUG.22
APPROVED		DATE

CLIENT **ALLIANCE ECOLOGY LTD**

PROJECT **RS SANDS QUARRY**

TITLE PROPOSED RESTORATION AND HABITAT ENHANCEMENT MAP NEWCOMBE ROAD SAND QUARRY

SCALE (A3) 1:6,000 FIG No. FIGURE 2. REV 0

Document Set ID: 11016218
Version: 1, Version Date: 22/05/2023

Appendix B: Long-tailed bat report

RS Sands Ltd

DRAFT Baseline long-tailed bat survey & preliminary effects assessment on bats of the prosed sand mine at Newcombe Road, Cambridge

Bluewattle Ecology

Table of Contents

Prepared by: Eva Kessels[1] & Gerry Kessels[2]

Reviewed by: Dr Matt Baber[3] (pending)

Version: Draft 1.1 220121

PWF Ref: FUL.00601

Cover Photo – Hannah Dumbleton

[1] Class A & B Bat Competency Certification – Department of Conservation
[2] Class A, B, C & D Bat Competency Certification – Department of Conservation
[3] Alliance Ecology

Executive Summary

RS Sand Limited have engaged Bluewattle Ecology (via Fulton Hogan Ltd/Kinetic Environmental Ltd) to undertake investigative, baseline bat surveys at a farm at 77 Newcombe Road, south of Cambridge, to support resource consents for a proposed sand quarry at this location. Automatic bat monitors were placed in within likely key habitats on the property. Two baseline acoustic long-tailed bat surveys were conducted between the period of December 2019 and June 2020, at 77 Newcombe Road, Cambridge, New Zealand.

In the December - January survey 159 bat passes were recorded over a total of 21 monitoring nights. Total bat passes averaged 0.95 passes per detector per night, equating to a low level of bat activity. In the May - June survey, a total of 4,709 bat passes were recorded over 41 nights of surveying, averaging 14.4 bat passes per functional ABM per night. Levels of bat activity were considered low-moderate, although one site detected a high-level average of 177 bat passes per night, indicative of a potential bat roost site at this survey location.

The property at 77 Newcombe Road exhibits a variety of structural and ecosystem traits which provide functional habitat for bats, including mature linear stands of trees, deeply incised gullies and close proximity to a stream and river system – the Karapiro Stream and the Waikato River, where insects tend to aggregate at dusk and dawn, and mature trees with cavity bearing qualities for roost are situated in relative shelter from wind.

The most important habitat features are likely to be the gullies leading in the Karapiro Stream and the mature exotic trees left in clusters or rows. Pasture, while being utilised, is likely to be less important in this locality for bats as they are an edge adapted species, and open grassland is not preferred habitat.

Before suitable avoidance, remediation and mitigation measures are adopted, the preliminary level of adverse effects assessment on on long-tailed bats is summarised as follows :

- Loss of open pastureland for foraging and commuting habitat - Moderate level of effect on bats;
- Loss of of gully and shelterbelt and pastureland habitat within 25 m of shelterbelts and gully habitats - High level of effect on bats;
- Loss of occupied solitary roost trees and unoccupied potential roost tree habitat – High level of effects on bats; and
- Loss of occupied roost tree – Very High level of effect on bats.

In order to address these [potential adverse effects of the proposed Newcombe sand mine on long-tailed bats, the following measures are recommended:

a) A survey and risk profile inventory of all potential bat roost trees is undertaken in accordance with best practice before sand extraction begins;

b) A Bat Management Plan (BMP) should be prepared by a recognised bat expert and implemented across the site which will outline detailed protocols around potential bat roost tree removal and ongoing monitoring; and

c) The loss of habitat of bats within the site is suitably mitigated, including appropriate offset offset measures such as buffer planting, animal pest control, erection of artificial bat roosts, habitat restoration, and long-term protection of high quality bat habitat areas. The type and quantum of any mitigation measures is best determined by biodiversity offset compensation or quantitative modelling.

Subject to review of the detailed sand extraction process and review of the full suite of avoidance, remediation, mitigation, offset and monitoring measures as broadly outlined above, the overall level of adverse effects on long-tailed bats as a consequence of this proposal is likely to be low.

1 Introduction

1.1 Scope

RS Sand Limited have engaged Bluewattle Ecology (via Fulton Hogan Ltd/Kinetic Environmental Ltd) to undertake investigative, baseline bat surveys at a farm at 77 Newcombe Road, south of Cambridge, to support resource consents for a proposed sand quarry at this location (Figure 1).

To gain an understanding of the habitat features that are of value to long-tailed bats it is necessary to monitor the site's key potential bat habitat features. Automatic bat monitors (ABMs) were placed within likely key habitats on the property that would would provide suitable habitat for bat roosting, foraging and commuting.

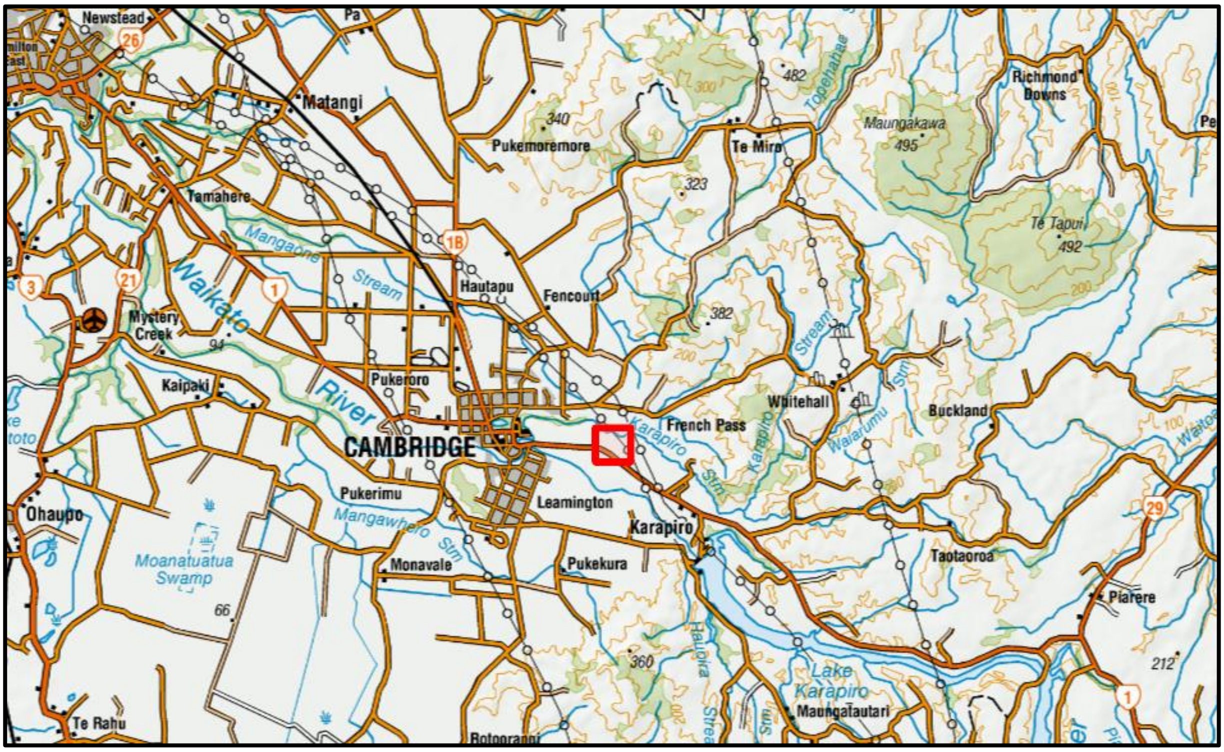


Figure 1: Location map of Newcombe Road sand quarry site

1.2 Background

Long-tailed bats (*Chalinolobus tuberculatus*, Threatened – Nationally Critical=- O'Donnell 2018[4]) are distributed widely throughout modified agricultural landscapes within the Waikato region, including in the vicinity of Cambridge. Review of the Department of Conservation (DOC) Bat Distribution Database (supplied in November 2020[5]), as well as several studies in this area, confirm that this species is found within rural habitats alongside the Waikato River and Karapiro Stream gully system in this locality (Kessels & Blair 2013[6]; Connolly 2013[7]).

Despite being classified as Nationally Critically Endangered by DOC, the presence of long-tailed bats within this highly modified landscape demonstrates they are able to adapt to major landscape change

[4] O'Donnell, C.F.J.; Borkin, K.M.; Christie, J.E.; Lloyd, B.; Parsons, S.; Hitchmough, R.A. 2018: Conservation status of New Zealand bats, 2017. New Zealand Threat Classification Series 21. Department of Conservation, Wellington. 4 p.

[5] Data supplied by from Moira Pryde, Technical Advisor, Research and Development, Department of Conservation -Te Papa Atawhai

[6] Kessels, G & Blair, J. 2013. Te Awa Lifecare Village Ltd. Assessment of Ecological Effects of the Te Awa Lifecare Village. Kessels Ecology.

[7] Connolly, T. 2013. Waikato Expressway: Cambridge Section. Long-tailed Bat Surveys Summer 2012-13 Lloyd Property, Mellow Manor, Karapiro Gully. Opus International Consultants.

from indigenous vegetation to landscape dominated by almost 100% exotic vegetation over time. This is despite likely ongoing pressures from introduced animal competition and predation.

Nonetheless, it appears that several structural and functional habitat factors must be present or addressed, including the presence of mature and well-vegetated corridor pathways and habitats for commuting, foraging and roosting habitats key for maintaining the life cycle requirements of this species (Dekrout et al 2014)[8]. These structural features, be they exotic or indigenous vegetation, access to stream, river, wetland or lake ecosystems, and varied topographical characteristics are likely critical to maintain the presence of bats in a rural landsacpe (Davidson-Watts 2019)[9].

The property at 77 Newcombe Road exhibits all of these structural and ecosystem traits likely to provide functional habitat for bats, including mature linear stands of trees, deeply incised gullies and proximity to a stream and river system – the Karapiro Stream and the Waikato River, where insects tend to aggregate at dusk and dawn, and mature trees with cavity bearing qualities for roost are situated in relative shelter from wind.

It is expected that the subject site is utilised throughout the year by long-tailed bats for commuting and foraging, as well as possibly roosting habitat. The most important habitat features are likely to be the gullies leading in the Karapiro Stream and the mature exotic trees left in clusters or rows. Pasture, while being utilised, is likely to be less important in this locality for bats as they are an edge adapted species, and open grassland is not preferred habitat (Parsons et el 1997).

2 Methodology

2.1 Acoustic Surveys

Two surveys were undertaken at the site – one from December 2019 to January 2020 and another from May until June 2020.

Omni-directional frequency compression monitors - “AR3” and “AR4” (also called automated bat monitors or ABMs), manufactured by DOC, were deployed to investigate the activity of long-tailed bats within the site according to best practice methodological protocols (Sedgeley 2012)[10]. The location of these detectors is shown in Figure 2 and coordinates and site descriptors detailed in Appendix A.

In the December - January survey, 12 ABMs were deployed with data collected from 8. The detectors were deployed on 19 December 2019 and retrieved 9 January 2020 (Table 1).

In the May survey, eight ABMs were placed near previously surveyed sites as in January 2020. The ABMs were deployed on 15 May 2020 and retrieved on 22 June 2020 (Table 1).

ABMs record any sound that may be a bat call or echolocation. When it is triggered by a potential bat pass it records one file for each pass. The recordings are prepared in a form of a compressed image of a spectrogram, and are saved onto an SD card in the form of bitmap format images. The images were viewed using BatSearch 3.12, software that was developed by DOC to help quickly view the files and create data from them. The frequency spectrum covered ranges from 0 Hz to 88 kHz and images represent 1-6 seconds of recording.

All detectors were calibrated to have the same time and date settings (NZST) and were pre-set to start monitoring one hour before sunset until one hour after sunrise. The distance between detectors of distinct monitoring locations was at least 50 m apart to increase the chance of independent bat

[8] Dekrout, BD Clarkson & S Parsons (2014) Temporal and spatial distribution and habitat associations of an urban population of New Zealand long-tailed bats (Chalinolobus tuberculatus), New Zealand Journal of Zoology, 41:4, 285-295, DOI: 10.1080/03014223.2014.953551

[9] Davidson-Watts Ecology Ltd. (2019). Long-tailed Bat Trapping and Radio Tracking Baseline Report 2018 and 2019 Southern Links, Hamilton. Prepared for AECOM.

[10] Sedgeley J. 2012. Bats: roost occupancy and indices of bat activity—automatic bat detectors. Inventory and monitoring toolbox: bats DOCDM-590899. Department of Conservation, wellington.

monitoring. The recorders were suspended at least 2 m above the ground to reduce superfluous detections caused by terrestrial insects (usually cicada species).

Figure 2: Location of detectors deployed at Newcombe Road proposed sand mine, 19/12/19 – 9/01/20; 15/05/20 – 22/06/20.

2.2 Ecological Effects Assessment

A preliminary effects assessment and management recommendations of the proposed sand extraction operation on long-tailed bats was undertaken in accordance with the Ecological Impact Assessment guidelines (EcIA) developed by the Ecological Institute of Australia and New Zealand (EIANZ)[11].

3 Results

3.1 January Survey

A total of 159 bat passes were recorded over a total of 21 monitoring nights, averaging 0.95 passes per functional ABM per night. Bats were detected on 61% (13/21) of consecutive monitoring nights. Passes were recorded on 61% (8/13) of the detectors. Of these passes, 99% were classified as stereotypical search phase passes used for orientation and foraging; 1 (out of 159) of these search phase passes were coupled with 'social' calls recorded inadvertently on the 28 kHz channel.

Overall nightly activity trends showed that bat activity peaked at the second hour after sunset (8:45pm) with 115 of the total passes recorded. Average passes per night across all detectors = 159/ 21 = 7.57 passes. Bat calls were obtained for every ABM. Note that BW04 recorded for 8 nights and ProSoc2 recorded for 4 nights

[11] Environment Institute of Australia and New Zealand Inc. (2018). Ecological Impact Assessment (EcIA). EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd Edition.

A summary of the results is shown in Table 2 and Figure 3a below, with detailed results for each ABM presented in Appendix B. '

Table 1: Corresponding detector number to site location of detectors deployed at Newcombe Road, 19/12/19 – 9/01/20; 15/05/20 – 22/06/20.

Site	Detector number	Deployment date
1	PRS1	19/12/19 – 9/01/20
2	PRS2	19/12/19 – 9/01/20
3	KB48	19/12/19 – 9/01/20
4	ProSoc2	19/12/19 – 9/01/20
5	PRS3	19/12/19 – 9/01/20
6	WEC2	19/12/19 – 9/01/20
7	WEC7	19/12/19 – 9/01/20
8	BW08	19/12/19 – 9/01/20
9	BW01	15/05/20 – 22/06/20
10	PRS4	15/05/20 – 22/06/20
11	BW04	15/05/20 – 22/06/20
12	PRS1	15/05/20 – 22/06/20
13	BW06	15/05/20 – 22/06/20
14	PRS2	15/05/20 – 22/06/20
15	BW05	15/05/20 – 22/06/20
16	KB48	15/05/20 – 22/06/20

Table 2: Distribution of total activity levels recorded at Newcombe Rd during the Dec 2019 -Jan 2020 (survey throughout the night at all locations including bat passes per night within 1-hour after sunset and bat passes per night within one hour before sunrise)

Site	Bat passes per night	Bat passes per night within 1-hour after sunset	Bat passes per night within one hour before sunrise
Site 1 – PRS1	2	0.09	0
Site 2 – PRS2	3.38	0.19	0
Site 3 – KB48	0.61	0	0
Site 4 – ProSoc2	0.24	0	0
Site 5 – PRS3	0.48	0	0
Site 6 – WEC2	0.24	0	0
Site 7 – WEC7	0.10	0	0
Site 8 – BW04	0.52	0.05	0

3.2 May-June Survey

Monitoring in May-June 2020 resulted in the detection of bat activity at all 8 different locations (Table 2). The average percentage of nights with bat passes across all detectors was 44%. A high level of bat activity was detected within the landscape during the survey. A total of 4,709 bat passes were recorded over 41 nights of surveying, averaging 14.4 bat passes per functional ABM per night. An overview of the bat activity results is shown in Figures 3-5. The graphs show activity levels expressed as average number of bat passes per night for all ABM deployed.

At total of 1,848 bat passes were detected in the first hour after sunset, across seven of the eight ABMs. No bat passes were detected in the first hour before sunrise by any of the eight of the ABMs (Table 2).

Detector BW06 (Site 13) detected a consistently high number of bat calls per night (average = 103.8), suggesting this site was likely an important foraging and/or commuting area during the survey period. BW06 reported 4,256 detections, or 90.4% of all calls which may be indicative of a roost site nearby. However, because no bat passes were detected 11-12 hours after sunset, suggest there may not be a roost present, or the bats may be returning via a different route if there was a local roost present.

Limited detection occurred in detector BW04 (7% of all nights) and in detector PRS1 (12%), most likely due to battery failure.

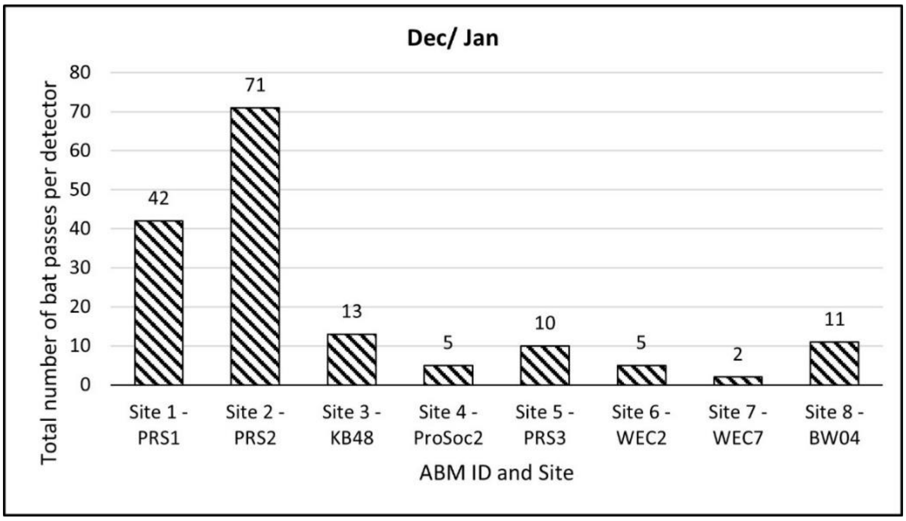
Over 70 feeding buzzes were captured by BW06 (Site 13) across the monitored nights. BW01, BW03 and BW04 each recorded one feeding buzz and PRS1 recorded three feeding buzzes.

Compared to the January survey, there was much greater bat activity detected in the May-June survey, predominantly due to the large number of positive passes detected at Site 13.

Table 3: Distribution of total activity levels at Newcombe Rd during the May-June survey 2020 (recorded throughout the night at all locations including bat passes per night within 1-hour after sunset and bat passes per night within one hour before sunrise)

Site	Bat passes per night	Bat passes per night within 1-hour after sunset	Bat passes per night within one hour before sunrise
Site 9 - BW01	3.86	1.14	0
Site 10 - PRS4	0.68	0.22	0
Site 11 - BW04	5.22	12.67	0
Site 12 - PRS1	38.40	29	0
Site 13 - BW06	177.33	66.91	0
Site 14 - PRS2	0.36	0.18	0
Site 15 - BW05	4.25	1	0
Site 16 - KB48	0.08	0	0

- Based on all functional detector nights



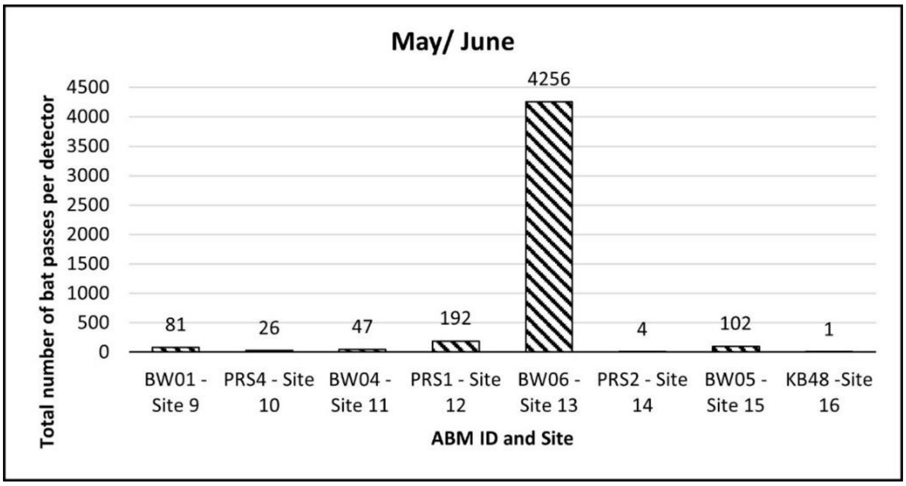


Figure 3a &b: Total bat passes for each ABM for both surveys at Newcombe Rd.

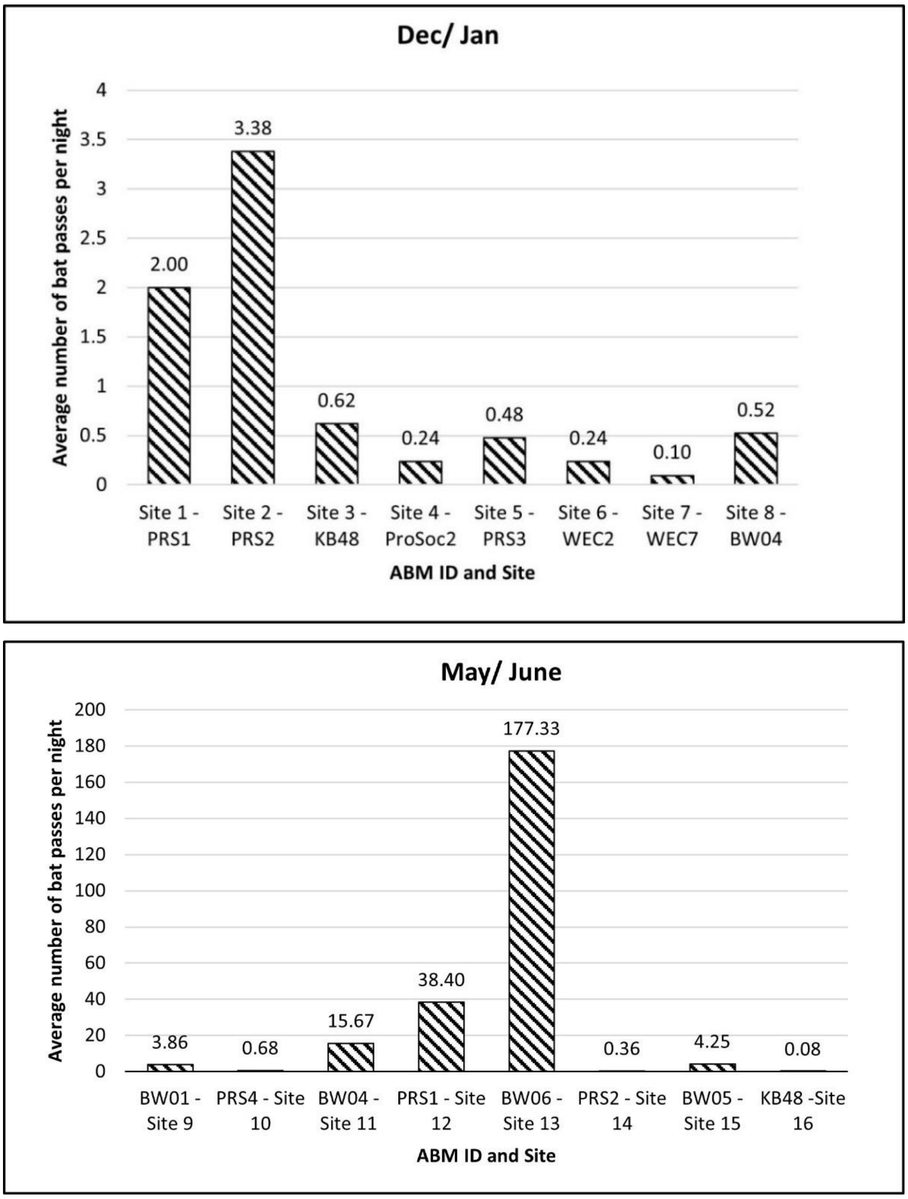


Figure 4a &b: Average bat passes per recorded night for each ABM for each survey at Newcombe Rd

Weather conditions during the entire Dec-Jan survey period were optimal for bat emergence (refer to Appendix B - Table B-1). Minimum temperatures at dusk for bat emergence are >8°C, ideally >10°C (O'Donnell, 2000)[12]. Dusk temperatures remained above 10°C during the entire survey period. Mean rainfall was low at 0.37 mm, with an average minimum temperature of 11 °C. The lowest dusk temperature recorded during the survey was 14.6°C and the coldest temperature recorded during the survey was 5.9°C. Rainfall was present six times during the survey period. Wind conditions were mild and suitable across the survey period, with maximum wind gusts below 20 km/hr.

Weather conditions during the entire May-June survey period were reasonable for bat emergence (refer to Appendix B - Table B-2). Minimum temperatures at dusk for bat emergence are >8°C, ideally >10°C. Dusk temperatures remained above 10°C during the entire survey period, with the exception of the lowest dusk temperature recorded during the survey which was 7.4°C on one night only. The coldest temperature recorded during the survey was -1.9°C. Rainfall was present once during the

[12] O'Donnell, C. 2000. Influence of season, habitat, temperature, and invertebrate availability on nocturnal activity of the New Zealand long- tailed bat (Chalinolobus tuberculatus). New Zealand Journal of Zoology 27: 207-221.

survey period. Wind conditions were mild and suitable across the survey period, with maximum wind gusts below 13 km/hr. Mean rainfall was 2.1 mm, with an average minimum temperature of 5.62 °C.

4 Preliminary effects assessment on bats & recommendations

4.1 Habitat Value

Long-tailed bats are utilising the area of the Newcombe Road proposed sand mine and surrounding landscape features as commuting and foraging habitat.

Figure 5 shows the location of these habitats and known significant natural areas (Deichmann & Kessels 2013)[13].

Due to the large number of feeding buzzes, social calls and general activity at Site 13 within Gully B, it is possible that the mature willow and poplar trees were being utilised as a roost site during the May-June survey. There was not evidence of roosting at any of the sites during the previous December – January survey, although ABM surveys are not generally able to definitely detect roosting habitats where social or bi-modal activity is not obvious. Further surveys employing dusk watches, or radiotracking would be required to establish roosts with a greater degree of certainty.

There are number of mature exotic trees on site which are suitable *potential* roosting habitat for bats. These are generally trees greater that 15 cm diameter at breast height (dbh), and which have cavities and crevasses which bats can crawl into (e.g. Figure 6). Generally, isolated tree in paddocks aren't used as roost trees because bats prefer groups of mature trees or double-lined shelter belts for roosting. Sometimes a solitary bat can use a tree for a temporary roost for a night or two though, and these can be difficult to locate without intensive radio tracking. Maternity or communal roosts, where female bats regularly occupy over the spring and summer month to raise their pups, are generally in sheltered areas with many mature trees. There is no evidence of a maternity site at Newcome Road at this point in time. While ABM surveys alone usually cannot determine roosts sites, high level activities over the spring-summer months, with bi-modal patterns of emergence/return activity patterns, can suggest a communal roost in the locality of the acoustic survey. These types of data were not found during the December-January surveys.

The location is being used for foraging and commuting though. As the data analysis show, commuting and feeding buzzes were found at many of the sites surveyed and detection rates ranged from low to high. Generally, bats are edge adapted animals, using the edges of forest as a guide to commuting within a landscape. They are opportunistic feeders of insects, but generally will return to areas, often over water or along side streams, rivers and lakes to feed on emerging flying insects. Bats can and do fly and forage over pasture but generally favour edge habitats.

The data therefore indicates that the Newcombe Road proposed sand mine site site and its surrounding locality main habitats for long-tailed bats:

- Commuting habitat: The mature shelterbelt trees at the site access, all of Gully B and the margin of the Karapiro Stream are likely to be used as regular commuting corridors across and along this site. Bats are likely to fly over all of the site on a regular basis, but likely less often that the gullies and shelterbelts.
- Foraging habitat: The main foregoing habitats are likely to be with the stream of Gully B, the margins of the Karapiro Stream and the wetland areas at the tope of Gully D alongside the Karapiro Stream. The open pastures are likely to be occasionally used for foraging but less often than these other habitats.
- Roosting habitat: The mature trees within Gully B are possibly used for roosting by solitary bats or as an occasional communal roost by bats. The mature trees within Gully C and

[13] Deichmann, B & Kessels, G. 2013. Significant Natural Areas of the Waipa District: Terrestrial and Wetland Ecosystems. Kessels & Associates Ltd for Waikato Regional Council: Technical report 2013/16

Gully D are possibly used as roosting habitat. The mature trees found in the shelterbelts, as well as the isolated trees within the pastureland, are less likely to be used as communal roost trees, but roosting may still occur in these trees.

Therefore, in accordance with the EcIA guidelines for assessing ecological value the Newcombe Road site for bats is considered to be 'Very High'.[14]

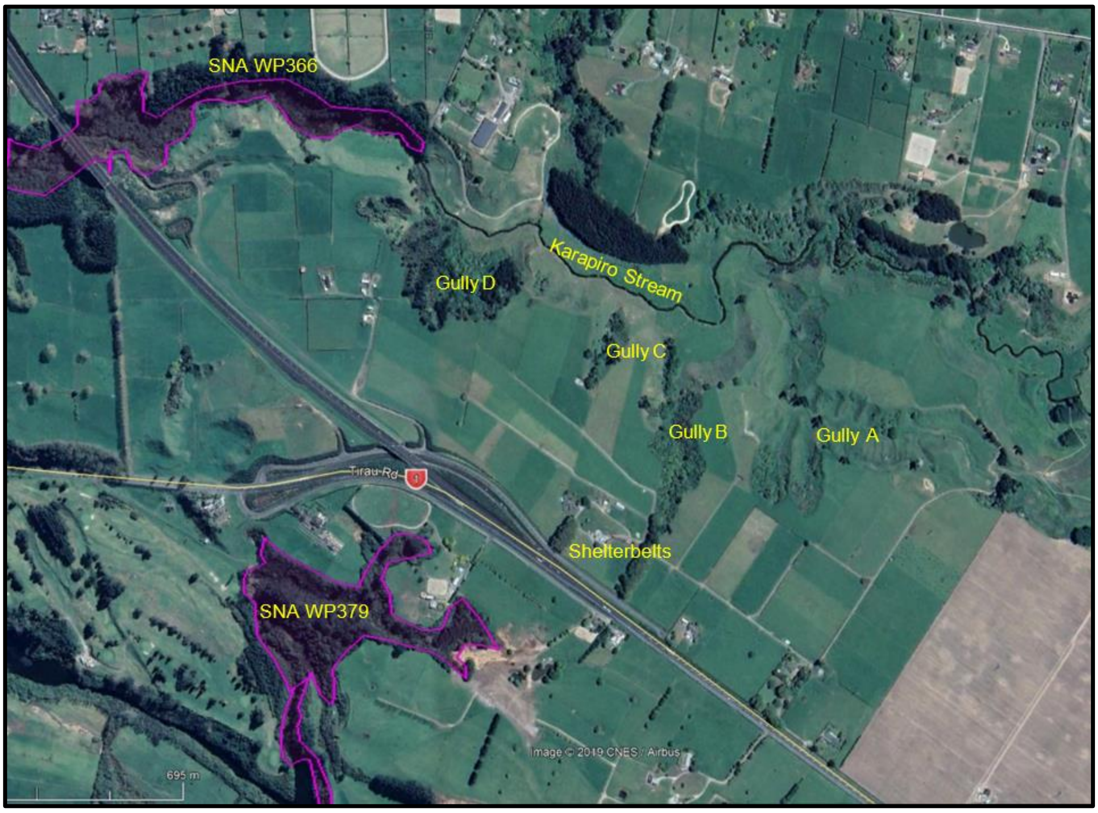


Figure 5: Location of key habitats for bats and WRC listed SNAs at Newcombe Road

[14] Refer to Table 5 (p67 EciA guidelines): "Nationally Threatened species, found in the ZOI either permanently or seasonally"

Figure 6: Crevices within these poplars are examples of potential bat roost trees at Newcombe Road

4.2 Preliminary ecological effects evaluation on bats

The removal of pasture and portions of some of the gully areas associated with the sand mine operation will result in the temporary loss of foraging and commuting habitat for bats. This effect is likely to cause a short-term disruption to movement of bats across this property. However, in the context of habitat availability in the wider landscape, long-term adverse significant adverse effects are unlikely to be discernible. Jones et al (2019)[15] suggest that long-tailed bats may be more resilient to development than the only other extant NZ bat species (short-tailed bat), because they appear less dependent on unmodified indigenous forest (due to their wide distribution throughout New Zealand), and because they are thought to be more flexible with their roost choice, as well as being edge-adapted (Borkin & Parsons, 2009; O'Donnell et al., 2006)[16]. There will, however, still be residual short to medium terms loss of habitat which will require mitigation. Opportunities for mitigation of lost foraging and commuting habitat require further consideration in the detailed ecological effects assessment for the project as a whole.

At this point in time there is no evidence that occupied bat roosts would be impacted by the proposed sand extraction operation. However, bats utilise a large number of trees as roosts throughout their home range and this can vary from year to year so that predicting roost tree usage within a bat population's home range without undertaking radio tracking is not possible. There are a number of trees on the site which could be utilised as bat roost trees which would be removed, or indirectly impacted, by the sand mine operation – these are termed potential bat roost trees. Trees that fit this category are not currently known to be occupied by bats but because they exhibit cavity bearing properties may be used by bats for roosting, although currently there is no evidence that they are occupied.

While any loss of an occupied roost tree can be considered to be a significant impact on a local population of bats, especially an occupied communal roost tree, the loss of potential roost trees is considered to be a lesser effect. However, given the uncertainty surrounding roost tree usage in rural Waikato landscapes, all potential roost trees should be checked immediately before felling to ensure they are not occupied, and if they are, a contingency strategy to avoid or offset these adverse effects should be put in place to address all scenarios, no matter how low the risk of one of those scenarios eventuating.

There may be a number of indirect and cumulative adverse effects of the sand mine extraction process on bats in this locality. For example, if night-time lighting is used on site this has potential to impact bat behaviour. Further effect assessment is required of each of these indirect and cumulative effects (such as lighting), in the detailed impact assessment reporting.

In accordance with the EcIA guidelines the 'Magnitude of Effect' of loss of foraging and commuting habitats for long-tailed bats is considered to be 'Moderate' in the short to medium term (0 to 25 years) and 'Low' in the long-term).[17] This is because the loss of the habitat in this locality is a small proportion of pastureland and exotic habitat for bats. Long-tailed bats are known to have a home range of

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[15] Jones C., Borkin K., Smith D. (2019). Roads and wildlife: the need for evidence-based decisions; New Zealand bats as a case study. New Zealand Journal of Ecology 43(2): 3376

[16] Borkin K.M. and Parsons S. 2009: Long-tailed bats' use of a Pinus radiata stand in Kinleith Forest: recommendations for monitoring. New Zealand Journal of Forestry 53(4): 38 43; O'Donnell C.F.J., Christie J.E., and Simpson W. 2006: Habitat use and nocturnal activity of lesser short-tailed bats (Mystacina tuberculata) in comparison with long-tailed bats

[17] Refer to Table 8 (p83) EcIA guidelines: Low: Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; and/or Having a minor effect on the known population or range of the element/feature. Moderate: Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; and/or Loss of a moderate proportion of the known population or range of the element/feature; High: Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; and/or Loss of a high proportion of the known population or range of the element/feature; Very High: Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; and/or Loss of a very high proportion of the known population or range of the element/feature.

hundreds of hectares (Dekrout et al 2014)[18]. In the long-term, as the site is rehabilitated and pasture and trees are established, bats will be able to re-enter and utilise this habitat for foraging and commuting.

In accordance with the EcIA guidelines the 'Magnitude of Effect of the loss of any occupied roost tree could range from 'Very High' if a communal bat tree is removed to 'High' if a solitary bat roost tree is removed. Suitable measures are required for robust prefelling checks of potential bat roost trees to ensure these are not occupied before being felled. If potential roost trees are proposed to be removed, suitable consent conditions will be required to monitor all potential roost trees before felling, and to avoid removal of any occupied roost trees. If a known roost tree is to be removed, implementation of robust biodiversity offset or compensation measures will be required to address this significant potential impact. At this point in time there is a small risk of finding an occupied communal roost tree within the sand mine footprint, particularly if intrusion into the gullies and mature shelterbelt trees are limited to as minimal an extent as possible.

Combining the ecological value of habitat for bats with the Magnitude of Effects of the proposed sand mine on bats leads to the following EcIA 'Level of Effects' thresholds for each habitat type associated with proposed sand mine at Newcombe Road before suitable avoidance, remediation and mitigation measures[19]:

- Loss of open pastureland for foraging and commuting habitat - Moderate level of effect on bats;
- Loss of of gully and shelterbelt and pastureland habitat within 25 m of shelterbelts and gully habitats - High level of effect on bats;
- Loss of occupied solitary roost trees and unoccupied potential roost tree habitat – High level of effects on bats; and
- Loss of occupied roost tree – Very High level of effect on bats.

5 Conclusion & Recommendations

The subject property provides foraging and commuting habitat for long-tailed bats. Some of the mature exotic trees in the gully systems may also provide roosting habitat for bats. The airspace above the open pastureland is likely being occupied by bats as they fly to and from key feeding and roosting habitats and for occasional foraging. However, the most significant habitats are likely to be the gully system, mature tree shelter belts and the riparian margins of the Karapiro River.

In order to address the effects of the proposed Newcombe sand mine on long-tailed bats, the following measures are recommended:

d) A survey and inventory of all potential bat roost trees is undertaken in accordance with best practice before sand extraction begins;

e) A Bat Management Plan (BMP) should be prepared by a recognised bat expert and implemented across the site which will outline detailed protocols around tree removal and ongoing monitoring; and

f) The loss of habitat of bats within the site is suitably mitigated, including appropriate offset offset measures such as buffer planting, animal pest control, erection of artificial bat roosts, habitat restoration, and long-term protection of high quality bat habitat areas. The type and

[18] Dekrout, A.S., Clarkson, B.D. & Parsons, S. (2014). Temporal and spatial distribution and habitat associations of an urban population of New Zealand long-tailed bats (Chalinolobus tuberculatus), New Zealand Journal of Zoology, 41:4, 285-295, DOI: 10.1080/03014223.2014.953551

[19] Refer to Table 10 (p84) EcIA guidelines.

quantum of any mitigation measures is best determined by biodiversity offset compensation or quantitative modelling.

Subject to review of the detailed sand extraction process and review of the full suite of avoidance, remediation, mitigation, offset and monitoring measures as broadly outlined above, the overall level of adverse effects on long-tailed bats because of this proposal is likely to be low.

Appendix A: ABM coordinates for the 2020 Newcombe Road Quarry long-tailed bat survey

Table A-1: Locations of ABMs for Dec 2019 – Jan 2020 survey

Site	January Survey	Latitude	Longitude
1	PRS1 (In Cabbage tree in large gully)	37°53’27.04”S	175°30’21.44”E
2	PRS2 (On cabbage tree near gate and stream)	37°53’27.51”S	175°30’23.37”E
3	KB48 (In large willow in gully)	37°53’37.56”S	175°30’43.05”E
4	ProSoC2(Poplar at bottom of gully)	37°53’34.61”S	175°30’36.11”E
5	PRS3 (On oak tree next to track)	37°53’48.92”S	175°30’40.56”E
6	WEC2 (On fence post)	37°53’40.05”S	175°30’41.45”E
7	WEC7 (On driveway near road)	37°53’47.30”S	175°30’32.84”E
8	BW04 (On tree fork, side of gully)	37°53’33.84”S	175°30’37.01”E

Table A-2: Locations of ABMs for May-June 2020 survey

Site	May Survey	Latitude	Longitude
9	BW01 (South of small gully)	37°53’30.36”S	175°30’18.18”E
10	PRS4 (On pine tree branch)	37°53’31.25”S	175°30’22.07”E
11	BW04 (Cabbage tree 50m west of stream, below pylon)	37°53’25.58”S	175°30’23.15”E
12	PRS1 (On Poplar tree, top SE corner of gully)	37°53’34.11”S	175°30’37.60”E
13	BW06 (Bottom of gully, poplar tree branch)	37°53’38.07”S	175°30’42.61”E
14	PRS2 (Far NE end of paddock)	37°53’43.91”S	175°30’46.47”E
15	BW05 (At first poplar)	37°53’47.35”S	175°30’42.95”E
16	KB48 (On driveway)	37°53’48.38”S	175°30’33.29”E

Appendix B: Weather data during the two survey periods

Table B-1: Summary of January survey weather conditions during the survey period. Temperatures in °C, precipitation in mm and wind speed in m/s. Data obtained from NIWA CliFlo database, at 26117

Date	Maximum Temperature(C)	Minimum Temperature (C)	Precipitation (mm)	Maximum Wind speed (m/s)
19/12/19	19.3	9.5	0.8	10.8
20/12/19	20.3	11.9	0	16.5
21/12/19	21.4	8.3	4.6	9.8
22/12/19	21.3	7.8	0	9.3
23/12/19	24.2	11.6	0	9.3
24/12/19	25.3	16	0	8.2
25/12/19	25.9	13.4	0	7.2
26/12/19	22.3	10.6	0	6.7
27/12/19	25	11.2	0	10.8
28/12/19	22.3	10.5	0.4	14.9
29/12/19	20.5	5.9	0	12.9
30/12/19	20.4	14.1	0	12.4
31/12/19	23.4	10.6	0.2	8.8
1/01/20	26.5	10.3	0	9.8
2/01/20	22.7	7.5	0	10.8
3/01/20	24	14.4	0	13.9
4/01/20	22.5	14.5	0.6	17
5/01/20	19.5	12.4	0	12.4
6/01/20	19.8	14.3	1.2	18.5
7/01/20	19.9	12.5	0	13.9
8/01/20	19.8	6.7	0	9.8
9/01/20	21.1	7.5	0	12.4

Table B-2: Summary of May survey weather conditions during the survey period. Temperatures in °C, precipitation in mm and wind speed in m/s. Data obtained from NIWA CliFlo database, at 26117

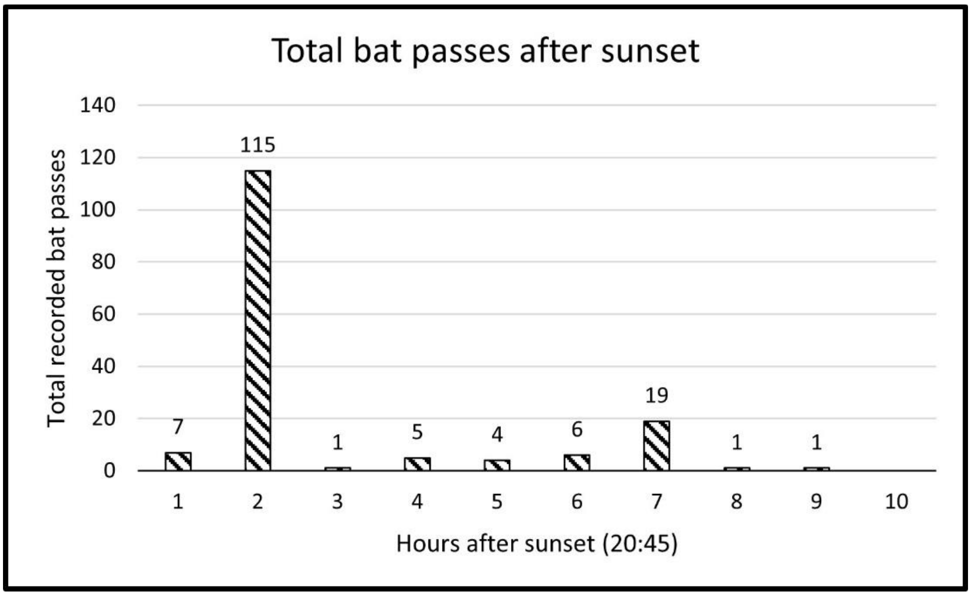
Date	*Maximum Temperature*(C)	*Minimum Temperature* (C)	*Precipitation (mm)*	*Wind max gusts* (m/s)
15/05/2020	19.3	2.5	0	4.1
16/05/2020	19.3	8.8	0	5.7
17/05/2020	20.4	6.3	0	6.2
18/05/2020	20.4	3.8	0	5.7
19/05/2020	19	3.2	0	6.7
20/05/2020	18	1.1	0	4.6
21/05/2020	17.3	0	0	4.1
22/05/2020	16.7	1.6	0	4.1
23/05/2020	17.6	-1.9	0	4.6
24/05/2020	13.1	2.3	0	6.7
25/05/2020	19.7	11.3	9.6	9.8

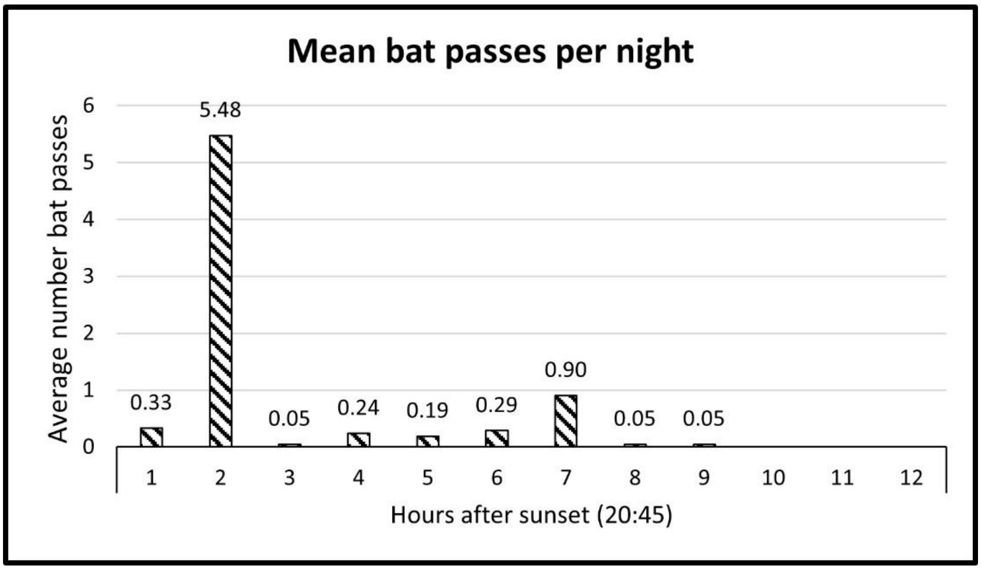
26/05/2020	19.7	11.1	4.8	5.1
27/05/2020	20	10.4	0	4.6
28/05/2020	14.7	2.3	0	2.6
29/05/2020	18	6.4	0	2.6
30/05/2020	15	8.7	3.4	5.7
31/05/2020	18.5	9.2	0.2	7.2
1/06/2020	16.7	10.8	4.2	8.8
2/06/2020	17.4	12.4	21	12.4
3/06/2020	18.6	4.8	0	8.8
4/06/2020	17.4	7.4	2.6	12.4
5/06/2020	18.6	7.1	1.6	7.2
6/06/2020	16.8	3.4	0.6	10.3
7/06/2020	16.5	6.2	1.2	10.8
8/06/2020	15.3	0.5	0	8.8
9/06/2020	16	1.1	0	11.3
10/06/2020	16.9	-0.1	0	3.6
11/06/2020	12.5	2.7	0.2	8.8
12/06/2020	17.1	5.9	0.2	8.2
13/06/2020	18.2	5.5	1.2	3.6
14/06/2020	16	6.8	0	3.6
15/06/2020	15.4	7.8	0	6.7
16/06/2020	16.2	5.3	0	3.1
17/06/2020	16	8	0	6.2
18/06/2020	18.4	8.1	0	11.8
19/06/2020	17	4.7	25.8	5.1
20/06/2020	17.6	4.6	0	5.1
21/06/2020	17.3	9.2	3.4	7.7
22/06/2020	18.8	9.9	0.6	8.8

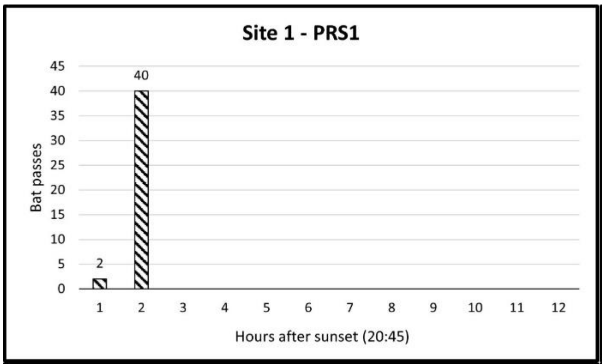
Appendix C: HAS for each individual detector and across all detectors

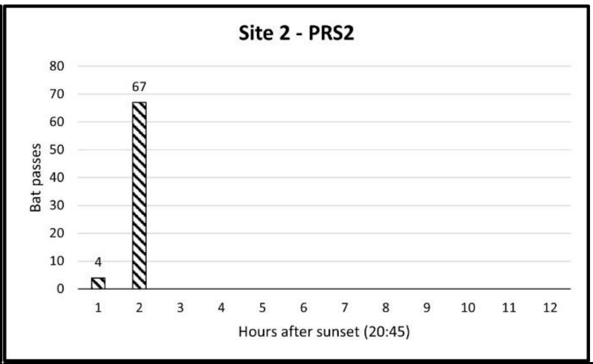
******Note a change of scale on the y axis*

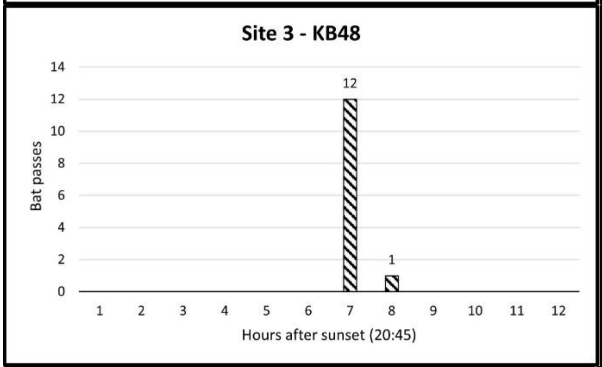
December/January Survey data

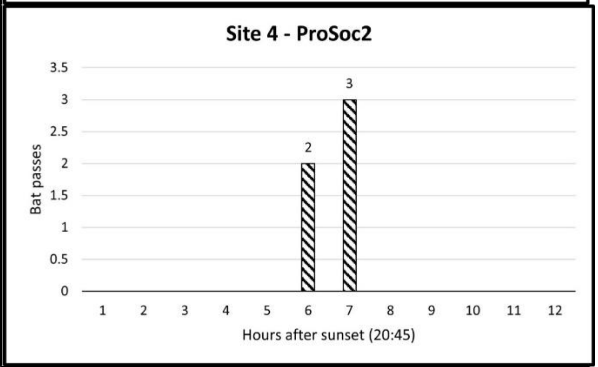


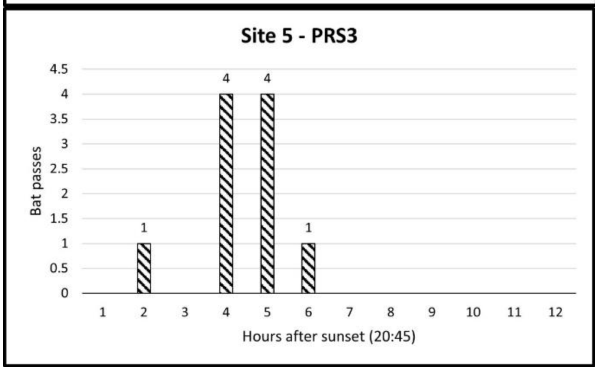


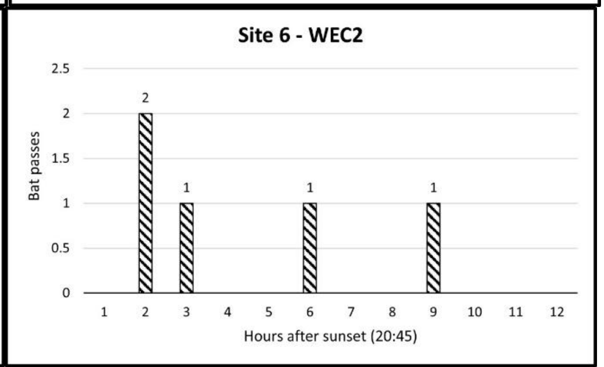

Site 1 - PRS1
Bat passes
Hours after sunset (20:45)
2
40

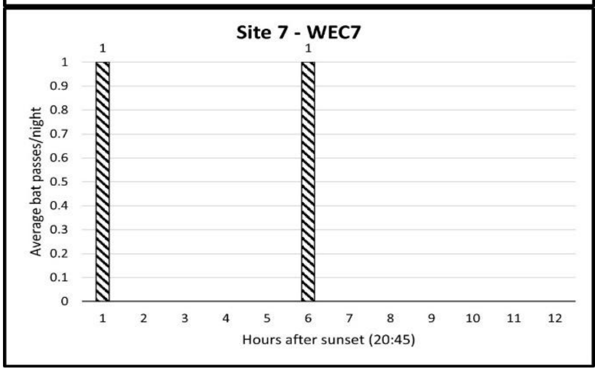

Site 2 - PRS2
Bat passes
Hours after sunset (20:45)
4
67

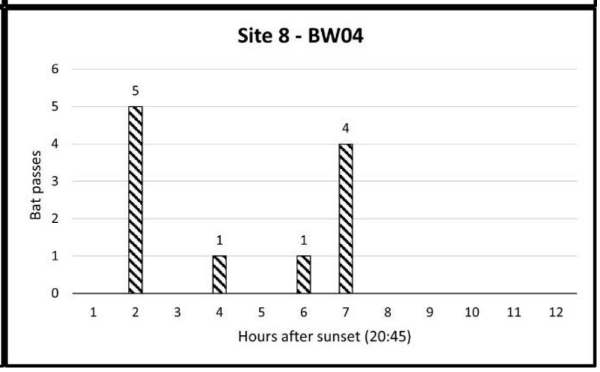

Site 3 - KB48
Bat passes
Hours after sunset (20:45)
12
1


Site 4 - ProSoc2
Bat passes
Hours after sunset (20:45)
2
3

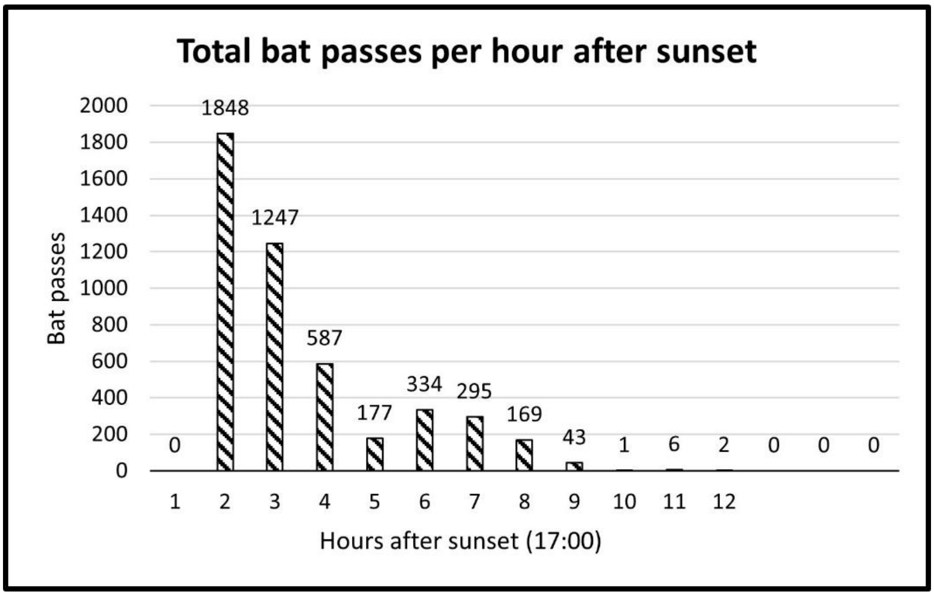

Site 5 - PRS3
Bat passes
Hours after sunset (20:45)
1
4
4
1

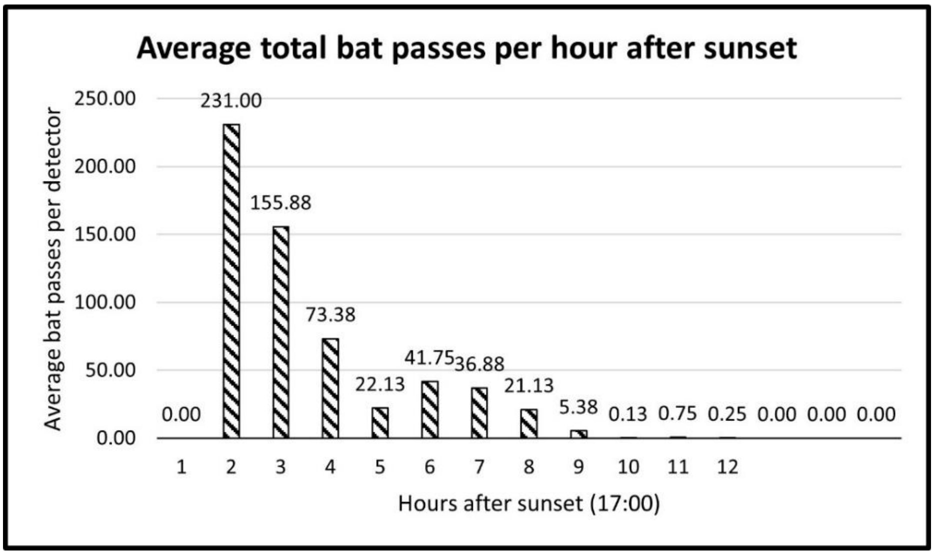

Site 6 - WEC2
Bat passes
Hours after sunset (20:45)
2
1
1
1


Site 7 - WEC7
Average bat passes/night
Hours after sunset (20:45)
1
1

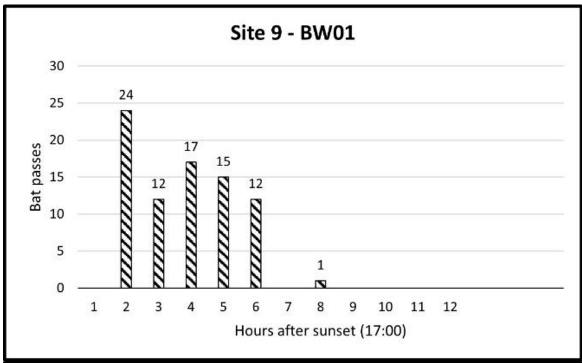

Site 8 - BW04
Bat passes
Hours after sunset (20:45)
5
1
1
4

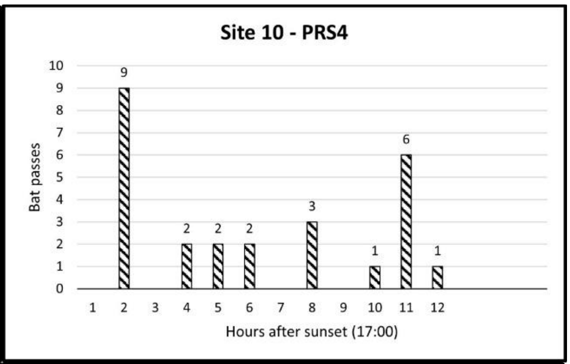
May/ June Data

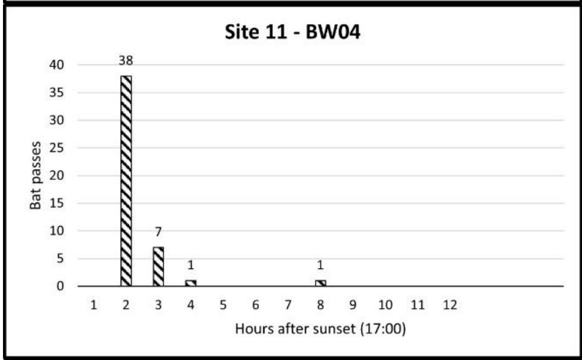


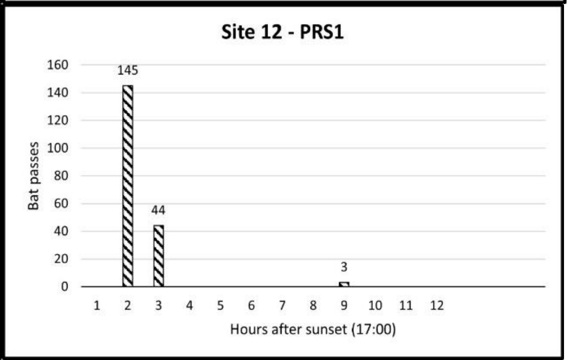


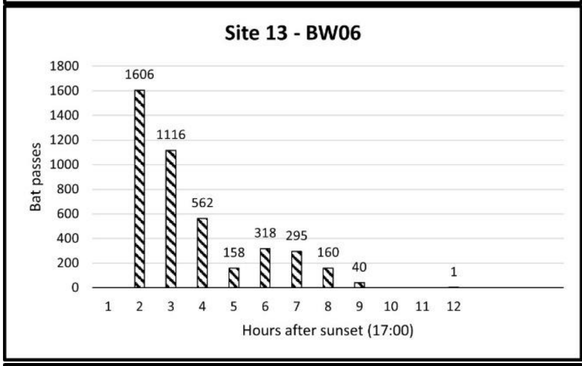
Bat passes per hour after sunset: May to June 2020

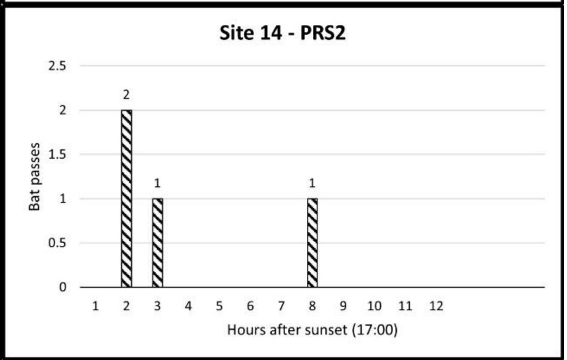


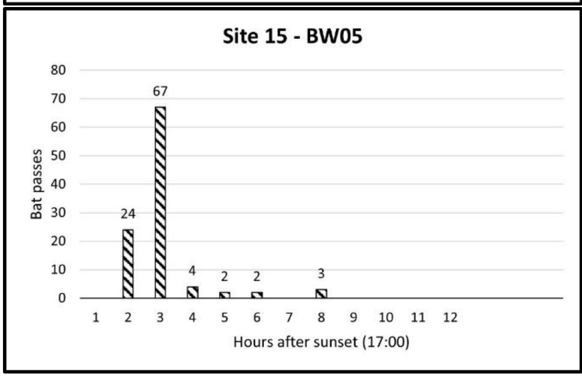


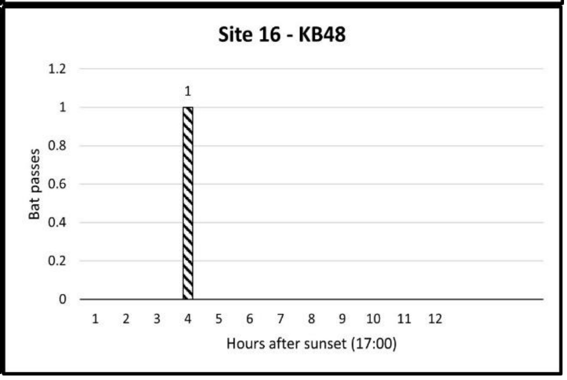












Appendix C: Ecological Effects Assessment Guidelines

Table 1: Ecological values assigned to habitats (adapted from EIANZ, 2018).

Attributes to be considered when assigning ecological value or importance to a site or area of vegetation/habitat/community.	
Matters	**Attributes to be considered**
Representativeness	Attributes for representative vegetation and aquatic habitats: • Typical structure and composition • Indigenous species dominate • Expected species and tiers are present Attributes for representative species and species assemblages: • Species assemblages that are typical of the habitat • Indigenous species that occur in most of the guilds expected for the habitat type
Rarity/ distinctiveness	Attributes for rare/distinctive vegetation and habitats: • Naturally uncommon, or induced scarcity • Amount of habitat or vegetation remaining • Distinctive ecological features • National priority for protection Attributes for rare/distinctive species or species assemblages: • Habitat supporting nationally Threatened or At Risk species, or locally uncommon species • Regional or national distribution limits of species or community • Unusual species or assemblages • Endemism
Diversity and Pattern	• Level of natural diversity, abundance and distribution • Biodiversity reflecting underlying diversity • Biogeographical considerations – pattern, complexity • Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation
Ecological context	• Site history, and local environmental conditions which have influenced the development of habitats and communities • The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA) • Size, shape and buffering • Condition and sensitivity to change • Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material • Species role in ecosystem functioning – high level, key species identification, habitat as proxy

Table 2: Ecological values assigned to species (adapted from EIANZ, 2018).

Value	**Species values**
Very high	Nationally Threatened - Endangered, Critical or Vulnerable.

Value	Species values
High	Nationally At Risk – Declining.
Moderate	Nationally At Risk - Recovering, Relict or locally uncommon or rare
Low	Not Threatened Nationally, common locally
Negligible	Exotic species, including pests

Table 3: Scoring for sites or areas combining values for four matters in Table 1

Value	Description
Very High	Area rates High for 3 or all of the four assessment matters listed in Table 1. Likely to be nationally important and recognised as such.
High	Area rates High for 2 of the assessment matters, Moderate and Low for the remainder, or Area rates High for 1 of the assessment maters, Moderate for the remainder. Likely to be regionally important and recognised as such.
Moderate	Area rates High for one matter, Moderate and Low for the remainder, or Area rates Moderate for 2 or more assessment matters Low or Very Low for the remainder Likely to be important at the level of the Ecological District.
Low	Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
Negligible	Area rates Very Low for 3 matters and Low or Very Low for remainder.

Table 4: Criteria for describing magnitude of effect (EIANZ, 2018).

Magnitude	Description
Very high	Total loss of, or very major alteration to, key elements/features/ of the existing baseline[1] conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature

[1]Baseline conditions are defined as 'the conditions that would pertain in the absence of a proposed action' (EIANZ, 2018).

Table 5: Timescale for duration of effects (EIANZ, 2018).

Timescale	Description
Permanent	Effects continuing for an undefined time beyond the span of one human generation (taken as approximately 25 years)
Long-term	Where there is likely to be substantial improvement after a 25 year period (e.g. the replacement of mature trees by young trees that need > 25 years to reach maturity, or restoration of ground after removal of a development) the effect can be termed 'long term'
Temporary[1]	Long term (15-25 years or longer – see above) Medium term (5-15 years) Short term (up to 5 years) Construction phase (days or months)

[1]Note that in the context of some planning documents, 'temporary' can have a defined timeframe.

Table 6: Criteria for describing overall levels of adverse ecological effects (EIANZ, 2018).

Ecological Value (Table 1) / Magnitude (Table 2	**Very high**	**High**	**Moderate**	**Low**	**Negligible**
Very high	Very high	Very high	High	Moderate	Low
High	Very high	Very high	Moderate	Low	Very low
Moderate	High	High	Moderate	Low	Very low
Low	Moderate	Low	Low	Very low	Very low
Negligible	Low	Very low	Very low	Very low	Very low

Appendix D: Wetland Delineation Protocol – results

Table 8.1 below summarises the characteristics of the wetlands in each of the stream catchments. Figures W-FW3 to W-FW6 depict the location of each of these wetlands.

Table 8.1: Wetland characteristics summary

Gully	Size (m^2)	Dominant species
Gully seepage wetlands within the Project footprint (estimated total 0.309 ha)		
Gully A	0.2 ha*	Likely > 80% native *Carex geminata* but unknown due to access issues that prevent being able to delineate and characterise wetlands
Gully B	0.025	*> 80% native Carex geminata*
Gully C	0.046	*> 80% native Carex geminata*
Gully D	0.038 ha	> 80% native *Carex geminata*
Gully basin wetland adjacent to the project footprint		
Gully A	0.816 ha	30% grey willow, 30% crack willow, 20% *Carex geminata*, 15% *Carex virgata*

Table 8.2: WDP Hydric Vegetation composition and relative abundance. Gully A was inaccessible so it was assumed wetlands were present but hydric vegetation or composition could not be determined.

Hydric vegetation test	Clarkson et al 2014 hydric vegetation category	Wetlands within the project footprint			
		Gully A*	Gully B	Gully C	Gully D
Hydric test		N/A	Rapid	Rapid	Rapid
Common name (Latin abbreviation)					
Carex geminate (CARgem)	FACW	?	29%	65%	81%
Crack willow (SALfra)	FACW	?	21%	0%	0
Soft Rush (JUNeff)	FACW	?	7%	2%	3%
Creeping buttercup (RANrep)	FAC	?	4%	8%	4%
Bindweed (CALsep)	FAC	?	1%	2%	3%
Blackberry (Rubfru)	FAC	?	10%	4%	6%

Isolepis prolifera (ISOpro)	OBL	?	2%	1%	0
Yorkshire fog (HOLlan)	FAC	?	4%	1%	<1
Willow weed (PERmac)	FACW	?	15%	0	0
Swamp kiokio (BLE min)	FACW	?	1%	1%	2%
Pampas (CORsel)	FAC	?	4%	16%	0
Water pepper (PERhyd)	FACW	?	2%	0	0
Creeping bent (AGRsto)	FACU	?	1%	<1%	1%
Birds-foot trefoil (LOTcor)	FACU	?	1%	<1%	<1%
Cabbage tree (CORaus)	FACW	?	2%	0	0
Totals (%)		?	100%	100%	100%

Appendix E: Qualitative Compensation Models Report

Qualitative Biodiversity Modelling Report

Prepared for
RS Sands Ltd

Prepared by
Alliance Ecology Ltd

Date
October 2021

Job Number
15.01.2021

Contents

1 Introduction

1.1 Background

This Qualitative Biodiversity Modelling (QBM) report[1] supports the assessment of ecological effects for a sand quarry at 77 Newcombe Road Cambridge. It should be read in conjunction with the Ecology Report (Alliance Ecology, 2021).

As set out in the Ecology Report, the project is expected to have residual adverse effects of 'Moderate' or higher on several indigenous biodiversity values. Specifically:

- The 'Level of Effects' on long-tailed bats after measures to avoid, remedy or mitigate effects was assessed as 'High.'
- the 'Level of Effects' on native-dominated gully seepage wetlands and on the native forest fauna assemblage were assessed as 'Moderate' after measures to avoid, remedy or mitigate effects.

Proposed measures to offset or compensate for these residual effects include approximately 12.5 ha of habitat restoration and enhancement that includes native revegetation, stock exclusion and weed control, which will:

- Create additional habitat and ecological connectivity for bats and other native forest fauna along approximately 2km of riparian margin, linking up two Significant Natural Areas; and
- Provide buffering and ecological connectivity for approximately 3.73 ha of floodplain and gully seepage wetlands through the native revegetation of associated wetlands margins.

1.2 Report purpose

The report serves as a decision support tool to assess the likelihood that the proposed habitat restoration and enhancement measures will achieve intended No Net Loss (NNL)/Net Gain (NG) outcomes for affected biodiversity values.

Separate QBMs are presented for long-tailed bat, native-dominated gully seepage wetlands, and the native forest fauna assemblage.

[1] This QBM report has been prepared in accordance with the terms and conditions set out in the proposed Offer of Service dated 11 January 2021.

2 Qualitative Biodiversity Model overview

QBMs have recently been developed to guide the type and magnitude of measures required to offset or compensate for habitat loss (Baber 2021; Tonkin & Taylor 2021). QBMs follow a similar approach to the Biodiversity Offset Accounting System (BOAS) commissioned by the Department of Conservation (Maseyk et al. 2015) but use qualitative information where quantitative data is unavailable. This qualitative information is derived from both expert assessment and available literature.

These qualitative models are an improvement on the status quo approach which involves the use of multipliers or environmental compensation ratios where quantifiable data is unavailable. The use of multipliers and compensation ratios have increasingly been challenged due to a lack of transparency and the often ad-hoc nature of their application. Further, they generate high variability in the type and management of compensation across projects relative to the type and level of residual effects.

The QBMs were developed to address these issues of transparency and consistency (Baber et al 2021) by adapting BOAS. QBMs determine the type and magnitude of proposed habitat and restoration measures that are considered *likely* to achieve NNL or preferably NG outcomes. The models provide a transparent and systematic method for assessing both the residual adverse effects on biodiversity values at impact sites, and the equivalent biodiversity benefits associated with compensatory actions at the proposed compensation sites.

The QBMs calculate whether NNL or NG outcomes will likely be achieved, accounting for uncertainty and the time lag between losses occurring at impact sites and gains being generated at compensation sites. The models assess the likelihood of achieving NNL/NG for specified biodiversity values based on:

- Available information on the areal extent of impact and the areal extent of the proposed habitat restoration and enhancement site(s);
- Expert assessment supported by a review of relevant literature or data (where quantitative data is unavailable) and field investigations on:
  - The reduction in habitat value or population/assemblage at the impact site(s) as a result of the project activities; and
  - The increase in habitat value or population/assemblage that can be directly attributed to compensation actions at the habitat restoration and enhancement compensation site(s) within a fixed time period
- Risk contingency for biodiversity values that is commensurate with threat status of habitats and species, and with the likelihood that impacts are understood;
- The expected benefit attributed to the proposed habitat restoration and enhancement measures within a given time period;
- An assigned percentage confidence (i.e. 50 to < 75 %, 75 to < 90 %, and ≥ 90 %) that those compensation actions would achieve the expected benefit; and
- Assigned time discount rate of 3 % to account for the time lag between when an impact is likely to occur and when the benefit of compensation action is likely to be achieved.

In applying any biodiversity offset or compensation model, it is important to acknowledge the limitations, constraints and uncertainties associated with such models (Maseyk et al, 2018). Notably for QBMs, these limitations, constraints and uncertainties have the potential to generate false positives, i.e. instances where the models generate NNL/NG outcomes when the converse is true. Conservative model inputs and stated NG outcomes are necessary to help to minimise this risk, following the approach in Baber et al (2021).

Equally, it is important to recognise that this approach provides a transparent and robust validation process for determining compensation requirements to address residual adverse effects.

3 Long-tailed bat QBM

As set out in the Ecology Report, project activities are expected to have a 'High' level of residual adverse effects on long-tailed bats after measures to avoid, remedy or mitigate for effects.

Based on the proposed type and quantum of proposed habitat restoration activities, the QBM indicates that Net Gain outcomes are likely to be achieved for bats within 10 years of impact at a given location. These Net Gain outcomes would be expected to continue beyond 10 years as biodiversity values at the proposed compensation sites will continue to increase through time.

Table 3.1 below summarises the bat habitat impact model inputs, and the compensation model inputs associated with the proposed terrestrial habitat restoration and enhancement activities. Table 3.2 provides impact and compensation scores and the expected percentage Net Gain model outcome.

Table 3.1 Long-tailed bat habitat QBM inputs

General model descriptor inputs	
Model inputs	**Explanation**
Biodiversity type	Long-tailed bats
Technical expert input(s)	Matt Baber and Gerry Kessels
Benchmark	**Data input**: 5 **Explanation**: The benchmark is set at 5 to align with EcIAG habitat categories. The benchmark constitutes a hypothetical but realistic potential 'best of' state, i.e., a large population of long-tailed bats that are located within high value, mature native forest dominated landscape that is subject to long-term pest control and is at carrying capacity.
Net Gain target	**Data input**: 20% **Explanation**: The Net Gain target was set at 20%. In general terms, the greater the assigned Net Gain outcome target, the greater the likelihood that No Net Loss or preferably Net Gain outcomes will be achieved. For compensation we consider a Net Gain outcome target of 20% to be generally appropriate, which equates to a 20% overshoot of No Net Loss, i.e. the Compensation Score is 20% higher than the Impact Score.
Impact model inputs and descriptions	
Habitat/site impacted	Pasture
Impact contingency (Value)	**Data input**: Very High value (the calculated impact score is multiplied by 1.20, i.e. 20%). **Explanation**: The impact contingency (value) relates to the modelled biodiversity value, which in this case is long-tailed bats. It addresses the need to take a more precautionary approach when impacting on habitats or species that are assessed as being of higher ecological value through the EcIAG ecological value assessment. Long tailed bats are considered to be of 'Very High' value based on the EcIAG. For

	biodiversity values assessed as 'Very High' the calculated impact score is multiplied by 1.20, i.e. 20%).
Impact contingency (uncertainty)	**Data input:** High uncertainty (the calculated impact score is multiplied by 1.20 (+20%) **Explanation**: The impact contingency (uncertainty) addresses the inherent uncertainties in some habitat or species values. This provides for a more precautionary approach when impacting on more complex habitats, or on species for which there is less information or certainty around effects. The impact contingency (uncertainty) in relation to the effects on bats associated with the loss of pasture habitat was deemed to be 'high'.
Areal extent of impact (ha)	**Data input**: 23.72 ha
Value score <u>prior to</u> Impact	**Data input**: 0.25 **Explanation**: Pasture within the project footprint has been assigned a score of 0.25 relative to the benchmark of 5, e.g., it is considered to equate to 5 % the value of benchmark habitats. This assessment is based on desktop and field investigations and using professional judgement. It is key to note that the EcIAG (2018) does not include criteria for determining habitat suitability for a given species. Since habitat suitability is a key component of a magnitude of effects assessment, this will ideally be addressed in subsequent versions of the EcIAG. In the interim proposed criteria that apply to all impact and compensation scores in this model are: 0 = Habitat not suitable < 1 = Marginal habitat that may be used but is not important for any part of the species or species assemblage life-cycle(s) 1 - <2 = Relatively low value habitat that provides some but not all of a species or species assemblage's life-history requirements and/or the habitat is of low quality and the relative abundance within the habitat is low compared to other habitat types 2 - <3 = Relatively moderate value habitat that provides for most if not all of a species or species assemblage's life-history requirements and/or the habitat quality is of moderate quality and the relative abundance within the habitat is moderate compared to other habitat types 3 - <4 = Relatively high value habitat that would typically provide for all species or species assemblage life-history requirements and/or provides a critical resource or resource(s) for life-history requirements. The habitat quality is high and the relative abundance within the habitat is, or is likely to be, high compared to other habitat types. 4 - <5 = Relatively very high value habitat that provides for all species or species assemblage life-history requirements and/or provides a critical resource or resource(s) needed for life-history requirements. The habitat quality is very high and the relative abundance within the habitat is or is likely to be very high compared to other habitat types. Likely to be a local hotspot for that species 5 = Highest quality habitat and/or relative abundance for a given species or species assemblage, likely to be a regional hotspot or benchmark with the species or species assemblage at carrying capacity.

Value score <u>after</u> Impact	**Data input**: 0 **Explanation**: A value of 0 has been assigned because it is conservatively assumed that all habitat within the project footprint will be lost and/or no longer used by bats.
Habitat/site impacted	Exotic plantation forestry (approximately 15 years old)
Impact contingency (Value)	**Data input**: Very High value (the calculated impact score is multiplied by 1.20, i.e. 20%). **Explanatio**n: The impact contingency (value) relates to the modelled biodiversity value, which in this case is long-tailed bats
Impact contingency (uncertainty)	**Data input:** High uncertainty (the calculated impact score is multiplied by 1.20 (+20%) **Explanation**: The impact contingency (uncertainty) in relation to the effects on bats associated with the loss of exotic plantation forest was deemed to be 'high'.
Areal extent of impact (ha)	**Data input**: 1.55 ha
Value score <u>prior to</u> Impact	**Data input**: 2 **Explanation**: Assessed as having Moderate value (low-range) for bats relative to the benchmark of 5, e.g., they are considered to equate to 40 % of the value of benchmark habitats.
Value score <u>after</u> Impact	**Data input**: 0 **Explanation**: A value of 0 as it is conservatively assumed that all habitat within the project footprint will be lost
Habitat/site impacted	Exotic-dominated scrub (approximately 10 years old but varies)
Impact contingency (Value)	**Data input:** Very high value (the calculated impact score is multiplied by 1.20 (+20%) **Explanation**: The impact contingency (value) relates to the modelled biodiversity value: long-tailed bats.
Impact contingency (uncertainty)	**Data input:** High uncertainty (the calculated impact score is multiplied by 1.20 (+20%) **Explanation**: The impact contingency (uncertainty) in relation to the effects on bats associated with the loss of exotic-dominated scrub was deemed to be 'high'.
Areal extent of impact (ha)	**Data input**: 0.98 ha
Value score <u>prior to</u> Impact	**Data input**: 1

	Explanation: Exotic scrub habitat within the project footprint was assessed as having 'Low' value for bats and has been assigned a score of 1 relative to the benchmark of 5, e.g., these habitats are considered to equate to 20% the value of benchmark habitats.
Value score after Impact	**Data input**: 0 **Explanation**: A value of 0 as it is conservatively assumed that all such habitat within the project footprint will be lost
Habitat/site impacted	Mature exotic forest (age varies)
Impact contingency (Value)	**Data input**: Very High value (the calculated impact score is multiplied by 1.20, i.e. 20%). **Explanatio**n: The impact contingency (value) relates to the modelled biodiversity value, which in this case is long-tailed bats
Impact contingency (uncertainty)	**Data input:** High uncertainty (the calculated impact score is multiplied by 1.20 (+20%) **Explanation**: The impact contingency (uncertainty) in relation to the effects on bats associated with the loss of mature exotic forest was deemed to be 'high'.
Areal extent of impact (ha)	**Data input**: 0.53 ha
Value score prior to Impact	**Data input**: 3 **Explanation**: Mature exotic forest was assessed as having High value for bats and has been assigned a score of 3 relative to the benchmark of 5, e.g., these habitats are considered to equate to 60 % the value of benchmark habitats for bats.
Value score after Impact	**Data input**: 0 **Explanation**: A value of 0 as it is conservatively assumed that all such habitat within the project footprint will be lost
Habitat/site impacted	Gully seepage wetlands
Impact contingency (Value)	**Data input**: Very High value (the calculated impact score is multiplied by 1.20, i.e. 20%). **Explanatio**n: The impact contingency (value) relates to the modelled biodiversity value: long-tailed bats
Impact contingency (uncertainty)	**Data input:** High uncertainty (the calculated impact score is multiplied by 1.20 (+20%) **Explanation**: The impact contingency (uncertainty) in relation to the effects on bats associated with the loss of gully seepage wetlands was deemed to be 'high'.
Areal extent of impact (ha)	**Data input**: 0.309 ha

Value score <u>prior to</u> Impact	**Data input**: 2 **Explanation**: Gully seepage wetlands were assessed as having Moderate value for bats and have been assigned a score of 2 relative to the benchmark of 5, e.g., these habitats are considered to equate to 40 % the value of benchmark habitats for bats
Value score <u>after</u> Impact	**Data input**: 0 **Explanation**: A value of 0 as it is conservatively assumed that all such habitat within the project footprint will be lost
Compensation model inputs	
Compensation action 1	Indigenous revegetation within riparian margins and gully slopes.
Discount rate	**Data input**: 3% **Explanation**: A discount rate of 3 % has been applied to account for the inherent risk in the temporal-lag between the impact occurring (due to project activities) and the biodiversity gains being generated (due to the offset actions). The worked examples provided in the model User Manual apply a discount rate of 3 %, as informed by research conducted as part of the Department of Conservation's research project on biodiversity offsetting in New Zealand.
Finite end-point	**Data input**: 10 years. **Explanation**: The project will be staged over 25 years but native revegetation will be completed within the first five years. Revegetation will therefore be approximately 20 years old on average, 10 years after impacts on long-tailed bat at a given location.
Compensation contingency (confidence)	**Data input**: 'High Confidence' (Calculated compensation gain is multiplied by 0.925). **Explanation**: Compensation contingency relates to the level of confidence in the likely success of the proposed habitat restoration/enhancement measures and methodology (see above). This reflects that even well-established management methods sometimes fail to achieve targets for a multitude of reasons. The model does not consider confidence in the implementer of the proposed habitat restoration/enhancement activity. Nor does it consider likelihood of abandonment of the project post-impact but prior to the implementation of habitat restoration or enhancement measures. 'High Confidence' equates to a well-tested and repeatedly proven measure to achieve intended biodiversity gains; evidence-based expert opinion is that success is very likely and which has been proven to succeed greater than 90% of the time..
Areal extent (ha) of compensation action	**Data input**: 12.5 ha **Explanation**: This equates to the available area of pasture within the restoration and habitat enhancement boundary.
Value score <u>prior to</u> compensation measure (relative to benchmark)	**Data input**: 0.5

	Explanation: Pasture within these areas has been assigned a score of 0.5 relative to the benchmark of 5, i.e., these areas are considered to equate to 10 % the value of benchmark habitats. In context, these areas are considered to be of higher quality for bats than pasture areas within the project footprint, the majority of which is on terraced pasture rather than in floodplain or gullies where bats are more likely to commute and forage.
Value score after compensation measure (relative to benchmark)	**Data input**: 2.5 **Explanation**: At 20 years of age, the native revegetation is assigned a value of 2.5 against the benchmark of 5, i.e., these areas are considered to equate to 50% the value of benchmark habitats.

Table 3.2. Long-tailed bat QBM outputs

Model output dashboard						
Impact model outputs	Totals	Mature exotic forest	Exotic dominated Scrub	Exotic plantation forestry	Gully seepage wetlands	Pasture
Impact Score	-3.06758	-0.40055	-0.24671	-0.78081	-0.15112	-1.48838
Compensation model outputs	Totals	Revegetation				
Compensation Score	3.44143	3.44143				
Net gain outcome	12.2%					

4 Wetland Qualitative Biodiversity Model

As set out in the Ecology Report, project activities are expected to have 'Moderate' residual adverse effects on approximately 0.309 ha of native *Carex geminata* dominated gully seepage wetlands[2]. These effects have been assessed in accordance with the Ecological Institute of Australia and New Zealand (EIANZ) guidelines (Roper Lindsay et al, 2018) and cannot practicably be avoided, remedied or mitigated at the point of impact.

Based on the proposed type and quantum of habitat restoration activities, the QBM indicates that Net Gain outcomes are likely to be achieved for wetland biodiversity values within 10 years of impact. These Net Gain outcomes would be expected to continue beyond 10 years as biodiversity values at the proposed wetland compensation sites will continue to increase through time.

Table 4.1 below summarises the wetland impact model inputs, and the compensation model inputs associated with the proposed wetland habitat restoration and enhancement activities within compensation wetlands. Table 4.2 provides impact and compensation scores and the expected percentage Net Gain model outcome.

Table 4.1 Wetland QBM inputs

General model descriptor inputs	
Model inputs	**Explanation**
Biodiversity type	Wetland habitat
Technical expert input (s)	Matt Baber
Benchmark	**Data input:** 5 **Explanation:** The benchmark is set at 5 to align with EcIAG habitat categories. The benchmark constitutes a hypothetical but realistic 'best of' state, i.e., a large indigenous-dominated freshwater wetland that has been subject to long-term pest control
How many habitat types OR sites are impacted	**Data input:** 1
Number of proposed compensation measures	**Data input:** 2
Net Gain target	**Data input:** 20%: **Explanation**: The Net Gain target was set at 20%. In general terms, the greater the assigned Net Gain outcome target, the greater the likelihood that No Net Loss or preferably Net Gain outcomes will be achieved. For compensation we consider a Net Gain outcome target of 20% to be generally appropriate, which equates to a 20% overshoot of No Net Loss, i.e. the Compensation Score is 20% higher than the Impact Score.
Impact model inputs and descriptions	

[2] This is an approximate estimate as the largest gully (Gully A) could not be surveyed due to inaccessibility issues in the form of 2-3m high blackberry and other dense weeds. It was conservatively assumed that this gully included 0.2 ha of wetland habitat.

Habitat/site impacted	Natural wetland
Impact contingency (Value)	**Data input**: Moderate value (calculated biodiversity impact score is multiplied by 1.05 (+5%)) **Explanation**: The impact contingency (value) relates to the modelled biodiversity value and addresses the need to take a more precautionary approach when impacting on habitats or species that are assessed as being of higher ecological value through the EcIAG ecological value assessment. Impacted wetlands were assessed in the Ecology report as being of 'Moderate' value based on the EcIAG. For biodiversity values assessed as 'Moderate' the calculated impact score is multiplied by 1.05, i.e. +5%.
Impact contingency (uncertainty)	**Data input**: Moderate uncertainty (calculated biodiversity impact score is multiplied by 1.1 (+10%)) **Explanation**: The impact contingency (uncertainty) addresses the inherent uncertainties in some habitat or species values. This provides for a more precautionary approach when impacting on more complex habitats, or on species for which there is less information regarding species-specific impacts associated with an effect. The impact contingency (uncertainty) in relation to the effects on bats associated with the loss of the wetlands was deemed to be 'moderate'. For impacts assessed as having 'Moderate' uncertainty the calculated impact score is multiplied by 1.10, i.e., + 10%.
Areal extent of impact (ha)	**Data input**: 0.309 ha (note that this conservatively assumes there is 0.2 ha within Gully A which cannot be accessed due to the dominance of 2-3 metre high blackberry)
Value score prior to Impact	**Data input**: A value of 2.5 (mid-range moderate) relative to the benchmark of 5 as per field investigations and the assessment of effects in the Ecology Report
Value score after Impact	**Data input**: a value of 0 assuming all wetlands within the project footprint will be completely lost.
Compensation model inputs	
Compensation action 1	**Description**: Native revegetation around **gully seepage wetland** margins including a 20-year maintenance programme coupled with stock exclusion fencing, weed control and infill planting
Discount rate	**Data input**: +3% (recommended default)
Finite end-point	**Data input**: 10 years **Explanation**: As described for compensation action 1
Compensation contingency (confidence)	**Data input**: Moderate (75%-90%) (calculated gain score multiplied by 0.825) **Explanation**: 'Moderate Confidence' equates to a well-known measure that is often implemented, and which has been proven to succeed greater than 75% of the time. However, complicating factors and/or expert opinion precludes greater confidence in this compensation measure. Likelihood of success is greater than 75% but less than 90%. Calculated compensation gain is multiplied by 0.825.

	NB: The approach used to assign contingency aligns with that used in Maseyk et al. (2015) except that the term 'offset' has been changed to 'compensation'.
Areal extent (ha) of compensation type	**Data input**: 0.313 ha **Explanation**: This quantum relates to the areal extent of wetlands that will be benefit from the proposed compensation within the habitat restoration and enhancement sites rather than the amount of planting that will be undertaken in these locations.
Value score <u>prior to</u> compensation measure (relative to benchmark)	**Data input:** 2.5 **Explanation**: This score equates to a 'Moderate' value (mid-range) for wetlands at compensation sites as per the characterisation and assessment of wetland values in the Ecology Report.
Value score <u>after</u> compensation measure (relative to benchmark)	**Data input 3** **Explanation:** This score equates to a 10% gain (relative to the benchmark) in ecological value associated with the proposed compensation action. The wetland margin buffer revegetation is expected to improve the biodiversity value of the wetland through the provision of terrestrial habitat (e.g. for aquatic wetland invertebrates that have a terrestrial adult phase) and through the provision of habitat structure/diversity generated by trees and tree roots. Also, the wetland margin will buffer wetland biodiversity from surrounding land-use activities to a certain degree. The increase in score associated with the wetland margin buffer revegetation was not considered to be higher because: • Some of the indigenous biodiversity values will take longer than 20 years to establish, • Surrounding land-use activities would be expected to compromise the ability of the wetland to reach its full biodiversity potential and the wetland margin buffer planting (as explained above for the wetland revegetation post compensation score), and • The compensation provides benefits to the wetland but is not located within the wetland itself
Compensation model inputs	
Compensation action 2	**Description**: Native revegetation around **floodplain wetland** margins including a 20-year maintenance programme coupled with stock exclusion fencing, weed control and infill planting
Discount rate	**Data input**: +3% (recommended default)
Finite end-point	**Data input**: 10 years **Explanation**: As described for compensation action 1
Compensation contingency (confidence)	**Data input**: Moderate (75%-90%) (calculated gain score multiplied by 0.825) **Explanation**: As described for compensation action 1

Areal extent (ha) of compensation type	**Data input**: 3.415 ha **Explanation**: This quantum relates to the areal extent of wetlands that will benefit from the proposed compensation within the habitat restoration and enhancement sites rather than the amount of planting that will be undertaken in these locations.
Value score <u>prior to</u> compensation measure (relative to benchmark)	**Data input:** 2 **Explanation**: This score equates to a 'Moderate' value (low-range) for wetlands at compensation sites as per the characterisation and assessment of wetland values in the Ecology Report.
Value score <u>after</u> compensation measure (relative to benchmark)	**Data input 2.5** **Explanation:** This score equates to a 10% gain (relative to the benchmark) in ecological value associated with the proposed compensation action. The wetland margin buffer revegetation is expected to improve the biodiversity value of the wetland through the provision of terrestrial habitat (e.g. for aquatic wetland invertebrates that have a terrestrial adult phase) and through the provision of habitat structure/diversity generated by trees and tree roots. Also, the wetland margin will buffer wetland biodiversity from surrounding land-use activities to a certain degree. The increase in score associated with the wetland margin buffer revegetation was not considered to be higher because: • Some of the indigenous biodiversity values will take longer than 20 years to establish, • Surrounding land-use activities would be expected to compromise the ability of the wetland to reach its full biodiversity potential and the wetland margin buffer planting (as explained above for the wetland revegetation post compensation score), and • The compensation provides benefits to the wetland but is not located within the wetland itself

Table 4.2 Wetland QBM outputs

Impact model outputs	**Wetlands**		
Impact Score	-0.187		
Compensation model outputs	**Totals**	**Gully seepage wetland buffer**	**Floodplain wetland buffer**
Compensation Score	0.3010	0.0192	0.2817
Net gain outcome			61%

5 Indigenous fauna assemblage

As set out in the Ecology Report, project activities are expected to have a 'Moderate' level of residual adverse effects on the indigenous fauna assemblage after measures to avoid, remedy or mitigate for effects.

Based on the proposed type and quantum of habitat restoration activities, the QBM indicates that Net Gain outcomes are likely to be achieved for indigenous fauna within 10 years of impact at a given location. These Net Gain outcomes would be expected to continue beyond 10 years as biodiversity values at the proposed compensation sites will continue to increase through time.

Table 5.1 below summarises the indigenous fauna impact model inputs and the compensation model inputs associated with the proposed terrestrial habitat restoration and enhancement activities. Table 5.2 provides impact and compensation scores and the expected percentage net gain model outcome.

Table 5.1 Indigenous forest fauna assemblage model inputs

General model descriptor inputs	
Model inputs	**Explanation**
Biodiversity type	Indigenous forest fauna assemblage
Technical expert input(s)	Matt Baber
Benchmark	**Data input**: 5 **Explanation**: The benchmark is set at 5 to align with EcIAG habitat categories. The benchmark constitutes a hypothetical but realistic future state, i.e., the composition and abundance of fauna is at carrying capacity, as would be expected in a large contiguous native forest that has been subject to long-term mammalian pest control.
Net Gain target	**Data input**: 20% **Explanation**: The Net Gain target was set at 20%. In general terms, the greater the assigned Net Gain outcome target, the greater the likelihood that No Net Loss or preferably Net Gain outcomes will be achieved. For compensation we consider a Net Gain outcome target of 20% to be generally appropriate, which equates to a 20% overshoot of No Net Loss, i.e. the Compensation Score is 20% higher than the Impact Score.
Impact model inputs and descriptions	
Habitat/site impacted	Mature exotic forest (age varies)
Impact contingency (Value)	**Data input**: Moderate value (the calculated impact score is multiplied by 1.05, i.e. 5%). **Explanation**: The impact contingency (value) relates to the modelled biodiversity value and addresses the need to take a more precautionary approach when impacting on habitats or species that are assessed as being of higher ecological value through the EcIAG ecological value assessment. Forest fauna are considered

	to be of 'Moderate' value based on the EcIAG. For biodiversity values assessed as 'Moderate' the calculated impact score is multiplied by 1.05, i.e. 5%.
Impact contingency (uncertainty)	**Data input:** Moderate uncertainty (the calculated impact score is multiplied by 1.10 (+10%)). **Explanation**: The impact contingency (uncertainty) in relation to the effects on native forest fauna associated was deemed to be 'moderate'. The impact contingency (uncertainty) addresses the inherent uncertainties in some habitat or species values. This provides for a more precautionary approach when impacting on more complex habitats, or on species for which there is less information regarding species-specific impacts associated with an effect.
Areal extent of impact (ha)	**Data input**: 0.53 ha
Value score <u>prior to</u> Impact	**Data input**: 2 **Explanation**: For native forest fauna, mature exotic forest habitat within the project footprint has been assigned a moderate score of 2 relative to the benchmark of 5, e.g., it is considered to equate to 40 % the value of benchmark habitats. A moderate value habitat provides for most if not all of a species or species assemblage's life-history requirements and/or the habitat quality is of moderate quality and the relative abundance within the habitat is moderate compared to other habitat types.
Value score <u>after</u> Impact	**Data input**: 0 **Explanation**: A value of 0 has been assigned because it is conservatively assumed that all such habitat within the project footprint will be lost and/or no longer used by indigenous forest fauna.
Habitat/site impacted	Exotic scrub (approximately 10 years old but varies)
Impact contingency (Value)	**Data input**: Moderate value (the calculated impact score is multiplied by 1.05, i.e. 5%). **Explanation**: Indigenous forest fauna assemblage was assessed as having 'Moderate' value
Impact contingency (uncertainty)	**Data input:** Low uncertainty (the calculated impact score is multiplied by 1.05 (+5%) **Explanation**: See above
Areal extent of impact (ha)	**Data input**: 0.98 ha
Value score <u>prior to</u> Impact	**Data input**: 1 **Explanation**: Exotic scrub habitat within the project footprint was assessed as having a low value for indigenous forest fauna and has been assigned a score of 1 relative to the benchmark of 5, i.e. these habitats are considered to equate to 20 % the value of benchmark habitats.

Value score <u>after</u> Impact	**Data input**: 0 **Explanation**: A value of 0 as it is conservatively assumed that all such habitat within the project footprint will be lost
Habitat/site impacted	Exotic plantation forestry (approximately 15 years old)
Impact contingency (Value)	**Data input**: Moderate value (the calculated impact score is multiplied by 1.05, i.e. 5%). **Explanation**: Indigenous forest fauna assemblage was assessed as having 'Moderate' value
Impact contingency (uncertainty)	**Data input:** High uncertainty (the calculated impact score is multiplied by 1.20 (+20%) **Explanation**: See above
Areal extent of impact (ha)	**Data input**: 1.55 ha
Value score <u>prior to</u> Impact	**Data input**: 1.5 **Explanation**: Assessed as having Low value (mid-range) for indigenous forest fauna relative to the benchmark of 5, e.g., they are considered to equate to 30 % of the value of benchmark habitats.
Value score <u>after</u> Impact	**Data input**: 0 **Explanation**: A value of 0 as it is conservatively assumed that all such habitat within the project footprint will be lost
Compensation model inputs	
Compensation action 1	Indigenous revegetation of pasture habitat within stream and wetland riparian margins and gully slopes.
Discount rate	**Data input**: 3% **Explanation**: A discount rate of 3 % has been applied to account for the inherent risk in the temporal-lag between the impact occurring (due to the development) and the biodiversity gains being generated (due to the offset actions). The worked examples provided in the model User Manual apply a discount rate of 3 %, as informed by research conducted as part of the Department of Conservation's research project on biodiversity offsetting in New Zealand.
Finite end-point	**Data input**: 10 years. **Explanation**: The project will be staged over 25 years but native revegetation will be completed within the first five years. Revegetation will therefore be approximately 20 years old on average, 10 years after impact on indigenous fauna.
Compensation contingency (confidence)	**Data input**: 'Moderate Confidence' (Calculated compensation gain is multiplied by 0.825).

	Explanation: 'Moderate Confidence' equates to a well-known measure that is often implemented, and which has been proven to succeed greater than 75% of the time. However, complicating factors and/or expert opinion precludes greater confidence in this compensation measure. Likelihood of success is greater than 75% but less than 90%. NB: The approach used to assign contingency aligns with that used in Maseyk et al. (2015) except that the term 'offset' has been changed to 'compensation'.
Areal extent (ha) of compensation type	**Data input**: 12.5 ha **Explanation**: This equates to the available area of pasture within the restoration and habitat enhancement boundary.
Value score <u>prior to</u> compensation measure (relative to benchmark)	**Data input**: 0 **Explanation**: Pasture within these areas has been assigned a score of 0.5 relative to the benchmark of 5, e.g., these areas are considered to equate to 10 % the value of benchmark habitats.
Value score <u>after</u> compensation measure (relative to benchmark)	**Data input**: 1.5 **Explanation**: At 20 years of age, the native revegetation is assigned a value of 1.5 against the Benchmark of 5, i.e., indigenous forest fauna values are expected to equate to 30% the value of benchmark habitats.

Table 5.2. Indigenous forest fauna QBM outputs

Model output dashboard				
Impact model outputs	Totals	Mature exotic Forest	Exotic Scrub	Exotic plantation forestry
Impact Score	-1.0552	-0.2564	-0.2369	-0.5623
Compensation model outputs	Totals	Revegetation		
Compensation Score	2.1165	2.1165		
Net gain outcome	100.58%			

6 References

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Roper-Lindsay, J., Fuller S.A., Hooson, S., Sanders, M.D., Ussher, G.T. 2018. *Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems*. 2nd edition.

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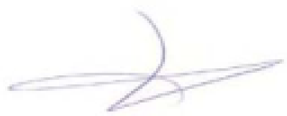
7 Applicability

This report has been prepared for the exclusive use of our client RS Sands Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Report prepared by:



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Matt Baber

Principal Ecologist/ Director

Alliance Ecology Ltd

Appendix F: Representative Site Photos

Photograph 1. Example of open pasture landscape (Alluvial terrace) with exotic-dominated forest in the background

Photograph 2: Example of open pasture landscape (Alluvial terrace) with exotic-dominated forest in the background (Alluvial terrace)

Photograph 3. Example of mixed native-exotic forest (Gully B) which is outside the footprint

Photograph 4. Example of exotic dominated forest Gully C (outside the project footprint)

Photograph 5. Example of exotic dominated forest Gully G (inside the project footprint)

Photograph 6. Largest native tree fern and cabbage tree patch within exotic dominated forest in Gully G (inside the project footprint)

Photograph 7. Example of exotic dominated forest Gully C (inside the project footprint) also showing ephemeral stream/overland flowpath/cattle track exiting the gully.

Photograph 8. Example of exotic dominated forest Gully F (inside the project footprint) also showing ephemeral stream/overland flowpath exiting the gully.

Photograph 9. Example of exotic plantation forest Gully G (inside the project footprint)

Photograph 10. Example of exotic plantation forest Gully G (lower trees are outside the project footprint) along with gully basin wetland which is outside the project footprint

Photograph 11. Example of Gully Basin Wetland under willow canopy

Photograph 12. Example of Gully Basin Wetland with native dominated understory (Carex Secta)

Photograph 13. Example of Gully Basin Wetland with native dominated understory (Carex Geminata)

Photograph 14. Example of exotic dominated scrub inside the fooptrint (Gully G)

Photograph 15. Example of exotic dominated scrub inside project footprint (Gully G)

Photograph 16. Example of exotic dominated scrub outside of project footprint and standing on ephemeral stream/overland flowpath at base of Gully (Gully G)

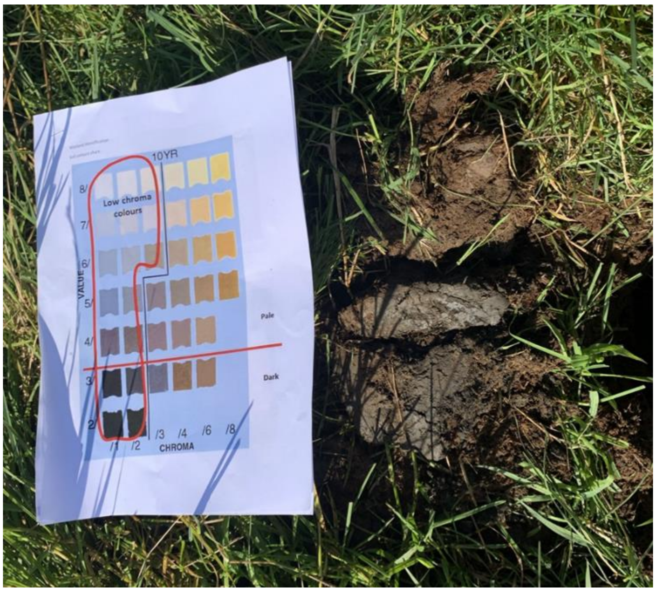
Photograph 17. Example of Gully Seepage Wetland (native Carex Geminata) within the Project footprint (Gully E)

Photograph 18. Example of floodplain wetland (native Carex Geminata) outside the Project footprint

Photograph 19. Example of non-wetland floodplain habitat outside of the footprint as determined through hydric soil testing (see below) and wetland plant classifications.

Photograph 20. Hydric soil testing (non-wetland soils).

Photograph 21. Example of wetland floodplain outside of the footprint as determined through hydric soil testing (see below) and wetland plant classifications.



Photograph 22. Hydric soil test indicating wetland soils based on colouration

Photograph 23. Hydric soil test indicating wetlands based on mottling