REPORT

Tonkin+Taylor

Mt Munro Wind Farm:

Long-tailed Bat Impact Assessment

Prepared for
Meridian Energy Limited
Prepared by
Tonkin & Taylor Ltd
Date
May 2023
Job Number
1016884.2000 v2

Together we create and sustain a better world
www.tonkintaylor.co.nz

Document control

Title: Mt Munro Wind Farm: Long-tailed Bat Impact Assessment					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
06/04/23	1	Draft	G. Cummings	J. MacKay Liz Curry	Dean Miller
11/05/23	2	Final	G. Cummings	Josh Markham	Dean Miller

Distribution:

Meridian Energy Limited	1 electronic copy
Tonkin & Taylor Ltd (FILE)	1 electronic copy

Table of contents

Executive summary

Background

Meridian Energy Ltd. (Meridian) is applying for resource consents to construct and operate a wind farm at Mount Munro. The Mount Munro site ('the Site') is in the Wairarapa region, approximately 5 km south of Eketāhuna and approximately 1.5 km north of the Pūkaha National Wildlife Centre.

Tonkin & Taylor Ltd. (T+T) has been engaged to undertake long-tailed bat surveys and prepare an Ecological Impact Assessment (EcIA) on the potential effects of construction and operations of the proposed wind farm on long-tailed bats (*Chalinolobus tuberculatus* – Threatened Nationally Critical).

Methods

A review of available desktop literature and databases was undertaken along with three site-specific acoustic bat surveys to assess the value of the Site for long-tailed bats and inform the EcIA.

Acoustic Bat Monitors were used to investigate relative bat activity across the Site and along potential habitat features in the immediately surrounding landscape.

Areas targeted by the surveys were:

- The ridgelines covered by the proposed Turbine Envelope Zone (where turbines are proposed).
- The features within the Site that would generally be considered preferred habitat for bats if they are present[1].
- The two river corridors that flow near the Site. Rivers are often important movement corridors for long-tailed bats, particularly in modified landscapes. As such, if bats are regularly using the area around the Site, it is expected that they would be active along the rivers.

A total of 35 locations were surveyed across the Site and immediate surrounds. Surveys were undertaken over three approximately one-month periods during the active bat season (approximately October-April inclusive).

The assessment of effects follows the Ecological Impact Assessment Guidelines (EcIA guidelines) published by the Environmental Institute of Australia and New Zealand in 2018.

Results

No bats were detected during the first survey (Spring 2022), **one bat pass was detected** during the second survey (Summer 2023), and **two bat passes were detected** during the third survey (Autumn 2023). The results to date are consistent with previous surveys undertaken by Boffa Miskell Ltd. (BML) in 2021 and 2022 which also recorded either no bats, or very low levels of activity[2].

The results of the desktop assessment showed that there are potentially multiple long-tailed bat colonies in the landscape surrounding the Site (within approx. 30 km), and that bats are occasionally present within the Site. **The very low levels of bat activity recorded over five surveys (including the two BML surveys) across three years strongly suggests that while long-tailed bats are present in the wider landscape, the Site is of limited importance for any of these bat colonies.**

Assessment

[1] Habitats considered 'preferred' compared to the improved pasture that comprises most of the site include native vegetation remnants, mature exotic vegetation and watercourses. Refer to Section 4.2 for more detail.
[2] Most survey locations recorded zero bat passes across all surveys. When bat passes were recorded, the activity levels averaged < 0.04 bat passes per night at each survey location across all surveys (including previous BML surveys).

Long-tailed bats are classified as Threatened – Nationally Critical under the New Zealand Threat Classification System. As such, the ecological value of long-tailed bats is Very High in accordance with the EcIA guidelines. However, the Very High ecological value does not accurately describe the value of the Site itself for long-tailed bats. The presence of highly mobile species on a site, and the importance of context for determining an appropriate ecological value is also discussed in the EcIA guidelines. Given the very low levels of bat activity recorded over multiple surveys across the site, **the ecological value of the Site for long-tailed bats is assessed as Low.**

Most of the wind farm footprint is limited to areas of improved pasture and very little, if any 'preferred'[3] bat habitat will be directly impacted. As such, the primary potential effect of the project on bats in injury or mortality associated bats interacting with the blades of operating turbines. **The magnitude of effect on bats is assessed as Moderate**. While the activity on the site is very low[4], this assessment considers the extensive evidence demonstrating high fatalities of species with similar characteristics to long-tailed bats at wind farms overseas. Long-tailed bats are highly threatened and so even occasional turbine-induced mortalities could potentially impact the bat population(s) in the wider area.

The value of the Site to long-tailed bats is assessed as Low (Section 4.5). The magnitude of the potential effects is assessed as Moderate (Section 6.2). In accordance with the EcIA guidelines, the **overall level of effect on long-tailed bats resulting from the proposed Mt Munro Wind Farm is anticipated to be Low.**

Although the potential effect is anticipated to be **Low**, the uncertainty associated with the potential impacts of wind turbines on long-tailed bats coupled with the high threat status of long-tailed bats (Threatened – Nationally Critical), necessitates a precautionary approach to managing potential impacts. As such a monitoring and adaptive management approach is recommended.

Mitigation recommendations

Given the uncertainty associated with the potential impacts of wind turbines on long-tailed bats, we recommend that acoustic bat monitoring is undertaken during the first five years of operation of the wind farm and an adaptive management framework is prepared if regular bat activity is recorded at turbines. Adaptive management could include turbine-specific mitigation measures being initiated, such as curtailment[5] if deemed appropriate.

Due to the very low levels of bat activity recorded on the Site to date, resulting in **an anticipated Low overall level of effect**, we do not consider bat-specific offset or compensation is required to manage residual effects. However, this could form part of the adaptive management framework if the proposed post-construction acoustic bat monitoring suggests additional effects management is required.

[3] Refer to footnote 1 above.
[4] Refer to footnote 2 above.
[5] Curtailment means reducing the energy production of a wind turbine below what it is capable of producing. For example, limiting the operation of a turbine when bats are present in the area.

1 Introduction

1.1 Background

Meridian Energy Ltd. (Meridian) is applying for resource consents to construct and operate a wind farm at Mount Munro. The Mount Munro site ('the Site') is in the Wairarapa region, approximately 5 km south of Eketāhuna and 4 km[6] north of the Pūkaha National Wildlife Centre (Figure 1).

Tonkin & Taylor Ltd. (T+T) has been engaged to undertake long-tailed bat surveys and prepare an Ecological Impact Assessment (EcIA) to address the potential effects of construction and operations of the wind farm on long-tailed bats (*Chalinolobus tuberculatus* – Threatened Nationally Critical[7]). An ecological effects assessment being prepared by Boffa Miskell Ltd (BML, 2023) addresses all other relevant ecological effects of this project.

Acoustic bat monitoring was undertaken within the proposed wind farm site and the immediate surrounding landscape using Acoustic Bat Monitors to determine whether long-tailed bats use the Site. The purpose of these surveys is to gain a better understanding of how long-tailed bats are utilising habitats across the proposed wind farm site during the seasons when bats are most active (approximately October-April inclusive).

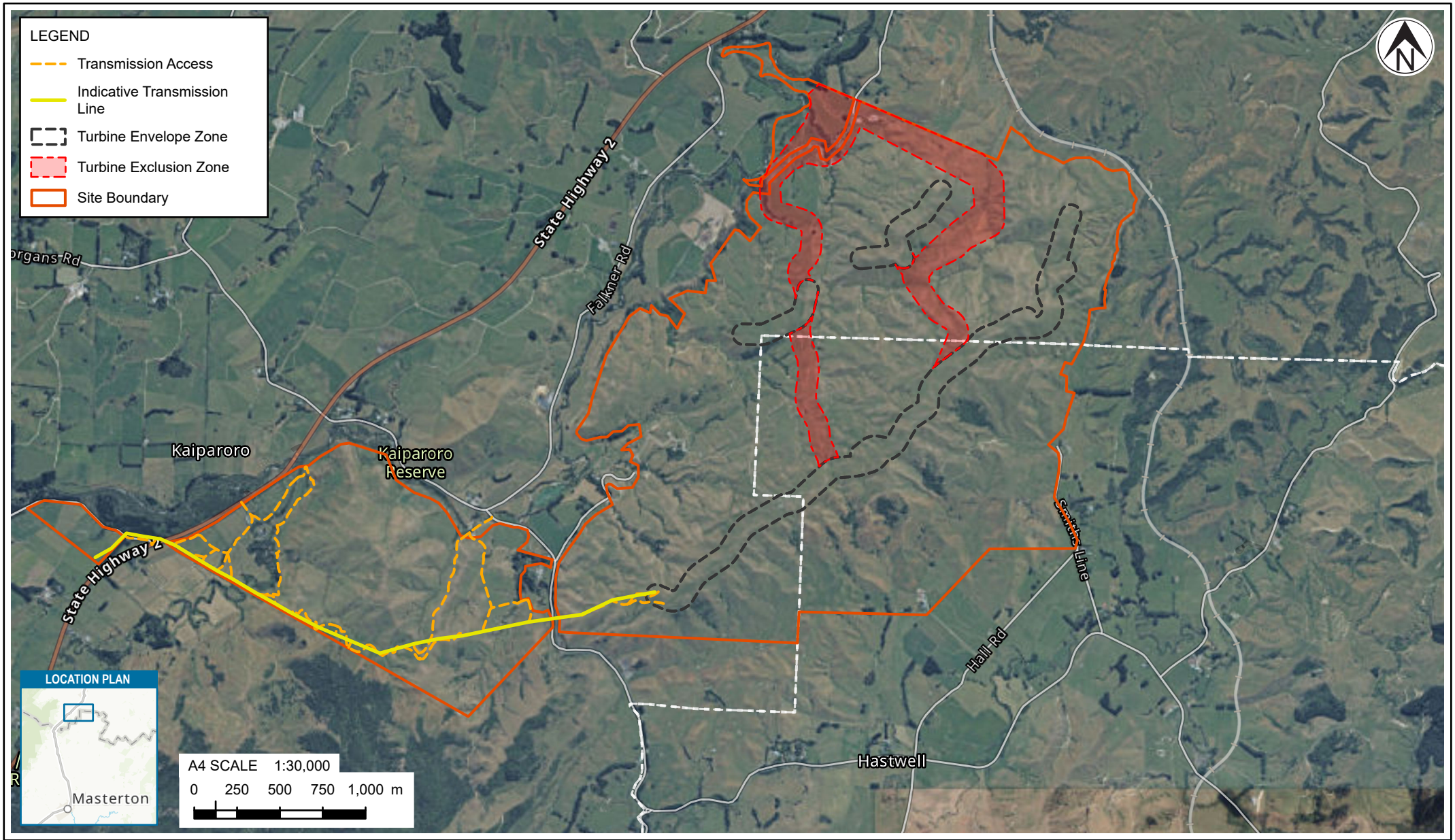
1.2 Scope and report structure

The purpose and scope of this report is to[8]:

- Describe the proposed activities of the wind farm in relation to potential effects on long-tailed bats.
- Describe the current values of the Site for long-tailed bats.
- Provide a brief overview of the literature relating to the impacts of wind energy development and bats.
- Assess the actual and potential effects on long-tailed bats resulting from the proposed activities.
- Recommend avoidance, mitigation and monitoring measures to manage potential effects on long-tailed bats.

[6] This is the distance between the nearest possible turbine location to the Pūkaha National Wildlife Centre.
[7] O'Donnell C.F.J., Borkin, K.M., Christie, J., Davidson-Watts, I., Dennis, G., Pryde, M. and Michel P. (2023): Conservation status of bats in Aotearoa New Zealand, 2022. New Zealand Threat Classification Series 41. Department of Conservation, Wellington. 18 p.
[8] This work has been undertaken in accordance with our contract dated 13 October 2022 and referenced as ME22067.

\\ttgroup.local\corporate\Wellington\TT Projects\1016884\1016884.2000\WorkingMaterial\GIS\MapDocuments\1016884.2000MtMunro\1016884.aprx Layout: Figure 1 280323 2023-Apr-04 8:31 am Drawn by RUGR



Tonkin+Taylor

www.tonkintaylor.co.nz

Exceptional thinking together

NOTES:

NZ Hybrid Reference (Vector): Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors.. NZ Topographic - Basemap Only: Eagle, LINZ, StatsNZ, OSM. NZ Imagery: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors. NZ Topographic - Reference Labels: Eagle, OSM

REVISIONS	NO.	BY
First version (28/03/23)	0	RUGR

PROJECT No.	1016884.2000		
DESIGNED	RUGR	APR.23	
DRAWN	RUGR	APR.23	
CHECKED	DXLR	APR.23	
APPROVED		DATE	

CLIENT **MERIDIAN ENERGY LIMITED**

PROJECT **MT MUNRO BAT ASSESSMENT**

TITLE MT MUNRO WIND FARM: SITE CONTEXT

SCALE (A4) 1:30,000 FIG No. FIGURE 1. REV 0

1.3 Ecological context

The Site is located on the border of the Puketoi and Woodville Ecological Districts (ED). Most of the Site is located in the Puketoi ED with the north-western edge of the Site crossing into the Woodville ED. Both EDs are now largely cleared for farming but were originally forested. Prior to modification, the Puketoi ED was characterised by rimu (*Dacrydium cupressinum*)-northern rātā (*Metrosideros robusta*) forest with tawa (*Beilschmiedia tawa*) or kāmahi (*Pterophylla racemosa*) also comprising a notable component of the canopy. The Woodville ED was originally largely characterised by dense podocarp and podocarp-hardwood forest.

The Pūkaha National Wildlife Centre (Pūkaha) is located less than 1.5 km south of the southern border of the site, but approximately 4 km from the nearest possible turbine location. Pūkaha is a 942 ha forested wildlife reserve which is subject to intensive predator control. The Tararua Range is located approximately 3.5 km to the west of the Site.

The Mākākahi River flows near the north-western boundary of the Site and the Kōpuaranga River flows near the southern boundary of the Site. These rivers flow from the eastern Tararua Range and Pūkaha/Mount Bruce, respectively.

A review of the Tararua District Plan and the Wairarapa Combined District Plan maps found no areas of Significant Indigenous Vegetation and Significant Habitats of Indigenous Fauna, or Significant Natural Areas present within the Site. The Tararua Range is listed in the schedule of 'Natural Features and Landscapes' in the Tararua District Plan. Pūkaha and the Tararua Range are both listed as 'Outstanding Natural Features and Landscapes' in the Wairarapa Combined District Plan.

1.3.1 Bat habitat available on the Site

Long-tailed bats are strongly associated with large areas of mature indigenous forest however they are adaptable and do also use more modified landscapes[9]. In modified landscapes long-tailed bats tend to focus their activity on specific habitat features, namely:

- Large open water courses, including ponds and wetlands.
- Native vegetation remnants.
- Well established exotic vegetation, particularly linear features such as shelterbelts.

Long-tailed bats will also use open areas such as improved pasture to a lesser extent for commuting and foraging. However, they are edge-adapted foragers and generally forage in open areas in vicinity of a woody vegetation edge (as opposed to completely out in the open).

The Site is situated in steep hill country that is dissected by numerous watercourses, most of which appear to flow only intermittently. The main ridge traverses the eastern portion of the Site in a roughly northeast-southwest direction. Secondary ridgelines occur in the north-western extent of the Site. The Site is comprised predominantly of improved pasture with rushland and wet pasture in the gully bottoms, and forest/ regenerating scrubland remnants which are largely limited to steep hillslopes and incised gullies[10]. Scattered exotic trees also occur in parts of the Site as is typical of agricultural landholdings. The vegetation across the Site was assessed by BML as part of the broader ecological effects assessment for the project, refer to 'Map 9' in the BML (2023) report.

As such most of the Site is not favourable habitat for long-tailed bats, but the Site does contain patches of habitat that are generally considered preferred by bats compared to improved pasture. These 'preferred habitats' include the forest and regenerating scrubland remnants, and the mature exotic trees that are patchily distributed across the site. Small areas of the aforementioned

[9] O'Donnell, C.F.J. (2001). Advances in New Zealand mammalogy 1990–2000: Long-tailed bat. Journal of the Royal Society of New Zealand, 31:1, 43-57.
[10] Vegetation descriptions supplied by BML, November 2022.

'preferred habitats' occur on the edge of the Turbine Envelope Zone which is otherwise limited to the grazed ridgetops. Small areas of exotic trees and māhoe/kāmahi forest and treeland also occur in the Turbine Exclusion Zone (refer to Map 9 in the BML (2023) report).

Open water is limited within the Site, but as mentioned above the Mākākahi River in particular is a large river corridor that flows near the Site boundary.

See Section 4.2 for additional detail. Appendix A includes site photos for context.

2 Description of the proposed activity/works

The subsections below provide a brief outline of key construction and operational activities of the proposed windfarm, and associated infrastructure that may cause adverse effects on long-tailed bats by way of habitat removal, disturbance, injury and mortality. Refer to Figure 1 above (the context map) for the locations of the proposed: Turbine Envelope Zone, Turbine Exclusion Zone, and transmission line that are discussed in the subsections below.

2.1 Wind turbines

A maximum of 20 turbines are proposed to be constructed at the Site. Rather than the traditional approach, which specifies turbine locations with micro-siting allowances, resource consent will be sought for:

1 A Turbine Envelope Zone in which all turbines and any infrastructure will be located.

2 A Turbine Exclusion Zone where any infrastructure but no turbines will be located.

3 A transmission corridor and substation to electrically connect the wind farm to the national electrical grid.

Up to 14 closely spaced turbines will be located on the main ridge Turbine Envelope Zone, with two further groups, each of up to three turbines on lower hills to the northwest of the main ridge.

The turbine make or model is not specified, rather parameters for a turbine have been determined (e.g. blade diameter and tip height). This is to allow flexibility for advancements in technology and unavailability of turbine models in the future. The parameters to be used for the resource consent process are those with the greatest effects. The physically largest turbine dimension proposed is:

- 136 m blade diameter; 92 m hub height, 160 m tip height.

2.2 Associated infrastructure

To transport, erect, and maintain the turbines the following infrastructure will be required.

Internal roads

Construction of an internal road network will be required to install and service the wind turbines. The roads along the ridges within the Turbine Envelope Zone will be between 8 and 11 m in width[11], with a combined length of approximately 6.0 km. The "access roads" that run from the bottom of the hill to the wind farm ridges will be between 6 m and 8 m in width[12]. The access roads will be located in the Exclusion Zone, with a combined length of approximately 5.5 km.

[11] The specified widths are the widths of the full bearing capacity part of the road and don't include feathered edges, drains, or removal of banks on the road shoulders to enable the passing of turbine blades etc.
[12] See footnote above.

Substations

A Terminal Substation (the Substation connecting directly into Transpower's existing 110 kV transmission line) for the wind farm will be located at the bottom of the hill, on the western side of the corner of Kaiparoro Road and SH2 as indicated in Figure 2.1 below.

The Terminal Substation site will consist of a switchyard and up to two control buildings over a footprint of approximately 100 m x 125 m. A further building for servicing the windfarm (the Services/O&M Building) may also be housed on this Substation (the alternative location being at the Site Entrance).

The Site Substation will be located on the hill, at the western edge of the Turbine Envelope Zone. The Site Substation will have a total footprint of approximately 70 m x 90 m and will consist of a switchyard and potentially a small control building.

The Terminal Substation will be connected to the Site Substation by a transmission line of approximately 3.5 km in length. The poles for the transmission line could be concrete or steel and up to a total height of 20 m.

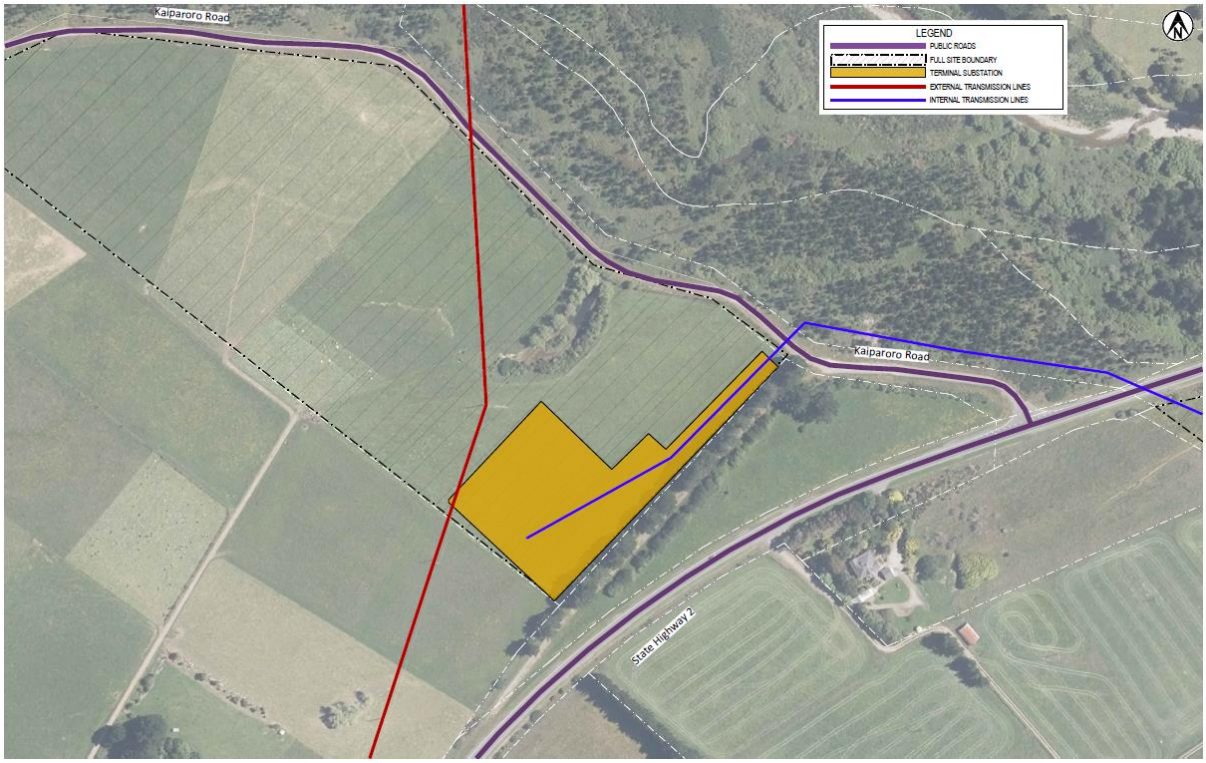


Figure 2.1: Terminal Substation Location (Figure provided by Meridian Energy Ltd.).

Figure 2.2: Location of the Site Entrance area in the north-western corner of the Site shown in light brown. The Turbine Envelope Zone is in blue, Turbine Exclusion Zone in grey thatching, and the Site boundary is the red and white dashed line (Figure provided by Meridian Energy)

Site entrance

The Site Entrance will be located at the end of Old Coach Road on a dedicated section of land that will serve as the main laydown area (Figure 2.2). This area will host several activities.

During construction this will house the construction village; including temporary site offices, amenities, security, parking, and a laydown area (for deliveries of turbine components and for holding these until delivery up to final turbine locations). The construction village will comprise temporary portacom structures that will be removed upon the completion of the construction phase.

After commissioning, the Site entrance area could be used for Operations, and could house the Services/O&M building, and/or continue to function as a storage area for spares and large components required for repairs etc.

Services/O&M Building

A Services/O&M building will be located either at the Site entrance area, or at the Substation or the corner of Kaiparoro Road and SH2 (see above). The building will be approximately 35 m x 20 m, and approximately 6.5 m high.

Concrete Batching Plant

The Site will include a concrete batching plant to be located within the Turbine Envelope or Turbine Exclusion Zones.

3 Assessment methods

3.1 Desktop review of available information

Project specific, and publicly available information and databases were reviewed to inform the methodology and approach to the ecological assessment and to establish the ecological context of the Site. This included a review of the following available information:

- Ecological Regions and Districts of New Zealand (Department of Conservation, 1987).
- Site-specific vegetation layers (provided by BML, November 2022).
- Previous site-specific bat surveys undertaken by BML[13].
- Tararua District Plan Maps[14]:
  - Significant Indigenous Vegetation and Significant Habitats of Indigenous Fauna
  - Natural Features and Landscapes
  - Significant Trees.
- Wairarapa Combined District Plan geographic information system (GIS) layers[15]:
  - Significant Natural Areas (SNAs)
  - Outstanding Natural Features and Landscapes
  - Notable Trees
  - Significant Water Bodies
  - Rivers.
- Bat records from the New Zealand bat distribution database (DOC).
- Previous surveys undertaken at Te Uku wind farm in the Waikato (previously unpublished T+T data). This is the only operational wind farm in New Zealand where bats are known to be resident in the area.

3.1.1 Literature review: wind farms and bats

There is very limited information on the impacts of wind farm developments on long-tailed bats. The reason being there is only one operational wind farm in New Zealand where long-tailed bats occur - Te Uku wind farm, near Raglan, Waikato.

To address this paucity of information, we undertook a review of overseas literature, focusing on bat species with similar characteristics to the long-tailed bat. Outcomes of acoustic bat monitoring at Te Uku wind farm are also summarised and discussed. This data is relevant as it is long-tailed bat specific.

3.2 Site investigations

The Mt Munro site was visited on three occasions by a T+T bat specialist:

- 20 – 21 October 2022
- 17 – 18 November 2022
- 11 – 13 January 2023.

[13] Boffa Miskell Ltd. (March 2022). Mt Munro bat monitoring – Spring 2021 surveys. Prepared for Meridian Energy Ltd; Boffa Miskell Ltd. (April 2022) Mt Munro Bat Monitoring. Prepared for Meridian Energy Ltd.
[14] Tararua District Plan maps: District Plan Maps | Tararua District Council (tararuadc.govt.nz).
[15] Draft Wairarapa Combined District Plan Map Viewer (arcgis.com).

The purpose of these site visits was to assess habitat available for long-tailed bats and to deploy Acoustic Bat Monitors (ABMs)[16] in and around the Site (see detailed methodology below).

A T+T bat specialist deployed the ABMs for the Spring 2022 and Summer 2023 bat surveys with the assistance of a BML ecologist. The BML ecologist deployed the ABMs for the Autumn 2023 survey and retrieved the ABMs for all three surveys.

3.2.1 Acoustic bat surveys

ABMs were used to investigate relative bat activity across the Site and along potential habitat features in the immediately surrounding landscape. ABMs passively record both long-tailed bat (40 kHz) and lesser short-tailed bat (28 kHz) echolocation calls on two concurrently operating frequency channels. They operate remotely by recording and storing each echolocation call (bat pass), along with the date and time of occurrence.

Areas targeted by the surveys were:

1 The ridges covered by the proposed Turbine Envelope Zone - 'peaks' and 'saddles' along the ridges were targeted to explore if bats moving across the Site are preferentially using specific landform features to cross the ridges[17].

2 Features across the Site that are considered to be preferred bat habitats (if bats are present) including:
   a native vegetation remnants
   b mature exotic vegetation, particularly linear vegetation features such as shelterbelts
   c watercourses
   d valley bottoms, particularly at the confluence of two gullies.

3 Along the two river corridors, Mākākahi River and Kōpuaranga River, that flow near the northwest and southern boundaries of the Site respectively.

A total of 35[18] locations were surveyed (Figure 4 and Figure 5):

- 14 'ridge top' locations - seven "Peak" and seven "Saddle" sites.
- 15[19] 'preferred habitat' locations (hereafter referred to as "PF" sites).
- Six 'Off-site' locations (along the Mākākahi and Kōpuaranga Rivers).

ABMs were deployed in trees (Photograph 3.1.) or on poles attached to fence posts (Photograph 3.2).

[16] Model AR4, produced by the Department of Conservation.
[17] Indicative turbine locations were not targeted as these specific locations may change. The habitat available along the ridges was uniform (pasture) so it was decided to focus on differences in landform (peaks versus saddles) instead of indicative turbine sites.
[18] Only 34 locations were surveyed in Survey 1 (Spring 2022), see footnote 13 below.
[19] The survey location 'PF 15' was added in Survey 2 (Summer 2023), hence 14 (not 15) 'PF' locations were surveyed in Survey 1 (Spring 2022). Refer to Figure 5 to see where 'PF 15' is located.

Photograph 3.1: Acoustic recorder (ABM) deployed in a willow tree at survey location Off-site 2

Photograph 3.2: ABM deployed along the main ridge at survey location Saddle 3

Long-tailed bat activity and habitat use can change throughout the year in relation to variables such as temperature, invertebrate availability, and reproductive status. As such, acoustic surveys were undertaken over three approximately one-month periods during the active season (approximately October-April inclusive) to cover key periods throughout the season:

- **Survey 1 – Spring 2022**
  - Spring to early summer when reproductive females are gathering in maternity roosts and giving birth to pups.
- **Survey 2 – Summer 2023**
  - Mid to late summer when this season's young are flying independently and establishing foraging grounds, and mating begins.
- **Survey 3 – Autumn 2023**
  - Late summer to early autumn when bats are mating and preparing for the colder months.

A brief description of the survey timing and ABM locations for each survey period is provided below.

Survey 1 – Spring 2022

For the spring survey ABMs were deployed on 20-21 October 2022. The ABMs were set to record from one hour before sunset until one hour after sunrise and deployed for between four to six weeks. Twenty ABMs were available for the survey, so the majority of the 20 ABMs were moved after approximately one month to cover all 34[20] survey locations (see Table 6.1 for the dates each

[20] See footnote 18 above.

location was surveyed). Refer to Figure 4 for survey locations for the Spring 2022 survey period. The ABMs were retrieved on 8-9 December 2022.

Survey 2 – Summer 2023

For the summer survey ABMs were deployed on 11-13 January 2023. The ABMs were set to record from one hour before sunset until one hour after sunrise and deployed for approximately one month. More ABMs were available for this survey and so all 35 monitoring locations were surveyed simultaneously (see Table 6.1 for the dates each location was surveyed). As well as the addition of the survey location 'PF 15' during the Summer 2023 survey, survey locations 'PF 6' and 'PF 14' were moved slightly to increase the likelihood of bat detections. Refer to Figure 5 for survey locations for the Summer 2023 survey period. The ABMs were retrieved on 8-10 February 2023.

Survey 3 – Autumn 2023

For the autumn survey ABMs were deployed on 15-17 March 2023. The ABMs were set to record from one hour before sunset until one hour after sunrise and deployed for approximately one month. As with the Summer 2023 survey, all 35 monitoring locations were surveyed simultaneously (see Table 6.1 for the dates each location was surveyed). Survey locations were the same as the Summer 2023 survey locations, refer to Figure 5. The ABMs were retrieved on 11-13 April 2023.

3.2.2 Acoustic data analysis

Audio recording spectra from the ABMs were processed using a machine learning tool[21] developed to automatically detect long-tailed bat calls. The tool's performance has been verified against a large database of more than more than 26,000 manually classified recordings obtained at a variety of locations. For this database, on average 98 % of bat calls are successfully detected using the tool. Recordings identified as potentially containing long-tailed calls, or cases which are sufficiently ambiguous (< 0.95 'prediction confidence' as determined by the software) were manually reviewed under the supervision of an experienced bat ecologist for quality assurance purposes.

Due to the paucity of bat activity recorded, the data was analysed for every survey night, and the mean number of bat passes per 'fine weather night' are not reported. Therefore, weather data across the survey periods has not been summarised.

3.3 Approach to ecological impact assessment

The method applied to this ecological impact assessment report broadly follows the Ecological Impact Assessment Guidelines 2018 (EcIA guidelines) published by the Environmental Institute of Australia and New Zealand (EIANZ)[22]. The guidelines provide a standardised framework and matrix allowing a consistent and transparent assessment of ecological effects.

The guidelines were used to establish the following:

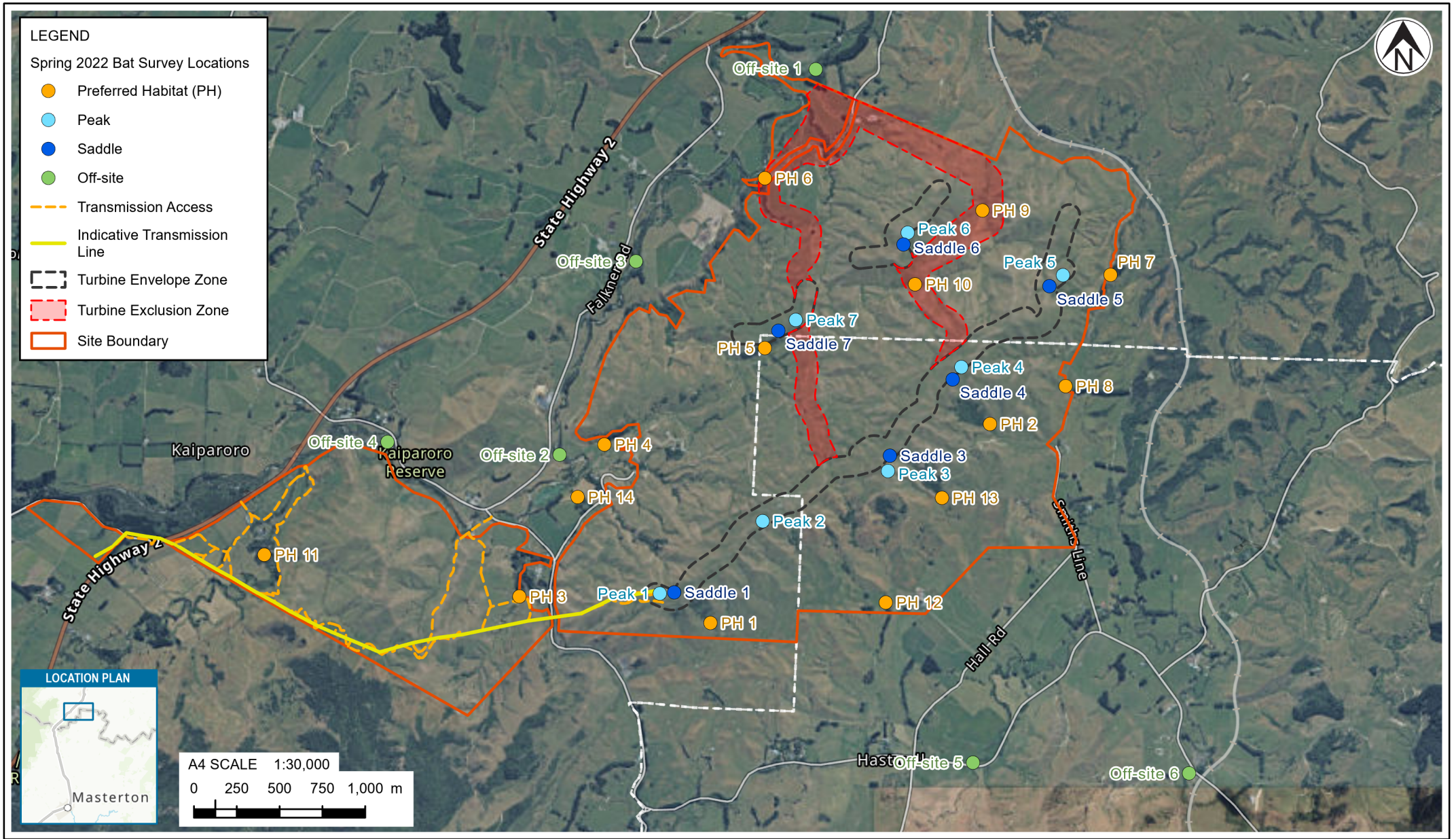
- Long-tailed bat values within the Site and immediate surrounds (see Appendix B Table 2).
- The magnitude of effect (see Appendix B Table 2) on long-tailed bat values from the construction and operation of the proposed wind farm in the absence of any effects management measures.
- The overall level of effects to determine whether avoidance, remediation or mitigation is required (see Appendix B Table 4).

[21] AutoBat (Version 0.3), 2022. Unpublished. Tonkin Taylor Ltd., New Zealand.
[22] Roper-Lindsay J, Fuller SA, Hooson S, Sanders MD, Ussher GT (2018). Ecological Impact Assessment (EcIA) – EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd Edition.

- The magnitude of effect and overall level of effect, taking into consideration the additional measures to avoid, remedy or mitigate effects and whether there are residual adverse effects that should be offset or compensated.

Refer to (Appendix B) for the criteria used in this assessment.

\\ttgroup.local\corporate\Wellington\TT Projects\1016884\1016884.2000\WorkingMaterial\GIS\MapDocuments\1016884.2000MtMunro\1016884.aprx Layout: Figure 4 280323 2023-May-10 12:09 pm Drawn by JORB



Tonkin+Taylor

www.tonkintaylor.co.nz

Exceptional thinking together

NOTES:

NZ Hybrid Reference (Vector): Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors.. NZ Topographic - Basemap Only: Eagle, LINZ, StatsNZ, OSM. NZ Imagery: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors. NZ Topographic - Reference Labels: Eagle, OSM

REVISIONS	NO.	BY
First version (27/01/23)	0	CHSA
Updated turbine exclusion and envelope zones (28/03/23)	1	RUGR

PROJECT No. 1016884.2000		
DESIGNED	JORB	MAY.23
DRAWN	JORB	MAY.23
CHECKED	DXLR	MAY.23
APPROVED		DATE

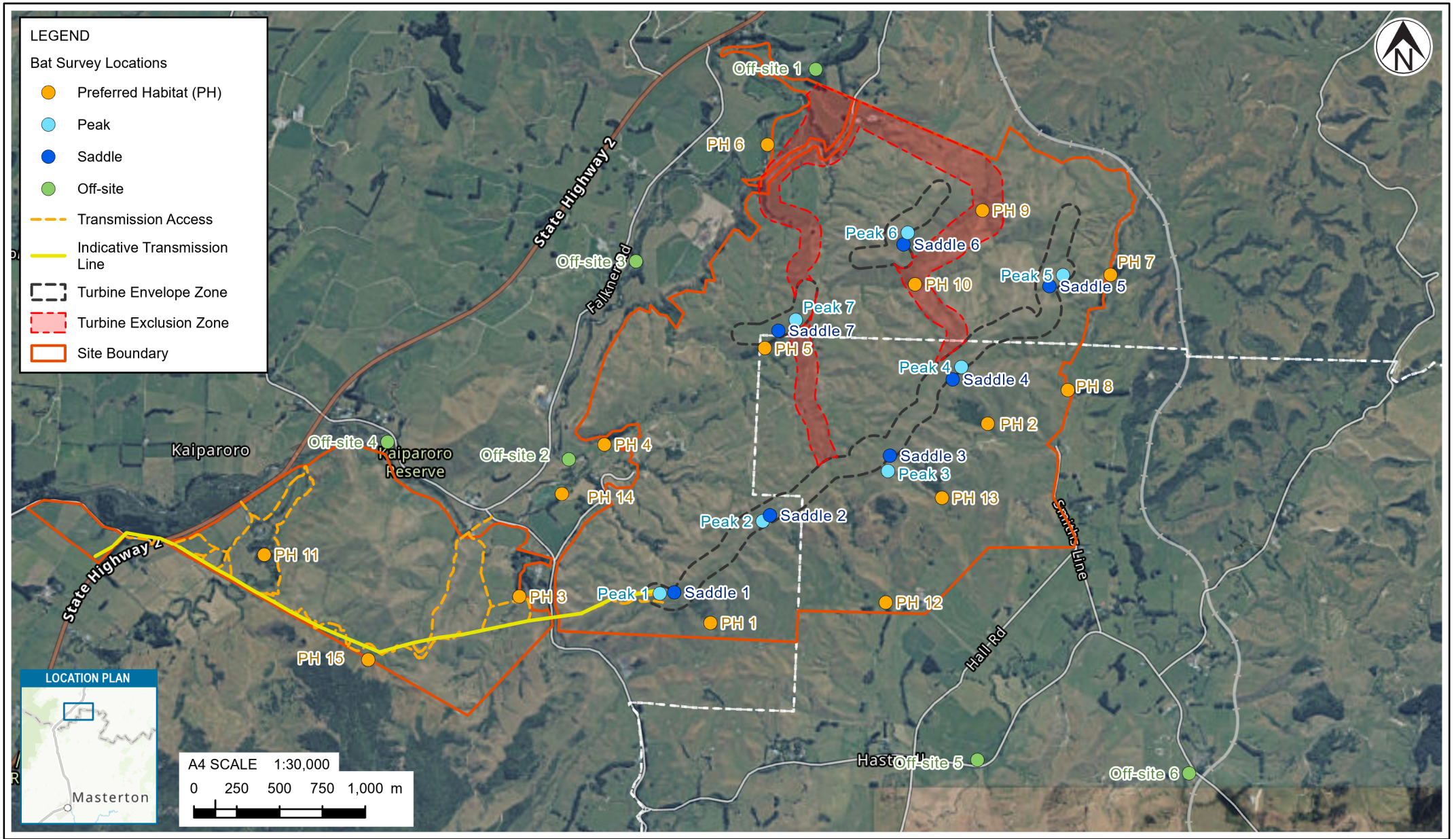
CLIENT **MERIDIAN ENERGY LIMITED**

PROJECT **MT MUNRO BAT ASSESSMENT**

TITLE MT MUNRO WIND FARM: SPRING 2022 BAT SURVEY LOCATIONS

SCALE (A4) 1:30,000 FIG No. FIGURE 4. REV 1

\\ttgroup.local\corporate\Wellington\TT Projects\1016884\1016884.2000\WorkingMaterial\GIS\MapDocuments\1016884.2000MtMunro\1016884.aprx Layout: Figure 5 280323 2023-May-10 12:09 pm Drawn by JORB



Tonkin+Taylor

www.tonkintaylor.co.nz

Exceptional thinking together

NOTES:

NZ Hybrid Reference (Vector): Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors.. NZ Topographic - Basemap Only: Eagle, LINZ, StatsNZ, OSM. NZ Imagery: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors. NZ Topographic - Reference Labels: Eagle, OSM

REVISIONS	NO.	BY
First version (28/03/23)	0	RUGR

PROJECT No. 1016884.2000		
DESIGNED	JORB	MAY.23
DRAWN	JORB	MAY.23
CHECKED	DXLR	MAY.23
APPROVED		DATE

CLIENT **MERIDIAN ENERGY LIMITED**

PROJECT **MT MUNRO BAT ASSESSMENT**

TITLE MT MUNRO WIND FARM: SUMMER AND AUTUMN 2023 BAT SURVEY LOCATIONS

SCALE (A4) 1:30,000 FIG No. FIGURE 5. REV 0

4 Long-tailed bat values

4.1 Desktop review results

4.1.1 National bat database

The National Bat Database administered by the Department of Conservation (DOC) was accessed on 12 October 2022. The search area was an approximately 30 km radius around the site.

Records from the database show that multiple long-tailed bat and short-tailed bat (*Mystacina tuberculata*) colonies occur along the Tararua Range.

There are numerous records of short-tailed bats in the Waiōhine Catchment of the Tararua Range, approximately 35 km south of the Site. The most recent record from this area is 2016. There is also a single record of a short-tailed bat approximately 15 km to the south of the Site near the Kipiwhakapapa Hut in the Tararua Range, but the record is dated 1978.

Short-tailed bats are adapted to forage within the forest interior and are always associated with large areas of mature forest. The Site does not provide appropriate habitat for short-tailed bats, and as such are not considered further in this report[23].

The most recent records of long-tailed bats (2022) are from near Mount Holdsworth to the west of Masterton in the Tararua Range and approximately 30 km from the southern boundary of the Site. The closest records of long-tailed bats to the Site are around the headwaters of the Ruamāhanga River (also the Tararua Range), just over 10 km from the Site. However, these records are over two decades old (dated 1998 and 1999). The most recent surveys undertaken in this area (as recorded in the database) were in 2013 and no bats were detected. The 2013 survey does not appear to be exhaustive however, with only three survey locations recorded in the database.

Long-tailed bats have also been recorded to the east of the Site near the Castle Hill Wind Farm site (consented but not constructed). The closest bat record from this group of records is approximately 15 km from the eastern boundary of the Site. These records were collected in 2010-2011.

To the north of the Site, long-tailed bats have been recorded along the Puketoi Range as part of the pre-consenting ecological surveys undertaken for Puketoi Wind Farm (consented but not constructed). The closest bat record from this group of records is approximately 32 Km from the north-eastern corner of the Site. These records were collected in 2011 – 2012.

While not registered in the Bat Database, there are news reports of a single recording of a long-tailed bat from Pūkaha in 2020[24]. As noted above, Pūkaha is located very close to the southern border of the Site.

4.1.2 Previous Mount Munro Site surveys

Boffa Miskell Ltd has previously undertaken two acoustic bat surveys targeting habitats across the Site that would be considered that most favourable habitat for long-tailed bats if they are present[25]. These surveys were undertaken in November/December 2021 and February/March 2022.

No bat passes were recorded in the 2021 survey. Four of the 20 ABMs deployed in February/March 2022 detected a single pass each. These results confirm bat presence, but activity levels were very

[23] O'Donnell, C.F.J., Christie, J.E. & Simpson, W. (2006). Habitat use and nocturnal activity of lesser short-tailed bats (*Mystacina tuberculata*) in comparison with long-tailed bats (*Chalinolobus tuberculatus*) in temperate rainforest. New Zealand Journal of Zoology. 33: 113-124.

[24] Rare bat recorded at Pūkaha - The Country News - NZ Herald

[25] Boffa Miskell Ltd. (March 2022). Mt Munro bat monitoring – Spring 2021 surveys. Prepared for Meridian Energy Ltd; Boffa Miskell Ltd. (April 2022). Mt Munro Bat Monitoring. Prepared for Meridian Energy Ltd.

low as each device was deployed for 45 days (i.e., average of 0.02 bat passes per night). Two bat passes (recorded on separate nights) were located north of the main ridge. The additional two passes were recorded along the southern slopes of the main ridge. These two passes were recorded with a minute of each other at adjacent survey locations, indicating that the recordings were of the same bat moving through the area.

The results above demonstrate that long-tailed bats are present in the landscape surrounding the Site, and that very low levels of bat activity have been confirmed at a limited number of locations within the Site itself.

4.2 Assessment of habitat availability at the Site

While long-tailed bats are primarily associated with large tracts of indigenous forest[26], some populations do occur in modified landscapes (particularly agricultural areas).

In agricultural landscapes long-tailed bats concentrate their activity around established vegetation, both native and exotic. Long-tailed bats are tree-roosting, and mature native and exotic vegetation is of particular importance as it provides roosting habitat. long-tailed bats will also use less established scrubland areas for foraging, but this habitat provides limited (if any) roosting opportunities. They also forage over open water, and large watercourses are used both for foraging and as dispersal corridors through modified landscapes[27].

Finally, long-tailed bats will also use open areas such as improved pasture to a lesser extent for commuting and foraging. However, they are edge-adapted foragers[28] and generally forage in open areas in vicinity of a woody vegetation edge (as opposed to completely out in the open).

The main ecological effects assessment report for this project (Boffa Miskell, 2023) includes a figure showing the vegetation types occurring across the Site[29]. The highest value habitats on Site for long-tailed bats are the native forest and shrubland remnants and the small areas of exotic trees. Several "rushland & wet pasture" habitats have been mapped in the lowland areas of the Site. Bats may forage for emergent aquatic insects in such areas, but the lack of open water and level of degradation (e.g. by stock) suggest that this habitat will not be high value compared to less impacted wetlands containing areas of open water.

Most of the Turbine Envelope Zone and the Turbine Exclusion Zone (where most of the works will be undertaken) is comprised of improved pasture. Aside from dwellings and other infrastructure, improved pasture is the lowest value habitat for bats available on the Site. Improved pasture is also the main habitat type in the surrounding landscape.

4.3 Results of the 2022/2023 acoustic bat surveys

4.3.1 Survey 1 – Spring 2022

No bat passes were detected at any survey location during the Spring 2022 survey.

The ABMs were deployed at each survey location for between 20 and 50 nights (Table 4.1). The locations with 49-50 days of data were survey locations 'PF 1'- 'PF 5' (Figure 4). At these locations,

[26] O'Donnell, C.F.J. (2001). Advances in New Zealand mammalogy 1990–2000: Long-tailed bat. *Journal of the Royal Society of New Zealand*, 31:1, 43-57

[27] Griffiths, R.W. (2007) Activity patterns of long-tailed bats (*Chalinolobus tuberculatus*) in a rural landscape, South Canterbury, New Zealand, New Zealand Journal of Zoology, 34:3, 247-258; Davidson-Watts Ecology Ltd. (2019). Long-tailed Bat Trapping and Radio Tracking Baseline Report 2018 and 2019 Southern Links, Hamilton. Prepared for AECOM.

[28] O'Donnell, C.F.J. (2001). Advances in New Zealand mammalogy 1990–2000: Long-tailed bat. *Journal of the Royal Society of New Zealand*, 31:1, 43-57.

[29] See Map 9 in the BML (2023) report.

the ABMs were not moved after one month, instead the batteries were changed, and they were left in place (refer to Section 3.2.1 for more detail).

The ABM at location 'PF 5' (Figure 4) had a presumed battery malfunction after 12 days and stopped recording at this point. Recording resumed after the battery change on 17 November 2022 and continued for the remainder of the survey. Consequently 42 nights of data were recorded at this location instead of 49 (Table 4.1).

Additionally, the ABM at survey location 'PF 2' appeared to be recording for the duration it was deployed[30], but it had no spectrogram files saved to the device when it was retrieved. It is very unusual for ABMs to not record numerous background noises (e.g., wind, rain, and insect interference) across a deployment period. Consequently, no recordings across 50 nights of survey indicates there may be an issue with the sensitivity of the microphone in this ABM. We have assumed equipment malfunction and stated that no data were collected at this location (as opposed to zero bat passes). The above situation is also applicable to the survey location 'Off-site 4' which had one spectrogram file saved to the device after 20 nights of survey.

The ABMs at the remaining 31 survey locations functioned as expected for the duration of the survey.

4.3.2 Survey 2 – Summer 2023

One bat pass was detected at survey location 'Peak 5' during the Summer 2023 survey (Figure 4.1). The bat pass occurred at 11:01 pm on 26 January 2023. No bat passes were recorded at the remaining 34 survey locations (but noting that there were equipment issues at some locations, see Table 4.1 for detail).

The ABMs were deployed at each survey location for between 27 and 30 nights (Table 4.1). All survey locations were monitored simultaneously (compared to a smaller number of ABMs being moved between sites as was required for the Spring 2022 survey).

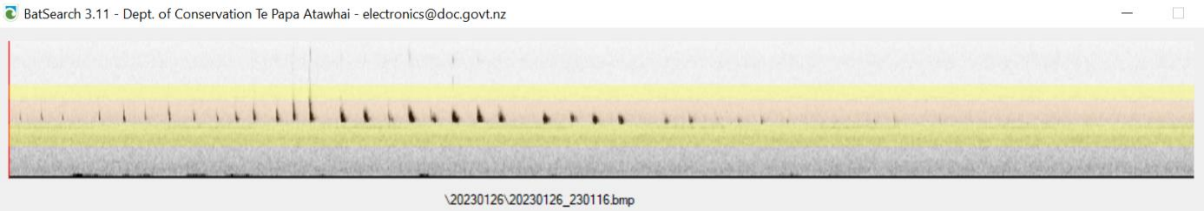


Figure 4.1: The spectrogram of the bat pass recorded at survey location 'Peak 5' at 11:01 pm on 26 January 2023.

4.3.3 Survey 3 – Autumn 2023

Two bat passes were detected during the Autumn 2023 survey, one pass at survey location 'PF 1', and the second at 'Off-site 3'.

The bat pass at survey location 'PF 1' occurred at 1:13 am on 5 April 2023, while the bat pass at survey location 'Off-site 3' occurred at 9:38 pm on 12 April 2023. No bat passes were recorded at the remaining 33 survey locations (but noting that there were equipment issues at some locations, see Table 4.1 for detail). The ABMs were deployed at each survey location for between 27 and 29 nights (Table 4.1). As with the Summer 2023 survey, all survey locations were monitored simultaneously.

[30] Based on the complete temperature log and folders being created for each night on the SD card.

Table 4.1: Results of the Spring 2022 and Summer 2023 acoustic bat surveys undertaken across the proposed Mt Munro Wind Farm site and surrounds.

Survey location	Survey 1 – Spring 2022			Survey 2 – Summer 2023			Survey 3 – Autumn 2023		
	Survey period	No. survey nights	No. of bat passes	Survey period	No. survey nights	No. of bat passes	Survey period	No. survey nights	No. of bat passes
Peak 1	20 October – 16 November 2022	28	0	12 January – 9 February 2023	29	0	17 March – 12 April 2023	27	0
Peak 2	20 October – 16 November 2022	28	0	12 January – 9 February 2023	29	0	17 March – 12 April 2023	27	0
Peak 3	20 October – 16 November 2022	28	0	12 January – 8 February 2023	28	0	16 March – 12 April 2023	28	0
Peak 4	20 October – 16 November 2022	28	0	12 January – 8 February 2023	28	0	16 March – 12 April 2023	28	0
Peak 5	20 October – 16 November 2022	28	0	13 January – 8 February 2023	27	1	16 March – 12 April 2023	28	0
Peak 6	20 October – 16 November	28	0	13 January – 8 February 2023	27	0	16 March – 12 April 2023	28	0
Peak 7	21 October – 16 November	27	0	12 January – 9 February 2023	29	0	17 March – 12 April 2023	27	0
Saddle 1	20 October – 16 November 2022	28	0	12 January – 9 February 2023	29	0	17 March – 12 April 2023	27	0
Saddle 2	20 October – 16 November 2022	28	0	12 January – 9 February 2023 [1]	29	No data	17 March – 12 April 2023	27	0
Saddle 3	21 October – 17 November	28	0	- [2]	0	No data	16 March – 12 April 2023	28	0
Saddle 4	20 October – 16 November	28	0	12 January – 8 February 2023	28	0	16 March – 6 April 2023 [3]	22	0

Survey location	Survey 1 – Spring 2022			Survey 2 – Summer 2023			Survey 3 – Autumn 2023		
	Survey period	No. survey nights	No. of bat passes	Survey period	No. survey nights	No. of bat passes	Survey period	No. survey nights	No. of bat passes
Saddle 5	20 October – 16 November	28	0	13 January – 8 February 2023	27	0	16 March – 2 April 2023 [3]	18	0
Saddle 6	20 October – 16 November	28	0	13 January – 8 February 2023	27	0	16 March – 6 April 2023 [3]	22	0
Saddle 7	21 October – 16 November	27	0	12 January – 9 February 2023	29	0	17 March – 12 April 2023	27	0
Preferred Habitat (PF) 1	20 October – 8 December 2022	50	0	12 January – 9 February 2023	29	0	17 March – 12 April 2023	27	1
PF 2	20 October – 8 December 2022 [1]	50	No data	11 January – 9 February 2023	30	0	16 March – 12 April 2023	28	0
PF 3	21 October – 8 December 2022	49	0	11 January – 9 February 2023	30	0	- [2]	0	No data
PF 4	21 October – 8 December 2022	49	0	12 January – 9 February 2023	29	0	17 March – 12 April 2023	27	0
PF 5	21 October – 1 November 2022 [3] 17 November – 8 December 2022	12 22	0	12 January – 9 February 2023	29	0	16 March – 12 April 2023	28	0
PF 6	17 November – 7 December 2022	21	0	12 January – 3 February 2023 [3]	23	0	15 March – 11 April 2023	28	0
PF 7	17 November – 8 December 2022	22	0	11 January – 8 February 2023	29	0	16 March – 12 April 2023	28	0
PF 8	17 November – 8 December 2022	22	0	11 January – 5 February 2023 [3]	26	0	16 March – 12 April 2023	28	0
PF 9	17 November – 8 December 2022	22	0	13 January – 6 February 2023 [3]	25	0	16 March – 9 April 2023 [3]	25	0

Survey location	Survey 1 – Spring 2022			Survey 2 – Summer 2023			Survey 3 – Autumn 2023		
	Survey period	No. survey nights	No. of bat passes	Survey period	No. survey nights	No. of bat passes	Survey period	No. survey nights	No. of bat passes
PF 10	17 November – 8 December 2022	22	0	13 – 18 January 2023 [5]	6	0	- [2]	0	No data
PF 11	18 November – 8 December 2022	21	0	- [2]	0	No data	16 – 21 March 2023 [5]	6	0
PF 12	18 November – 8 December 2022	21	0	11 January – 5 February 2023 [4]	26	0	16 March – 12 April 2023	28	0
PF 13	18 November – 8 December 2022	21	0	11 January – 9 February 2023	30	0	16 March – 10 April 2023 [3]	26	0
PF 14	18 November – 8 December 2022	21	0	12 January – 9 February 2023	29	0	17 March – 13 April 2023	28	0
PF 15	Not surveyed	-	-	13 January – 9 February 2023	28	0	16 March – 5 April 2023 [3]	21	0
Off-site 1	17 November – 7 December 2022	21	0	12 January – 7 February 2023	27	0	15 March – 11 April 2023	28	0
Off-site 2	18 November – 8 December 2022	21	0	12 January – 7 February 2023	27	0	17 March – 13 April 2023	28	0
Off-site 3	18 November – 7 December 2022	20	0	12 January – 7 February 2023	27	0	15 March – 12 April 2023	29	1
Off-site 4	18 November – 7 December 2022	20	No data [4]	13 January – 7 February 2023	26	0	15 March – 3 April 2023 [3]	20	0
Off-site 5	18 November – 7 December 2022	20	0	11 January – 1 February 2023	22	0	- [6]	0	No data
Off-site 6	18 November – 7 December 2022	20	0	11 January – 7 February 2023	28	0	15 – 19 March 2023 [5]	5	0

Notes:

1. No spectrogram files saved to the device, assumed microphone malfunction.
2. Complete equipment failure.
3. Batteries depleted.
4. As with Note 1. – a single spectrogram recorded, assumed microphone malfunction.
5. Assumed equipment malfunction, stopped recording after only six nights (unlikely to be a battery issue).
6. ABM lost during deployment; (data not retrieved).

4.4 Summary of bat values

The results of the desktop assessment showed that there are potentially multiple long-tailed bat colonies in the landscape surrounding the Site, and that bats are occasionally present within the Site.

The additional acoustic bat surveys undertaken to inform this preliminary effects assessment targeted:

- The ridgelines covered by the proposed Turbine Envelope Zone.
- The features within the Site that would generally be considered 'preferred habitat' for bats, if bats were regularly using the site (Section 3.2.1).
- The two river corridors that flow near the Site. Rivers are often important movement corridors for long-tailed bats, particularly in modified landscapes. As such, if bats are regularly using the area around the Site, it is expected that they would be active along the rivers.

The very low levels of bat activity recorded over five surveys (including the two BML surveys) across three years strongly suggests that while long-tailed bats are present in the wider landscape, the Site is of limited importance for any of these bat colonies.

Meridian provided a summary of the wind data collected from the on-site wind sensor[31] at the time of the single bat pass recorded in the Turbine Envelope Zone during the Summer 2023 survey (Section 4.3.2). At the time of the bat pass (26 January 2023, 11:01 pm), the wind speed was 5.2 ms^{-1}. This is a relatively light wind speed, being in the lowest 30th percentile. The average wind speed recorded at this sensor between 2010-2023 is 9.5 ms^{-1}. During the Summer 2023 bat survey period (11 January - 9 February 2023) the average wind speed was 7.5 ms^{-1}. The wind direction was 335° (a nor-westerly wind), this is typical for the Site.

Given what we know of long-tailed bat behaviour and habitat preferences, it is noteworthy that the single bat pass recorded during the Summer 2023 survey was on the ridge as opposed to at any of the 'preferred' habitat features that were monitored. Very little information can be deduced from a single bat pass, but it is indicative of a bat passing through the Site. Particularly given that long-tailed bats roost in mature trees and generally forage in sheltered edge ecotones where insects tend to congregate. The ridgeline of a proposed wind farm site which is comprised of improved pasture, provides none of the preferred habitat characteristics. Although the bat pass was recorded at a "Peak" survey location, this is the lowest peak within the Turbine Envelope Zone along the main ridge. While there are lower "Saddle" areas either side of the Peak 5 location it, it does sit within a particularly low area of the ridge.

The two bat passes recorded during the Autumn 2023 survey were recorded along the Mākākahi River ('Off-site 3', Figure 5), and at a patch of native treeland/regenerating shrubland on the southern slopes of the main ridge ('PF 1', Figure 5). Based on long-tailed bat ecology and behaviour, these habitat types are where you would expect to find bats within the site, compared to the ridge lines where the Turbine Envelope Zone is located. As with the pass recorded in the Summer 2023 survey, a single pass at each survey location over approximately a month of survey is indicative of the occasional bat passing through the site.

4.5 Ecological value of the Site for bats

The ecological value of long-tailed bats has been assessed in accordance with the EcIA guidelines (as described in Section 3.3). Long-tailed bats are classified as Threatened – Nationally Critical under the

[31] The wind mast location is 390459E 5492777N (NZTM) and the sensor is located 40 m above the ground.

New Zealand Threat Classification System[32]. As such, the ecological value of long-tailed bats is **Very High** in accordance with Appendix B Table 1 in Appendix B (adapted from the EcIA guidelines).

However, the above value does not accurately describe the value of the Site itself for long-tailed bats. The presence of highly mobile species on a site, and the importance of context for determining an appropriate ecological value in this instance is discussed on page 68 of the EcIA guidelines. This relevant section is quoted below.

"However, for migratory or highly mobile species the assessment will need to consider the importance of the area for their life-cycle. E.g., an occasional record of a single bird would warrant a different value from regular visits by breeding birds. The relative values should be explained. The occurrence of a species is not usually enough on its own to inform impact assessment. ***An EcIA must assess the importance of a place in supporting a species throughout the season, year or lifetime****."*

In accordance with the guidance above, we have assigned the ecological value of *the Site* as **Low** for long-tailed bats. Our reasoning is outlined below.

The results of the five surveys undertaken across the Site (including previous BML surveys) demonstrate that while bats are present in the wider landscape, they are only very occasionally using the Site. No foraging behaviour (feeding buzzes) has been recorded and the very low levels of bat activity does not suggest bats are roosting in the area.

The Site comprises a typical sheep and beef hill country farm that is predominately in improved pasture with small pockets of regenerating shrubland/forest and some exotic trees. These habitats do not appear to be rare in the landscape, as such the bats inhabiting the wider landscape are likely focusing their habitat use in areas that are closer to their primary roosting sites.

[32] 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 Bats and wind farms: a literature review

There is very limited information on the impacts of wind farm developments on long-tailed bats. The reason being there is only one operational wind farm in New Zealand where long-tailed bats occur – Te Uku wind farm, near Raglan, Waikato.

Below is a summary of overseas research to contextualise the potential effects of wind farm developments on long-tailed bats in the absence of robust species-specific research. Outcomes of acoustic bat monitoring that has been undertaken at Te Uku wind farm are also discussed. This data is relevant as it is long-tailed bat specific, however, the research undertaken at Te Uku is limited in scope. Consequently, the extensive research of the impacts of wind farms on similar bat species overseas cannot be discounted.

5.1 Overseas context

There is evidence that high numbers of bats die at overseas wind farms as a result of direct collisions with turbine blades and potentially barotrauma from being subjected to rapid pressure changes when flying through the turbine sweep area. A review of mortality at US wind farms has shown that the species suffering the most fatalities are migratory tree roosting bats[33]. In Europe, bats adapted to foraging in open areas comprised 98 % of wind farm fatalities[34].

Research in the northern hemisphere has demonstrated a notable spike in fatalities in late summer and autumn when bats are migrating[35]. The observed spike in fatalities at this time could be associated with bats dispersing long distances over open areas when they fly at greater heights. However, studies have shown that a large proportion of fatalities are from local populations[36].

As long-tailed bats are not migratory, they are unlikely to be affected to the same extent as migratory bats studied overseas. Long-tailed bats do however move across open areas (although preferentially forage near edges) and have similar morphological and behavioural characteristics to overseas species that are known to be impacted by wind development. A species closely related to the long-tailed bat, the Gould's wattled bat (*Chalinolobus gouldii*) has been found to be the primary fatality at two adjacent wind farms in Tasmania, Australia[37]. It is worth noting, however, that turbines at both wind farms are placed close to large forest and scrubland patches, with some turbines placed directly into the vegetation in small areas cleared for the turbines ('keyholing'). There is also evidence from overseas that some bat species, particularly tree roosting bats (like long-tailed bats), appear to be attracted to wind turbines, potentially because of their similarity to trees[38].

[33] Thompson, M., Beston, J.A., Etterson, M., Diffendorfer, J.E., Loss, S.R. 2017. Factors associated with bat mortality at wind energy facilities in the United States. Biological Conservation. 215. 241-245; Goldenberg, S.Z., Cryan, P.M., Gorresen, P.M. & Fingersh, L.J. (2021). Behavioral patterns of bats at a wind turbine confirm seasonality of fatality risk. Ecol Evol. 11: 4843–4853.

[34] Rydell, J., Bach, L. & Dubourg-Savage, M. 2010. Bat mortality at wind turbines in northwestern Europe. Acta Chiropterologica, 12(2). 261–274.

[35] Goldenberg, S.Z., Cryan, P.M., Gorresen, P.M. & Fingersh, L.J. (2021). Behavioral patterns of bats at a wind turbine confirm seasonality of fatality risk. Ecol Evol. 11: 4843– 4853.

[36] Lehnert, L.S., Kramer-Schadt, S., Schönborn, S., Lindecke, O., Niermann, I., Voigt, C.C. 2014. Wind Farm Facilities in Germany Kill Noctule Bats from Near and Far. PLoS ONE 9(8): e103106.

[37] Hull, C.L. & Cawthen, L. (2013). Bat fatalities at two wind farms in Tasmania, Australia: bat characteristics, and spatial and temporal patterns, New Zealand Journal of Zoology, 40:1, 5-15; Richardson, S.M., Lintott, P.R., Hosken, D.J. et al. (2021). Peaks in bat activity at turbines and the implications for mitigating the impact of wind energy developments on bats. Scientific Reports, 11:3636.

[38] Cryana, P.M., Gorresen, P.M. & Hein C.D et al. 2014. Behavior of bats at wind turbines. PNAS. 111(42). 15126–15131; Goldenberg, SZ, Cryan, PM, Gorresen, PM, Fingersh, LJ. Behavioral patterns of bats at a wind turbine confirm seasonality of fatality risk. Ecol Evol. 2021; 11: 4843– 4853.

5.2 New Zealand context: Te Uku wind farm bat surveys

In 2019 Tonkin & Taylor Ltd were engaged by BML (on behalf of Meridian) to undertake acoustic monitoring of long-tailed bats at the operational Te Uku wind farm in the Waikato Region (approximately 320 km to the northwest of the Mt Munro site). The results of the 2019 Te Uku wind farm monitoring have not previously been published, as such the methodology and results are outlined in Appendix C of this report.

Bat surveys were undertaken at Te Uku because it is the only operational wind farm in New Zealand where long-tailed bats are present. Consequently, there is very little information on the impacts of wind farms on New Zealand's endemic bats and currently there is a heavy reliance on international research undertaken on other bat species.

The Te Uku wind farm shares a border with Pirongia Forest Park where at least one long-tailed bat colony occurs. At Te Uku low levels of activity have been recorded at most bat survey locations across all seasons over multiple years of survey, with more activity being recorded at survey locations close to vegetation edges[39]. In contrast, the surveys undertaken at Mount Munro have either recorded no bat activity at all, or very low levels at a small subset of survey locations.

The objective of the bat monitoring at the Te Uku wind farm was to explore bat activity patterns after approximately 10 years of the wind farm being operational. As there is limited information about how long-tailed bats respond to wind farm development, the findings from the Te Uku survey have been used to inform the assessment of potential effects of the proposed Mt Munro Wind Farm on long-tailed bats.

Post-construction monitoring was undertaken at Te Uku wind farm during the first three years following the operation of the turbines (March 2011 to February 2014). These surveys entailed deploying ABMs at nine turbine sites and three control locations. These same locations were surveyed during the 2019 monitoring with additional survey locations associated with each monitored turbine site (Figure Appendix C.2). The additional survey locations included a 'vegetation edge treatment' and an 'open treatment' for each turbine monitored, totalling 27 survey locations for the nine turbines monitored.

The purpose of these additional monitoring locations was to explore the difference in bat activity levels between:

- The turbines.
- The closest corresponding vegetation edge.
- A corresponding open area at a similar elevation to the turbine in question, and a similar distance from the same vegetation edge, but a minimum of 200 m from all turbines.

An additional three 'control' locations were surveyed which corresponded to the same control locations monitored in the post-construction monitoring discussed above.

A summary of the findings is presented below.

5.2.1 Summary of findings from Te Uku wind farm

Long-tailed bats were recorded at 26 of the 30 survey locations (87 %) during the 2019 monitoring including all monitored vegetation edges surrounding the Te Uku site (Figure Appendix C.2). There was a statistically significant decrease in bat activity recorded between turbine monitoring locations

[39] Boffa Miskell Limited 2014. Project Te Uku Post-construction Avifauna & Bat Monitoring: Year 3 Annual Report. Report prepared by Boffa Miskell Limited for Meridian Energy Limited.

and comparable open sites that were minimum 200 m from any turbines, but still within the wind farm site.

This finding suggests that bats are not attracted to the turbine structures. On the contrary, they appear to be preferentially using open areas at least 200 m from a turbine. This finding is not consistent with overseas research that suggests some bat species are attracted to turbines, and this behaviour is resulting in largescale mortality of bats at overseas wind farms.

The above findings suggest that while the Te Uku bat population appears to preferentially use open areas away from turbines compared to turbine sites, the bats are still active across the majority of monitored locations within the wind farm, particularly vegetation edges. All monitored vegetation edges recorded bat activity.

Although we cannot use relative activity levels to make assumptions about population trends, the data has confirmed that the wind farm has not caused the local extinction of the population since it became operational, and bats have not abandoned the area.

5.3 Context summary

The above findings indicate that long-tailed bats may not be as susceptible to wind farm fatality as some of the more vulnerable bats studied overseas. However, the scope of the 2019 Te Uku survey is limited. More robust research should be undertaken before discounting the extensive evidence demonstrating high fatalities of species with similar characteristics to long-tailed bats at windfarms overseas. Differences in turbine size, layout, and a wind farm's location in the landscape must also be considered when using data from another wind farm development.

Given the above, a precautionary approach to assessing the potential effects of the proposed wind farm on long-tailed bats has been taken, as detailed in the sections below.

6 Assessment of ecological effects

The Section 4 described the bat values present within the project site. This section focuses on assessing the actual and potential effects of the proposed wind farm bat values and includes:

- A summary of the proposed works and the effects on bats.
- An assessment of the magnitude of effects from the proposed works and the overall level of effect on long-tailed bats.
- Proposed measures to avoid, monitor, and minimise effects.

The assessment is based on the EcIA guidelines produced by EIANZ and adapted based on expert opinion as described in Section 4.5 to determine the overall 'level of effect' of the project on bats.

6.1 Proposed works and summary of potential ecological effects

The assessment of effects includes consideration of effects during the construction and operational phases of the project and associated direct and indirect effects on bats in the short and long term.

6.1.1 Summary of proposed works

A detailed description of the proposed activities that could impact long-tailed bats is provided in Section 0. These activities can be separated into two general categories:

- Initial wind farm construction activities.
- Ongoing operation of the wind farm.

The construction phase of the project will include erecting up to 20 wind turbines along the ridges within the Turbine Envelope Zone shown in Figure 1.1. To transport, erect, and maintain the turbines, additional infrastructure will be required. This infrastructure will include: internal roads, a temporary laydown area and facilities for construction personnel, a permanent O&M building, substations, and transmission lines. Refer to Section 0 for detailed information about this infrastructure.

6.1.2 Potential effects on long-tailed bats

The key effects potentially arising from both the construction and operational activities of the proposed wind farm which could adversely impact long-tailed bats are:

- Habitat removal, including the removal of roosts and vegetation edges that long-tailed bats preferentially forage and disperse along.
- Severing of commuting/dispersal routes across the Site which can result in habitat fragmentation.
- Injury or mortality resulting from the removal of occupied roost trees.
- Injury or mortality resulting from bats colliding with turbine blades or from barotrauma[40].

6.1.2.1 Habitat removal

The proposed construction activities will occur entirely in the Turbine Envelope Zone, Turbine Exclusion Zone (Figure 1.1), and transmission corridor and substation. Habitats in these areas largely comprise improved pasture which is not preferred habitat for long-tailed bats. All the native forest and shrubland remnants within the Site will be avoided. Some removal of exotic trees may be required within the Turbine Exclusion Zone, and to construct the access tracks and the overhead

[40] Barotrauma is internal injuries caused by rapid changes in atmospheric pressure that occur around the blades of an operating wind turbine.

transmission lines, but this is likely to be minimal. This assessment is based on the habitat available in the Turbine Envelope Zone, the Turbine Exclusion Zone (where roads will be located)[41], and in the vicinity of the proposed transmission lines.

6.1.2.2 Injury or mortality resulting from the removal of occupied roost trees

Based on the results of the bat surveys undertaken across the Site, it is very unlikely that bats are roosting in the Site. Furthermore, as discussed above, removal of established vegetation (bats generally roost in the largest trees available[42]) is likely to be minimal. As such it is extremely unlikely bat roosts will be removed as a consequence of this project.

6.1.2.3 Disturbance during construction

Long-tailed bats are sensitive to anthropogenic disturbance, particularly light. As discussed above, it is very unlikely that bats are roosting on the Site during the day and so the likelihood of construction related activities such as noise and dust disturbing the bats during the day is extremely unlikely. It is understood that most construction activities will be limited to daytime hours. Artificial lighting may be used to assist some night works, such as night-time concrete pours for the turbine foundations. Such artificial night-time lighting will be temporary and given the low levels of bat activity on the site, it is unlikely such temporary lighting will have a notable impact on bats in the wider area.

As such, it is unlikely that there will be a measurable impact on bats due to construction-related disturbance.

6.1.2.4 Disruption of dispersal routes/ habitat fragmentation

There is growing evidence in overseas literature of bat mortality resulting from wind turbines (Section 5.1), yet there is limited evidence exploring potential indirect impacts such as avoidance behaviour resulting in habitat fragmentation. A small number of overseas studies have found evidence that bats show avoidance behaviour of wind turbines[43] but most of the research suggests that many species are either indifferent or attracted to turbines (hence the high levels of mortality).

Data collected at Te Uku wind farm[44], suggests that wind turbines may be a deterrent to long-tailed bats, but bats are still active around the Te Uku site with low levels of activity around the turbines themselves (refer to Section 5.2 and Appendix C).

In contrast to the Te Uku wind farm where bats are resident in the area, the bat activity recorded in the Site suggests that, although long-tailed bats are moving through the area on occasion, their use of the Mt Munro site is very limited. Long-tailed bats preferentially disperse along linear landscape features such vegetation edges and river corridors. Such features are limited at the Mt Munro site, although the hill ranges themselves may provide a linear structural feature in the landscape. The single bat pass recorded at survey location 'Peak 5' demonstrates that bats will cross the ridges on occasion, but the Site clearly does not form part of a commonly used movement route for bats in the wider landscape.

The roads built to service the wind farm will have low traffic levels, with no regular traffic at night, and will not be lit. Artificial lighting may be required during the construction phase to assist night works (Section 6.1.2.3). This lighting will be limited in both space and time and is unlikely to have a measurable impact on bats in the wider area.

[41] Refer to Map 9 in the main ecological effects assessment report for the project (BML, 2023).
[42] O'Donnell, C.F.J. & Sedgeley, J.A. (2004). Roost use by long-tailed bats in South Canterbury: examining predictions of roost-site selection in a highly fragmented landscape. *New Zealand Journal of Ecology*. 28(1): 1-18
[43] Millon, L., Colin, C., Brescia, F. & Kerbiriou C. (2018). Wind turbines impact bat activity, leading to high losses of habitat use in a biodiversity hotspot. *Ecological Engineering*, 112, 51 – 54.
[44] The only wind farm in NZ operating in the presence of resident a long-tailed bat population.

There is limited data both overseas and in New Zealand about whether wind turbines are a deterrent to bats, but there is evidence to suggest long-tailed bats are less active near wind turbines at Te Uku wind farm (Section 5.2). Regardless, the very low levels of activity recorded at the Mt Munro site suggest that potential avoidance of the area is unlikely to lead to a notable increase in habitat fragmentation in the landscape.

6.1.2.5 Injury or mortality resulting from bats interacting with turbines

Section 0 summarises the extensive evidence demonstrating that overseas wind farms cause considerable fatalities of bats with similar characteristics to long-tailed bats.

There is very limited information on the impacts of wind farm developments on long-tailed bats specifically. The reason for this is there is only one operational wind farm in New Zealand where long-tailed bats occur, Te Uku wind farm. The information gathered from Te Uku, albeit limited, suggests that wind turbines may not pose as much of a risk to long-tailed bats as to the species which comprise most of the fatalities overseas.

As outlined in Section 0, the scope of the 2019 Te Uku survey is limited, and a precautionary approach should be adopted when assessing the potential effect of injury or mortality caused by wind turbines.

A key mitigating factor is the very low levels of bat activity recorded across the Site. Te Uku wind farm has a resident bat population using the site and surrounds regularly. In a 2019 survey at Te Uku, one survey location recorded an average of 87.2 bat passes *per night*. At Mt Munro a *total* of seven bat passes (two of which were likely the same bat) have been recorded across five bat surveys spanning three years. Mt Munro is clearly not regularly used by bats and so potential interactions with turbines will be very limited.

6.2 Magnitude of effect on bats

The magnitude of effect of the proposed project on long-tailed bats has been assessed following the EcIA guidelines. The likely magnitude of effect for each of the potential effects summarised above have been assigned in Table 6.1 below. The magnitude for each potential effect has then been used to assign an overall magnitude of effect of the proposed wind farm on long-tailed bats. The magnitude of effect of the proposed wind farm on long-tailed bats is considered to be **Moderate**.

Table 6.1: The magnitude of effect on long-tailed bats (as per EcIA guidelines) resulting from individual potential effects that could arise from the construction and operation of the Mt Munro Wind Farm.

Potential effect	Magnitude of effect	Reasoning
Habitat removal	Negligible	• Very little (if any) preferred habitat will be removed. • The Turbine Envelope Zone and Turbine Exclusion Zone are comprised almost entirely of improved pasture. This is not preferred habitat for long-tailed bats and is widely available in the landscape. • Use of the Site by bats is very limited. They are a wide-ranging species, and the survey results indicate individual bats are occasionally moving through the Site.
Injury or mortality (roost tree removal)	Negligible	• Very little (if any) potential roosting habitat will be removed.

Potential effect	Magnitude of effect	Reasoning
		• Use of the Site by bats is very limited. They are a wide-ranging species, and the survey results indicate individual bats are occasionally moving through the Site. • Even if on a very rare occasion a bat does roost on the Site, long-tailed bats often move roosts on a nightly basis. Consequently, the likelihood this coinciding with the removal of the tree they happen to be roosting in that day is extremely unlikely.
Disturbance during construction	Negligible	• Use of the Site by bats is very limited. They are a wide-ranging species, and the survey results indicate individual bats are occasionally moving through the Site. • Construction activity will be largely undertaken during daytime hours, but some temporary night-time lighting may be required.
Disruption of dispersal routes	Negligible	• The Site does not appear to possess any key dispersal routes. Dispersal through the Site is on an occasional basis. • Evidence from monitoring undertaken at Te Uku wind farm does not suggest that the presence of turbines create a barrier to bat movement across a wind farm site.
Injury or mortality (resulting from operational turbines)	Moderate	• Overseas research shows that wind farms can result in large numbers of fatalities of bat species that have similar traits to long-tailed bats. • The monitoring undertaken at Te Uku wind farm does not suggest this is likely to be the case with long-tailed bats. Bats were still regularly using the Te Uku site approx. 10 years post-construction and no bat carcasses were discovered in during three years of post-construction mortality monitoring. • Use of the Site by bats is very limited. Survey results indicate bats will rarely interact with operational turbines. • This is a precautionary assessment - while it is highly unlikely that the proposed wind farm would result in fatalities, it cannot be completely ruled out given the extensive evidence of fatalities overseas. It is unknown how large the long-tailed bat colonies in that surrounding landscape are. Furthermore, at a species level long-tailed bats are highly threatened. As such, even occasional turbine-induced mortalities could potentially impact the bat population(s) in the wider area.

6.3 Overall level of effect on long-tailed bats

Under the EcIA guidelines, the overall level of effect is calculated by combining the value of the ecological feature with the magnitude of effect of the proposed development on said ecological feature as per Appendix B Table 2.

The value of the Site to long-tailed bats is assessed as Low (Section 4.5). The magnitude of the potential effects is assessed as **Moderate** (Section 6.2). As per Appendix B Table 2, the **overall level of effect on long-tailed bats resulting from the development of the proposed Mt Munro Wind Farm is considered to be Low.**

7 Mitigation recommendations

The overall level of effect of the proposed Mt Munro wind farm development on long-tailed bats is assessed as **Low**, due to the very low levels of bat activity recorded across the Site over multiple

surveys. The Turbine Envelope Zone also limits the potential turbine locations to the grazed ridge tops, avoiding areas of established woody vegetation (native and exotic) which have been assessed as preferred habitat for bats (Section 4.2). Furthermore, the design of the proposed development seeks to avoid the removal of preferred habitat during construction.

However, high levels of bat fatalities have been recorded at wind farms overseas, and data specific to long-tailed bats is limited. Given the uncertainty associated with the potential impacts of wind turbines on long-tailed bats we recommend that acoustic bat monitoring is undertaken during the first five years of operation of the wind farm and an adaptive management framework prepared in the unlikely event that regular bat activity is recorded at turbines. Adaptive management could include turbine-specific mitigation measures being initiated, such as curtailment. If curtailment is deemed necessary, we recommend it is specific to the individual turbines where regular bat activity is recorded. Curtailment would only need to be implemented at night and could potentially be linked to real-time bat activity monitoring (i.e., only required when bats are confirmed present in the vicinity of the turbine in question).

As noted above, minimal clearance of established woody vegetation is likely to be required to construct the proposed wind farm. But to minimise potential effects as much as possible, it is recommended that all practicable steps should be taken to minimise the vegetation clearance required to construct the wind farm. This includes minimising vegetation clearance of both native and mature exotic vegetation. If trees containing potential bat roosting features (including, but not limited to, cavities, cracks, or flaking bark) are to be removed, current best-practice vegetation removal protocols administered by Department of Conservation should be followed.

Due to the very low levels of bat activity recorded on the Site to date resulting in a **Low** overall level of effect, we do not consider bat-specific offset or compensation is required to manage effects. However, this could form part of the adaptive management framework if post-construction acoustic bat monitoring suggests additional effects management is required.

8 Summary and conclusion

To date, five acoustic bat surveys have been undertaken across the Site over three years. The most recent surveys undertaken by T+T covered 30+ survey locations targeting high-value habitat in the Site, the Turbine Envelope Zone (where turbines will be located), and river corridors close to the Site. This comprehensive survey effort has recorded very low bat activity in or around the Site.

The proposed Mt Munro wind farm development has been designed to avoid impacting preferred habitat of long-tailed bats, namely established native and exotic woody vegetation. However, potential adverse effects of the proposed project on long-tailed bats, as a result of injury or mortality of bats through collisions with wind turbine blades or potentially barotrauma cannot be completely discounted. **Due to the very low levels of bat activity recorded to date on the Site, the overall potential effect of the proposed windfarm has been assessed as 'Low' for long-tailed bats.**

There is only one operational wind farm in New Zealand that is located in an area where a long-tailed bat population is resident – Te Uku wind farm. Consequently, there is only limited research available on the impacts of wind farms that is specific to long-tailed bats. The surveys undertaken at Te Uku wind farm have found that after approximately 10 years of operation, bats are still active across most of the Te Uku site.

Conversely there is a large body of evidence from overseas that has found large numbers of bat fatalities associated with wind turbines. Some of these species share similar morphological and behavioural traits to long-tailed bats. The results of the surveys undertaken at Te Uku wind farm suggest long-tailed bats may not be as heavily impacted as some bat species overseas. Nevertheless, the high threat status of long-tailed bats (Threatened – Nationally Critical) coupled with the large body of evidence from overseas wind farms necessitates a cautious approach when managing

potential impacts in the face of uncertainty. As such, even though very low levels of bat activity have been recorded across the Site to date, a monitoring and adaptive management approach is recommended.

We recommend that bat activity monitoring is undertaken at all turbines for five years post-construction and an adaptive management programme is implemented if regular bat activity is recorded at turbines. Adaptive management could include turbine-specific curtailment.

Due to the very low levels of bat activity recorded on the Site to date, resulting in a Low overall level of effect, we do not consider bat-specific offset or compensation is required to manage effects. However, this could form part of the adaptive management framework if post-construction acoustic bat monitoring suggests additional effects management is required.

9 Applicability

This report has been prepared for the exclusive use of our client Meridian Energy Limited, 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.

We understand and agree that our client will submit this report as part of an application for resource consent and that Horizons Regional Council and Greater Wellington Regional Council as the consenting authority will use this report for the purpose of assessing that application.

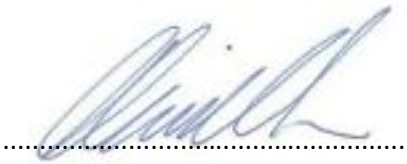
Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:

.....

Georgia Cummings
Terrestrial Ecologist

Authorised for Tonkin & Taylor Ltd by:



.....

Dean Miller
Project Director

GECU
\\ttgroup.local\corporate\wellington\tt projects\1016884\1016884.2000\issueddocuments\20230510_mtmr consentstudies ecology bateffectsassessment v02-02\20230510_mtmr_consentstudies_ecology_bateffectsassessment_v02-02.docx

Appendix A Site Photos

Photograph Appendix A.1: View south towards Pūkaha from on top of the main ridge (the Turbine Envelope Zone). Photo taken November 2022.

Photograph Appendix A.2: View east towards the valley below from the slope off the main ridge. Note remnant treeland and shrubland on the slope leading up to the ridge. Photo taken November 2022.

Photograph Appendix A.3: View east from the main ridge towards the farmland in valley below. Photo taken at survey location 'Peak 3'. Photo taken January 2023.

Photograph Appendix A.4: View southeast from survey location 'Saddle 6' toward the main ridge in the distance. Photo taken January 2023.

Photograph Appendix A.5: View of a native forest and regenerating shrubland remnant, looking up slope towards the main ridge. Photo taken January 2023.

Photograph Appendix A.6: Mature exotic trees (Pinus radiata and Eucalyptus spp.) at survey location 'PF 3'. Photo taken January 2023.

Photograph Appendix A.7: A small gully in improved pasture, indigenous forest contiguous with Pūkaha on the right (outside of the Site boundary). Photo taken November 2022.

Photograph Appendix A.8: View south from survey location 'PF 15' towards the indigenous forest contiguous with Pūkaha (outside of the Site boundary). Photo taken January 2023.

Photograph Appendix A.9: The Mākākahi River that flows near the north-western boundary of the Site. Photo taken at survey location 'Off-site 3'. Photo taken January 2023.

Photograph Appendix A.10: The Mākākahi River where it borders the Site. Photo taken from survey location 'PF 14' looking west. Photo taken January 2023.

Appendix B EIANZ Guidelines

B1 Assigning ecological value

Ecological values are assigned on a scale of 'Low' to 'Very High' based on species, communities and habitats present in the project footprint and immediate surrounds (see Appendix B Table 1). Values are assessed in terms of:

- Representativeness of the habitat including species assemblages.
- Rarity/distinctiveness, whether the area represents a threatened ecosystem (naturally or induced), rarity of the species the area supports.
- Diversity and pattern, biotic and abiotic diversity.
- Ecological context, how the area contributes to ecosystem functioning through its relationship with the surrounding landscape.

Appendix B Table 1: Ecological values assigned to species and habitats (adapted from Roper-Lindsay et al., 2018

Value	Species values	Habitat values
Very high	Nationally Threatened - Endangered, Critical or Vulnerable.	Supporting more than one national priority type. Nationally Threatened species found or likely to occur there, either permanently or occasionally.
High	Nationally At Risk - Declining.	Supporting one national priority type or naturally uncommon ecosystem and/or a designated significant ecological area in a regional or district Plan. At Risk - Declining species found or likely to occur there, either permanently or occasionally.
Moderate-high	Nationally At Risk - Recovering, Relict or Naturally Uncommon.	A site that meets ecological significance criteria as set out in the relevant regional or district policies and plans.
Moderate	Not Nationally Threatened or At Risk, but locally uncommon or rare.	A site that does not meet ecological significance criteria but that contributes to local ecosystem services (e.g., water quality or erosion control).
Low	Not Threatened Nationally, common locally.	Nationally or locally common with a low or negligible contribution to local ecosystem services.
Negligible	Not Threatened Nationally, common locally, poor habitat with few species.	Nationally or locally common with a negligible contribution to local ecosystem services.

B2 Assessment of magnitude of effects

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. The magnitude of an effect is scored on a scale of 'Negligible' to 'Very High' (Appendix B Table 2) and is assessed in terms of:

- Level of confidence in understanding the expected effect.
- Spatial scale of the effect.
- Duration and timescale of the effect (Appendix B Table 3).
- The relative permanence of the effect.
- Timing of the effect in respect of key ecological factors.

The spatial scale for effects are considered in the context of the local and landscape scale effects as appropriate. The magnitude of effects is assessed after measures to avoid, minimise and mitigate are applied.

Appendix B Table 2: Criteria for describing magnitude of effect (Roper-Lindsay et al., 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.

Notes:

1. Baseline conditions are defined as 'the conditions that would pertain in the absence of a proposed action' (Roper-Lindsay *et al*., 2018).

Appendix B Table 3: Timescale for duration of effects (Roper-Lindsay et al., 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).

Notes:

1. In the context of some planning documents, 'temporary' can have a defined timeframe.

B3 Assessment of the level of effects

An overall level of effects (Appendix B Table 4) is identified for each activity or habitat/fauna type using a matrix approach that combines the ecological values with the magnitude of effects after measures to avoid, minimise and remedy are applied (described in **Section 3.**).

The matrix describes an overall level of effect on a scale of 'Negligible' to 'Very High'. Positive effects are also accounted for within the matrix.

The level of effect is then used to guide the extent and nature of further ecological management response required, which may include offsetting or compensation.

Appendix B Table 4: Criteria for describing overall levels of ecological effects (Roper-Lindsay et al., 2018)

Ecological value (Appendix B Table 1) / Magnitude (Appendix B 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
Positive	Net gain	Net gain	Net gain	Net gain	Net gain

Appendix C Te Uku Wind Farm Bat Surveys (2019)

C1 Introduction

In 2019 Tonkin & Taylor Ltd were engaged by Boffa Miskell (on behalf of Meridian Energy Ltd) to undertake acoustic long-tailed bat at the operational Te Uku wind farm in the Waikato Region (approximately 320 km to the northwest of the Mt Munro site).

Bat surveys were undertaken at Te Uku because it is the only operational wind farm in New Zealand where long-tailed bats are present. Consequently, there is very little information on the impacts of wind farms on New Zealand's endemic bats and currently there is a heavy reliance on international research undertaken on other bat species.

The objective of the bat monitoring at the Te Uku wind farm was to explore bat activity patterns after approximately 10 years of the wind farm being operational. As there is limited information about how long-tailed bats respond to wind farm development, the findings from the Te Uku survey have been used to inform the assessment of potential effects of the proposed Mt Munro Wind Farm on long-tailed bats.

C2 Methodology

C2.1 Survey design

The conditions of consent for the Te Uku wind farm development specified three years of long-tailed bat monitoring commencing once the turbines were operational (henceforth referred to as post-construction monitoring). The results of post-construction monitoring did not show a statistical change in bat activity pre- and post-construction. Post-construction monitoring concluded in February 2014 and no bat monitoring has been undertaken since.

In order to compare the data collected during this round of monitoring to previous bat monitoring undertaken at Te Uku, a similar survey design was used. Monitoring was undertaken in spring when the baseline (pre-construction) bat monitoring had been undertaken in 2009.

The post-construction monitoring described above entailed deploying acoustic recorders at nine turbine sites and three control locations (refer to Figure Appendix C.1). Those same locations were surveyed during this round of monitoring with additional survey locations associated with each monitored turbine site (Figure Appendix C.2). The additional survey locations included a 'vegetation edge treatment' and an 'open treatment' for each turbine monitored, totalling 27 locations for the nine Turbines monitored (Figure Appendix C.2). The purpose of these additional monitoring locations was to explore the difference in bat activity levels between:

- The turbine sites.
- The closest corresponding vegetation edge.
- A corresponding open area at a similar elevation to the turbine in question as well as distance from the same vegetation edge, but a minimum of 200 m from all turbines.

A total of 30 ABMs (27 sites described above plus an additional three sites not associated with particular turbines) were deployed across the Te Uku site from 16 October to 7 November 2019.

ABMs at turbine locations were attached to the fence posts at an approximate height of 2 m (Photograph Appendix C.3). The open treatment ABMs were attached to waratahs (Photograph Appendix C.4). The vegetation control ABMs were hung from branches at an approximate height of between 2-4 m (Photograph Appendix C.5).

A map of the ABM locations is provided in Figure Appendix C.2.

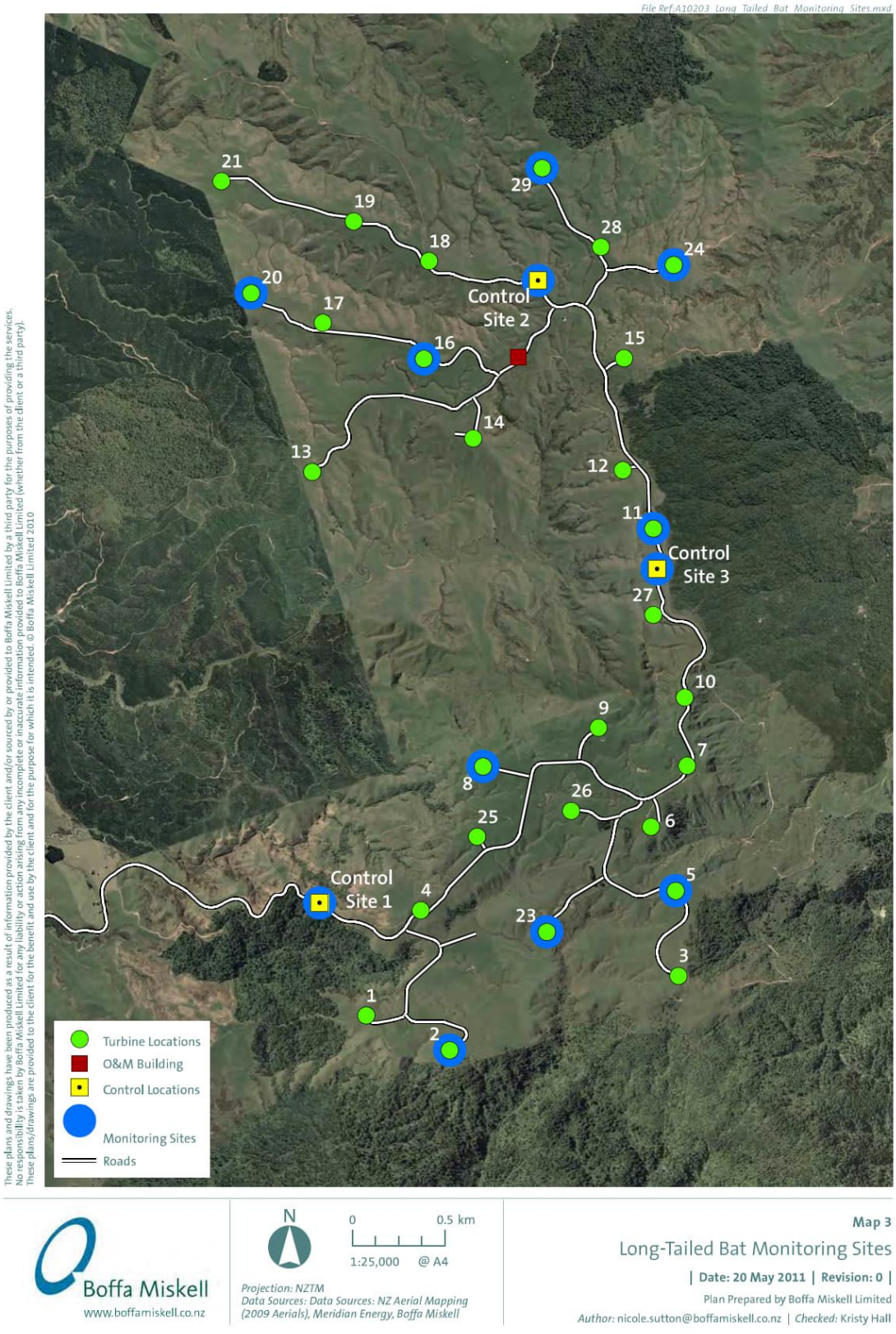
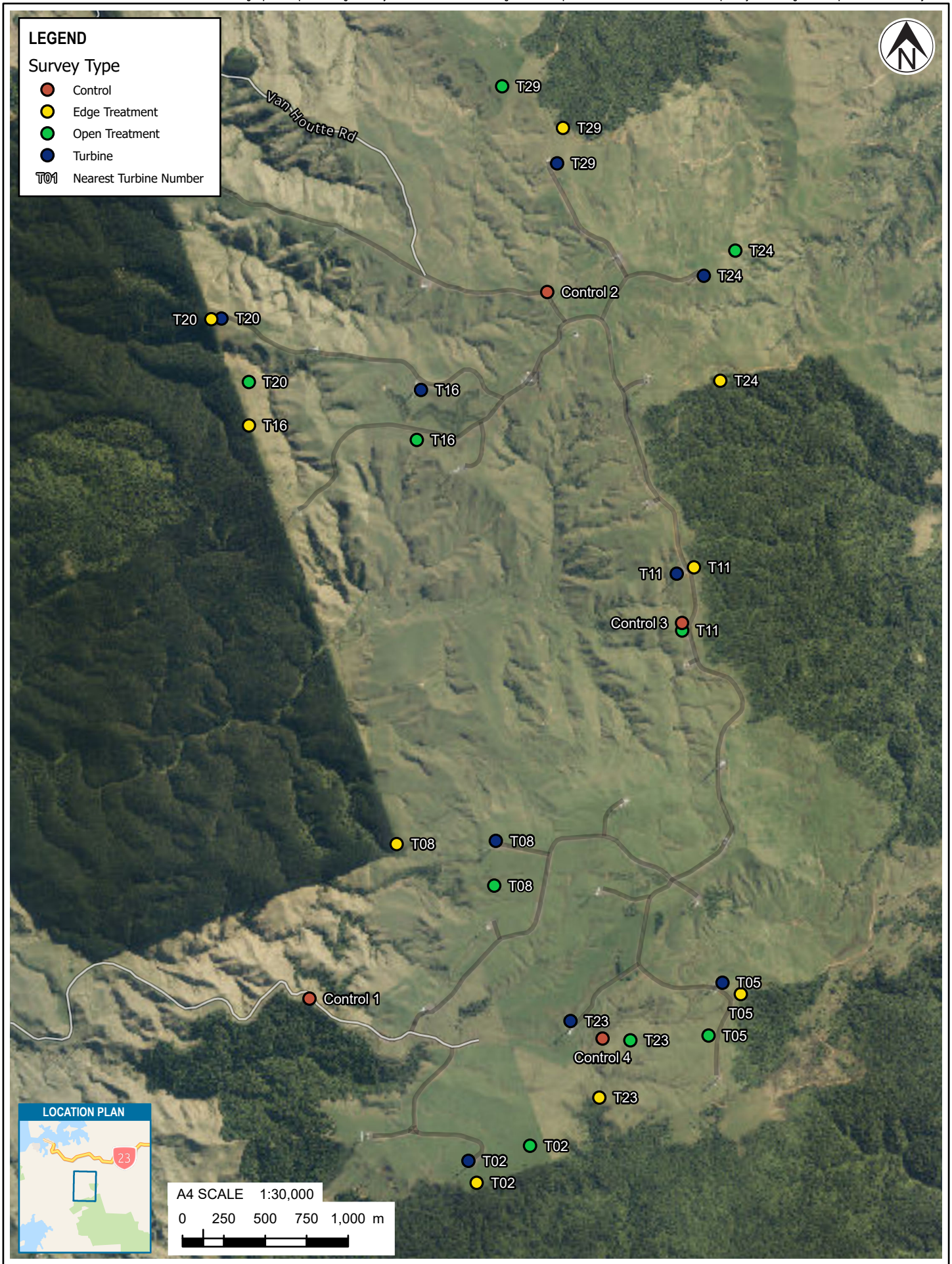


Figure Appendix C.1: Long-tailed bat acoustic monitoring sites during post-construction monitoring at Te Uku wind farm. Map sourced from: Boffa Miskell Limited (2014). Project Te Uku Post-construction Avifauna & Bat Monitoring: Year 3 Annual Report. Report prepared for Meridian Energy Limited.



Tonkin+Taylor
www.tonkintaylor.co.nz
Exceptional thinking together

PROJECT No.	1016844.2000	
DESIGNED	RUGR	APR.23
DRAWN	RUGR	APR.23
CHECKED	DXLR	APR.23
APPROVED		DATE

CLIENT **MERIDIAN ENERGY LTD**
PROJECT **TE UKU WIND FARM**
TITLE LONG-TAILED BAT SURVEY LOCATIONS 2019
SCALE (A4) 1:30,000 FIG No. APPENDIX C FIGURE 2 REV 0

Photograph Appendix C.3: Acoustic recorder deployed on a fencepost adjacent to a turbine at Te Uku wind farm.

Photograph Appendix C.4: An 'open treatment' acoustic recorder deployed in open pasture a minimum 200 m away from any turbine on Te Uku wind farm.

Photograph Appendix C.5: Acoustic recorder hanging from a tree branch (to the left of the red arrow) at Control Site 1 at Te Uku wind farm.

C2.2 Data analyses

The data stored on the ABMs was analysed using BatSearch v3.12 (Department of Conservation). It was analysed by ecologists certified by DOC as competent in analysing acoustic monitoring data.

Bat activity is influenced by weather including temperature, wind speed and rainfall. All survey nights were evaluated for the presence of bats. However, to enable accurate comparison of bat activity in this survey to any future surveys we have defined a 'valid' night as any survey night where the weather conditions met the parameters listed below:

- Air temperature ≥ 10°C from sunset until four hours after sunset.
- ≤ 2.5mm of rain in the first two hours after sunset.
- Max wind gusts ≤ 60 km/h.

We note that it is sometimes recommended that nights where the average overnight wind speed exceeds 20 km/h should also be excluded from analysis. However, this parameter has not been included in this instance due to the very windy nature of the area. The inclusion of this parameter in combination with the parameters above have resulted in the exclusion of the majority of the nights available for analysis.

The survey nights that meet the above parameters are considered to have had weather conditions conducive to higher bat activity and are henceforth referred to as 'fine weather nights'.

Temperature data was provided by Meridian, collected from an onsite weather mast. Rainfall was collected from the nearest CliFlo station[45] as the rainfall data collected from the on-site mast was not a cumulative measurement.

C2.3 Statistical analyses

A biostatistician, Derek Christie, was engaged to undertake the statistical analyses described below. The methods described below and the results in Section C3 are summarized from his report[46].

The mean number of bat passes per night at each survey location was graphed. This demonstrated that the bat activity at the vegetation edge was noticeably higher across the survey groups. There also appeared to be a slight increase in activity around the open control locations compared to the corresponding turbine. A two-way ANOVA was used to explore this potential difference in bat activity levels.

A Generalised Linear Model (GLM) was used because the data was unbalanced (there is different numbers of data points in some of the survey groups), and the results of the standard ANOVA were also compared with other methods because the data was not normal. The second method was a fourth root transformation of the data before running the two-way ANOVA. A fourth root transformation was used as it performs well with data that has sharp permutations and a lot of zeros[47]. The third method was to run a permutation ANOVA (Monte Carlo approach).

C3 Results

A total of 30 acoustic recorders were deployed across the Te Uku site for approximately three weeks from mid-October to early November 2019. The results of the surveys are summarised in Appendix C Table 1. Bat activity was recorded at 26 of the 30 survey locations.

[45] The "Whatawhata 2 Ews": Latitude: -37.78832 Longitude: 175.06906

[46] Christie, D. 2020a. Te Uku bat monitoring report. Report prepared by Derek Christie (biostatistician) for Boffa Miskell Ltd.

[47] Quinn, G.P. & Keough, M.J. (2002). Experimental design and data analysis for biologists. Cambridge University Press.

Location within the Te Uku site appears to be a key variable influencing bat activity levels. While there was a lot of variability between survey locations, some broad activity patterns were observed. Survey locations along the northern edge of Pirongia Forest Park (the southern boundary of the Te Uku site) recorded comparatively low bat activity ranging from 0.2 passes per night (T05) to 2.8 passes per night (T02 - Edge). Conversely the ABMs located along the edge of the pine block that forms western boundary of the Te Uku site all recorded comparatively high activity levels, averaging between 13.8 and 16.7 passes per night. The survey locations along the northern and eastern boundary of the Te Uku site recorded more variable activity (Appendix C Figure 2).

As is expected from an edge-adapted bat, significantly more activity was recorded adjacent to vegetation compared to both the turbine and 'open' survey locations. Refer to Section C3.2 for more detail.

Appendix C Table 1: Summary of the results of the Spring 2019 acoustic bat surveys undertaken at the operational Te Uku wind farm site.

Turbine No.	Monitoring Location	Survey period	No. 'fine weather' survey nights analysed	Total no. of bat passes	Mean no. bat passes per night	SE	Percent of survey nights with passes
Turbine 02	Turbine	17 October - 7 November 2019	19	7	0.4	0.19	21 %
	Edge	17 October - 7 November 2019	19	53	2.8	1.66	58 %
	Open	17 October - 7 November 2019	19	15	0.8	0.28	47 %
Turbine 05	Turbine	17 October - 7 November 2019	19	4	0.2	0.16	11 %
	Edge	17 October - 7 November 2019	19	18	0.9	0.50	32 %
	Open	17 October - 7 November 2019	19	3	0.2	0.09	16 %
Turbine 08	Turbine	17 October - 7 November 2019	19	0	0	0	0 %
	Edge	17 October - 7 November 2019	19	262	13.8	3.25	89 %
	Open	17 October - 7 November 2019	19	2	0.1	0.11	5 %
Turbine 11	Turbine	16 October - 7 November 2019	20	0	0	0	0 %
	Edge	17 October - 7 November 2019	20	1	0.1	0.05	5 %
	Open (also Control 3)	17 October - 7 November 2019	19	14	0.7	0.24	47 %
Turbine 16	Turbine	17 October - 7 November 2019	19	1	0.1	0.05	5 %
	Edge	17 October - 7 November 2019	19	311	16.4	4.38	95 %
	Open	17 October - 7 November 2019	19	2	0.1	0.11	5 %
Turbine 20	Turbine	16 October - 7 November 2019	20	4	0.2	0.12	15 %
	Edge	16 October - 7 November 2019	20	334	16.7	3.60	90 %
	Open	17 October - 4 November 2019	16	6	0.4	0.15	31 %
Turbine 23	Turbine	17 October - 7 November 2019	19	5	0.3	0.15	16 %
	Edge	17 October - 7 November 2019	19	31	1.6	0.36	74 %
	Open	17 October - 7 November 2019	19	21	1.1	0.45	47 %
Turbine 24	Turbine	16 October - 7 November 2019	20	0	0	0	0 %
	Edge	16 October - 7 November 2019	20	413	20.7	13.00	65 %

Turbine No.	Monitoring Location	Survey period	No. 'fine weather' survey nights analysed	Total no. of bat passes	Mean no. bat passes per night	SE	Percent of survey nights with passes
	Open	16 October - 3 November 2019	16	28	1.8	0.69	44 %
Turbine 29	Turbine	16 October - 30 October 2019	12	3	0.3	0.13	25 %
	Edge	16 October - 7 November 2019	20	44	2.2	0.84	65 %
	Open	16 October - 29 October 2019	11	1	0.1	0.09	9 %
Control 1	Edge Control	17 October - 7 November 2019	19	1657	87.2	23.65	100 %
Control 2	Open Control - Ridge	16 October - 7 November 2019	20	0	0	0.00	0 %
Control 4	Open Control - Gully	17 October - 7 November 2019	19	48	2.5	1.43	42 %

C3.1 Comparison with spring 2009 baseline surveys

Note that the comparisons below are general observations as there could be a number of factors contributing to any changes in bat activity observed. Such factors include advances in acoustic recorder technology, different weather variables used to define a 'fine weather night', and changes in the wider landscape. The pest control programme across the neighbouring Pirongia Forest Park for example. Given the number of uncontrolled variables, we have not attempted analyse the findings statistically. Instead, the mean number of passes per night across all spring bat surveys undertaken at Te Uku is shown in Figure Appendix C.6 and Appendix C Table 2 and broad patterns discussed below.

As with the previous bat survey findings at Te Uku, the levels of bat activity were highly variable between survey locations. Control 1 recorded the most consistent bat activity during the spring post-construction surveys. This location appears to still be a key area for bats using the Te Uku site, averaging 87.2 passes per night in the most recent survey. This level of activity is an order of magnitude higher than activity levels previously recorded at this location (refer to Figure Appendix C.6: Mean number of bat passes per night at monitored turbines and 'control sites' at Te Uku wind farm across five survey periods, including a pre-construction baseline survey.

Figure Appendix C.6). The general pattern emerging for the other survey locations is that the activity levels recorded in 2019 are lower than the 2009 spring baseline activity levels but higher than the year 1 - 3 post-construction levels.

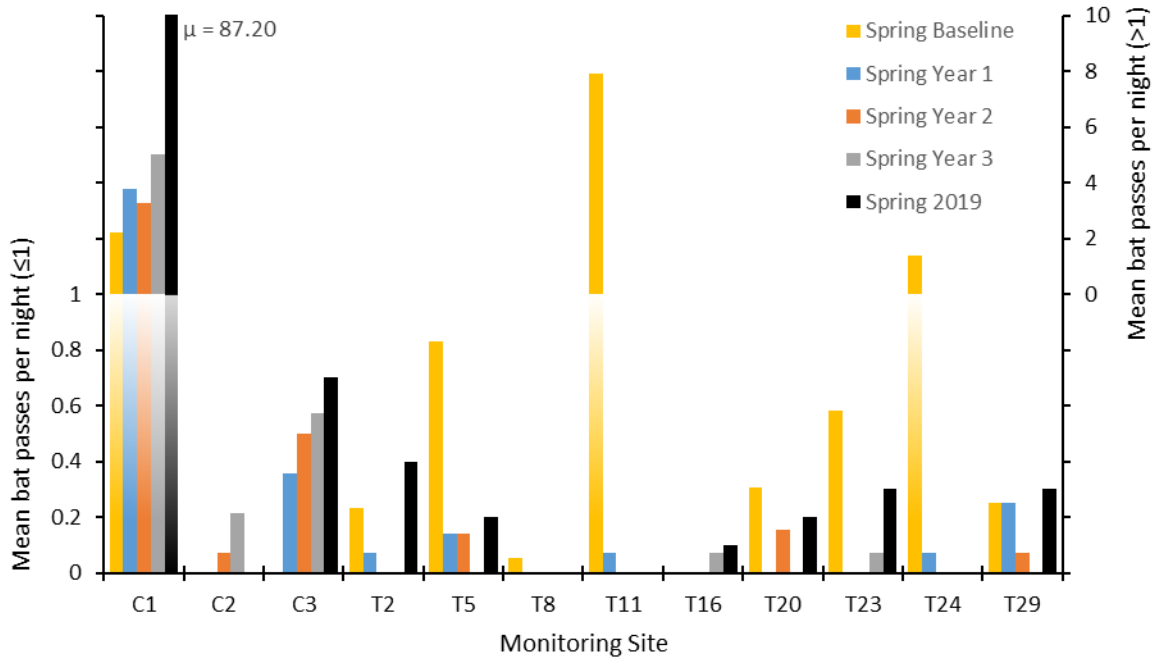


Figure Appendix C.6: Mean number of bat passes per night at monitored turbines and 'control sites' at Te Uku wind farm across five survey periods, including a pre-construction baseline survey.

Appendix C Table 2: Summary of bat activity across four survey periods at Te Uku wind farm

Survey Location	Average number of bat passes per night				
	Spring 2009 baseline	Spring post-construction Y1	Spring post-construction Y2	Spring post-construction Y3	Spring 2019
Control 1	2.23	3.79	3.29	5.00	87.2
Control 2	0	0	0.07	0.21	0
Control 3[1]	-	0.36	0.5	0.57	0.7
T02	0.23	0.07	0	0	0.4
T05	0.83	0.14	0.14	0	0.2
T08	0.06	0	0	0	0
T11	7.91	0.07	0	0	0
T16	0.00	0	0	0.07	0.1
T20	0.31	0	0.15	0	0.2
T23	0.58	0	0	0.07	0.3
T24	1.38	0.07	0	0	0
T29	0.25	0.25	0.07	0	0.3

Notes:

1. Same location as T11 - O in the Spring 2019 survey.

C3.2 Comparison between activity levels at turbine and control locations

As described in Section C2.1, for each turbine monitored, two corresponding treatment sites were also simultaneously surveyed:

- an ‘edge treatment’ located at the closest corresponding vegetation edge.
- an ‘open treatment’ located at a similar elevation and distance from vegetation as the monitored turbine, but at least 200 m from all turbines.

Figure Appendix C.7 displays the average passes per night at all of the turbine, ‘edge’ and ‘open’ locations. The graph clearly demonstrates that more bat activity was recorded at edge sites compared to the corresponding turbine and open locations. This is expected given the what is known of long-tailed bat ecology. There also appears to be a trend of open sites recording slightly more activity than the corresponding turbine location.

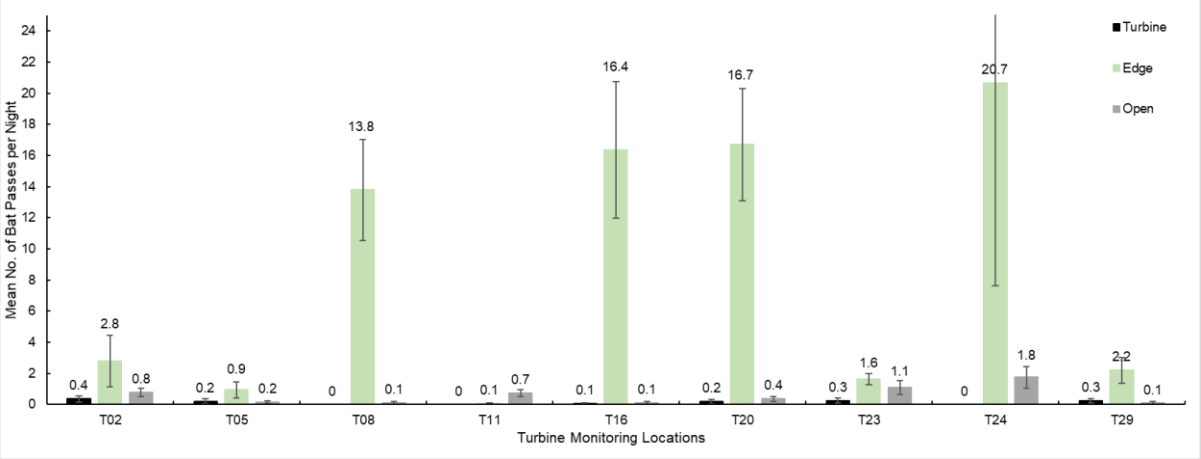


Figure Appendix C.7: Bat activity results from Spring 2019 acoustic bat monitoring undertaken at the operational Te Uku wind farm. Mean number of bat passes per night recorded at turbine survey locations and corresponding 'edge' and 'open' locations.

This trend was analysed using a two-way ANOVA[48] with both raw and transformed data. The relationship was also analysed using a permutation ANOVA which does not have the assumption of normal data. All three analyses found a significant difference in bat activity between open sites ($\bar{x}$ = 0.59 passes per night) and turbine sites ($\bar{x}$ = 0.15 passes per night), $p < 0.001$ for each analysis. By comparison, the mean number of bat passes over the edge sites was 8.6 passes per night.

[48] A Generalised Linear Model (GLM) was used as the design was unbalanced due to some ARs not recording for the entire monitoring period.

www.tonkintaylor.co.nz