Kaimai Wind Farm

ECOLOGICAL EFFECTS ASSESSMENT

March 2018

Kessels Ecology
survey, assessment, restoration

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EXECUTIVE SUMMARY

Aim of the Ecological Effects Assessment

Ventus Energy proposes the construction of 24 wind turbines over an area of approximately 1,850 ha within hill country farmland, situated on the north-western flanks of the Kaimai Range between Mt Aroha and the Karangahake Gorge – the proposed Kaimai wind farm. Kessels Ecology have been commissioned to undertake an ecological effects assessment of the wind farm proposal. This assessment includes an evaluation of:

- The location, extent, type and significance of terrestrial and aquatic indigenous vegetation communities, existing protected natural areas and fauna habitats supported within and adjacent to the project area;
- Results of botanical and faunal surveys;
- The nature and magnitude of any potential adverse ecological effects arising from the proposed wind farm on key ecological features, indigenous fauna habitats and migratory, foraging or commuting routes;
- A broad outline of suitable avoidance, remediation and mitigation measures required to address any potential adverse ecological effects; and
- An outline of any further ecological investigations and monitoring requirements.

The field work for this investigation was undertaken from 2009 to 2017, enabling data to be collected across multiple years on the distribution and habitat utilisation of the locality by birds and bats. Further, desktop-based analysis was undertaken to determine the effects of the proposal on aquatic freshwater biota, indigenous vegetation, lizards and terrestrial invertebrates.

Summary of Potential Ecological Effects Associated with Wind farms

Potential impacts of wind farms on indigenous vegetation and indigenous fauna can be divided into two categories – direct impacts and indirect impacts. Direct impacts could include:

- Habitat loss and damage, and loss of plants and other wildlife, in the course of the wind farm, transmission line and access road construction;
- Sediment run-off from the road, transmission line and turbine construction affecting waterways; and
- Mortality of birds, flying insects, or bats when in a collision with the turbines, associated wind eddies, transmission lines or associated wind farm structures.

Indirect impacts could include:

- Disturbance either from the wind farm and associated activities (noise, human presence) and associated behavioural responses, such as avoidance or attraction to the area;
- Reduced breeding success of birds or other wildlife breeding in close proximity to the wind farm;
- New weeds and diseases being introduced into natural areas by machinery and fill material; and
- Changes in interactions between species, such as predator prey dynamics, e.g. increased predation and scavenger pressure in treeless, unbuilt areas and adjoining fauna habitats, as the wind farm may provide suitable perches and shelter for predators that previously did not inhabit the area.

Effects on Vegetation

The wind farm area can generally be described as a mosaic of rolling pasture land with a number of exotic plantations and indigenous forest remnants scattered throughout. Some 72% of the site is covered in pasture. Smaller stands of secondary broadleaved forest are mainly present within the gully systems in the northern half of the site, while larger areas of logged tawa forest remain along the eastern margin of the site (i.e. the Kaimai Ranges), as well as in the southern extent of the site and near the quarry at the north-western margin of the site. While indigenous forest and scrubland is situated within 100 m from the edge of some of the turbine locations, since all the centres of the turbines are located in the pastoral land no indigenous vegetation will be removed in the turbine footprint.

No ecologically significant indigenous vegetation or nationally threatened plant species would be affected by the proposal.

The introduction of new weeds, diseases and the spread of existing weed species will need to be managed to protect the ecological health of the existing indigenous vegetation remnants in the locality. All machinery and aggregate brought onto site will need to be cleaned, or otherwise guaranteed free of attached seed or plant matter before being brought on to site. Provided due care and initial weed control is carried out as and when required, it is expected that the pasture or indigenous scrubland species will quickly gain a foot-hold and dominate vegetative cover along access road batters and cuts.

Effects on Freshwater Aquatic Habitats

No fish or aquatic macroinvertebrate habitats would be adversely affected provided appropriate sediment control measures are adopted. No upgrades to existing access stream crossing are proposed with the current roading design. Although water abstraction requirements have not be defined at this point in time, abstraction points should result in no more than minor adverse effects on in-stream biota provided suitable storage and/or non-fully allocated water sources can be devised and found.

Sediment control measures include, but are not restricted to, controlling run off, the prevention of slumping of batters, cuts and side casting, maintain slope stability and contingency measures for heavy rainfall events.

Effects on Lizards, Frogs and Terrestrial Invertebrates

As no ecologically significant indigenous vegetation will be disturbed during the construction phase adverse ecological effects on lizards and indigenous terrestrial invertebrates is likely to be minimal. However, it is possible that areas of non-ecologically significant vegetation (both exotic and indigenous) cleared or trimmed for infrastructure development or tower placement will include lizard and invertebrate habitat. The consequential relatively minor adverse effects on these fauna groups can be managed through appropriate mitigation and monitoring measures. Details of these measures can be dealt with as part of the consent conditions.

Effects on Birds

According to international best practice guidelines a summary of the main bird habitat areas which should be avoided when locating a wind farm are:

(1) Areas with a high density of wintering or migratory waterfowl and waders where important habitat might be affected by disturbance or where there is potential for significant collision mortality;

(2) Areas with a high level of raptor activity, especially core areas of individuals breeding ranges and in cases where local topography focuses flight activity which would cause a large number of flights to pass through the wind farm; and

(3) Breeding, wintering or migrating populations of less abundant species, particularly those of conservation concern, which may be sensitive to increased mortality as a result of collision.

The main bird groups impacted by wind farm developments internationally have been swans, geese, ducks, waders, gulls, terns, large soaring raptors, owls and nocturnally migrating passerines.

Most resident bird species within the study site are common and widespread with the potential exceptions of New Zealand pipit, North Island kaka and New Zealand falcon, which are all found in the local area. There is a risk of collision with the turbine blades, especially along the forest edge.

It is possible that New Zealand falcon and kaka will suffer occasional strike, particularly by the turbines along the forest edge of the Kaimai-Mamaku Conservation Park. Australasian bittern may also be at risk from strike while moving between the Bay of Plenty and Kopuatai Peat Dome. However, of these species, only pipit was detected during the bird surveys or by the acoustic surveys, so while non-detection does not necessarily mean these birds are absent from the locality, it does suggest that they may be present in low densities.

While the ability of these key forest and wetland bird species to adapt to the turbines and become accustomed to associated noise and movement is likely, and the birds should be able to fly around the turbines to gain access to other remnant bush areas within the locality, there is a likelihood that strike will occur from time to time. There is insufficient data for this site to determine the strike level, but modelling and carcass searches at other similarly situated New Zealand wind farms suggest strike rates will be low. Nonetheless, the local effects of this mortality may be more than minor on threatened species, so some form of offset mitigation, such as a contribution to local animal pest control to increase bird productivity, is recommended.

The impact of the wind farm on migratory birds is dependent on any flight path these species may take between key habitats in the Bay of Plenty and Firth of Thames. Wader and shorebird species, such as bar-tailed godwit, wrybill and South Island pied oystercatcher, may move between the Firth of Thames and Tauranga Harbour on a regular basis and in doing so traverse the proposed windfarm footprint. The sound recorders detected two flocks of South Island pied oystercatchers crossing the proposed wind farm site on one occasion in January 2013, from a total recording effort of some 4,000 hours. These detected South Island pied oystercatchers were crossing the southern section of the windfarm over the Kaimai range. This indicates that the site is likely part of a seasonal commuting route for waders between the Haruaki Gulf and Tauranga Harbour.

Initial strike risk analysis at similar New Zealand sites indicates that turbine strike is possible for wader species and it will be in the range of less than 2-5 birds per annum for the proposed Kaimai wind farm. This level of strike risk is considered to have a minor adverse effect on the target shorebird species. However, given that several other wader species, such as wrybill and godwit may cross this site and thus be at risk of turbine blade strike, offset mitigation may be required to compensate for any residual adverse effects on wader bird species. Quantification of this offset can be addressed at the consenting stage, but could involve a contribution to conservation activities by community groups at Miranda, which is a key site for international and national wader birds.

Effects on Bats

The nationally threatened North Island long-tailed bat is known to be present within the Kaimai Ranges and was detected during the surveys for this proposal. The survey results showed long-tailed bat activity during 4-17 January 2013, and from 22 September to 27 October 2015 at the study site. In the 2015 survey 63% (eight) of all of the surveyed sites contained long-tailed bats, while in the 2013 bat survey 55% (11) of the sites contained bats. In total 59% (19) of the surveyed sites detected bats.

No publicly accessible studies have investigated the impacts of wind farms on the spatial use of either of New Zealand's native bat species. Therefore, it is not clear whether avoidance behaviour occurs in either native bat species. Based on review of international studies it is considered possible that long-tailed bats will suffer mortality as a result of interactions with the turbines. Thus, bats are considered to be at moderate risk of being killed or injured by turbine strike at this proposed wind farm site.

A combination of habitat restoration and pest control would enhance the local North Island long-tailed bat population, producing a healthy source population which could mitigate against any declines at the proposed wind farm site.

Avoidance, Remediation and Mitigation Recommendations

The proposed Kaimai wind farm is situated within a largely pastoral environment, heavily modified by human activities and animal pests.

No ecologically significant or legally protected natural features will be directly affected by the proposed wind farm.

However, there are several threatened birds and one bat species which could be adversely affected by the turbines in the form of turbine blade strike. The biodiversity consequences of this risk are low to moderate at a local level, and the effects are likely to be minor at a regional, national and international scale.

It is recommended that measures are taken to avoid, remedy or mitigate the adverse effects of turbine strike on these key animals and their habitats, as well as address the localised potential adverse effects associated with construction. A range of measures that will avoid, remedy or mitigate the adverse effects of the project (inclusive of the wind turbines, access roads and the transmission lines) are required. They should include:

- Ensuring all aspects of the construction and operation of the wind farm minimise any potential adverse effects associated with indigenous flora and fauna habitat disturbance, sediment runoff, water abstraction and stream crossings (if any);
- Preparation and implementation of a mitigation package to compensate for potential turbine strike on key indigenous fauna which incorporates enhancing productivity of the target species through ongoing animal pest control and ecological enhancement of targeted natural features; and
- Monitoring of key fauna species, as well as carcass searches under the operational turbines, for a specified period, in order to ensure that the risks associated with the operation of the wind farm are low and to allow for adaptive management risk minimisation contingencies if required.

1 INTRODUCTION

1.1 Project Brief

Ventus Energy proposes the construction of 24 wind turbines over an area of approximately 1850 ha, situated on the north-western flanks of a the Kaimai Range between Mt Aroha and Karangahake Gorge (Figure 1) – the proposed Kaimai wind farm. Kessels Ecology have been commissioned to undertake an ecological effects assessment of the Kaimai wind farm.

This report presents the results of this investigation. The study consisted of a series of field visits which included the collection of data on fauna and flora, as well as GIS mapping of indigenous and exotic terrestrial vegetation. The field work was undertaken from 2009 to 2017, enabling data to be collected across multiple years on birds and bats. Desktop analysis was undertaken to determine any potential adverse effects of the proposal on aquatic freshwater biota, indigenous vegetation, lizards and terrestrial invertebrates.

This report is structured as follows:

- Outline of the methods used;
- Description and mapping of indigenous and exotic vegetation;
- Description of the avifauna (resident and non-resident) and bat survey results;
- Description of possible fauna and flora present and threat status;
- An assessment of ecological effects;
- Avoidance, remediation, mitigation and monitoring actions; and
- Recommendations for any further investigations.

1.2 Project Outline

The proposal specifies the construction of 24 wind turbines, with a proposed height of up to 132 m, and with a total generation capacity of approximately 100 MW. The proposed Kaimai wind farm site is located on privately owned farmland, which predominantly consists of pasture, with occasional pockets of exotic forest plantations and indigenous scrub and forest remnants. It is situated adjacent to intact forest areas of the Kaimai-Mamaku Conservation Park and extends approximately 7.4 km from the north-west to the south-east ends along a corridor of circa 2 km.

The project's infrastructure requirements include the establishment of grid connection to the existing 110kV power lines which pass over part of the proposed wind farm site. In addition, utilisation of the existing Rawhiti Road for heavy transportation purposes, and use of the existing Rotokohu Road for traffic associated with post-construction operation and maintenance, has been proposed.

1.3 Policy context

The Resource Management Act 1991 (RMA) requires all those exercising functions and powers under it to recognise and provide for the protection of areas of significant indigenous vegetation and significant habitats for indigenous fauna as a matter of national importance (section 6c). The ecological values the proposed Kaimai wind farm may effect transgresses both the Bay of Plenty Regional Council (BOPRC) and the Waikato Regional Council (WRC). The assessment criteria of both regions Regional Policy Statements were used to evaluate ecological significance. In addition, both Hauraki District Council and Matamata Piako District Council have mapped a number of terrestrial sites of high ecological value that have been identified using WRC criteria for assessing indigenous vegetation and habitats of indigenous fauna – significant natural areas.

WRC has also classified waterbodies in the region in accordance with their predominant ecological value in the Waikato Regional Plan.

1.4 Existing ecological features in the vicinity of the project area

Two Crown owned conservation areas are found in the vicinity of the wind farm. These are the Mangaiti Scenic Reserve, an area of 20.2 ha approximately 1.5 km to the south of the site, and the Kaimai Range, a part of the Kaimai-Mamaku Conservation Park, along the eastern boundary of the site (Figure 1, 2 and 3).

The Kaimai Range is part of a series of ranges, with the Coromandel Range to the north and the Mamaku Ranges to the south. The range separates the Waikato in the west from the Bay of Plenty in the east. The forest of the Kaimai Ranges is thus part of the largest continuous tract of forest in the upper North Island covering 89,000 ha, of which 70% is formally protected within the Conservation Park. While much of the forested part of the project area is managed by the Department of Conservation (DOC), there are also large areas of indigenous vegetation (more than 25,000 ha) in private and Māori ownership. Various pest animal species are present throughout, often having pervasive effects, however, increasing areas of Crown and privately-owned remnants are legally protected, and subject to active pest control and restoration management.

The indigenous forest within the Kaimai-Mamaku Conservation Park consists mostly of climax indigenous lowland podocarp forests, with tawa and kamahi dominating the canopy and scattered emergent rimu and northern rata present throughout. The actual wind farm site consists of hill country farmland, consisting largely of pasture.

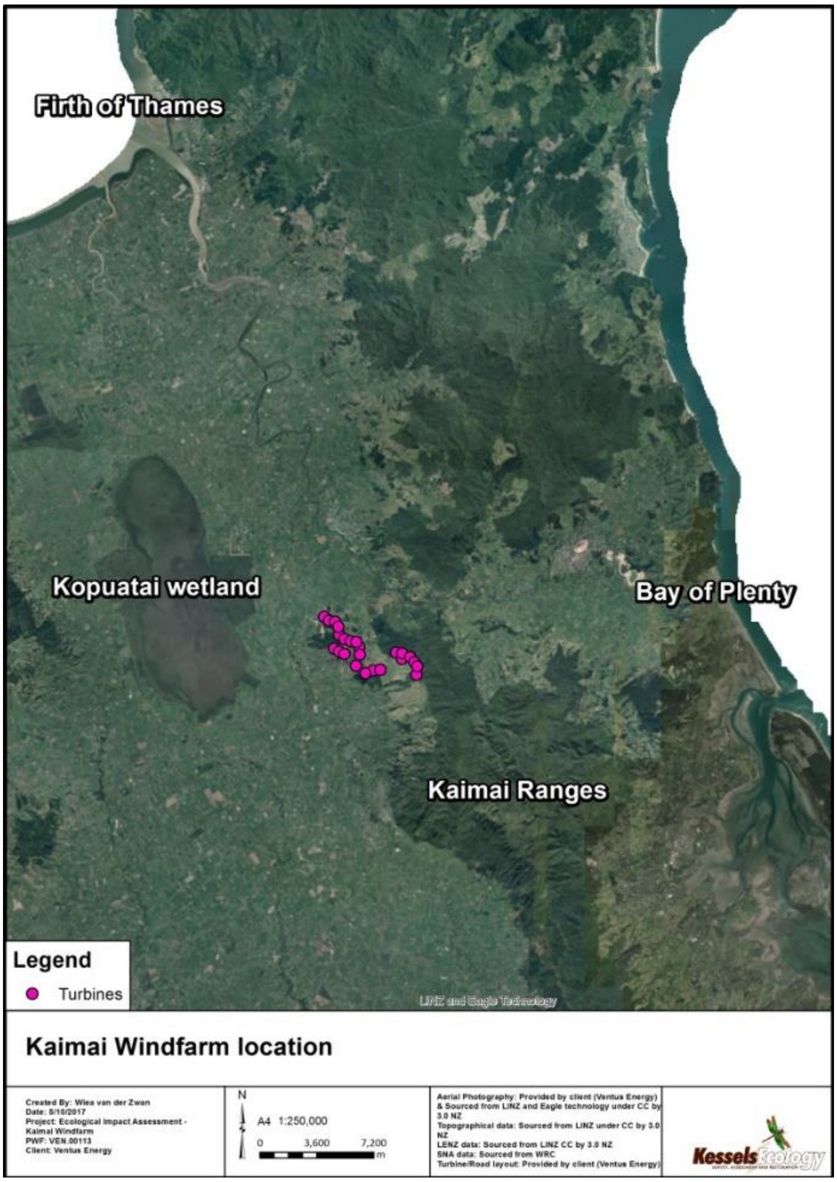

Figure 1. Location of the proposed turbines in relation to wetlands and other landscape features.

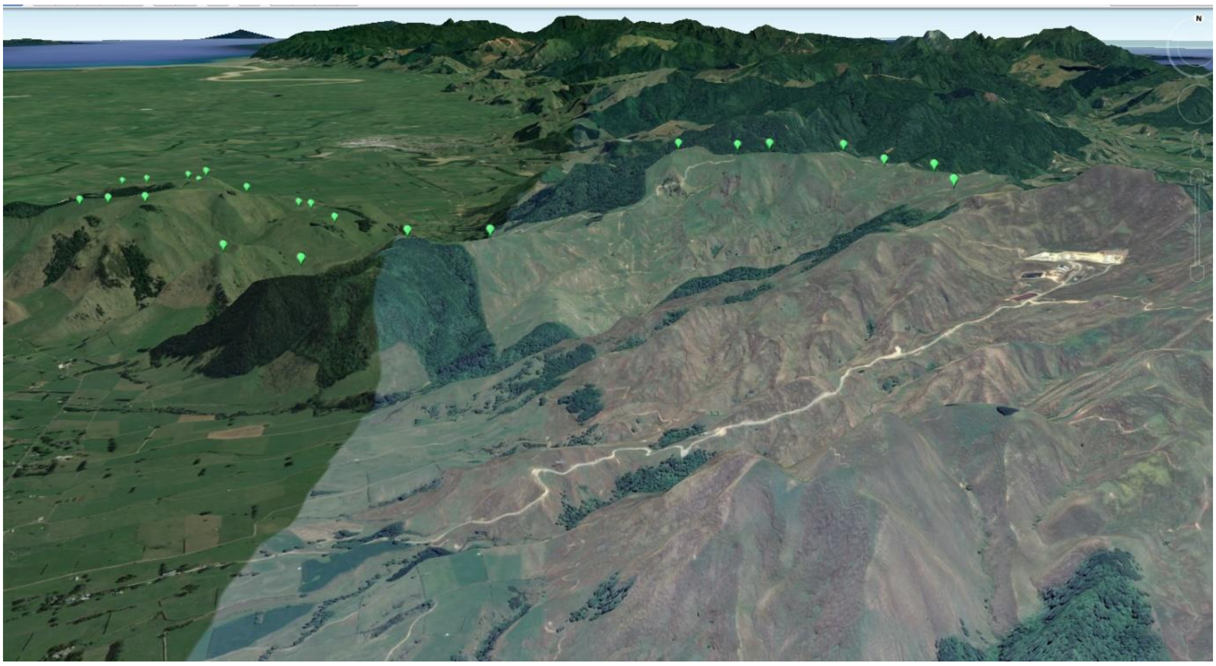

Figure 2. The proposed wind farm site within the Kaimai landscape with turbine locations indicated as green icons. Northern aspect.

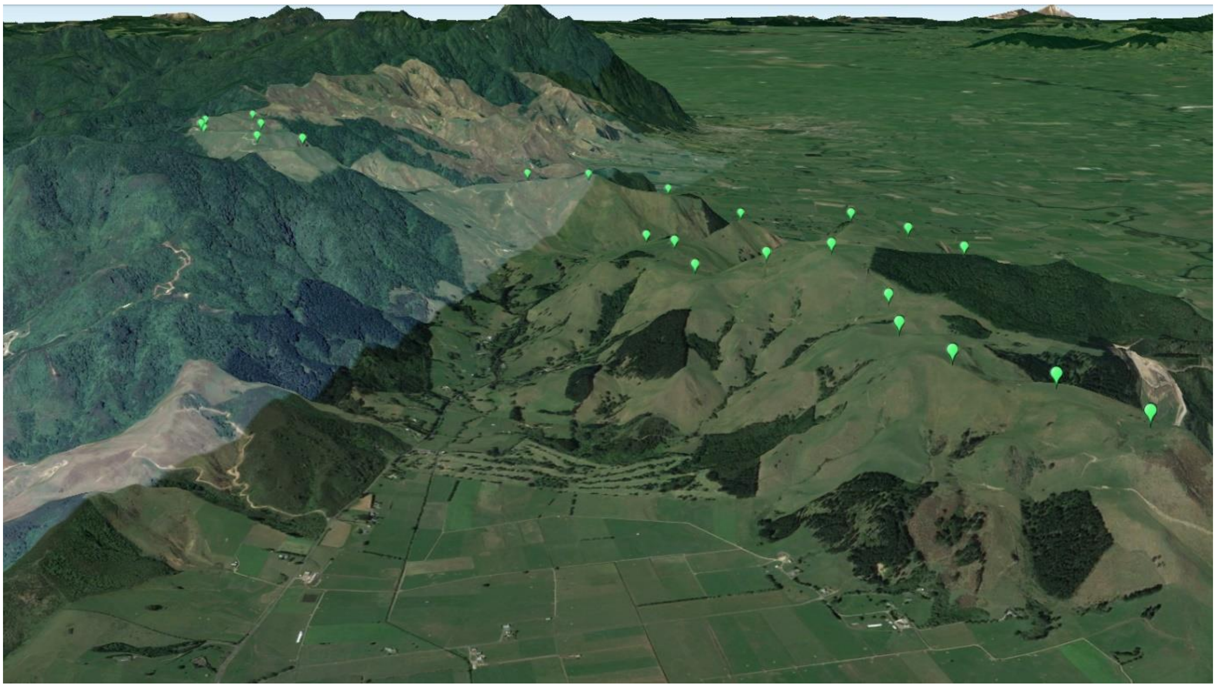

Figure 3. The locations of the turbines (green icons) in relation to the landscape, South aspect.

2 METHODOLOGY

This report is based on a general field survey of the study area conducted in March 2017 and on specific bird and bat surveys carried out in 2009, 2010, 2013, 2015 and 2016. A review of existing literature and databases was also undertaken. During the scoping report analysis, a review of existing ecological data highlighted key ecological "hot spots" and most sensitive fauna where potential adverse effects may be greatest.

No surveys were undertaken for herpetofauna, terrestrial invertebrates or freshwater aquatic biota.

2.1 Background Literature Review

Existing information on the ecological features, the wider locality and nearby natural areas were reviewed to establish an understanding of the ecological status and issues associated with the windfarm including:

- Department of Conservation (DOC) BioWeb database;
- New Zealand Freshwater Fish Database (NZFFDB, 2017);
- NIWA Freshwater Biodiversity Database; and
- Data and relevant policy from Hauraki District Council, Bay of Plenty Regional Council (BOPRC) and Waikato Regional Council.

In addition, Matamata-Piako District Council provided up to date information on regionally rare flora and fauna which have been recorded in the area through SNA reporting.

Any at risk or threatened species found were recorded and their threat status checked against the relevant national threatened species classification lists (de Lange *et al*., 2013; Goodman *et al*., 2014; Hitchmough *et al*., 2016; Robertson *et al*., 2017). Implications for threatened species as a consequence of the proposed wind farm were defined in terms of their habitat usage or location relative to works.

2.2 Vegetation Survey and Mapping

No specific detailed vegetation surveys were undertaken.

Broad vegetation types were recorded during walk-through surveys and a basic botanical species list was compiled (Appendix V). Vegetation type names are derived using the method developed by Atkinson (1985), which includes elements of structure and composition. Common names are used in most cases in the report; refer to Appendix V for botanical names.

The vegetation types identified were initially identified and incorporated into the project's GIS database using recent high-resolution aerial imagery a proportion of which was then ground-truthed during a site visit in March 2017. Furthermore, the site walkway in March 2017 did include searches for any rare or threatened plant species. Species records from relevant literature and biodiversity databases were utilised to focus search efforts on certain areas within the project site. Dominant vegetation types were recorded and the main species composition identified, with particular attention paid to uncommon or unusual species. All vegetation within at least 200 m of the proposed wind farm footprint was classified into broad vegetation types, resulting in ten distinctive vegetation community classes. Photos of key habitat and vegetation types within and adjacent to the proposed wind farm are contained in Appendix I.

2.3 Avifauna

On-site bird surveys were carried out to provide information on bird populations that are utilising the area of the proposed wind farm site. In this context, an overview of the species present and an initial evaluation of strike risk factors for species within the proposed wind farm site were established. The bird surveys, in combination with a review of the Ornithological Society of New Zealand (OSNZ) records, also provided an outline of the distribution of rare and common avifauna within the study area. Data from the OSNZ national bird-distribution mapping exercise, based on the presence of bird species in 10,000-yard grid squares, between 1969 and 1979 and again from 1999 to 2005, was obtained for this locality (Robertson *et al.*, 2007). The records from the first atlas scheme are likely to be reasonably accurate for common species, but should not be relied upon for less common species and recent colonisers. The latest Bird Distribution Atlas Mapping Scheme is a more coordinated programme in which the entire country was divided into 10 km x 10 km squares which participants searched, over the five years up until to 31 March 2005 (Robertson *et al.*, 2007).

Specific bird surveys were carried out in 2009, 2010, 2013, 2015 and 2016 across the initially proposed wind farm envelope of the wind farm (Figures 4 and 5). Bird species utilising or migrating through the proposed wind farm site were determined using three methods: vantage point counts; distance line sampling and bioacoustic sound detection. These methods are described in more detail below. Vantage point counts were undertaken to determine the diversity and abundance of bird species in the locality. Automatic sound recorders were deployed to increase the survey time and capture either nocturnal, rare, cryptic or migratory species.

2.3.1 Point counts and line transects

Two methods of sampling are commonly used to assess bird populations, distance line sampling and vantage point counts. Using point counts in addition to line sampling, allows the observer more time to locate rarer or difficult to detect species which are likely to be missed when concentrating on a line and using the 'snap shot' methodology of a line transect observation. The point count method involves counting all birds seen or heard within a 100 m radius during a set time period. Vantage point surveys were conducted at eleven different sites on the proposed wind farm area. Observation intervals ranged from five to fifty minutes in the 2009 and 2010 surveys, and were carried out as strictly five-minute counts in the 2013 and 2015 surveys, amounting to a total of 24.4 observation hours.

Bird counts were undertaken in accordance with the methodology described by Dawson and Bull (1975). No bird was knowingly recorded twice within the observation period and no bird was assumed to be present (e.g. only the accurate number of birds heard calling or seen were recorded, not the size of the flock estimated to be present by the amount of calling heard). The survey sites were not randomly selected, but were chosen at proposed turbine sites along the Kaimai-Mamaku Conservation Park edge and in representative locations in the pasture habitat. The observation method involves an observer, who is stationary at a single point, counting every bird of every species that they see or hear over a set time period. Bird species were identified and recorded regardless of distance from the observer.

In addition, 11 hours of line transect observations were conducted in four locations within the Kaimai-Mamaku Conservation Park in order to ascertain what birds where present within the forest areas adjacent to the upper ridge turbine locations. The slow-walk transect involves walking along a set route (or “transect”) and counting all birds of selected species detected within a set distance either side of the transect, in this case 200 m. Species observed further than 200 m were also recorded, but in some cases, positive identification was not always possible. These surveys were conducted in 2010 and 2013 only.

Opportunistic point records were also carried out, especially for NZ falcon. This allowed for observations of birds outside of the bird point count and line transect stations to be recorded.

The collision risk to non-migrant birds could not be quantified from the bird surveys undertaken. However, literature review and personal observations were used to estimate strike risk.

The grid reference locations of the survey sites and a summary of the data collected is presented in Appendix III.

2.3.1.1 NZ Falcon

During the bird count surveys NZ falcon were opportunistically surveyed for by scanning suitable nest trees, rocky bluffs, fence posts and other likely falcon perching sites. During the breeding season (September to March) New Zealand falcons are very vocal around their nest sites and will make a characteristic “kekking” call when their nests are approached by predators (including humans). Depending on the stage of the breeding season falcons can react in this way up to 500 metres from the nest. This calling was listened for, along with other characteristic calls made at different stages of the breeding cycle. Prey species, such as spur winged plover and magpie, are very vocal when falcons are nearby, and flocking species such as exotic finches will scare into the air together when attacked. These signs were also continually watched for. Prominent perches were checked for prey items, pellets and droppings indicative of New Zealand falcon presence.

2.3.2 Bioacoustic surveys

Bioacoustics are a useful method to identify vocal migratory, nocturnal or cryptic species, which require long monitoring periods to ensure detection and often migrate or move between feeding and roosting locations at night. For example, the southward migration of waders during winter takes place predominantly through the night, as shown by comprehensive radar/observer studies at the Hauāuru mā raki wind farm site (Stirnemann & Kessels, 2009); while cryptic wetland species, such as spotless crake and bitterns, call very early in the morning, often well before dawn).

An array of up to eleven Department of Conservation automated digital sound recorders (Version D.2) were deployed across the site between in 2013 2015 and 2016 (Figure 4 and Table 1, specific locations shown in Appendix III). The recorders were deployed at approximately 750 m intervals on landscape features offering good acoustic coverage. These intervals were selected as South Island pied oystercatcher calls have previously been detected with these recorders from a horizontal range of up to 400 m in estuary environments. They were pre-set on a "low" (0 - 4 kHz) setting to record for upwards of ten nights. Recorders activation periods were variable depending on the time of year deployed but always focussed on detection of nocturnal and crepuscular activity (refer to Table 1). Microphone wind covers were not used.

The key species of concern which may cross the potential wind farm site include migratory seabird species. South Island pied oystercatchers were used as surrogates for all wader species of concern because they can be efficiently tracked and they are known to be vocal during migration. An assumption was made that all the wader species are utilising the same migration corridor across the Kaimai Ranges as wader species are likely to be taking the most energy efficient migration pathways.

Sound recorders were deployed in spring 2015 (morning-evening) and summer 2013 and 2016 (night) (Table 1). Analysis of the data collected on the sound recorders in 2016 revealed poor detection possibilities from some of the 2016 dataset due to adverse weather conditions which effectively muted bird calls during these rain events.

Table 1. The period over which automatic bird recorders were operating and total number of hours of recording

Year	Start date	Finish date	Start time	Finish time	Hours of recording
2015	22/09/2015	10/11/2015	15:00	21:00	808.25
2013	04/01/2013	18/01/2013	20:30	6:30	1,489.75
2016	22/02/2016	9/03/2016	19:00	7:00	1,807
		TOTAL			4,105

Table 2. Target bird species for acoustic surveys

Threatened	At Risk	Notable but not Threatened
NZ falcon	Variable oystercatcher	Bellbird
White heron	Fluttering shearwater	New Zealand pigeon
Australasian bittern	Spotless crake	Tui
New Zealand dabchick	Marsh crake	Tomtit
New Zealand dotterel	Long-tailed cuckoo	New Zealand scaup
Banded dotterel	South Island pied oystercatcher	Bar-tailed godwit
Wrybill	Fernbird	Red knot
Kaka	New Zealand pipit	Turnstone
	Pied stilt	Little tern

2.3.3 Analysis of acoustic data

Analysis of automatic sound recordings was conducted automatically in Matlab using the Wavelet Toolbox, which is a comprehensive toolbox for wavelet analysis. Detailed methods are described in Priyadarshani *et al*. (2016). Training calls were developed by collecting the appropriate bird calls using both the DOC automated recorders, a PDM Marantz recorder and a parabolic microphone. Calls were then marked to be developed as training files.

To achieve high detection in the low signal to noise ratio of natural bird recordings, a method of denoising which utilises a combination of the wavelet packet decomposition and band-pass or low-pass filtering was used, improving in noise reduction over the bird recordings and increasing detectability.

The probability of detection was determined by manually sorting recordings for the target species of interest (Table 2), where reliable call data was available. This step was completed by an experienced ornithologist. These recordings were then used to train the program. The algorithms were run on data where calls had already been selected to determine detectability and precision of the manual sorting. Both good quality and poor quality calls were used to gain a realistic estimate. This enabled analysis of the recordings from the Kaimai Ranges to determine presence and absence of the target bird species call on the recorders.

For migratory species, collision risk for threatened and notable wader species strike risk was subjectively estimated by reviewing the proportion of the population of waders to the north and east of the windfarm based on literature reviews. Potential worst-case scenario impacts to the population were then estimated based on the current knowledge of wader movement and the potential proportion of the population impacted in the worst-case scenario. Assumptions were made that the available data is representative of the current population size and spatial usage patterns along with the review of strike risk analysis undertaken for other New Zealand wind farm sites.

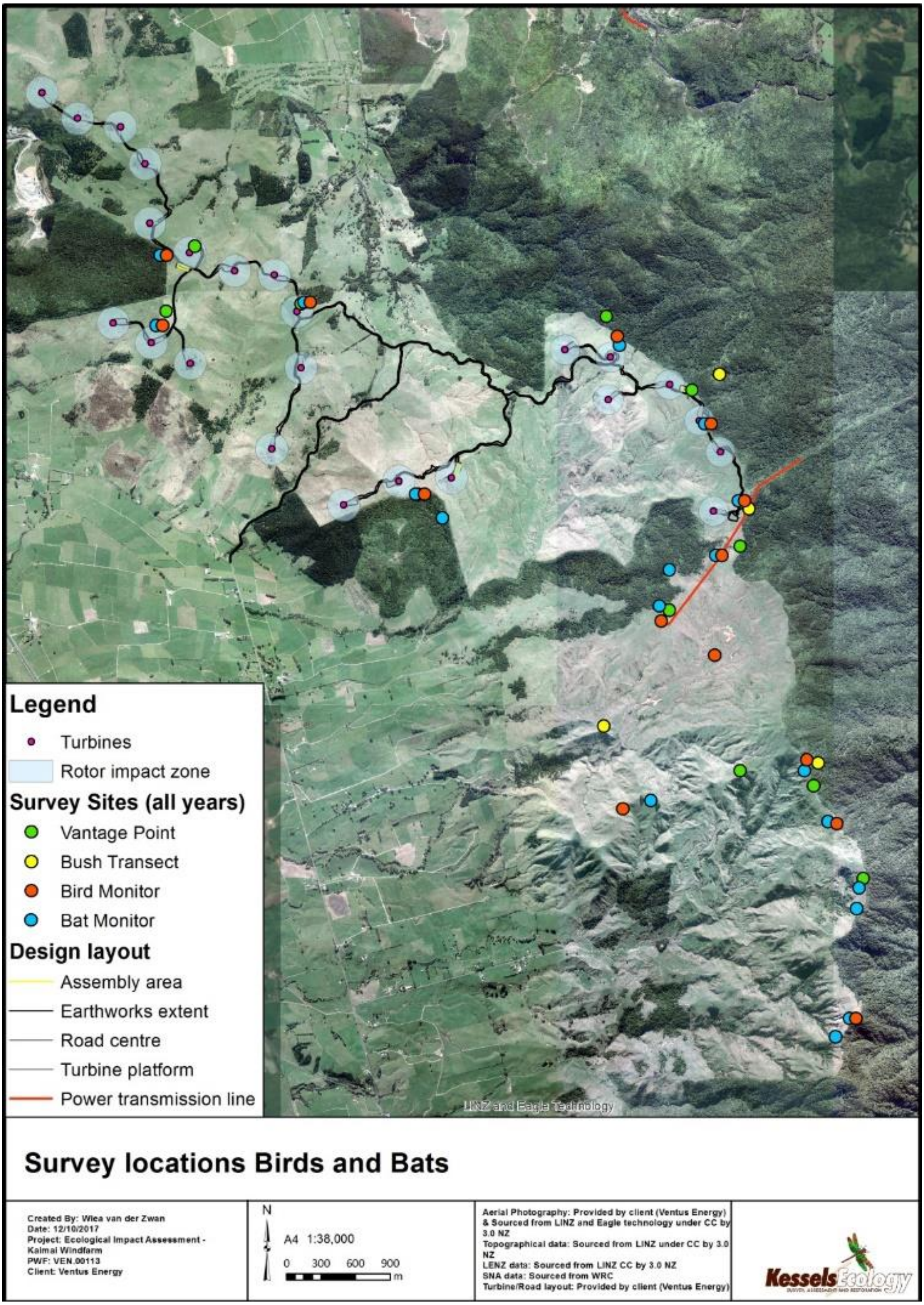

Figure 4. Overview of bird and bat recorder locations in relation to the turbine layout.

2.4 Bats

To establish whether bats are present in the proposed Kaimai wind farm area and its immediate surrounds, acoustic bat surveys were undertaken during spring 2013 and summer 2015 using multi-night deployments of digital bat recorders at fixed sites (refer to Table 3 and Appendix III for station locations). The digital bat recorders are ultrasound detectors designed DOC specifically to survey for New Zealand's two bat species. They monitor and record the optimum ultrasound frequencies (28 and 40 kHz) for the echolocation calls from both species simultaneously. The recorders have an effective working range of c. 50 m for long-tailed bats (*Chalinolobus tuberculatus*) and c. 25 m for short-tailed bats (*Mystacina tuberculata*).

For the survey, static heterodyne Automated Bat Monitors (ABM) were pre-set to start monitoring 30 minutes before sunset until 30 minutes after sunrise. Detectors were deployed in accordance with protocols described by Lloyd (2009). At the end of each deployment, the recordings from the recorders were transferred to a laptop computer and reviewed using software developed by DOC. The data was analysed to determine the spatial use of bat species across the site by mapping presence and absence of calls, type of call (e.g. social, feeding) and number of calls per location.

Locations of bat detectors were based on the planned location of the wind farm as supplied by the client at the time, and covered an initial turbine footprint which was later altered in early 2017 to cover a smaller area (Figure 4).

Table 3. The time period and number of hours of bat monitoring that occurred within the proposed site.

ID	Year	Date in	Date out	No. of hours active
KB1	2015	22/09/2015	27/10/2015	472.5
KB2	2015	22/09/2015	1/11/2015	26.83
KS6	2015	22/09/2015	26/10/2015	436.25
KS5	2015	1/10/2015	26/10/2015	199.25
K7	2015	22/09/2015	22/09/2015	13.5
KS2	2015	22/09/2015	27/10/2015	472.5
K6	2015	1/10/2015	28/09/2015	108
B10	2013	4/01/2013	18/01/2013	140
B11	2013	4/01/2013	18/01/2013	140
B15	2013	4/01/2013	18/01/2013	140
B16	2013	4/01/2013	18/01/2013	142.33
B19	2013	4/01/2013	18/01/2013	140
B20	2013	4/01/2013	18/01/2013	140
B21	2013	4/01/2013	18/01/2013	140
B22	2013	4/01/2013	18/01/2013	140
B23	2013	4/01/2013	18/01/2013	142.33
B25	2013	4/01/2013	10/01/2013	140.23
B28	2013	4/01/2013	18/01/2013	140
B8	2013	4/01/2013	11/01/2013	140

2.5 Threatened Flora and Fauna

Any threatened species found or considered likely to be present due to records found in the Department of Conservation's BioWeb database in the vicinity of the project area were recorded and classified in accordance with Hitchmough *et al.* (2007): "New Zealand Threat Classification System lists-2005. Science & Technical Publishing, Department of Conservation, Wellington." and any subsequent published updates to this Document (Robertson *et al.,* 2017; Hitchmough *et al.,* 2016; Goodman *et al.,* 2013; de Lange *et al.,* 2013 Newman *et al.,* 2013; O'Donnell *et al.,* 2013).

Implications for threatened species as a consequence of the project were defined in terms of their habitat usage. Habitat usage for any threatened species recorded was broadly defined as transitory, home range, territory or breeding. Risk assessment was undertaken in terms of habitat usage in relation to the proposed wind farm footprint and the extent to which any habitat removal/modification or potential turbine strike would affect populations at a local, regional and national level.

3 VEGETATION DESCRIPTION

3.1 Key Vegetation Communities

The proposed Kaimai wind farm area is a mosaic of rolling pasture land with a number of exotic plantations and indigenous forest remnants scattered throughout; some 72% of the site is covered in pasture.

Aside from pasture dominated land, several other vegetation types remain within the wind farm area, which spans 2,367 ha. The distribution of these other vegetation types in relation to the proposed turbine locations is shown in Figure 5.

Indigenous vegetation within the proposed wind farm site consists largely of isolated trees and small fragments in sheltered gullies and forest edge habitat consisting of logged tawa-podocarp forest or secondary broadleaved forest. Smaller stands of secondary broadleaved forest are occasionally present within the gully systems in the northern half of the site, while larger areas of contiguous logged tawa forest remain along the eastern margin of the site (i.e. the Kaimai Ranges), as well as in the southern extent of the site and near the quarry at the north-western margin of the site.

There are also fragments of indigenous treeland with grazed understorey. The gully remnants and intact forest areas are the most ecologically valuable vegetation within the site. The scrub vegetation around any forest site can be regarded as valuable in part for the positive buffering affects against wind, invasive species and stock impacts, but generally have minimal ecological value.

The broad mapping process distinguished ten different vegetation types, aside from predominantly pastureland, within the wider wind farm site (refer to descriptions below and Table 4). The areas that are situated within the rotor sweep zone of the proposed turbines are tabulated in Table 5.

1. (Exotic pines)/scrub (1.70 ha)

This vegetation was mapped in areas near plantation forestry where scattered exotic tree species, mostly radiata pines, emerge over indigenous broadleaved scrub.

2. Exotic forest (57.2 ha)

The areas mapped as this forest type mainly consist of radiata pine but can also include other exotic tree species, e.g. macrocarpa or eucalyptus.

3. Exotic scrub (8.0 ha)

These areas consist of gorse scrub and have been sprayed in some places.

4. Exotic treeland (5.0 ha)

This vegetation type includes areas of various exotic tree species with a canopy cover of less than 80%. It can consist of scattered old pine trees amongst pasture, rows of macrocarpa trees, planted ornamental tree species on the golf course, or exotic plantings and woodlots near house sites, along roads or around farm yards.

5. Kahikatea treeland (0.4 ha)

This vegetation type includes a reasonably small and narrow strip of kahikatea dominated treeland along a stream near the quarry area, with pukatea and cabbage tree also present.

6. Logged tawa forest (166.0 ha)

This forest type includes the larger areas of indigenous vegetation near the quarry and within the Kaimai-Mamaku Conservation Park. It consists of secondary and primary growth tawa forest, which remains after logging of the original rimu-tawa forest. The tall rimu trees are gone from these areas today, and the canopies consist of tawa and rewarewa emerging over broadleaved species such as mangeao, mahoe, puriri, and lancewood, as well as nikau and treefern species. The understorey in the Kaimai Ranges adjacent to the site is dense and has shrub species such as pate, rangiora and kanono, as well epiphytes and climbing species such as puka, tank lily, kiekie, supplejack, and climbing rata and fern species. The groundcover has a variety of ferns and parataniwha is present in moist places.

7. Secondary broadleaved forest (166.5 ha)

This forest type is present at lower altitudes and contains mainly broadleaved species such as kohekohe, rewarewa, mangeao, as well as pukatea, puriri and cabbage trees where streams are present. Tawa is less common in these areas but tree fern species, such as ponga and wheki, are widespread.

8. Secondary broadleaved scrub (11.1 ha)

This vegetation types comprises areas of regenerating broadleaved species and areas of tree fern scrub with a canopy height of less than 6 m. These areas may comprise scattered emergent tree species.

9. Secondary broadleaved shrubland (2.0 ha)

This vegetation type describes areas in the southern extent of the sites that have a canopy cover of less than 80% and contain low growing broadleaved shrub species as well as cabbage trees and tree ferns. The occasional tall broadleaved tree may remain in these areas.

10. Secondary broadleaved treeland (28.8 ha)

These areas contain the same species as described for ‘Secondary broadleaved forest’ but the canopy cover is reduced to less than 80%.

Table 4. Total area coverage of each vegetation type, excluding pasture, within the wind farm property (Figure 5).

Vegetation type	Area (ha)
1. Exotic pine/scrub	1.7
2. Exotic forest	57.2
3. Exotic scrub	8.0
4. Exotic treeland	5.0
5. Kahikatea treeland	0.4
6. Logged tawa forest	166.0
7. Secondary broadleaved forest	166.5
8. Secondary broadleaved scrub	11.1
9. Secondary broadleaved scrubland	2.0
10. Secondary broadleaved treeland	28.8
Total	**446.6**

Table 5. Vegetation defined as under the rotor sweep zone for all turbines (excluding pasture)

Affected vegetation type	Total amount (ha)
2. Exotic forest	0.91
3. Exotic scrub	2.85
6. Logged tawa forest	1.64
7. Secondary broadleaved forest	0.91
8. Secondary broadleaved scrub	0.61
9. Secondary broadleaved shrubland	0.33
10. Secondary broadleaved treeland	1.10
Total exotic	3.76
Total indigenous	4.59
Total vegetation (excluding pasture vegetation)	8.35

3.2 Threatened Flora

No threatened or regionally uncommon plants were found on the proposed Kaimai wind farm site during the field assessment. Despite a wide range of threatened and regionally uncommon plants have been found within the Matamata-Piako District and in the Kaimai Ranges, the majority of these species are confined to specific habitats, such as in peatland and wetland habitats, and thus are not likely to be found within the wind farm site. Some species are known from the Kaimai and Mamaku Ranges however, as shown in Table 6. These species prefer forest or scrub habitats and could be found within or adjacent to the wind farm site, but as stated above have not been detected in surveys to date.

Table 6. Vascular plant species of importance recorded in the Matamata-Piako District and in the Kaimai Ranges (names and conservation status obtained from NZ Plant Conservation Network database (2011); de Lange *et al.* (2013).

Scientific name	Common Name	Conservation status
Brachyglottis kirkii var. *kirkii*	Kirk's Daisy	At Risk - Declining
Fuchsia procumbens	Creeping fuchsia	At Risk - Naturally Uncommon
Geranium microphyllum		At Risk - Naturally Uncommon
Hymenophyllum australe	Filmy fern	At Risk - Naturally Uncommon
Libocedrus plumosa	Kawaka	At Risk - Naturally Uncommon
Lindsaea viridis		At Risk - Naturally Uncommon
Peraxilla colensoi	Scarlet mistletoe	At Risk - Declining
Peraxilla tetrapetala	Red mistletoe	At Risk - Declining
Pimelea longifolia	Long-leaved pimelea	At Risk - Declining
Pittosporum kirkii	Thick-leaved kohukohu	At Risk - Declining
Pittosporum virgatum	None known	At Risk - Naturally Uncommon
Pseudopanax ferox	Fierce lancewood	At Risk - Naturally Uncommon
Ptisana salicina	King fern	At Risk - Declining
Solanum aviculaire var. *aviculare*	Poroporo	At Risk - Declining
Veronica punicea	Hebe	At Risk - Naturally Uncommon

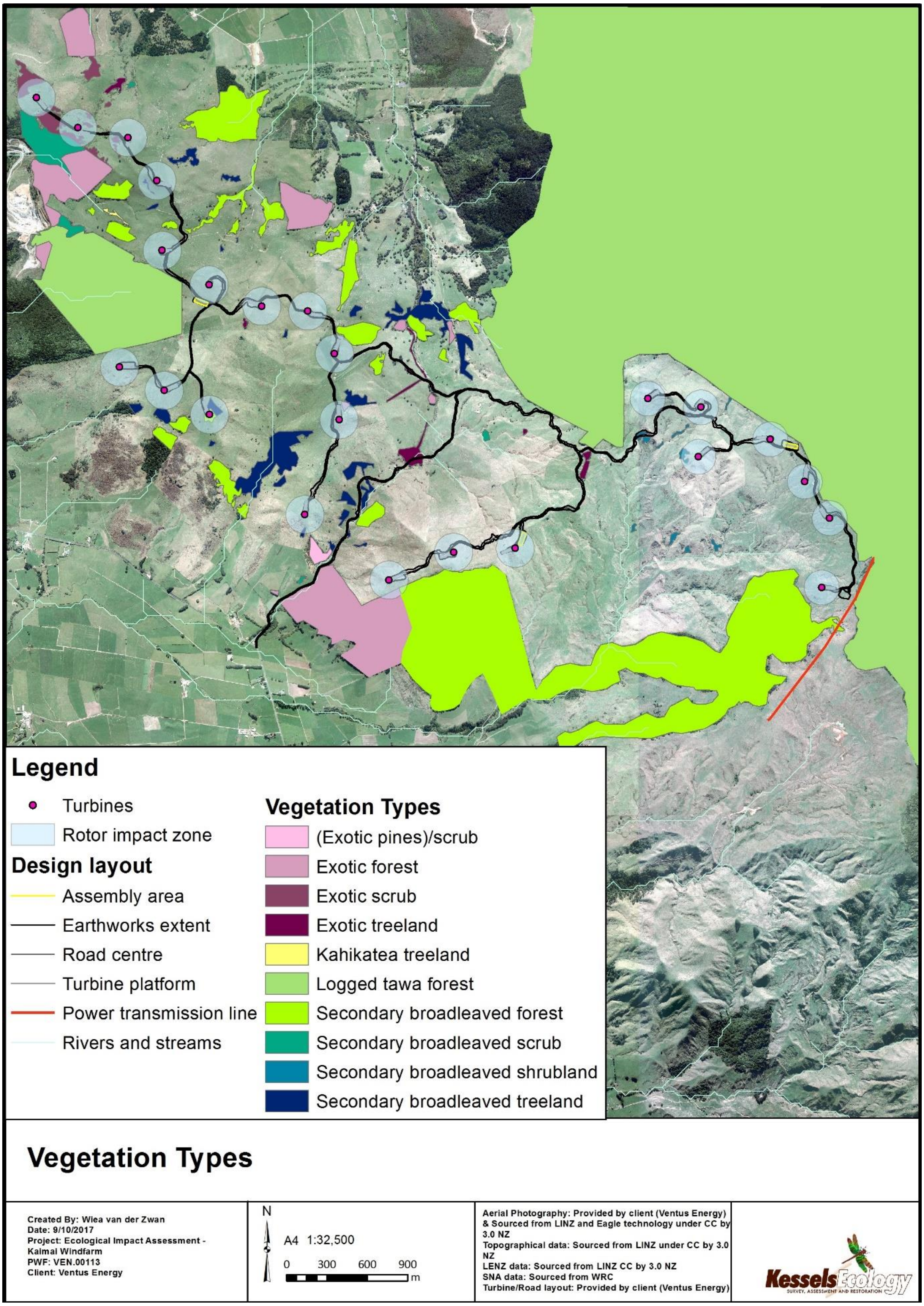

Figure 5. Proposed turbines and surrounding vegetation matrix (vegetation where pasture is dominant has not been mapped). Zoomed-in detailed map sections are presented in Appendix IV.

4 FAUNA

4.1 Avifauna

4.1.1 Resident birds

The predominant birds observed within the pasture and scrub lands of the study area are common grassland passerines and wetland species, comprising of chaffinch, greenfinch, goldfinch, house sparrow, Indian myna, yellowhammer, starling, song thrush, Australian magpie, harrier hawk, kingfisher, silvereye, welcome swallow, spur-winged plover. Turkey were also heard or seen in localised areas. Appendix III provides tabulation of the relative abundances of key indigenous birds for the bird counts and line distance transects. Notably, tomtit and rifleman still persist within the Kaimai-Mamaku Conservation Park adjacent to the site.

Most commonly observed or heard birds within the bush habitats were blackbird, silvereye, grey warbler, fantail, tui, bellbird, kereru, harrier hawk, shining cuckoo (October-November) and morepork (dusk). Eastern rosella were also occasionally seen or heard.

Surveys using vantage point bird counts (Appendix III), sound recorders and line transects across the site indicated 29 species were resident over the survey (Table 7).

Of the observed resident species, the surveys indicated seven species (five native, two introduced) utilised areas near to where the turbines will be positioned (Table 8). Of these species, five used the area within the RSA strike area (three native, two exotics) (Table 8).

Table 7. List of resident bird species found within the site of the proposed windfarm, with threat status as defined by Robertson *et al.* (2017).

Scientific name	Common name	Conservation status
Acridotheres tristis	Indian myna	Introduced
Alauda arvensis	Skylark	Introduced
Anthornis melanura	Bellbird	Not Threatened
Anthus novaeseelandiae	New Zealand pipit	At Risk-Declining
Carduelis carduelis	Goldfinch	Introduced
Carduelis chloris	Greenfinch	Introduced
Chrysococcyx lucidus	Shining cuckoo	Not Threatened
Circus approximans	Swamp Harrier	Not Threatened
Emberiza citrinella	Yellowhammer	Introduced
Fringilla coelebs	Chaffinch	Introduced
Gerygone igata	Grey warbler	Not Threatened
Gymnorhina tibicen	Australian magpie	Introduced
Hemiphaga novaeseelandiae	Kereru	Not Threatened
Hirundo neoxena	Welcome swallow	Not Threatened
Meleagris gallopavo	Turkey	Introduced
Passer domesticus	Sparrow	Introduced
Petroica macrocephala	Tomtit	Not Threatened
Phasianus colchicus	Common pheasant	Introduced
Platycercus eximius	Eastern rosella	Introduced
Prosthemadera novaeseelandiae	Tui	Not Threatened
Rhipidura fuliginosa	Fantail	Not Threatened
Sturnus vulgaris	Common starling	Introduced

Tadorna variegate	Paradise duck	Not Threatened
Todiramphus sanctus	Kingfisher	Not Threatened
Turdus merula	Blackbird	Introduced
Turdus philomelos	Songthrush	Introduced
Vanellus miles	Spur-winged plover	Not Threatened
Zosterops lateralis	Silvereye	Not Threatened
Ninox novaeseelandiae	Morepork	Not Threatened

Table 8. Results of surveys showing resident bird species spatial use in the areas near the proposed turbines, based on vantage point surveys.

Bird species	Minimum height of flight (m)	Maximum height of flight (m)	Air space utilised
Fantail	4	6	Along bush line
Goldfinch	2	100	Along bush line predominantly.
Harrier	20	200	Often flying over pasture along bushline.
Magpie	20	50	Flying up hill, over pasture.
Swallow	2	15	Flying over pasture.
Tui	5	30 (Aerial displays <50)	Flying along bushline.
Kereru	6	12 (Aerial displays <50)	Flying above bush canopy, flying up valley across pasture.

4.1.2 Special status bird species

Eighteen special status bird species are located within the vicinity pf the Kaimai Wind farm (Table 9). However, a number of these species will not be affected at all by the development. Other species will only migrate through the area and will not be present all year.

Table 9. Threatened and notable bird species recorded utilising or migrating over the Kaimai Ranges (obtained from field surveys, discussions with experts and DOC Bioweb, 2016. Threat status in accordance with Robertson *et al*. (2017).

Scientific name	Common name	Conservation status
Acanthisitta chloris	Rifleman	At Risk- Declining
Anarhynchus frontalis	Wrybill	Threatened- Nationally Vulnerable
Anthus novaeseelandiae	New Zealand pipit	At Risk- Declining
Botaurus poiciloptilus	Australasian bittern	Threatened- Nationally Critical
Chrysococcyx lucidus	Shining cuckoo	Not Threatened
Eurodynamis taitensis	Long-tailed cuckoo	At Risk- Naturally Uncommon
Falco novaeseelandiae	New Zealand falcon	At Risk- Recovering
Gallirallus philippensis	Banded rail	At Risk- Declining
Hemiphaga novaeseelandiae	Kereru	Not Threatened
Megalurus punctatus	Fernbird	At Risk- Declining
Nestor meridionalis	North Island kaka	At Risk- Recovering
Ninox novaeseelandiae	Morepork	Not Threatened
Petroica macrocephala	Tomtit	Not Threatened
Porzana pusilla affinis	Marsh crake	At Risk- Declining

Porzana tabuensis	Spotless crake	At Risk- Declining
Procellaria parkinsoni	Black petrel	Threatened- Nationally Vulnerable
Prosthemadera novaeseelandiae	Tui	Not Threatened
Pterodroma gouldi	Grey-faced petrel	Not Threatened

In terms of special status resident bird species New Zealand falcon is known to occur in the Kaimai Ranges but not detected during surveys for this project. North Island kaka are also itinerant visitors throughout the Kaimai Ranges, again not detected during the wind farm specific surveys. During surveys New Zealand pipit was recorded around the wind farm site and therefore will occur close to the proposed turbines. Rifleman have also been recorded in the area above Katikati. Other species once occurred in the area but have not be observed in recent years. Within conservation efforts this may of course alter in the future. For instance, taiko (black petrel) once had substantial colonies in the ranges, though they are unlikely to still be breeding in the area currently. This may alter with the introduction of pest control.

4.1.2.1 New Zealand falcon

New Zealand falcons require large territories and nests are generally widespread. Falcons occasionally utilise areas outside the forest and utilise forest of all ages (Thomas *et al.,* 2010). New Zealand falcons nest in scrapes on the ground, with varying amounts of cover, on a ledge or within an epiphyte in a tree. In hilly areas, the nest is generally half way up a slope. They are regularly observed in the Kaimai Ranges, though they were not observed at the study site during any of the surveys.

New Zealand falcon primarily prey on small to medium-sized birds (Kross *et al.,* 2013). They will also take mammals such as rabbits and small hares (Kross *et al.,* 2013). They often glide low along the contours of the ground while foraging for food and along habitat edges as well as utilizing a perch and hunt technique.

This distinctive raptor was not observed or heard in any of the bird surveys conducted on site.

4.1.2.2 North Island kaka

The North Island kaka are classified as at risk and recovering. This species is known to be present in the locality of the proposed windfarm. Kaka are considered episodic breeders whose timing of reproduction is closely linked to mast production of seeds and fruit (Beggs and Wilson, 1991; Powlesland *et al.,* 2003). Generally speaking, adult kaka have relatively small home ranges, but will, on occasion, make substantial excursions before returning to a core area. In contrast the movements of recent fledglings can cover areas >30 km, this age group does not tend to settle for some time (Beggs and Wilson, 1991; Powlesland *et al.,* 2003).

North Island kaka have not been found in any of the site surveys, but they very well pass through the site and are known to roam throughout the Waikato in winter and spring (pers obs).

4.1.2.3 Cuckoo species

Shining cuckoo was detected in the surveys as being present in forested area within the project footprint. In contrast ling-tailed cuckoo (currently listed as at risk) was not detected. However, this species can occur throughout New Zealand when migrating, otherwise, they mainly occur in extensive native or exotic forest or scrub, holding one or more of their three host species, on Little Barrier Island and from Waikato south. They are present in spring, summer and autumn only, either breeding or on passage to or from breeding locations. Birds seen in farmland or urban areas, where there are no host species, will be birds on passage. Thus long-tailed cuckoo could be passing through the site from time to time.

4.1.2.4 Australasian bittern

The Australasian bittern has a small population of approximately 900 birds. A Nationally Endangered species, it is widely distributed in the North Island, particularly in the Waikato and the Bay of Plenty (Heather & Robertson, 2005). It favours freshwater wetlands (Heather & Robertson, 2005; Robertson *et al.,* 2007). Bitterns are thought to move from inland sites to coastal wetlands for autumn and winter (Marchant & Higgins, 1990) and therefore could be flying through the windfarm site when transiting to and from these habitats.

4.1.3 Migratory waders

Most long distance migratory waders arrive back in New Zealand in small groups over a wide period in the spring and early summer, notably the bar-tailed godwit. The peak of the migratory wader population in New Zealand is reached by December–January (Sagar *et al.,* 1999). Most migrant waders leave New Zealand in small, usually single-species flocks from late February to early April. Once back in New Zealand, evidence from monthly counts at different estuaries (Hawkins, 1980; Veitch, 1999a, 1999b), suggest overseas migrants can move from one estuary to another after reaching New Zealand, but how far, at what point they cross the landscape and how frequently they move around the landscape is not well known for most species (Boere, Galbraith, & Stroud, 2006). Monthly counts however suggest a general trend for birds to move south after initial arrival in spring, and then to move north in summer or early autumn to congregate at northern harbours before departing. Movement between these areas is also likely for many internal migrants.

The large, northern harbours (Manukau, Matarangi spit and Firth of Thames) are vital wintering grounds for all the internal migrants (South Island pied oystercatcher, pied stilt, black stilt, banded dotterel and wrybill), as well as being important in some cases for the variable oystercatcher, New Zealand dotterel and arctic migrants (Table 9). Thirty-one species of wader have been counted on the Manukau Harbour and Firth of Thames in summer and winter censuses (Veitch, 1999a).

The adjacent large estuaries of the Firth of Thames and Manukau Harbour (southeast and southwest of Auckland, respectively) both host significant numbers of various indigenous New Zealand migrants. They are also two of the terminal points of the East Asian-Australasian Flyway used by about five million shorebirds that migrate annually (between July and October) from Siberia and Alaska for summer in the southern hemisphere, and return between March and June to their northern breeding grounds (Barter, 2002). Over 100,000 waders use the Firth of Thames and the Manukau Harbour through the year (Veitch & Habraken, 1999).

The sound recorders detected South Island pied oystercatchers crossing the proposed wind farm site on several occasions. For example, on the 18th of January 2013 between 6.15 and 6.30 two flocks of South Island pied oystercatchers crossed the windfarm site at 0634 and 0702-0714. All detected South Island pied oystercatchers were crossing the southern section of the windfarm directly over the Kaimai range. These were the only wader species detected flying over the proposed Kaimai wind farm site and the implications of these detections in terms of potential turbine strike risk is discussed in section 6.4.

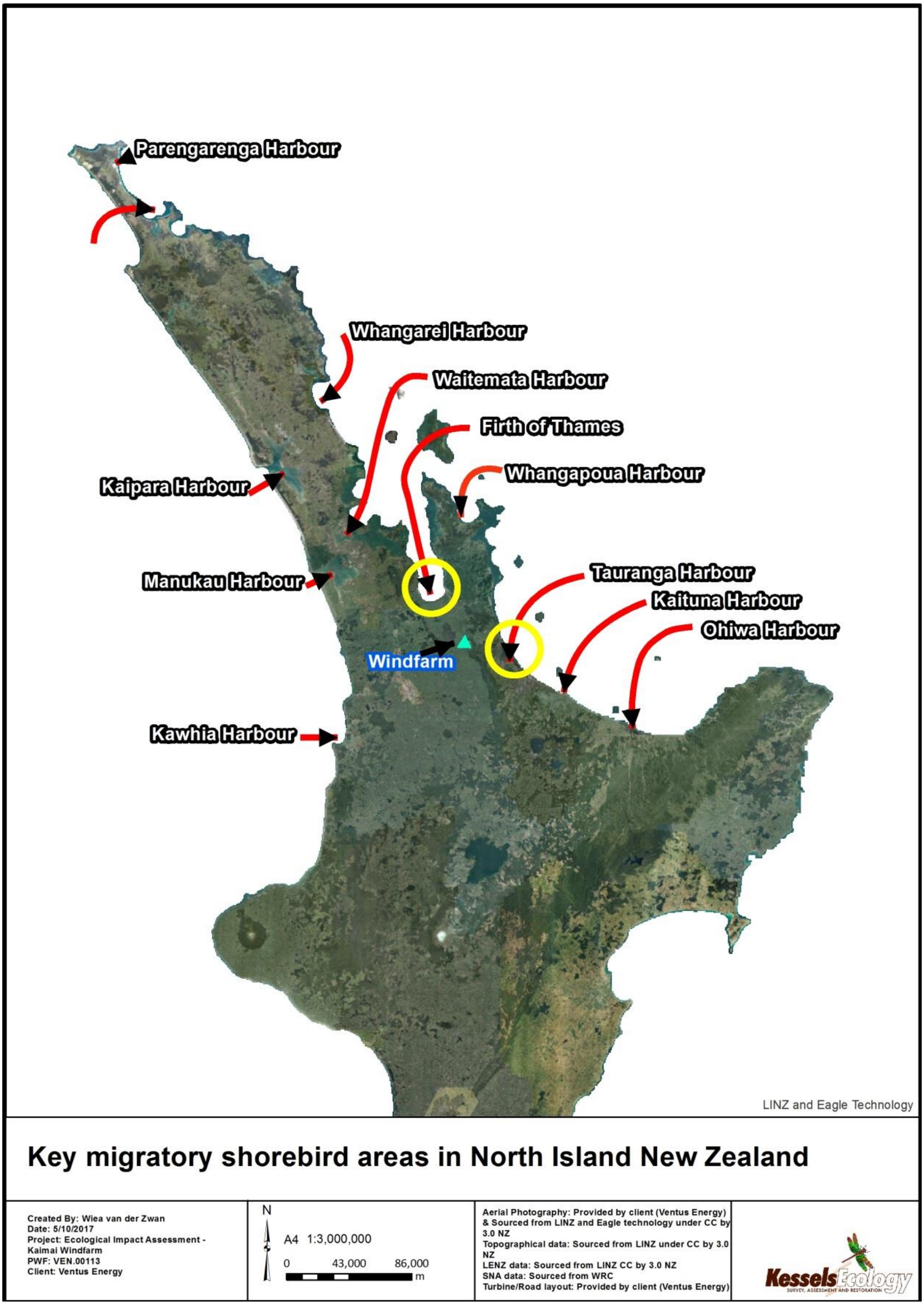

Figure 6. Key migratory shorebirds areas in New Zealand, the green filled triangle is indicative of the Kaimai wind farm, and the yellow circles show the likely sources of potentially migrating populations across the wind farm.

4.2 Bats

The Nationally Vulnerable North Island long-tailed bat is known to be present within the Kaimai Ranges and was detected during the surveys (Figures 7 & 8). The survey results showed long-tailed bat activity during 4-17 January 2013, and from 22 September to 27 October 2015 at the study site. In the 2015 survey 63% (eight) of all of the surveyed sites contained long-tailed bats, while in the 2013 bat survey 55% (11) of the sites contained bats. In total 59% (19) of all the surveyed sites detected bats.

As the results from the different sound recorders show, bat activity was concentrated in particular areas (Figures 7 & 8). In particular, activity increased in areas near to the forest margins or in areas where the flight path would lead to a gully containing native vegetation. This is not surprising given that long-tailed bats are attracted to key resources associated with remnant gully vegetation such as:

- mature exotic and native vegetation for roosting purposes;
- insect prey as a food resource;
- freshwater for drinking; and
- linear landscape corridors for movement and navigation.

Short-tailed bats were not detected during the survey and are not expected to be present in the locality.

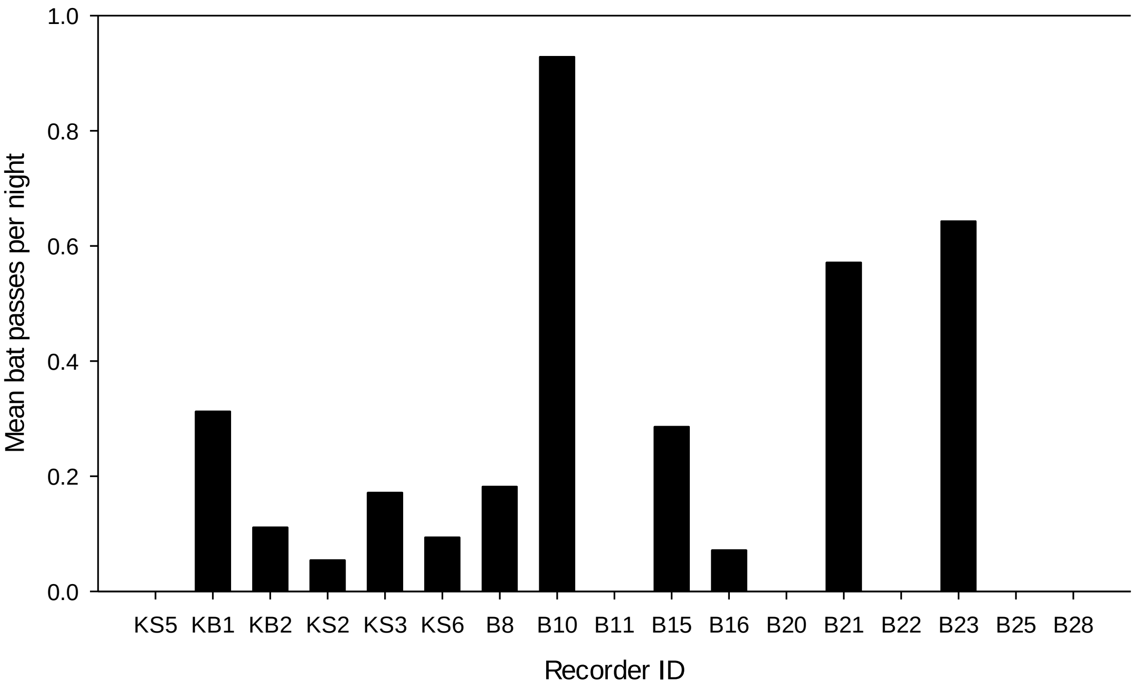

Figure 7. Mean number of calls per night for at all automated bat recorders (from both of the survey years combined).

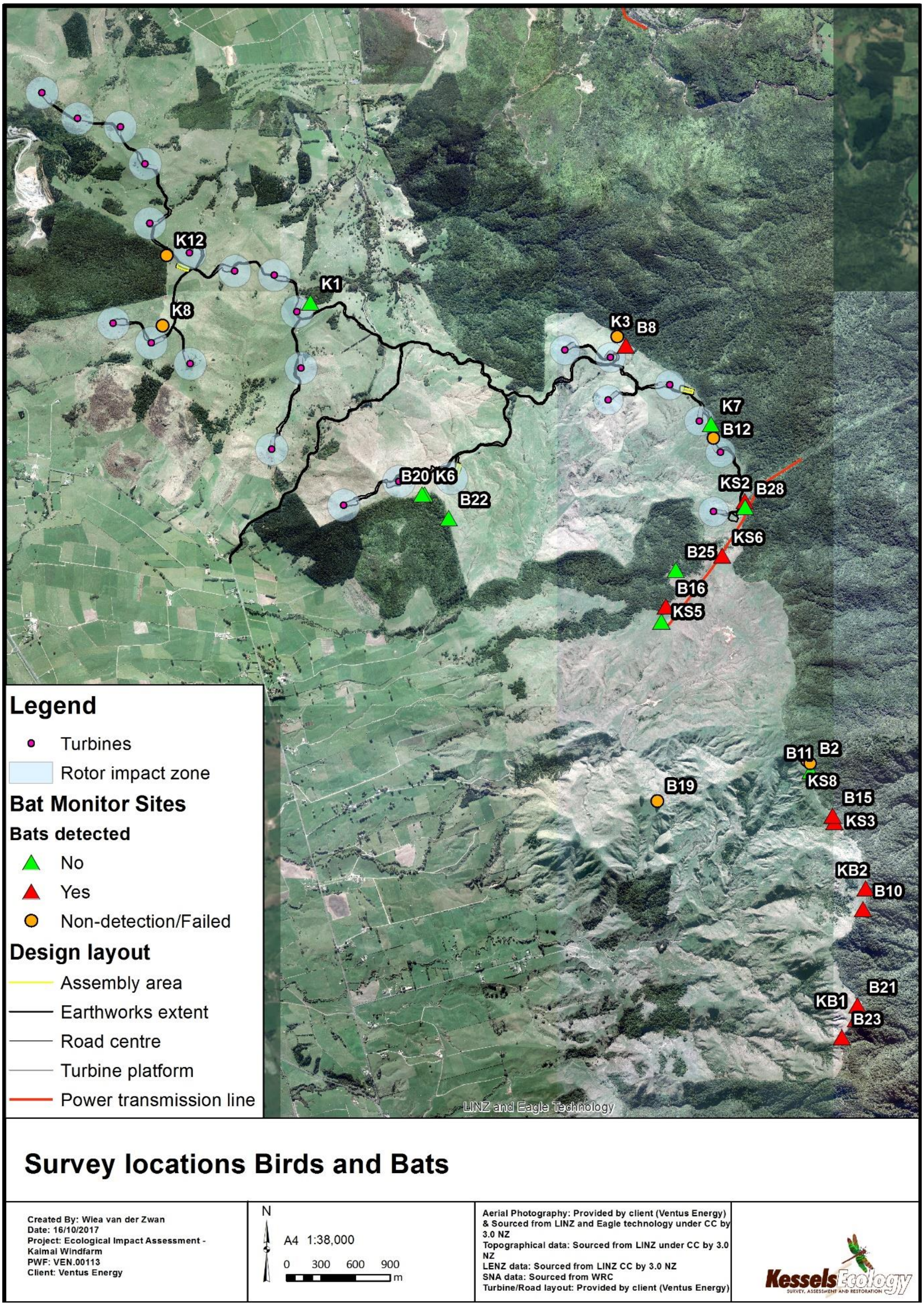

Figure 8. Map showing detector location and presence of bats in 2013 and 2015 within the proposed Kaimai Wind Farm site.

4.3 Lizards and Frogs

Eighteen species of lizards and frogs are potentially present in the Kaimai Ranges or neighbouring areas (see Table 10). Because mainland herpetofauna populations have been severely depleted by introduced predators, some species now occur in mainland forests at densities so low that they are difficult to detect.

4.3.1 Geckos

Five gecko species have been observed in the Kaimai Ranges (Table 10). All of these species were once wide spread in the North Island and are now either Declining or At Risk with the exception of the common gecko. Many of these species have not been observed for some time in the Kaimai Ranges and some are presumed extinct, while others may sparsely occupy the site. Green gecko was observed just to the west of Waihi in 1965. Pacific gecko was recorded from Paeroa in 1984 and the Karangahake Gorge in 2009. Recent mainland records of forest gecko have been only from above 400 m. Green gecko was observed by Tony Whitaker at Katikati in 1964 and at Waihi in 1965. Two green geckos were recorded near Rereioturu Falls in the early 1980s but were not observed during the 2000 survey of Opuiaki (Whitaker, 2000). Duvaucel's gecko (*Hoplodactylus duvacelli*) was recorded at Paeroa in 1941.

4.3.2 Skinks

Twelve species of skink have been recorded in the Kaimai Ranges. However, skink have undergone massive range contractions and declines since the arrival of people in New Zealand. Previous surveys in habitat in the Kaimai ranges revealed striped skink (*Oligosoma striatum*) in Ngawaro (1979), and near the Mount Te Aroha summit road (2002 and 2005). The striped skink is listed as Nationally Vulnerable. Given the proximity of these sites to the proposed wind farm, it is possible striped skink could occur in vegetation within the wind farm's construction footprint.

The non-threatened copper skink (*Oligosoma aeneum*) are widespread through the ranges and are also likely to be present on the site. Though not threatened, this species is protected under the Wildlife Act 1953 (as are all indigenous animals), and a wildlife permit is required for any activities that are likely to harm this species.

4.3.3 Frogs

New Zealand has four species of endemic frogs (*Leiopelma* spp.), all of which are regarded as threatened. Hochstetter's frog (*Leiopelma hochstetteri*) is widespread in forested streams throughout the northern two thirds of the Kaimai Range, as far south as Wairere Falls on the west and the Aongatete River on the east (Table 10). The species requires dense damp forest and streams. Its presence within the windfarm or in any potentially affected area adjacent to the proposed windfarm footprint is unlikely based on the habitat types present and the fact that these sensitive frogs rarely persist in stream margins extensively grazed by stock as found in this site.

Table 10. Lizard and frog species recorded by DOC for Kaimai-Mamaku area (names and threat status obtained from DOC Bioweb, 2009; Hitchmough *et al.,* 2016; Newman *et al.,* 2013). Species which are threatened and in the surrounding Kaimai site area are highlighted in bold.

Scientific Name	Common Name	Historical Presence	Threat category
Hoplodactylus granulatus	Forest gecko	Widespread in North Island	At Risk- Declining
Hoplodactylus pacificus	Pacific gecko	Widespread In North Island.	At Risk- Declining
Hoplodactylus duvaucelii	Duvaucel's gecko	Widespread In North Island.	At Risk- Declining
Hoplodactylus maculatus	Common gecko	Widespread In North Island.	Not Threatened
Naultinus elegans	Auckland green gecko	Widespread In North Island.	At Risk- Declining
Oligosoma homalonotum	Chevron skink	Widespread In North Island.	Threatened- Nationally Vulnerable
Oligosoma infrapunctatum	Speckled skink	Wide spread in the North Island, up to at least 800 m.	At Risk- Declining
Oligosoma microlepis	Small scaled skink	May have been widely distributed along axial ranges of North Island	Threatened- Nationally Vulnerable
Oligosoma moco	Moko skink	Widespread in coast and lowlands of north eastern North Island	At Risk- Relict
Oligosoma smithii	Shore skink	Common along coast	Not threatened
Oligosoma striatum	Striped skink	Widely distributed from Taranaki to at least Kaipara	Threatened- Nationally Vulnerable
Oligosoma aeneum	Copper skink	Widespread.	Not Threatened
Cyclodina alani	Robust skink	Lowland forest throughout North Island	At Risk- Recovering
Cyclodina macgregori	McGregor's skink	Widespread throughout North Island	At Risk- Recovering
Cyclodina oliveri	Marbled skink	Widespread from Northland to Northern Bay of Plenty	At Risk- Relict
Cyclodina ornata	Ornate skink	Widespread at lower elevations throughout the North Island.	At Risk- Declining
Cyclodina whitakeri	Whitaker's skink	Lowland forest throughout North Island	Threatened- Nationally Endangered
Leiopelma hochstetteri sensu stricto	Hochstetter's frog	Most widely distributed native frog	At Risk- Declining

4.4 Invertebrates

Opportunistic surveys were undertaken for terrestrial invertebrates while other surveys were conducted. Among the invertebrates, the most notable were giant centipedes (*Cormocephalus rubriceps*), which were common under cover in a range of vegetated habitats. Other invertebrate species included cicada nymphs (*Amphipsalta* sp. and a smaller species), ground beetles (*Ctenognathus novaezelandiae*), rhaphidophorid weta (*Neonetus variegatus* and at least one other species), huhu grubs (*Prionoplus reticularis*) in decaying pine logs, vagrant spiders (*Uliodon* sp.) and geoplanid flatworms (possibly *Arthurdendyus* sp.). All of these species are ubiquitous and found throughout the Waikato region.

Two insect species are of particular concern in the area of the proposed wind farm, because of their small and localised populations as discussed further below, but were not found during any of the site surveys within the project area (Table 11).

4.4.1 Te Aroha stag beetle

The presence of the Te Aroha stag beetle (*Geodorcus auriculatus*) in this locality is notable. The Te Aroha stag beetle is a regional endemic listed as protected by the New Zealand Wildlife Act 1953 (Schedule 7). Adult beetles have been found under fallen logs in the moist layer of decaying wood between a log and the soil underneath it. Forest types vary and include canopies of tawa, rimu, northern rata, kauri, red and hard beech (Sherley *et al.,* 1994). Like other *Geodorcus* species, *G. auriculatus* spends its entire life in cool damp environments such as under logs and rocks, emerging at night to feed on sappy exudations from trees or other plants (Sherley *et al.,* 1994).

4.4.2 Helm's butterfly/ forest ringlet butterfly

Remnant populations of Helm's butterfly or the forest ringlet butterfly, *Dodonidia helmsii*, occur in the area. The species is currently classified as "At Risk: Relict" (Stringer *et al.,* 2012). Patrick & Patrick (2012) point to a reduction in range over last 30 years, when previously it was widespread and locally common, stating that less than 20 populations known to still occur. The forest ringlet is not only a forest butterfly. Marshall (1896) described "*all specimens were captured in small bush-gullies, the sides of which are partially cleared of the light bush that formerly covered them*". The butterfly has been observed in a very open area with widely scattered canopy trees, which looked partially cleared (David Riddell pers. comm.). Habitat descriptions by Marshall (1896), Millar and Patrick (2014) and D. Riddell (pers. comm.) suggest the butterfly is able to make use of open habitats which are either relatively static (as with tussocks above the treeline), or in a state of re-vegetating transition back towards (but not yet at) more natural, high-canopy cover. The remnant vegetation in the proposed wind farm may, therefore, be suitable habitat for this species. The favoured food plants are different *Gahnia* spp. which are also used for breeding. Vespulid wasp predation is a possible cause of the decline of this species.

Table 11. Invertebrate species of interest which are present in the surrounding Kaimai area (Patrick & Patrick 2012)

Scientific name	Common name	Historical presence	Conservation status
Dodonidia helmsii	Helm's butterfly	Small local range	At Risk
Geodorcus auriculatus	Te Aroha stag beetle	Small local range	At Risk

4.5 Aquatic Biota

There are a number of waterways that border the wind farm site and drain to the Waihou River. The streams within the site are generally first order streams and are unlikely to flow all year round. Streams which border the wind farm site include the Owhakatina Stream, Raeotepapa Stream, Waitoki Stream and its tributaries and the Kuaoiti Stream tributaries. The first order tributaries of the Raeotepapa, Waitoki and Kuaoiti Streams, where they are surrounded by indigenous vegetation, are classified as Natural State Streams in the Waikato Regional Plan.

A number of indigenous fish species have been captured in the streams surrounding the wind farm site (Table 12) of particular interest is the presence of longfin eel (*Anguilla dieffenbachii*) and torrentfish (*Cheimarrichthys fosteri*) which have a threat status of At Risk - Declining (Goodman *et al.,* 2014).

Table 12. Fish species recorded within the waterways bordering the wind farm site (from the NZFFDD (2017); names and threat status obtained from Goodman *et al.,* 2014).

Scientific name	Common name	Location	Conservation status
Gobiomorphus cotidianus	Common bully	Waitoki and Romaru Streams	Not threatened
Retropinna	Common smelt	Waitoki and Romaru Streams	Not threatened
Anguilla australis	Shortfin eel	Waitoki and Romaru Streams	Not threatened
Anguilla dieffenbachii	Longfin eel	Waitoki and Romaru Streams	At Risk - Declining
Cheimarrichthys fosteri	Torrentfish	Waitoki Stream	At Risk - Declining
Gambusia affinis	Gambusia	Owhakatina Stream	Introduced

5 ASSESSMENT OF ECOLOGICAL SIGNIFICANCE

5.1 Significance Assessment according to Regional Policy Statement Criteria

The proposed Kaimai wind farm site is situated within the Matamata-Piako and Hauraki Districts (ED), in the Waikato Region. In accordance with section 171(1)(a)(iii) of the RMA particular regard must be had to a regional policy statement or proposed regional policy statement when considering the effects on the environment of allowing the requirement. The Waikato Regional Policy Statement (RPS) were both used to assess ecological significance of key indigenous ecosystems within the proposed wind farm footprint. Table 13 below outlines the assessment criteria against the criteria. The detailed RPS criteria are appended as Appendix II.

To meet its functions under the RMA, and to address the regionally significant issue of biodiversity decline, Policy 11.1 of the RPS seeks to promote positive indigenous biodiversity outcomes to maintain the full range of ecosystem types and maintain or enhance their spatial extent. It is important to note that this Policy applies to all indigenous biodiversity, including, but not limited to those areas identified as significant natural areas (SNAs) under section 6(c) of the RMA. The relevant sections of the RPS require that: "*Regional and district plans shall: protect or enhance areas of significant indigenous vegetation and the significant habitats of indigenous fauna, including all identified significant natural areas; require that activities avoid the loss or degradation of areas of significant indigenous vegetation and the significant habitats of indigenous fauna, in preference to remedying or mitigating adverse effects; and require that any unavoidable adverse effects on areas of significant vegetation and significant habitats of indigenous fauna are effectively remedied or mitigated through processes that: replace like-for-like habitats or ecosystems (including being of at least equivalent size or ecological value); involve the legal and physical protection of existing habitat; or involve the creation of new habitat. Remediation or mitigation may occur off site if improved ecological outcomes will result.*" s11.2.2.

Policy 11.1 also identifies a number of focus areas to assist in achieving the maintenance and enhancement of all indigenous biodiversity:

Working towards achieving no net loss of indigenous biodiversity at a regional scale;

- The continued functioning of ecological processes;
- The re-creation and restoration of habitats and connectivity between habitats;
- Supporting (buffering and/or linking) ecosystems, habitats and areas identified as significant indigenous vegetation and significant habitats of indigenous fauna;
- Providing ecosystem services;
- The health and wellbeing of the Waikato River and its catchment;
- Contribution to natural character and amenity values;
- Tangata whenua relationships with indigenous biodiversity including their holistic view of ecosystems and the environment;
- Managing the density, range and viability of indigenous flora and fauna; and
- The consideration and application of biodiversity offsets.

The ecological values of most of the footprint area of the proposed Kaimai wind farm have been highly modified by a long history of agriculture (predominantly dry stock farming), and as a consequence the ecological value for most of the wind farm directly under the turbines and which the infrastructure passes through is low.

However, the Waikato District Plan identifies that the proposed Kaimai wind farm would be in the close vicinity of a series of indigenous conservation areas that can be regarded as being ecologically significant. Some of the proposed turbines are located close to these areas; most notable of these is the significant conservation areas which overlap or are directly adjacent to some of the proposed turbines (Figure 9).

The adjacent Kaimai-Mamaku Conservation Park conservation area (6,159.43 ha) qualifies as nationally significant with outstanding wildlife values (Table 13, Figure 15). The park meets the WRC SNA criteria because it has been:

1) set aside and protected by the crown;
2) it provides habitat for threatened species e.g. kiwi, short and long-tailed bats, Hochstetter's frog, Kirk's daisy (*Brachyglottis kirkii* var. *kirkii)* and king fern (*Ptisana salicina*);
3) it is a large area ranked as of outstanding habitat; and
4) due to its buffering function to adjacent areas of indigenous forest.

The wind farm area provides habitat for the threatened long-tailed bat. It is likely that gullies and forest fragments, particularly those with potential roost tree habitat will be regularly used by this species (see section 4.2).

Migratory and resident birds may also use habitat and airspace over the wind farm site (section 4.1.3). Some of these bird species are regional to local migrants, such as South Island pied oystercatchers, bittern and North Island kaka, while others are long distance migrants, such as bar-tailed godwits. The site may provide a corridor along which seabird species migrate from Miranda to the Tauranga Harbour, Ohiwa Harbour, Maketu Estuary/ Kaituna River mouth and Waihi Estuary/Pukehina Spit region. Alternatively, in the case of the bittern, movement migration may occur from the Bay of Plenty to the Kopuatai wetland.

Of the other SNAs, within 100 m of Turbines 5 and 7 is SNA (site T13UP87), a QEII National Trust Open Space Covenant (Figure 9). This covenant is classified as regionally moderately significant and covers an area of 108 ha, and is comprised primarily of indigenous podocarp/hardwood forest.

Land Environments of New Zealand (LENZ) is a national environment-based classification of ecosystems mapped across New Zealand's landscape based on the wider ecological theory as described by Walker *et al.,* (2015). The majority of the wind farm site falls into an area that is classified as a threat category of 1, 3 and 6 'Acutely Threatened,' 'At Risk' and 'Less Reduced & better protected' ecological area. In effect this means that the indigenous vegetation near turbines 1-16 and turbines 18 and 19 is categorised "National Priority 1" as a national priority for protection. Therefore, the ecological significance of indigenous vegetation or habitat for indigenous fauna or flora close to these turbines should be regarded as a priority in terms of the focus of national biodiversity policy objectives to halt biodiversity decline. In addition, discovery of threatened indigenous flora or fauna species (in this case the discovery of NZ long-tailed bats) results in "National Priority 4" being triggered where habitat for these species occurs.

Table 13. Criteria for determining significance of indigenous biodiversity in accordance with RPS criteria within and adjacent to the Kaimai Wind Farm.

Criteria		Kaimai- Mamaku Conservation Park- T13P90 (Fig. 17)	SITE- T13UP87 (Fig. 17)	Windfarm area and impacted forest edge
1	It is indigenous vegetation or habitat for indigenous fauna that is currently, or is recommended to be, set aside by statute or covenant or by the Nature Heritage Fund, or Nga Whenua Rahui committees, or the Queen Elizabeth the Second National Trust Board of Directors, specifically for the protection of biodiversity, and meets at least one of criteria 3-11.	Yes- National significance Kaimai Mamaku conservation park.	Yes- Regional significance; area of ecological significance DOC 1993.	Forest edges designated
2	In the Coastal Marine Area, it is indigenous vegetation or habitat for indigenous fauna that has reduced in extent or degraded due to historic or present anthropogenic activity to a level where the ecological sustainability of the ecosystem is threatened.	No.	No.	No.
3	It is vegetation or habitat for indigenous species or associations of indigenous species that are: Classed as threatened or at risk; or endemic to the Waikato region.	Provides habitat for kiwi & Hochstetter's frog. Kirks' daisy, Pseudopanax laetus & Marattia salicina present in higher altitude areas. Habitat for long tailed bats.	Yes- Habitat for long tailed bats.	Habitat for long tailed bats, NZ pipit, & potentially Kaka and NZ falcon.
4	It is indigenous vegetation, habitat or ecosystem type that is under-represented (20% or less of its known or likely original extent remaining) in an Ecological District, or Ecological Region, or nationally.	Tawa and podocarp forest with stands of dense regenerating kauri. Part of Kaimai-Mamaku wildlife habitat which is ranked outstanding.	Yes- LENZ: 'At Risk', 'Acutely Threatened', 'Less reduced & better protected'.	No.
5	It is indigenous vegetation or habitat that is, and prior to human settlement was, nationally uncommon such as geothermal, chenier plain, or karst ecosystems, hydrothermal vents or cold seeps.	No.	No.	No.
6	It is wetland habitat for indigenous plant communities and/or indigenous fauna communities (excluding exotic rush/pasture communities) that have not been created and subsequently maintained for or in connection with: Waste treatment; wastewater renovation; hydroelectric power lakes (excluding Lake Taupō); water storage for irrigation; or water supply storage; unless in those instances they meet the criteria in Whaley *et al.,* (1995).	No.	No.	No.
7	It is an area of indigenous vegetation or naturally occurring habitat that is large relative to other examples in the Waikato region of similar habitat types, and which contains all or almost all indigenous species typical of that habitat type. Note this criterion is not intended to select the largest example only in the Waikato region of any habitat type.	Part of large DOC Kaimai-Mamaku Conservation Park, ranked as outstanding.	No.	No.
8	It is aquatic habitat (excluding artificial water bodies, except for those created for the maintenance and enhancement of biodiversity or as mitigation as part of a consented activity) that is within a stream, river, lake, groundwater system, wetland, intertidal mudflat or estuary, or any other part of the coastal marine area and their margins, that is critical to the self-sustainability of an indigenous species within a catchment of the Waikato region, or within the coastal marine area.	No.	No.	No.
9	It is an area of indigenous vegetation or habitat that is a healthy and representative example of its type because: It's structure, composition, and ecological processes are largely intact; and If protected from the adverse effects of plant and animal pests and of adjacent land and water use (e.g. stock, discharges, erosion, sediment disturbance), can maintain its **ecological sustainability** over time.	No.	No.	No.
10	It is an area of indigenous vegetation or habitat that forms part of an **ecological sequence**, that is either not common in the Waikato region or an ecological district, or is an exceptional, representative example of its type.	No	No	No
11	It is an area of indigenous vegetation or habitat for indigenous species (which habitat is either naturally occurring or has been established as a mitigation measure) that forms, either on its own or in combination with other similar areas, an ecological buffer, linkage or corridor and which is necessary to protect any site identified as significant under criteria 1-10 from external adverse effects.	Yes	No	Forest edges likely to be a buffer

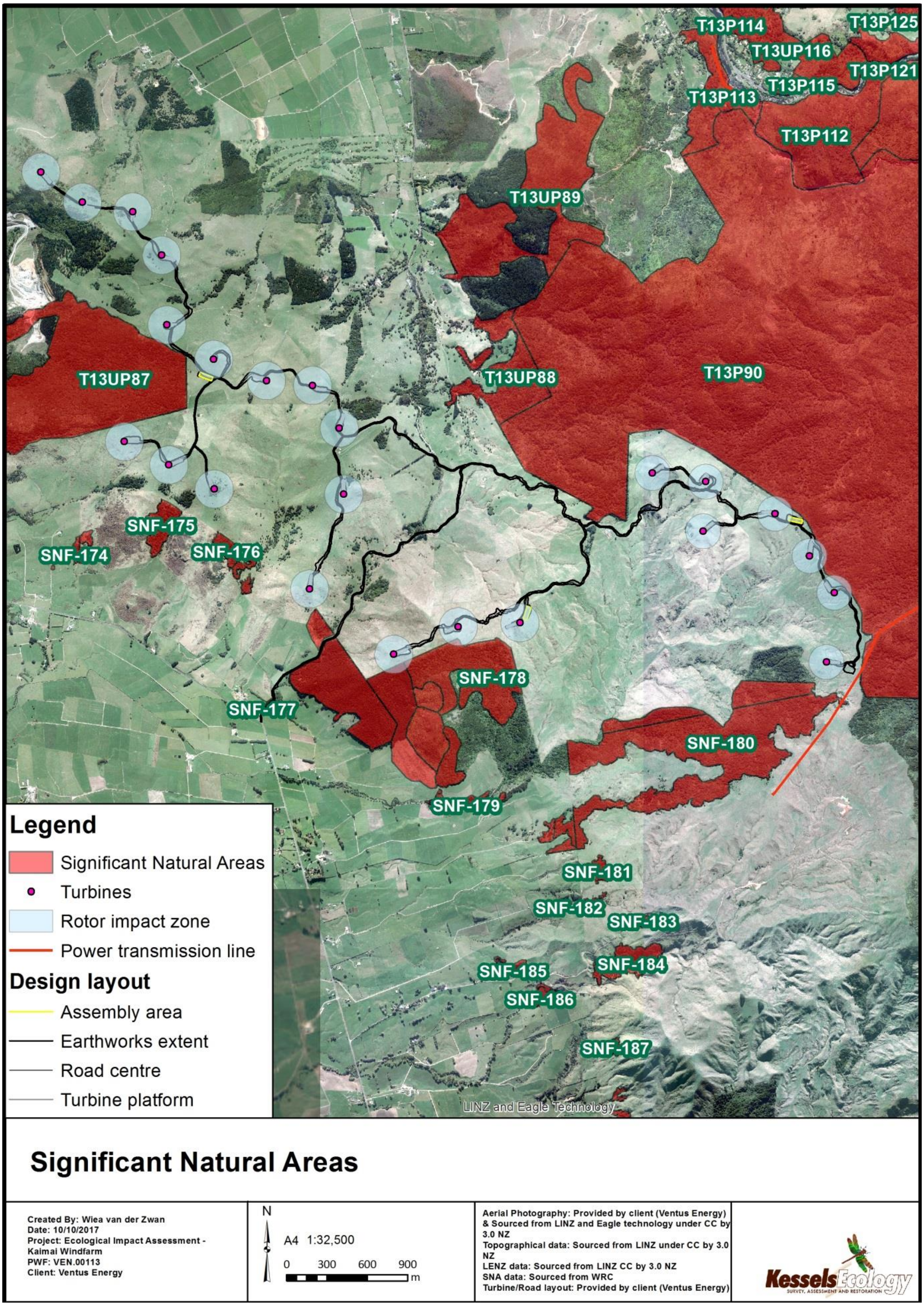

Figure 9. Locations of the Hauraki District significant natural areas and public conservation land in relation to the proposed turbine placements.

6 ASSESSMENT OF ECOLOGICAL EFFECTS

6.1 Status of Assessment

This assessment is based on the on supplied turbine locations, specifications and locations and extents of other infrastructure required (e.g. roads). If additional consents are required for activities associated with construction and operation not provided for at this point in time, such as water abstraction or culvert installation, effects will need to be assessed in further detail as part of the consent application process.

6.2 Summary of Ecological Effects

Generally, the 24 turbines and associated infrastructure of the proposed Kaimai wind farm are situated within pasture land. There are still four main aspects of the wind farm proposal which could generate adverse ecological effects without suitable management or mitigation. These are:

- The direct removal and trimming of indigenous secondary small-leaved-broadleaved forest vegetation and associated fauna habitat loss;
- Resident bird (terrestrial, wetland) and bat turbine strike;
- Migratory shorebird bird turbine strike; and
- Potential adverse effects associated with construction, such as sediment runoff and increased spread of weeds into sensitive natural features.

6.3 Effects on Vegetation

The proposed Kaimai wind farm is situated in a landscape comprised primarily of farmland with little ecological value. Ventus Energy states that no indigenous vegetation will be required to be trimmed or removed under the rotor sweep zones at any of the turbine sites.

No ecologically significant wetlands have been identified as being directly affected by this wind farm proposal.

Ventus Energy states that no indigenous vegetation will be removed in the construction of the infrastructure and roading upgrades to the wind farm.

Figure 10 and Table 5 present an overview of the affected vegetation under the rotor sweep zone. Affected vegetation under the rotor sweep zone of the turbines (excluding pasture) totals approximately 8.35 ha, of which 4.6 ha comprises indigenous vegetation, and some 3.8 ha exotic vegetation. The majority of indigenous vegetation under the rotor sweep zone comprises small areas along the boundary of indigenous treeland and forest areas. Indigenous vegetation at this locality comprises a pocket of secondary broadleaved forest and secondary broadleaved treeland.

The only site where indigenous vegetation will be required to be removed for the placement of a turbine is at Turbine site 13. At this locality vegetation will need to be cleared for the construction of the infrastructure of the turbine and associated access. The direct impact of vegetation removal at this locality equates to 1,657 m^2 (0.17 ha) of secondary broadleaved forest and 70 m^2 of secondary broadleaved treeland. This is fragment is heavily modified by grazing and is not ecologically significant. The remaining 11,500 m^2 (1.15 ha) of indigenous vegetation at this locality will be not be directly impacted as it falls under the rotor sweep zone and Ventus Energy has stated that no trimming or clearance of indigenous vegetation will be undertaken under the rotor sweep zone for any of the proposed turbines.

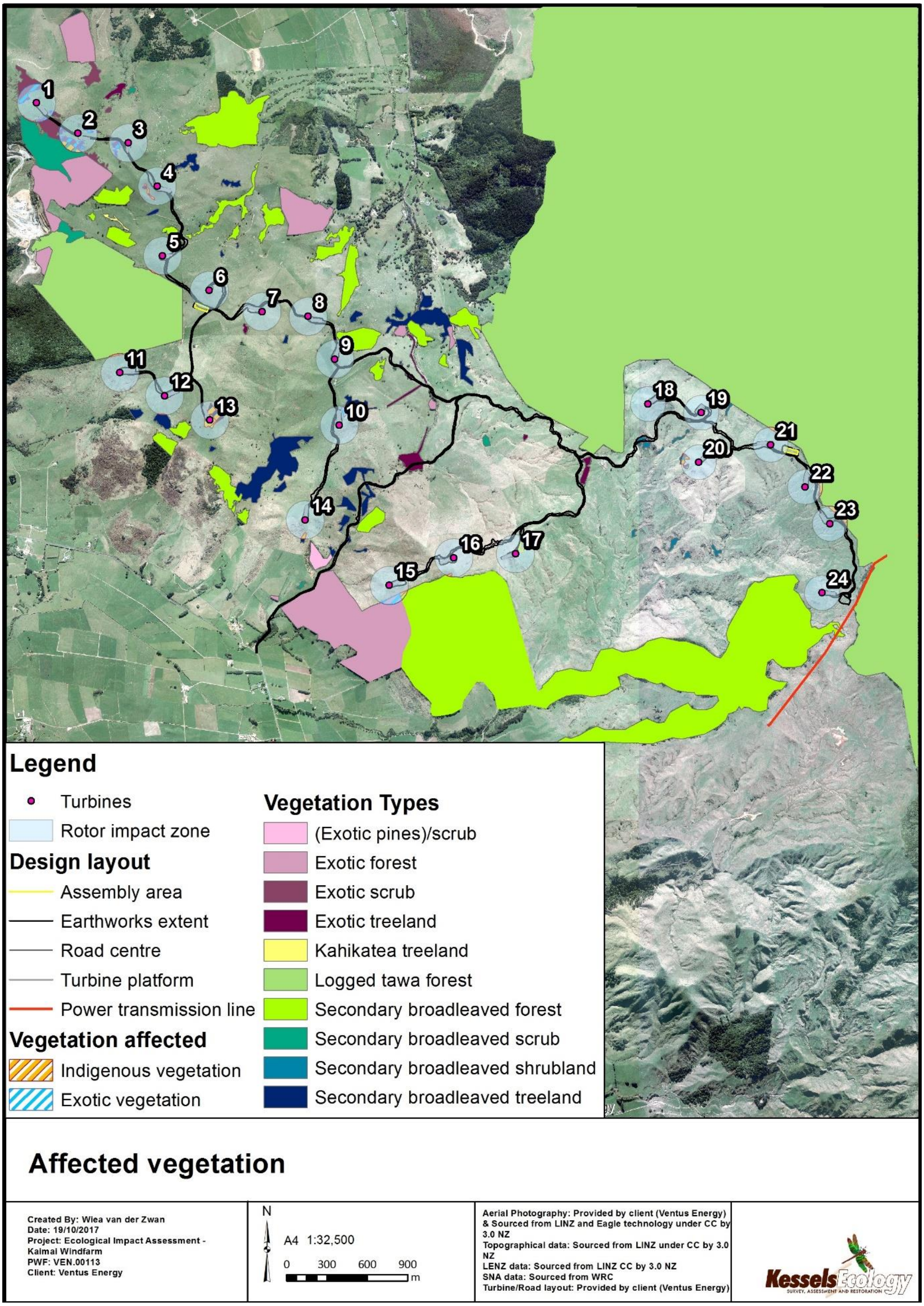

Figure 10. The Kaimai Wind Farm footprint in relation to indigenous vegetation. Zoomed-in map sections are presented in Appendix IV.

6.4 Effects on Avifauna

6.4.1 Summary of potential impacts

Based on surveys to date, most birds detected are resident within the study site, and are common widespread species. Evidence from New Zealand and international studies suggests that any potential effects of wind farm construction and operation to these species will be of no concern, should they eventuate.

Local flight movements of internal migrant New Zealand shorebirds, wetland and resident shorebirds/seabirds, and movements of international migrants to their staging areas between the Firth of Thames and the Bay of Plenty indicate that flocks of these birds will pass over the Kaimai Range on a regular basis and that some of these species could be at risk from turbine blade strike.

Collision mortality can occur when a bird flies into turbine blades, towers, overhead lines or associated wind farm infrastructure (e.g. Drewitt & Langston, 2006). The risk of a bird colliding with a turbine and its blades depends on a range of factors including behaviour, weather conditions, topography and the design of the wind farm (e.g., layout, number, density, type and size of turbines - Drewitt & Langston, 2006). Such risks are likely to be greater on or near areas regularly used by large numbers of feeding or roosting birds and migratory bird habitats or flight paths.

The results of mortality monitoring undertaken at Meridian's West Wind Farm are the first publicly available results of collision monitoring at an operational wind farm in New Zealand (Bull & Fuller, 2011) and these show that this wind farm caused a low mortality of birds and mainly of common species.

However, observations by Kessels Ecology at other sites show that several resident bush birds, notably kereru and tui, can fly through the rotor sweep area (RSA) of a turbine, particularly during display dive rituals in the mating season (about November – January).

Table 14 presents a summary of the key bird groups and a preliminary assessment for each group in terms of turbine strike risk for the proposed Kaimai wind farm. A conservative approach has been taken in determining these risk levels.

Table 14. The groups of birds that could be affected by the presence of a wind farm in their flight paths.

Bird Group	Risk Assessment	Assessment of effect after avoidance, remediation or mitigation	Mitigation and monitoring recommendations
Internal Migratory Shorebirds	Flight paths may cross the site. South Island Pied oystercatcher have been detected flying over the site but in low numbers	Low adverse effect likely with suitable mitigation and monitoring provisions	Compensation and offset mitigation required to increase productivity at least equal to the number of predicted mortality rates per annum for each target species
Northern Hemisphere Migrants	Migration and local flight pathways may cross the site, but bioacoustic surveys have not detected any calls of migratory species to date.	Low adverse effect likely with suitable mitigation and monitoring provisions	Compensation and offset mitigation required to increase productivity at least equal to the number of predicted mortality rates per annum for each target species
Resident Birds	Studies on this site suggest key resident birds, such as harrier, tui and kereru, are likely to be present in low numbers. Studies and modelling at other wind farm sites show low predicted and actual strike rates.	Low adverse effect likely with suitable mitigation and monitoring provisions	Compensation and offset mitigation required to increase productivity at least equal to the number of predicted mortality rates per annum for each target species
Local migrants	Collision may occur during dispersal or localised migration by NZ falcons and North Island kaka, but likely to be occasional and rare occurrences	Low adverse effect likely with suitable mitigation and monitoring provisions	Compensation and offset mitigation required to increase productivity at least equal to the number of predicted mortality rates per annum for each target species

6.4.2 Effects on resident birds

There is likely movement of native bird species between the Kaimai forest and indigenous forest fragments within the site. During the survey, these were found to be harrier, tui, kereru, swallow and fantail and non-native passerines. However, At Risk and Threatened bird species were also detected in the area or which previous data suggests that they may use the study area. These include kaka, pipit, long-tailed cuckoo and New Zealand falcon. Specific impact assessment of these species are described further below.

6.4.2.1 Bush Birds

Two of the most commonly sighted indigenous birds with the site were tui and kereru. In addition, bellbirds may also be at risk. Tui and kereru flights are likely to be most active during spring and late summer when seeking new food sources as different trees and shrubs fruit and as nectar and buds becomes available in accordance with climate, forest type and altitude. Kereru will also undertake display and courtship flights in spring and these display flights generally occur over bush but have been observed over pasture adjacent to bush (Kessels, *pers obs*). The height of these display dives can intercept the RSA on occasion and kereru displays up to 40 m above ground has been observed in the investigations for other wind farm sites (Stirnemann, 2008). While there is a risk of tui and kereru entering the RSA during display flights, for the majority of the year these birds are considered to be at a low risk of strike during normal flight movements, either within or between forest fragments. It is also important to note that avoidance measures may be taken by these birds, and in reality, both species are expected to undertake avoidance measures given that their flights are diurnal and that display flights are usually only undertaken during fine and calm weather. Moreover, many observations of tui and kereru in the forest remnants suggest that these species do not usually fly high over ridges or knobs, and usually fly less than 10 m above a pasture ridge, around a high hill point or just about the tree canopy when flying over a forested ridge.

Nesting for all of the indigenous forest bird species also tend to occur wholly within densely forested areas. While the habitat of potentially vulnerable juveniles of these forest birds is not well understood, evidence tends to suggest that for most species, they do roost close to their nests for several weeks after fledging (Robertson, 1985). This suggests that the risk of strike on turbine blades for juveniles of bird species, such as tui, kereru and morepork would be moderate to high where turbines or transmission lines are situated directly in their habitats, but lower when situated on the edge of bush and even less with wide spacing (c.f. 100 m) between turbines.

Generally, noise generated by the turbines is considered unlikely to disturb forest birds within the vicinity of the turbines, apart from perhaps those present along the immediate boundary and then only until they become habituated to the presence of the wind turbines. Tui and kereru appear to adapt to noise associated with roads and urban environments which are likely to be louder than wind turbines (Kessels, *pers obs*).

Moreporks seem to be mainly birds of forest interiors and edges. They remain on territory all year round but dispersing young birds move around after breeding. It is not known if this movement would place them at risk. They do come to lights to feed on the insects that are also attracted (Kessels, pers. obs.) and this feeding behaviour must place them at risk if the turbines are lighted in any way.

Tui and kereru flights across farmland are likely to be most active during spring and late summer when seeking new food sources as different trees and shrubs fruit and as nectar and buds becomes available in accordance with climate, forest type and altitude. Kereru will also undertake display and courtship flights in spring.

Nesting for all of the indigenous forest bird species also tend to occur wholly within densely forested areas. Even morepork tend to nest in dense bush where they can (Stephenson & Minot, 2006). While the habitat of potentially vulnerable juveniles of these forest birds is not well understood, evidence tends to suggest that for most species, they do roost close to their nests for several weeks after fledging (Robertson, 1985).

In conclusion, while the ability of these “keystone” forest bird species to adapt to the turbines and become accustomed to associated noise and movement should not be underestimated, and the birds should be able to fly around the turbines to gain access to other remnant bush areas within the locality, there is a likelihood that strike will occur from time to time.

6.4.2.2 New Zealand falcon

The effects on New Zealand falcons within an operational wind farm in New Zealand was reviewed for the Hurunui Windfarm (Seaton and Barea, 2013). Evidence gathered suggests that NZ falcon and wind farms might be able to co-exist (Seaton and Barea, 2013). At the Mahinerangi Wind Farm several individuals of the local population of New Zealand falcon are known to regularly use the wind farm, yet no incidences of falcon bird strike have been recorded there (despite there also being a programme of radio-telemetry monitoring of the falcons in addition to the general bird strike monitoring); indeed, falcons have been observed on several occasions to avoid the blades when flying through a wind farm turbine zone (Seaton and Barea, 2013).

6.4.2.3 North Island kaka

Kaka has a non-continuous distribution mainly associated with large tracts of central North Island podocarp forest, and offshore islands that are free of mammalian predators (Robertson *et al.,* 2007). However, as a result of intensive control of introduced predators in forests during the past 15 years and the establishment of new populations through translocation and supplementary feeding, kaka distributions have increased and are expected to continue to increase and spread. Since kaka are generally both intelligent and inquisitive, some interaction between them and wind farm structures could be expected. However, to date, no collision fatalities have been reported at the Brooklyn wind turbine, Wellington, despite approximately 60 kaka inhabiting the nearby Karori Sanctuary (Powlesland, 2009a). The impacts on kaka are therefore expected to be low at the Kaimai wind farm unless there is some corridor they prefer to utilise which will increase their probability of collision.

6.4.2.4 Long-tailed cuckoo

It is possible that cuckoos would also suffer from collision fatalities with wind turbines during their nocturnal migration flights through New Zealand. Like migratory waders, their flight characteristics and routes are unknown. The turbine sites closer to the forest are more likely to result in interactions with native bird species such as cuckoos than those in purely pastoral situations. However, unless this is an unidentified migration pathway it is unlikely that any turbine strike will impact population numbers significantly enough to have an significant adverse effect.

6.4.2.5 Australasian bittern

It is possible that the Kaimai wind farm is part of a flyover for bittern between the Bay of Plenty wetlands and the Hauraki Plains wetlands (e.g. the Kopuatai Peat Dome). The magnitude of potential turbine collision risk, and hence effects (if any), on this cryptic wetland species are not known as the bird survey methods utilised for this study would have a low probability of detecting bittern and no known previous research has studied movements across the Kaimai Range.

6.4.2.6 Pipit

The New Zealand pipit was detected within farmland and is classified as being At Risk - Declining. Similar species in the same genera overseas have been recorded as suffering collision mortality with turbines (Kingsley & Whittam, 2005). The decline in the New Zealand pipit has been linked to several factors, including interspecific competition with skylark, the sealing of roads, increased traffic densities and road speeds, the spread and increase in density of magpies, increased spraying of roadside verges, avian diseases, accidental poisoning, reduction in breeding habitats, predation and a reduction in over-wintering habitats (Beauchamp, 1995).

New Zealand pipit may spend some time flying at a height which would place them at risk of turbine collision. The proportion of the time New Zealand pipit may spend within the proposed RSA is currently unknown. Although it is currently not possible to make a definitive conclusion regarding the effect of wind farm construction on New Zealand pipit due to a lack of detailed information on flight heights, they are a species that appears spend much of their time on the ground and well below the height of the proposed turbine blades. As a result it seems unlikely that the New Zealand pipit will be at a high risk of suffering collision mortality with turbine blades. Disturbance of habitat due to wind farm operation also seems unlikely given that effect on the breeding success or distribution of similar species overseas has been recorded (Thomas, 1999, cited in Percival, 2005) and it thus any effects on pipits likely to be minor.

6.4.3 Effects on waders and shorebirds

There is limited knowledge of the flight characteristics (e.g. altitude, flock size, collision avoidance) and migration routes of both threatened and non-threatened migratory waders species through New Zealand. This makes predictions of collision fatalities difficult. Migratory wader populations which could be impacted are present in Tauranga Harbour and the Firth of Thames.

Little information is available about the movements of these migrant waders within the country (Dowding & Moore, 2006). Previous studies suggest that the vast majority of observations of all resident shorebird species in West Coast localities were over sea and beach habitats, although radar based studies have shown that some species fly overland where main pathways (Stirnemann & Kessels, 2009). Manukau Harbour, Matarangi Spit and the Firth of Thames and Tauranga are listed as some of the most important sites for New Zealand's external and internal migratory waders (Dowding & Moore, 2006). The proposed wind farm is located directly between these sites.

The risk of turbine strike on these waders is largely unknown but important to consider (Table 15). Internally migrant New Zealand shorebirds (birds that breed in New Zealand and whose populations largely overwinter in New Zealand) that potentially move between the key wetlands in significant numbers are variable oystercatchers, South Island pied oystercatcher, wrybill and dotterels. These New Zealand shorebirds migrate every summer and winter between their breeding grounds in the south and their wintering grounds in the north. While undertaking these internal migrations or when moving between harbours and estuaries a proportion of the population of various species is likely to pass over the Kaimai Ranges.

Census data from 1984 to 1993 showed that the Firth of Thames and Manukau Harbour held, on average, 41-47% of the national total of pied oystercatchers in summer, of which approximately 26% were in the Firth of Thames (Dowding & Moore, 2006). There is potential movement of >2.31% of the population through the Kaimai Ranges to reach sites in Tauranga, the Bay of Plenty and Ohiwa Harbour.

Census data from 1984 to 1993 showed that the Firth of Thames holds 83% of the national total of wrybill in summer (Dowding & Moore, 2006). It is further estimated that >3.53% of the birds may migrate between the northern and the eastern estuaries, crossing the Kaimai Ranges. Wrybill is considered a high risk species for turbine strike as it is possible a significant proportion of their already small and declining population migrating through the area (Dowding & Moore, 2006).

Initial strike risk analysis at similar New Zealand sites indicates that turbine strike is possible for wader species and it will be in the range of less than 2-5 birds per annum for the proposed Kaimai wind farm. This level of strike risk is considered to have a minor adverse effect on the target shorebird species.

The likelihood of migratory birds being displaced from flying through the wind farm, i.e. how likely they are to avoid the entire farm (as opposed to the likelihood of an individual avoiding collision with a wind turbine once it is within the wind farm – i.e. the avoidance rate) is difficult to determine definitively but an important point to consider when determining strike risk on these migratory species. Migratory shorebirds have been noted to be displaced from wind farms overseas and hence this may also occur at the proposed Kaimai wind farm site. In this instance displacement would be beneficial as it would reduce the number of birds flying through the wind farm, and hence the number of birds at risk of collision with the turbines.

Further, it has been suggested that clusters of turbines separated by wide corridors may present less of a barrier to the movements of birds (Langston & Pullan 2003). The layout of the proposed Kaimai wind farm broadly fits this template and it is plausible that migrating birds will, if not displaced entirely move around the turbines once the wind farm is constructed.

Given that several species are threatened, such as wrybill, offset mitigation may be required to compensate for any residual adverse effects on wader bird species. Quantification of this offset can be addressed at the consenting stage, but could involve a contribution to conservation activities by community groups at Miranda, which is a key site for international and national wader birds.

Table 15. Threatened and notable bird species population estimates to the north and east of the proposed wind farm (data extracted from Davies, 1997; Pierce, 1999; Riegen, 1999; Riegen and Dowding, 2003; Sagar *et al.,* 1999; Schekkerman and Tulp, 2003; Southey, 2009; Veitch, 1999a, 1999b).

	SI Pied oystercatcher (*Haematopus finschi*)	**Variable oyster-catcher (*Haematopus unicolor*)**	**Pied stilt (*Himantopus himantopus*)**	**North Island NZ dotterel (*Charadrius obscurus*)**	**Banded dotterel (*Charadrius bicinctus*)**	**Wrybill (*Anarhynchus frontalis*)**	**Red knot (*Calidris canutus*)**	**Eastern bar-tailed godwit (*Limosa lapponica*)**	**Turnstone (*Arenaria interpres*)**
National threat category	At Risk-Declining	At Risk-Declining	At Risk-Declining	Threatened-Nationally Vulnerable	Threatened-Nationally Vulnerable	Threatened-Nationally Vulnerable	Threatened-Nationally Vulnerable	At Risk- Declining	Migrant
Total population estimate for the country	112,675	4000	30,000	1700	20,000	4100	59,000	102,000	7000
East Coast habitats									
Tauranga Harbour	0.89%	2.18%	1.53%	2.60%	1.73%	1.73%	0.05%	5%	5%
Bay of Plenty	1.17%	9%	2.90%	6%	3.90%	1.80%	0.22%	9.30%	2.51%
Ohiwa Harbour	0.25%	1.60%	0	2.50%	1.58%	0	0	3.80%	3.80%
Subtotal	**2.31%**	**12.78%**	**4.43%**	**11.10%**	**7.21%**	**3.53%**	**0.27%**	**18.10%**	**11.31%**
Western habitats									
Manukau Harbour	0.16	0.2	13.27	56.65	4.68	45.85	31.7	17.29	5.71
Firth of Thames	0.26	0.85	13.03	0	0.295	37.05	6.33	23%	1.87
Subtotals	**0.42%**	**1.05%**	**26.30%**	**56.65%**	**4.98%**	**82.90%**	**38.03%**	**17.52%**	**7.59%**

6.4.3.1 South Island pied oystercatcher

Approximately 57% of this species migrates to North Island feeding grounds from South Island breeding areas between late December and early February (Sagar & Geddesz, 1999). After breeding, the majority of individuals migrate to the large harbours of the northern North Island, though some birds over-winter in coastal areas of the South Island (Figure 11). In late July adults migrate back to the breeding grounds. The species is present in good numbers at all major Bay of Plenty estuaries and is also in high numbers at the Firth of Thames and Manukau Harbour (Veitch, 1999b).

There is no knowledge of the height that the South Island pied oystercatchers are crossing the Kaimai Ranges, and therefore true strike risk cannot be determined. Data collected at other locations may be relevant for this site however. However, as stated above, the bioacoustic survey results show that there is movement of this species between these areas across the proposed wind farm site although few calls were detected. While it is noted that a large proportion of the national flock migrates up the west coast of New Zealand where they will not be impacted by the presence of this windfarm, approximately 2.3% of the population is estimated to cross the Kaimai Range and so a portion of these birds have the potential to be at risk of turbine strike from at this site. Review of previous wind farm studies in New Zealand using strike risk models, based on intensive ground based, radar and bioacoustic surveys, have determined that strike risk is likely to be in low numbers in relation to the national flock size on an annual basis (for example, the statement of evidence of Dr Seaton for the Hauāuru mā raki Wind Farm Board of Inquiry, 2010). The sound recorders detected two flocks of South Island pied oystercatchers crossing the proposed wind farm site on one occasion in January 2013, from a total recording effort of some 4,000 hours. These detected South Island pied oystercatchers were crossing the southern section of the windfarm over the Kaimai range. This indicates that the site is likely part of a seasonal commuting route for waders between the Haruaki Gulf and Tauranga Harbour.

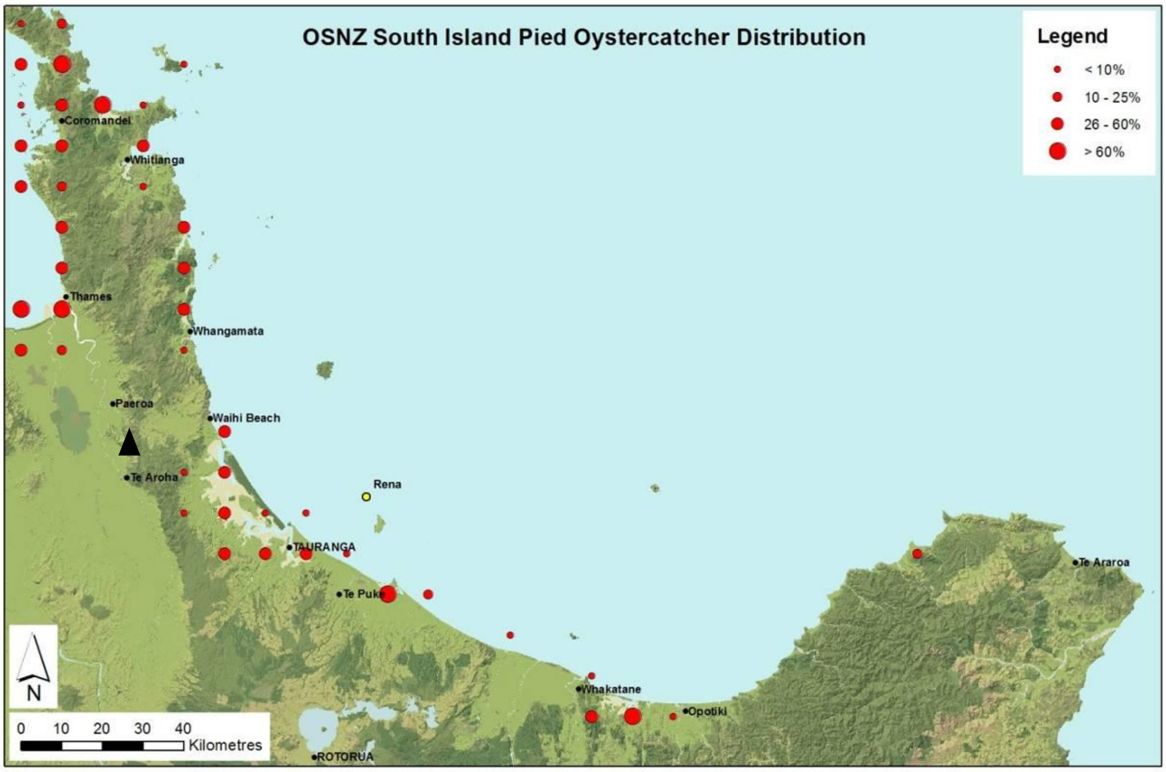

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Figure 11. South Island Pied oystercatcher distributions in relation to the wind farm location (filled triangle). Map altered from the OSNZ Atlas scheme, 1999 – 2004 (Robertson *et al.,* 2007).

6.4.3.2 Wrybill (*Anarhynchus frontalis*)

Wrybills breed in South Island riverbeds, and migrate to northern harbours post-breeding, from late November, with most movements in late December – early January. Wrybills start returning to breeding grounds in August. They are usually only in small numbers on most Bay of Plenty harbours and in the Firth of Thames (Figure 12). However, these small numbers represent 3.53% of the population of this nationally vulnerable species. As this species already is a small population and any additional mortality due to turbine strike could have major adverse implications for the national population. The proposed Main Power Mt Cass wind farm site (Kessels et al, 2013) and the proposed Hauāuru mā raki Wind farm (Seaton, 2010) showed low and mitigatable potential strike risk fatalities after strike risk modelling for key shorebird species. Thus, it would be expected, given that the proposed Kaimai wind farm is not within a known major migratory route, that strike risk would be low and mitigatable at this site.

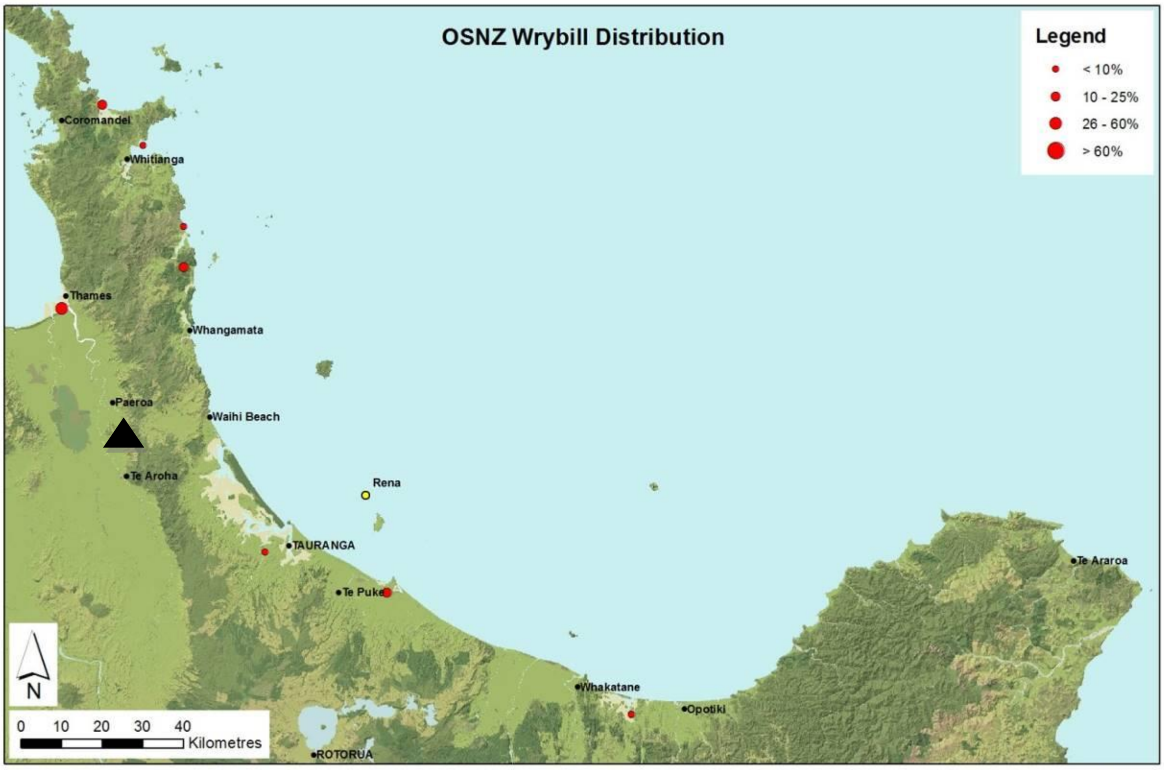

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Figure 12. Wrybill distributions in relation to the wind farm location (filled triangle). Map altered from the OSNZ Atlas scheme, 1999 – 2004 (Robertson *et al.,* 2007).

6.4.3.3 Additional wader species

Pied stilt, and to a lesser extent NZ dotterel, while not migratory, could still move through the Kaimai wind farm site on a regular basis, especially given the high proportion of these birds found along the coastline to the east of the proposed windfarm, these species are considered to be at moderate risk of turbine strike (Table 15).

Only a small proportion of the variable oystercatcher population is in the Firth of Thames and Manukau Harbour, therefore it is unlikely that a high proportion of the population is crossing the Kaimai Ranges. The risk of windfarm development on this species is therefore considered to be low.

The estuaries to the east of the Kaimai Ranges hold >11.31% of the turnstone population. It is expected that there will be movement across the Kaimai Ranges, and therefore there may be some risk to the species.

North Island banded dotterel migrate locally or to the Auckland region (Pierce, 1999). It is possible that >7.21% of the population cross the Kaimai Ranges.

6.4.4 Effects on northern hemisphere migratory species

Red knot, bar-tailed godwit and turnstone are the three species of northern hemisphere migrants most commonly found in New Zealand. While none of these species were detected during the point count or bioacoustic surveys for the proposed Kaimai windfarm, non-detection does not necessarily mean absence, as the survey methods may not have been suitable or frequent enough to detect these species.

The godwit population in the Firth of Thames is a significant part of the entire population. Between 1984 and 1993 an average of 23,562 ± 5325 bar-tailed godwits was counted in the Firth of Thames and Manukau Harbour, 23% of New Zealand's population. Based on counts it is possible that 18.10% of the godwit population fly over the Kaimai Ranges.

The most recent population estimate for red knots in New Zealand was 59,000, an average count between 1994 and 2003 (Southey, 2009; Rogers *et al.,* 2010) but the population has been declining almost continuously since an assessment in 1983-94 (Southey, 2009). The population for the East Asian-Australasian Flyway (of which New Zealand is a part) has recently been estimated at 105,000 birds of two distinct subspecies and is also declining (Rogers *et al.,* 2010). The Firth of Thames held, on average, 10,186 red knots in summer, 25% of the national total and 10% of the flyway total.

Turnstones are the third most abundant wader visiting New Zealand. The estuaries to the east of the Kaimai Ranges hold >11.31% of the population. It is expected that there will be movement across the Kaimai Ranges, and therefore there may be some risk to the species.

It is expected that the migration direction of these birds would carry them across the point of lowest energetic cost. It is possible that, like the South Island pied oystercatcher, as this point transects the proposed windfarm especially since the birds can catch the currents along the ridge to reduce energy expenditure they may be flying over the site.

6.4.4.1 Bar-tailed godwit (*Limosa lapponica*)

This species breeds in the Arctic and migrates to New Zealand estuaries in late September – early April; some (mostly young birds) over-winter. This is the most abundant arctic migrant in New Zealand. It is found in most of the larger estuaries in the Bay of Plenty. Approximately 10-18% of the total population may potentially cross the Kaimai Ranges when moving between these habitats although there is no available research to verify internal flightpaths for this species (Table 15, Figure 13).

6.4.4.2 Red knot (*Calidris canutus*)

Red knot breed in eastern Siberia and migrate to New Zealand harbours (September – April). After bar-tailed godwit, it is the second most common of the Arctic migrants. Usually only small flocks are found at Bay of Plenty estuaries (Figure 14). Only 0.27% of the population is usually found in the north-east side of the Kaimai Ranges in the Tauranga Harbour and Bay of Plenty (Table 15). Since most of the population is unlikely to be utilising this pathway this species is considered to be at low risk of significant turbine strike.

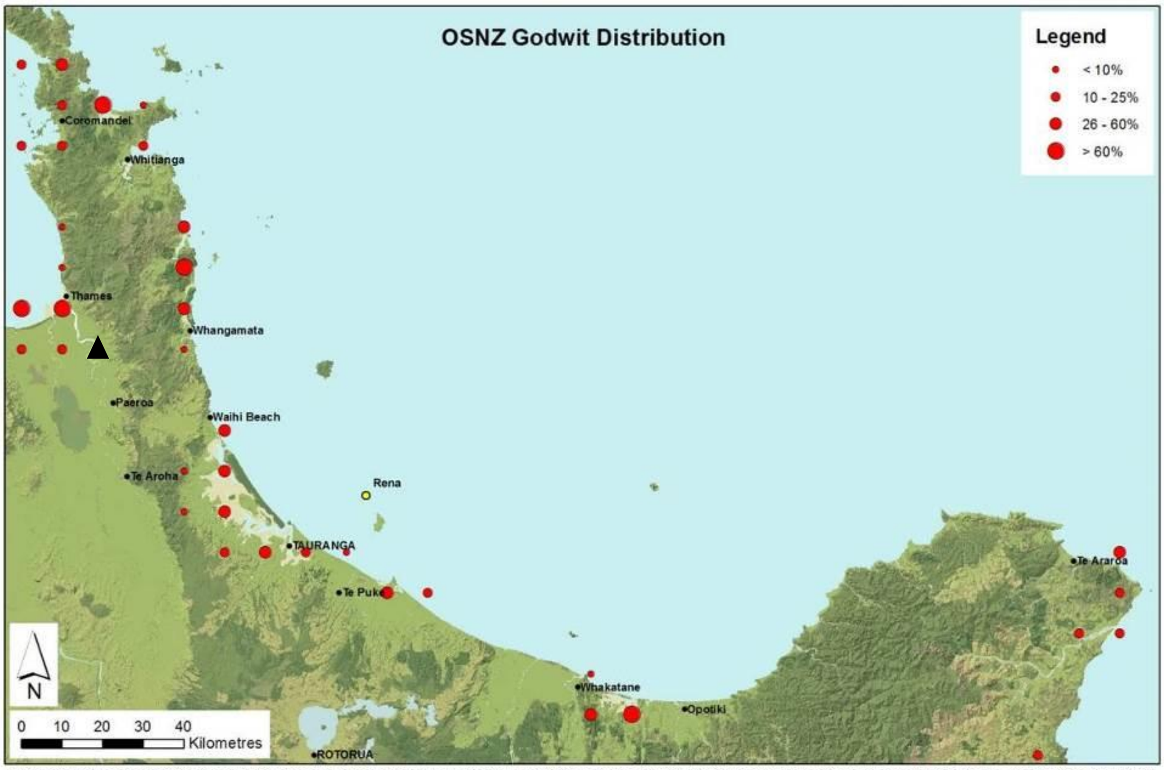

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Figure 13. Bar-tailed Godwit distributions in relation to the wind farm location (filled triangle). Map altered from the OSNZ Atlas scheme, 1999 – 2004 (Robertson *et al.,* 2007).

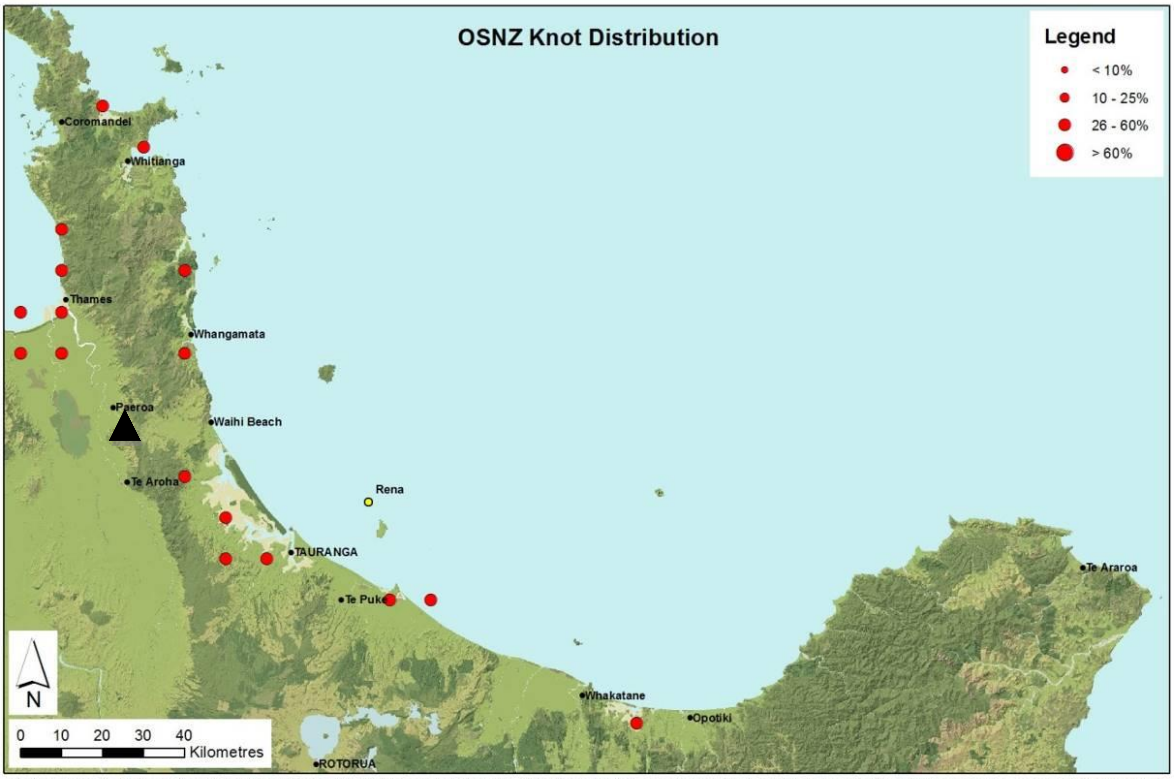

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Figure 14. Red knot distributions in relation to the wind farm location (filled triangle). Map altered from the OSNZ Atlas scheme, 1999 – 2004 (Robertson *et al.,* 2007).

6.5 Effects on Bats

6.5.1 Significance of long-tailed bats in the project area

Long-tailed bats, an endemic New Zealand species, are protected by the New Zealand 1953 Wildlife Act. Once common throughout New Zealand, long-tailed bats numbers have declined markedly over the last 100 years (O'Donnell *et al.*, 2013). Although widespread throughout the North Island, there is little detailed information on current trends or population sizes. However, it is likely that North Island's populations of long-tailed bats are continuing to decline as a result of a combination of pressures such as competition and predation from invasive species (Pryde *et al.,* 2005).

The proposed project area provides favourable foraging habitat for long-tailed bats including shelter belts, plantation and native forest and shrub lands. Though the proposed site is predominantly pasture, long-tailed bats are known to be active over open pasture and utilise cavity bearing exotic trees as roosts (Kunz *et al.,* 2007a).

Potential adverse effects and mitigation solutions for long-tailed bats are outlined in Table 16. The major causes of long-tailed bat decline are known to be habitat loss and predation (Pryde *et al.,* 2005). A combination of habitat restoration and pest control could enhance the North Island long-tailed bat population, producing a healthy source population which could mitigate against any declines at the proposed wind farm site.

To develop a healthy source population, it is recommended that habitat enhancement and pest control should occur away from the wind farm development so populations which are enhanced are not adversely affected by the proposed development. Pest control should cover rats, possums and wasps across an area which is optimal bat habitat within the Kaimai Ranges.

Table 16. Effects and suggested mitigation for long-tailed bats.

Effect	Likelihood of effect	Maximum potential spatial scale of effect	Assessment of effect after avoidance, remediation or mitigation	Recommended mitigation
Habitat loss (only small amount of vegetation and few potential roost tree)	Low	Localised in areas of vegetation clearance	Negligible if offset mitigation undertaken	Revegetation and mitigation in the form of pest control to improve populations. Supplementary artificial roosts.
Roost tree felling (if necessary)	Low	Localised in areas of vegetation clearance	Negligible if pre-felling roost checks undertaken	Pre-clearance surveys, fell areas outside of winter and breeding months.
Mortality of bats from wind farm	Unknown	Local population-wide effects	Uncertain; will be monitored and adaptive management applied accordingly	a) Mitigation to provide a healthy source population to reduce sink effects of the wind farm. b) Popular roosts and flight paths should be a minimum of 50 m from blade tip to feeding or commuting areas.

6.5.2 Turbine strike risk effect on bats

<u>Bat flight altitude</u>

No studies that primarily investigate flight altitude in New Zealand bats have been conducted to date but there is considerable overseas research on effects associated with windfarms on similar insectivorous bat species. However, a New Zealand study investigating the effect of aircraft noise on long-tailed bat activity, showed bats flying at lower heights of 4 – 7 m, and at altitudes of 15 – 30 m (Le Roux and Waas 2012).

The insectivorous, hibernating serotine bat (*Eptesicus serotinus*) from two locations in Denmark, however, has been shown to exhibit a variety of hunting flight altitudes ranging from 1 m to 18 m above ground (Jensen and Miller 1999). The average flight altitude was calculated as 10.7 ± 2.7 m and 6.8 ± 3.6 m, respectively, dependent on the location.

Similarly, a study on the potential impact of wind development sites on multiple bat species in the north-eastern USA, demonstrated that the majority of observed bats flew at approximately tree canopy height (Reynolds 2006). In this study, microphones were placed at ground-level, in the supra-canopy zone and at turbine level height. It was shown that 49% of bat passes occurred at ground level, 34% in the supra-canopy zone and 17% of bat passes were recorded at turbine level height.

However, previous studies in Germany on impacts of wind facilities on bats, such as the non-migratory, insectivorous common pipistrelle (*Pipistrellus pipistrellus*, Brinkmann et al. 2006), r, indicate frequent flying altitudes near wind turbine blades. In this context, bats were shown to fly at altitudes of above 40 m and at wind speeds of up to 10.9 ms^{-1}. Similarly, a study on the effectiveness of acoustic bat deterrents at wind farms in the US (Horn et al. 2007) investigated bat activity near the wind turbine rotor swept zone, which extended from 38 m to 120 m above ground. It was demonstrated that most bats (60%) flew below 38 m, however, 34.5% of all observed bats flew between 38 m and 120 m, and 5.5 % flew above 120 m height.

In contrast, multiple insectivorous bat species in Zimbabwe have been shown to perform foraging flights accompanied by feeding echolocation calls at altitudes that ranged from 0 – 100 m (± 50 m) to 450 – 500 m (± 50 m) altitude (Fenton and Griffin 1997). These previous studies indicate a markedly variability in flight altitude of bat species. Correspondingly, it has been proposed that bats may be altering the altitudes of their nightly flights in dependence of weather conditions and cloud cover (Dürr and Bach 2004).

Wind-turbine driven fatalities of microbats have been recorded in many regions of the world including Australia, Canada, USA and Europe (Baerwald *et al.,* 2009; de Lucas *et al.,* 2012; Rydell *et al.,* 2010). These fatalities are caused by the bats either being struck by turning blades or through barotrauma (internal haemorrahaging of the lungs) resulting from rapid decompression in the vortices behind the moving blade tips (Rollins *et al.,* 2012). Several behaviours exhibited by long-tailed bats increase the risk of turbine mortality:

- **Tree roosting**: This is a common feature of bat species suffering from turbine strike. It is theorised that bats are investigating turbines as potential roost trees (Kunz *et al.,* 2007a).
- **Aerial hawking**: Long-tailed bats commonly forage higher than 35 m above the ground within the rotor sweep zone (Kunz *et al.,* 2007a).
- **Wide ranging**: Long-tailed bats cover distances exceeding 10 km while foraging. Therefore even if the roost tree is far from the turbines they are at risk while foraging.

Preferential foraging along forest edges and linear corridors. Anthropogenically formed vegetation edges are preferred foraging areas for long-tailed bats. The habitat associated with the proposed wind farm contains a number of these areas. Given this research, it is considered possible that bats are at risk of wind turbine strike at the proposed Kaimai wind farm. The level of this risk and quantification of strike injury or mortality is not able to be determined at this point in time. However, it is recommended that further monitoring will be able to allow greater determination of habitat utilisation at this site. Regardless, mitigation for potential bat strike is considered prudent. The most appropriate method for mitigation would be to undertake rat, possum, mustelid and feral cat control at a nearby area of forest which is known long-tailed bat habitat for the duration of the wind farm operation.

6.5.3 Transmission lines

Transmission lines will be placed in the proposed wind farm. There have been no reports of bats colliding with transmission lines in New Zealand. However, overseas literature has reported mortality events during strong winds. The impact on New Zealand long-tailed bats from transmission lines is however expected to be low given that the species forages in dense areas using echolocation to avoid obstacles.

6.5.4 Risk during habitat clearance

Long-tailed bats are cavity roosting bats. Roost trees are both in large trees within indigenous vegetation and in non-native trees such as pine, macrocarpa, elm, wattle, popular, and eucalypt

(Daniel, 1981; Griffiths, 2007; O'Donnell & Sedgeley, 1999; Pryde *et al.,* 2005). Any standing dead or mature tree with a diameter of >15 cm diameter at breast height may contain suitable roost cavities for long-tailed bats. Felling occupied roost trees can result in mortality of long tail bats. Fatalities are most likely during the winter torpor period (May-September) when roosting bats are likely to be unresponsive. However, clearance is proposed for only a small patch of vegetation at the site of Turbine 13 and likely poses little threat to long-tailed bats.

6.6 Effects on Herpetofauna

As Ventus Energy state there will be no indigenous vegetation or undisturbed scrubland is affected during the construction phase aside from at Turbine 13 the effect on lizards is likely to be minimal. Herpetological surveys are therefore only recommended within the vegetation at Turbine 13 prior to any felling activity. These surveys are best conducted between the mid-spring and summer months – from November to March. Any captured individuals can be relocated to suitable habitat nearby.

Details of these measures can be dealt with through a separate Lizard Management Plan as part of the consent conditions.

6.7 Effects on Terrestrial Invertebrates

The main potential effects of wind farms on terrestrial invertebrates are:

- Displacement due to disturbance;
- Habitat change and loss; and
- Disruption to flight paths/dance of flying insects.

Disturbance during construction is unlikely to lead to the displacement of indigenous invertebrates or their habitats, as the sites are all on farmland. Once the wind farm is operational the turbines will not form a wide permanent barrier to insect movement. The mating dance of some taxa may be influenced by disruptions to airflows but as most insects are localised and reproductive dance activity occurs in calmer conditions any effects are expected to be negligible or no more than minor.

Flightless species such as the Te Aroha stag beetle, are unlikely to be impacted by the presence of turbines. There is also no evidence to suggest that butterfly mortality is a concern at commissioned wind farm sites as a result of collisions with turbines. The primary impact to either species would like to be through direct loss of habitat if native vegetation had to be cleared. However, given that the proposed turbine sites are to be situated predominately within pasture it is only areas where native habitat removal is required that any impact is likely to occur. Thus, effects are likely to be minor, subject to final design, and no specific avoidance, remediation or mitigation measures are considered necessary for terrestrial invertebrates.

6.8 Effects on Aquatic Habitats

While the turbines themselves are on the ridge lines, there is the potential for sediment runoff to adversely affect ecologically sensitive stream habitats and possibly concentrate contamination, depending on method utilised for construction of access roading and associated infrastructure.

6.8.1 Increased sediment

There is an increased potential for sediment or concrete runoff to streams as a result of exposed excavation associated with turbine construction and road construction activities.

The potential adverse effects associated with sediment runoff from exposed excavations may cause significant and prolonged sediment discharges if not adequately controlled. Effects can be avoided by adoption of appropriate sediment control measures. During construction, care will be needed to prevent sediment and concrete from discharging into the streams. Sediment control measures include, but are not restricted to, controlling run off, the prevention of slumping of batters, cuts and side casting, maintain slope stability and a contingency measure for heavy rainfall events.

It would also be prudent to immediately stabilise exposed earth areas and construct sediment ponds and geo-textile silt traps at suitable drainage points and key erosion points.

6.8.2 Potential culvert installation

Ventus Energy states that no additional stream crossing or instream works will be required for the infrastructure or access construction and upgrade works.

6.8.3 Fill disposal sites

If fill disposal sites are required during the construction phase, it is recommended that design engineers and the site ecologist work together in consultation with the landowners to ensure any fill disposal sites avoid seepage zones and indigenous vegetation remnants wherever possible and that any wetland and stream infills are adequately mitigated for habitat lost.

6.8.4 Water abstraction requirements

Although water abstraction requirements have not be defined at this point in time, abstraction points should result in no more than minor adverse effects on in-stream biota provided suitable storage and/or non-fully allocated water sources can be devised and found.

6.9 Animal and Plan Pests and Disease

6.9.1 Plant pests

The introduction of new weeds and the spread of existing weed species is probably one of the most critical aspects of this project which will need to be managed in terms of protecting the ecological health of the existing indigenous vegetation remnants in the locality. It is therefore vital that the issue of weeds is taken very seriously during both the construction and operation phase.

Infrastructure development can result in a greater diversity and density of introduced plant species establishing in natural areas. Vigilance will be required to ensure that new weedy species are not accidently brought on site during construction and any new weeds are detected early and removed.

Along the length of the access roads fresh earth exposed during clearance and construction will provide ideal conditions for the further spread of weeds already existing within the area. Furthermore, machinery and aggregate brought in from other areas increases the risk of new weed species establishing within the existing natural areas. Therefore, it is critical that all machinery and aggregate is thoroughly cleaned, or otherwise guaranteed free of attached seed or plant matter before it is brought on site.

Provided due care and initial weed control is carried out as and when required, it is expected that the pasture or indigenous scrubland species will quickly gain a foot-hold and dominate vegetative cover along access road batters and cuts.

6.9.2 Disease spread

The introduction of weeds and disease is a risk during construction activity. In particular myrtle rust and kauri dieback disease are potentially transmittable ecological diseases through the movement of machinery during the construction phase.

Thus, procedures and measures to prevent the introduction and or spread of kauri dieback and myrtle rust into the area should be developed and implemented. For instance, it is recommended that all equipment brought to site, both during construction and operation, is washed to remove soil prior to entry into the area and all contractors clean their equipment with the appropriate chemicals to kill the spores before undertaking work on the site to avoid any spread of the spores.

6.9.3 Animal pests

Given that the wind farm site is entirely within farm land and that no indigenous forest habitats would be fragmented by the proposal or its access ways there is no threat that the works will assist in the dispersal of introduced predators or pests in any way what so ever as all these species (e.g. stoats, possums, ship rats, feral cats) have free and unimpeded access at present.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary of Ecological Effects

The proposed Kaimai wind farm is situated in a landscape comprising farmland, production forestry with remnant forest in gullies and a large conservation forest located adjacent to the site. The footprint of the wind farm contains few significant natural areas, but it is adjacent to the Kaimai Mamaku Conservation Park. However, Ventus Energy state that the features within the Conservation park will not be directly affected by the construction of the turbines or their associated infrastructure.

Potential impacts of wind farms on indigenous vegetation and indigenous fauna can be divided into two categories – direct impacts and indirect impacts. Direct impacts could include:

- habitat loss and damage, and loss of plants and other wildlife, in the course of the wind farm, transmission line and access road construction;
- sediment run-off from the road, transmission line and turbine construction affecting waterways; and
- mortality of birds, flying insects, or bats when in a collision with the turbines, associated wind eddies, transmission lines or associated wind farm structures.

Indirect impacts could include:

- disturbance either from the wind farm and associated activities (noise, human presence) and associated behavioural responses, such as avoidance or attraction to the area;
- reduced breeding success of birds or other wildlife breeding in close proximity to the wind farm;
- new weeds and diseases being introduced into natural areas by machinery and fill material; and
- changes in interactions between species, such as predator prey dynamics, e.g. increased predation and scavenger pressure in treeless, unbuilt areas and adjoining fauna habitats, as the wind farm may provide suitable perches and shelter for predators that previously did not inhabit the area.

Effects on indigenous vegetation, aquatic habitats, lizards and terrestrial invertebrates associated with construction and operation of the proposed Kaimai Wind Farm are likely to be less than minor, provided best practice measures are implemented during construction and operation phases.

The potential adverse effects of turbine blade strike is likely to result in injury or mortality of some resident and migrating bird species, as well as long-tailed bats.

Tui, New Zealand falcon, kaka and kereru do fly at turbine blade height, and can perform aerial breeding displays at heights of over 30-50 m. However, collision risk analysis and carcass search studies under operating wind farms at other New Zealand sites have indicated that actual strike is rarely detected and where it occurs is in low numbers which the local population is able to sustain. Fencing, habitat restoration and animal pest control are recommended to an extent sufficient to increase the breeding success of these species to a level which will at least match the predicted effect.

Local flight movements of internal migrant New Zealand shorebirds, wetland and resident shorebirds/seabirds, and movements of international migrants to their staging areas between the Firth of Thames and the Bay of Plenty indicate that some of these birds will likely pass over the Kaimai Range on a regular basis. Bioacoustic surveys confirmed that South Island pied oystercatcher are at risk because they have been heard crossing the site on several occasions. Other migratory birds are likely to be using flight pathways across the Kaimai Range, even though they have not been detected. Therefore, these species may also be at risk of collision with turbine blades. However, previous studies of these species in New Zealand suggest that strike mortality will be low and able to be mitigated through the implementation of appropriate offset, compensation and monitoring/adaptive management measures during the operational lifespan of the wind farm. For example, to compensate for these potential turbine strike losses supporting initiatives which increase the breeding success of each of these species to a level that effectively replaces this number of breeding adults of each species would be an appropriate offset mitigation measure.

The nationally threatened North Island long-tailed bat is known to be present within the Kaimai Ranges and was detected during the surveys for this proposal within the wind farm site. Based on review of international studies it is considered possible that long-tailed bats will suffer mortality as a result of interactions with the turbines. Thus, bats are considered to be at moderate risk of being killed or injured by turbines. A combination of habitat restoration and pest control would enhance the local long-tailed bat population, producing a healthy source population which could mitigate against any declines at the proposed wind farm site. This offset animal pest control work should ideally be combined with the pest control and habitat restoration work recommended to offset strike mortality on resident indigenous birds.

7.2 Recommended Amelioration Measures

A range of measures that will avoid, remedy or mitigate (including biodiversity offset mitigation) the adverse effects of the project (inclusive of the wind turbines, access roads and the transmission lines) will be required. They should include:

- Preparing and implementing an ecological management plan (and associated fauna and flora specific management plans) to ensure that all aspects of the construction and operation of the wind farm are carried out in such a way to minimise any potential direct and indirect adverse effects on indigenous fauna and flora habitat disturbance associated with the 24 turbines;
- Preparing a mitigation package for mitigating the adverse effects associated with effects on habitats of indigenous fauna and potential bird and bat injury or mortality associated with turbine blade strike, which incorporates the following key principles:
    - Intensive sustained and targeted animal pest control in indigenous forest habitats nearby, but not directly adjacent to, the windfarm;
    - Enhancement of the ecological quality of targeted natural features (for example, through retirement and restoration of an equivalent-sized area of semi-grazed scrubland); and
    - Providing compensation funds for ongoing wader bird conservation initiatives potential wader bird strike to organisations, such as the Miranda Naturalists' Trust.
- Post construction mortality monitoring of key fauna species to ensure that the actual turbine strike injury or mortality associated with the operation of the wind farm are proven to be low and to allow for quantifiable risk minimisation contingencies if required. Monitoring should comprise of a dedicated “collision carcass retrieval team” (including a trained search dog if possible) that will undertake grid searches of a statistically robust representative sample of turbines at dusk for a period of three years post-operation, with associated reporting detailing any bird/bat fatalities, known or likely cause of death and any species, seasonal or spatial patterns.

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APPENDIX I
Site Photos

Figure 15. Kaimai Range forest adjacent to the proposed location of the turbines.

Figure 16. View of Kaimai conservation area from the grazed pasture near where turbines will be positioned.

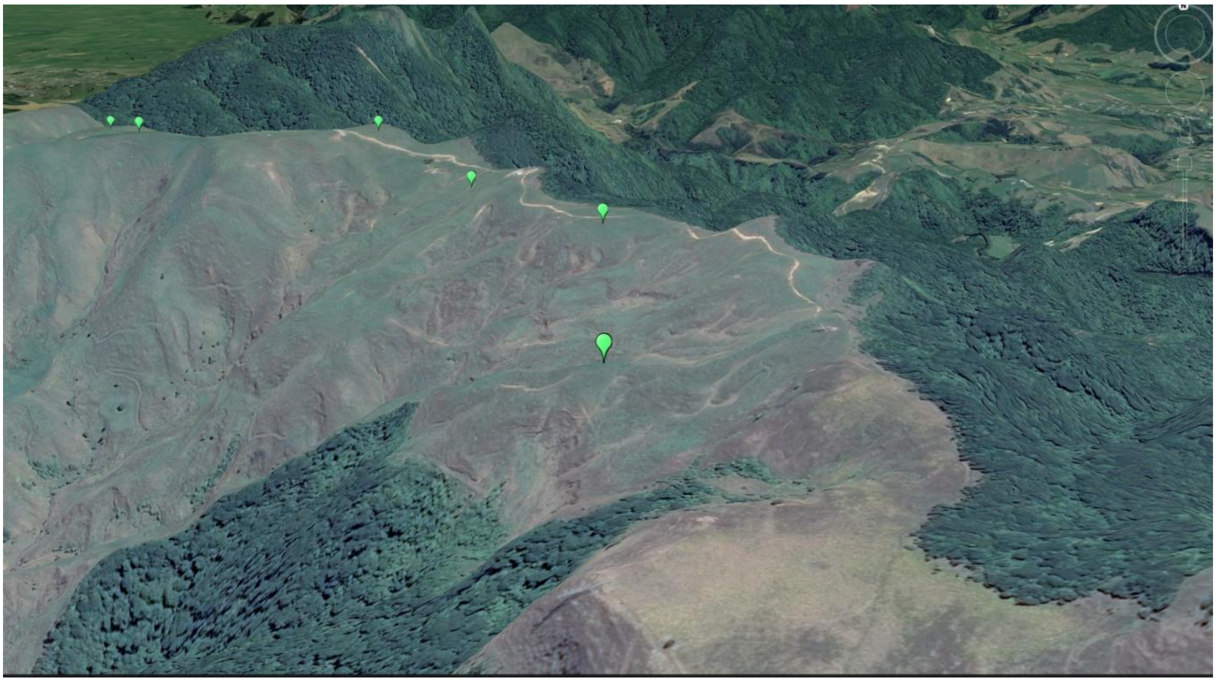

Figure 17. Image of the Kaimai Forest Park (right) and the proposed position of turbines 22-24 (front-rear). Image source: Google Earth

Figure 18. View into the farmland with its small stands of remnant forest and treeland. Trees are not fenced of and no understory is present.

Figure 19. View from the farm road which is likely to be developed for the windfarm with its small stands of remnant native trees.

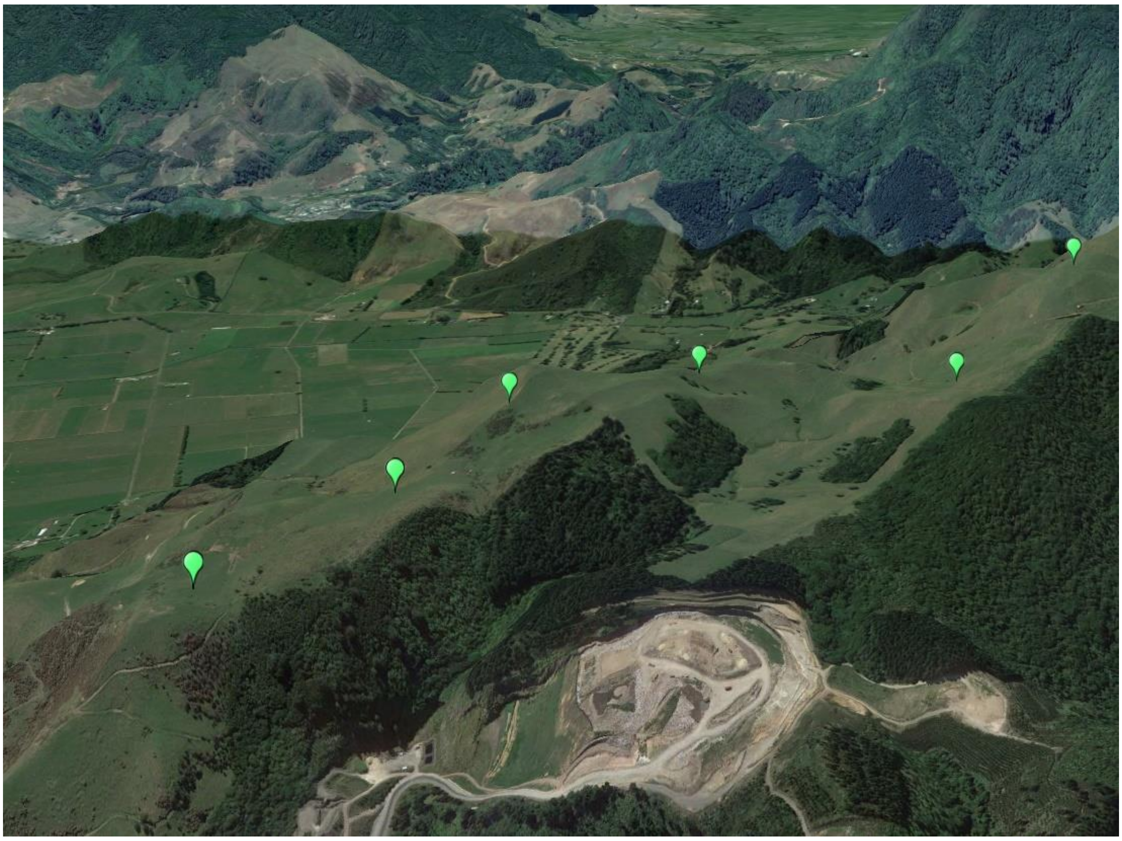

Figure 20. Pine plantations and native scrub/forest of mahoe, kanuka, treeferns with mature sections of rewarewa, tawa, rimu in gullies along streams near turbines 1, 3, 6, 9, and 11 (green dots, left to right) adjacent to the quarry site. Image source: Google Earth

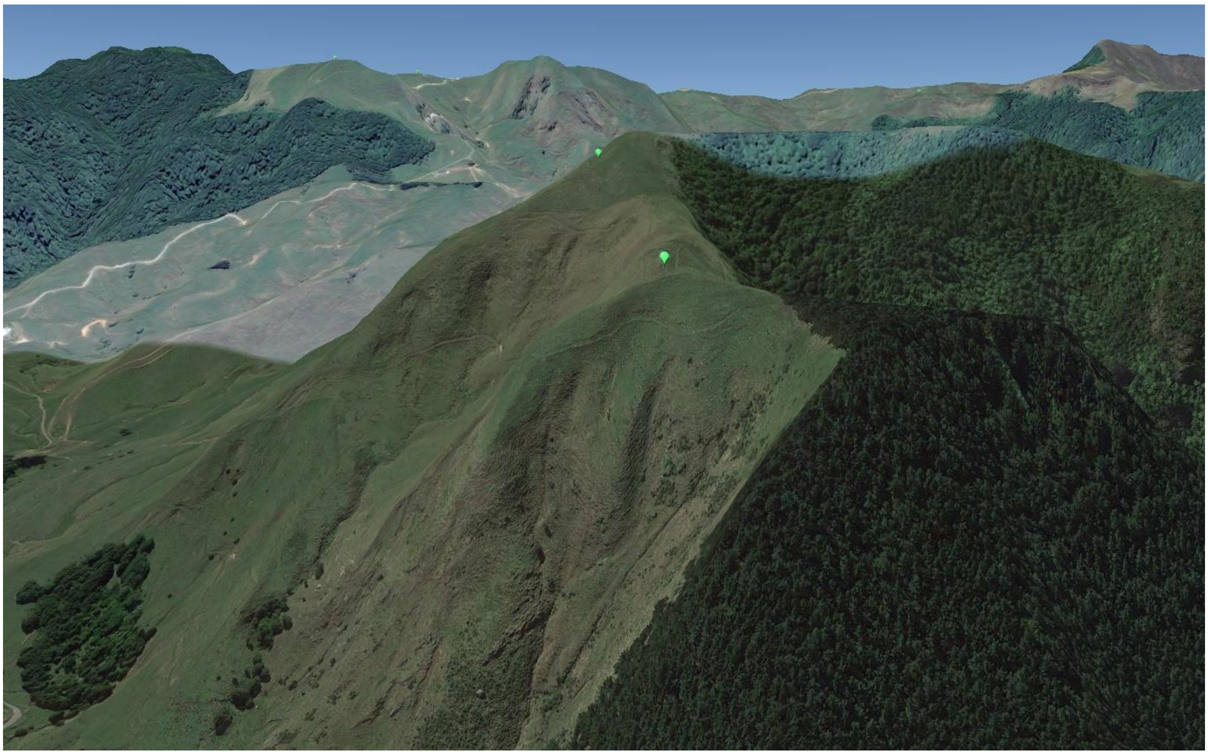

Figure 21. View onto mixed pasture and-broadleaved forest near proposed turbine site 18 -17 (front-back). Image source: Google Earth

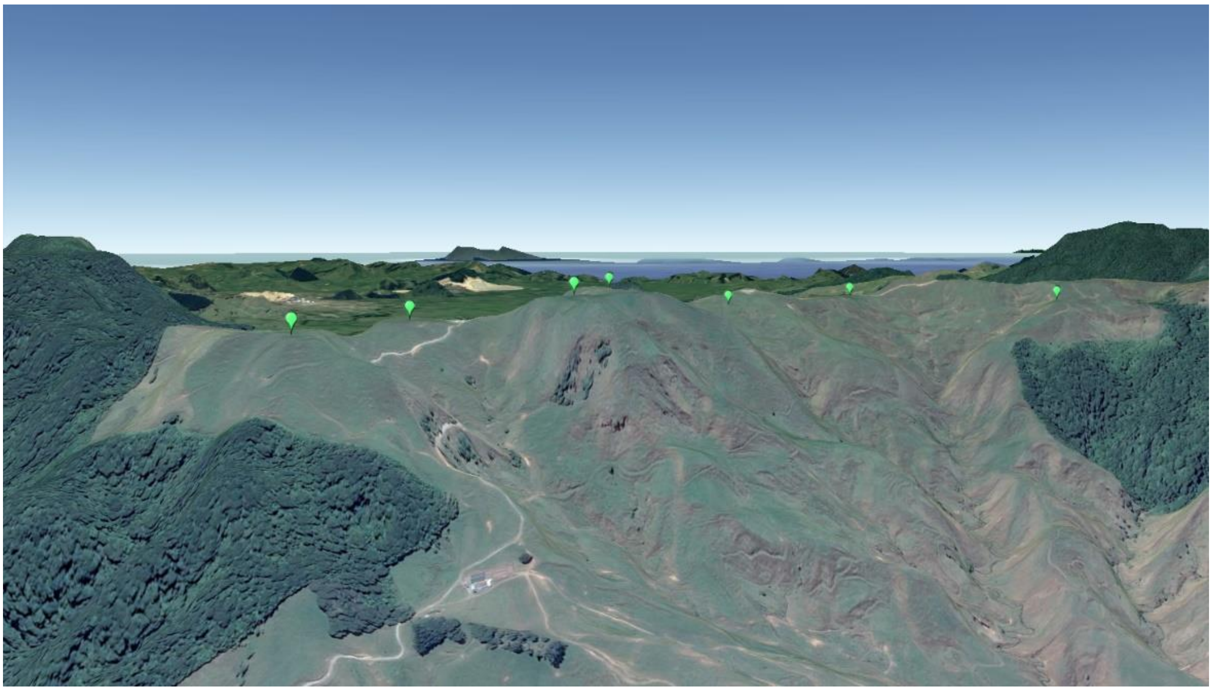

Figure 22. View to the east towards the Bay of Plenty showing mixed pasture kanuka-broadleaved forest remnants predominantly in steep gullies near proposed turbine sites 20-24. Image source: Google Earth

APPENDIX II
Waikato Regional Council Regional Policy Statement Criteria
(Utilised in Determining Ecological Significance)

Previously assessed site	
1.	It is indigenous vegetation or habitat for indigenous fauna that is currently, or is recommended to be, set aside by statute or covenant or by the Nature Heritage Fund, or Nga Whenua Rahui committees, or the Queen Elizabeth the Second National Trust Board of Directors, specifically for the protection of biodiversity, and meets at least one of criteria 3-11.
Ecological values	
2A	In the coastal environment, it is indigenous vegetation or habitat that has reduced in extent or degraded due to historic or present anthropogenic activity to a level where the ecological sustainability of the ecosystem is threatened.
3.	It is vegetation or habitat for indigenous species or associations of indigenous species that are: classed as threatened or at risk, or **endemic** to the Waikato region.
4.	It is indigenous vegetation or habitat type that is under-represented (20% or less of its known or likely original extent remaining) in an Ecological District, or Ecological Region, or nationally.
5.	It is indigenous vegetation or habitat that is, and prior to human settlement was, nationally uncommon such as geothermal, chenier plain, or karst ecosystems, hydrothermal vents or cold seeps.
6.	It is wetland habitat for indigenous plant communities and/or indigenous fauna communities (excluding exotic rush/pasture communities) that has not been created and subsequently maintained for or in connection with: waste treatment; wastewater renovation; hydro electric power lakes (excluding Lake Taupō); water storage for irrigation; or water supply storage;
7.	It is an area of indigenous vegetation or naturally occurring habitat that is large relative to other examples in the Waikato region of similar habitat types, and which contains all or almost all indigenous species typical of that habitat type. Note this criterion is not intended to select the largest example only in the Waikato region of any habitat type.
8.	It is aquatic habitat (excluding artificial water bodies, except for those created for the maintenance and enhancement of biodiversity or as mitigation as part of a consented activity) that is within a stream, river, lake, groundwater system, wetland, intertidal mudflat or estuary, or any other part of the coastal marine area and their margins, that is critical to the self-sustainability of an indigenous species within a catchment of the Waikato region, or within the coastal marine area. In this context "critical" means essential for a specific component of the life cycle and includes breeding and spawning grounds, juvenile nursery areas, important feeding areas and migratory and dispersal pathways of an indigenous species. This includes areas that maintain connectivity between habitats.
9.	It is an area of indigenous vegetation or habitat that is a healthy and representative example of its type because: its structure, composition, and ecological processes are largely intact; and if protected from the adverse effects of plant and animal pests and of adjacent land and water use (e.g. stock, discharges, erosion, sediment disturbance), can maintain its **ecological sustainability** over time.
10.	It is an area of indigenous vegetation or habitat that forms part of an **ecological sequence**, that is either not common in the Waikato region or an ecological district, or is an exceptional, representative example of its type.
Role in protecting ecologically significant area	
11.	It is an area of indigenous vegetation or habitat for indigenous species (which habitat is either naturally occurring or has been established as a mitigation measure) that forms, either on its own or in combination with other similar areas, an ecological buffer, linkage or corridor and which is necessary to protect any site identified as significant under criteria 1-10 from external adverse effects.

APPENDIX III
Location of bird and bat survey stations and summary of data collected

Table 17. Bird and bat survey site locations

Survey Site	NZTM-Eastings	NZTM-Northings	WGS-lat	WGS-lon	Type of Survey
VP1	1841170.00	5851486.00	-37.452057	175.726462	Vantage Point
VP2	1840975.00	5849575.00	-37.469314	175.724884	Vantage Point
VP3	1841588.00	5848178.00	-37.481732	175.732267	Vantage Point
VP4	1842657.00	5847242.00	-37.489879	175.744653	Vantage Point
VP5	1841600.00	5850511.00	-37.460723	175.731638	Vantage Point
VP6	1841589.00	5850129.00	-37.464166	175.731638	Vantage Point
VP7	1840426.00	5852127.00	-37.446480	175.717851	Vantage Point
VP8	1842226.00	5848052.00	-37.482699	175.739516	Vantage Point
VP9	1837777.11	5852235.95	-37.446183	175.687902	Vantage Point
VP10	1836852.84	5852738.02	-37.441900	175.677303	Vantage Point
VP11	1836604.33	5852173.06	-37.447050	175.674678	Vantage Point
BT1	1841340.00	5851679.00	-37.450275	175.728319	Bush Transect
BT2	1842198.00	5848302.00	-37.480456	175.739118	Bush Transect
BT3	1841600.00	5850511.00	-37.460723	175.731638	Bush Transect
BT4	1840337.00	5848625.00	-37.478033	175.717987	Bush Transect
KB1	1842592.07	5846080.73	-37.500351	175.744302	ABM
KB2	1842676.96	5847218.61	-37.490084	175.744886	ABM
KS3	1842406.07	5847793.41	-37.484980	175.741636	ABM
KS8	1842168.57	5848330.57	-37.480206	175.738776	ABM
KS6	1841433.00	5850105.72	-37.464416	175.729884	ABM
KS5	1840905.29	5849535.02	-37.469692	175.724110	ABM
K7	1841336.05	5851248.09	-37.454156	175.728415	ABM
KS2	1841627.97	5850579.44	-37.460100	175.731931	ABM
K3	1840522.08	5852010.22	-37.447506	175.718974	ABM
K6	1838847.03	5850638.20	-37.460293	175.700502	ABM
K1	1837857.35	5852305.13	-37.445540	175.688786	ABM
K12	1836607.38	5852714.26	-37.442177	175.674539	ABM
K8	1836573.38	5852105.24	-37.447669	175.674350	ABM
B10	1842654.89	5847038.57	-37.491711	175.744696	ABM
B11	1842200.26	5848234.00	-37.481067	175.739166	ABM
B12	1841358.29	5851128.34	-37.455228	175.728705	ABM
B15	1842390.73	5847849.12	-37.484482	175.741444	ABM
B16	1840943.71	5849667.00	-37.468494	175.724501	ABM
B19	1840867.92	5847976.29	-37.483736	175.724198	ABM
B2	1842197.91	5848301.31	-37.480462	175.739117	ABM
B20	1838824.61	5850638.34	-37.460298	175.700249	ABM
B21	1842606.10	5846201.01	-37.499264	175.744421	ABM
B22	1839057.58	5850432.52	-37.462091	175.702947	ABM
B23	1842471.81	5845925.14	-37.501783	175.742994	ABM
B25	1841027.78	5849980.76	-37.465647	175.725348	ABM
B28	1841629.95	5850527.57	-37.460567	175.731970	ABM
B8	1840595.41	5851931.82	-37.448193	175.719827	ABM
R1	1842211.91	5848308.30	-37.480395	175.739273	AR
R10	1841367.92	5849238.30	-37.472243	175.729433	AR
R11	1840951.92	5849625.30	-37.468867	175.724607	AR
R13	1841397.92	5850022.30	-37.465176	175.729515	AR
R14	1840548.92	5851943.30	-37.448102	175.719299	AR
R15	1842620.92	5846108.30	-37.500095	175.744619	AR
R16	1842428.92	5847774.29	-37.485146	175.741900	AR
R17	1841308.92	5851260.30	-37.454053	175.728105	AR
R19	1838920.92	5850670.30	-37.459985	175.701326	AR
R20	1841712.92	5850699.30	-37.458999	175.732851	AR
R7	1840569.72	5847902.27	-37.484480	175.720853	AR
KS18	1842592.07	5846080.73	-37.500351	175.744302	AR
KA10	1842168.57	5848330.57	-37.480206	175.738776	AR
KA11	1841433.00	5850105.72	-37.464416	175.729884	AR
KA16	1840905.29	5849535.02	-37.469692	175.724110	AR
KA3	1841336.05	5851248.09	-37.454156	175.728415	AR
KA12	1841627.97	5850579.44	-37.460100	175.731931	AR
KA16	1840522.08	5852010.22	-37.447506	175.718974	AR
KA1	1838847.03	5850638.20	-37.460293	175.700502	AR
KA9	1837857.35	5852305.13	-37.445540	175.688786	AR
KA8	1836607.38	5852714.26	-37.442177	175.674539	AR
KS20	1836573.38	5852105.24	-37.447669	175.674350	AR

Table 18. Vantage point bird observations. Total number of birds heard or seen at each vantage point site (VP1-VP11) from 2009, 2010, 2013 and 2015.

		VP1		VP2		VP3		VP4		VP5		VP6		VP7		VP8		VP9		VP10		VP11	
Year	Species	Heard	Seen	Heard	Seen	Heard	Seen	Heard	Seen	Heard	Seen	Heard	Seen	Heard	Seen	Heard	Seen	Heard	Seen	Heard	Seen	Heard	Seen
	Bellbird	3				3																	
	Blackbird	4		3		7		2															
	Chaffinch	5		3		6	1	7	1														
	Eastern rosella	2		1		1	3		2														
	Fantail					1																	
	Goldfinch		3	1	2	2	11	2	4														
	Grey warbler	1		5		4		5															
	Harrier		6				8		6														
	Indian myna			1				1															
	Kereru		1		1				1														
	Kingfisher	2		2		2		1															
	Magpie	3	3	2	1	5	18	5	6														
	Paradise duck																						
2009	Pheasant			2		3		3		N/A		N/A		N/A		N/A		N/A		N/A		N/A	
	Pipit																						
	Shining cuckoo	1		1		1																	
	Silvereye			1		3	1	1															
	Skylark			1		5	3	5	1														
	Sparrow																						
	Spur-winged plover							2	1														
	Starling																						
	Swallow		1				5		2														
	Tomtit			1		1																	
	Tui		1	1		2	2	1															
	Turkey		6	5		3		3															
	Unidentified																						
	Welcome swallow		2		1		1		3														
	Yellowhammer	2	1	2		13	1	9	3														
	Bellbird																						
	Blackbird									3	1	2		1									
	Chaffinch	3		4		5		2		5	1	5		4	1	2	3						
	Eastern rosella		1	2	1			1		1		1											
	Fantail				1				1			1		4									
	Goldfinch	2	4		6		19	1	13	1	1												
	Grey warbler	2		6		6	1	6	1	1	1	2		5	1	1	4						
	Harrier		11		17		5		7				3		1		1						
	Indian myna		6																				
	Kereru										1												
	Kingfisher			2	1																		
	Magpie	15	16	9	17	14	23	12	11					4		1							
	Paradise duck																						
2010	Pheasant					1		2				1						N/A		N/A		N/A	
	Pipit						1																
	Shining cuckoo	1		1						1		3											
	Silvereye							1		1				1									
	Skylark	2		3	1	5	2	2		1		3				3							
	Sparrow	2	6																				
	Spur-winged plover	2				1																	
	Starling																						
	Swallow		3	3			5		4								1						
	Tomtit													2	1								
	Tui				2																		
	Turkey	3	18	1	16		1																
	Unidentified				2						2												
	Welcome swallow																						
	Yellowhammer	3	1	1		1		2		4		2	1			4	3						

	Bellbird																						
	Blackbird											1											
	Chaffinch	2		1		3		2				3		5		3							
	Eastern rosella																						
	Fantail			2		2							1	2	1	1							
	Goldfinch	4	2											2		1							
	Grey warbler	2		1		3	1	1				2		2	1	2							
	Harrier						1								1								
	Indian myna																						
	Kereru																						
	Kingfisher															2							
	Magpie	1				2																	
	Paradise duck																						
2013	Pheasant									N/A								N/A		N/A		N/A	
	Pipit																						
	Shining cuckoo																						
	Silvereye																						
	Skylark	2	1			2		4					1										
	Sparrow																						
	Spur-winged plover																						
	Starling																						
	Swallow																						
	Tomtit																						
	Tui											1											
	Turkey					1	2																
	Unidentified				2																		
	Welcome swallow	1	2	5	4							2	3										
	Yellowhammer																						
	Bellbird																						
	Blackbird										1												
	Chaffinch	1								1								1					
	Eastern rosella													1						1			
	Fantail													3								1	
	Goldfinch																						
	Grey warbler	1								1		2		1	1	1		1		1		1	
	Harrier																	1					
	Indian myna																			1			
	Kereru																						
	Kingfisher											1		1		1						1	
	Magpie	1						1	1	1			3	1	1	1		1	8	2	1		
	Paradise duck												2								2		2
2015	Pheasant			N/A		N/A																	
	Pipit																						
	Shining cuckoo																	1					
	Silvereye	1																					
	Skylark															1							
	Sparrow									1													
	Spur-winged plover																						
	Starling																	1	3				
	Swallow																						
	Tomtit																						
	Tui																	1	1				
	Turkey								9				2	1		1			4		5		
	Unidentified																						
	Welcome swallow								1							1	1		3				
	Yellowhammer										1					1							

Table 19. Bush line transect bird surveys. Total number of observed birds at each survey site (BLT1-BLT4) from 2010 and 2013.

		Total number of bird observations			
Year	Species	BT1	BT2	BT3	BT4
2010	Bellbird	1			
	Blackbird	8	1	2	
	Chaffinch	11	4	4	
	Eastern rosella	1			
	Fantail	23	7		
	Goldfinch	2	6		
	Greenfinch			2	
	Grey warbler	31	15	1	
	Harrier			3	4
	Kereru	2	1	1	1
	Kingfisher			1	
	Magpie	23	18	2	4
	Morepork		1		
	Paradise duck				
	Pipit		1		1
	Shining cuckoo	1			
	Silvereye	13	8		
	Skylark		6	2	4
	Songthrush			1	
	Spur-winged plover	5			
	Tomtit	11	9		
	Tui		1		
	Turkey				
	Unidentified				
	Welcome Swallow				9
	Yellowhammer	1	1	2	1
2013	Bellbird				
	Blackbird				
	Chaffinch	8	6	2	4
	Eastern rosella				
	Fantail	13	4	2	
	Goldfinch	1			
	Greenfinch				
	Grey warbler	9	1	1	
	Harrier		2	1	1
	Kereru	1			
	Kingfisher				1
	Magpie	1	1		1
	Morepork				
	Paradise duck				4
	Pipit				
	Shining cuckoo	2			
	Silvereye				
	Skylark		7	3	15
	Songthrush				
	Spur-winged plover				
	Tomtit	2			
	Tui				
	Turkey			2	
	Unidentified		1		
	Welcome Swallow		6	18	17
	Yellowhammer		6		2

APPENDIX IV
Vegetation matrix map sections

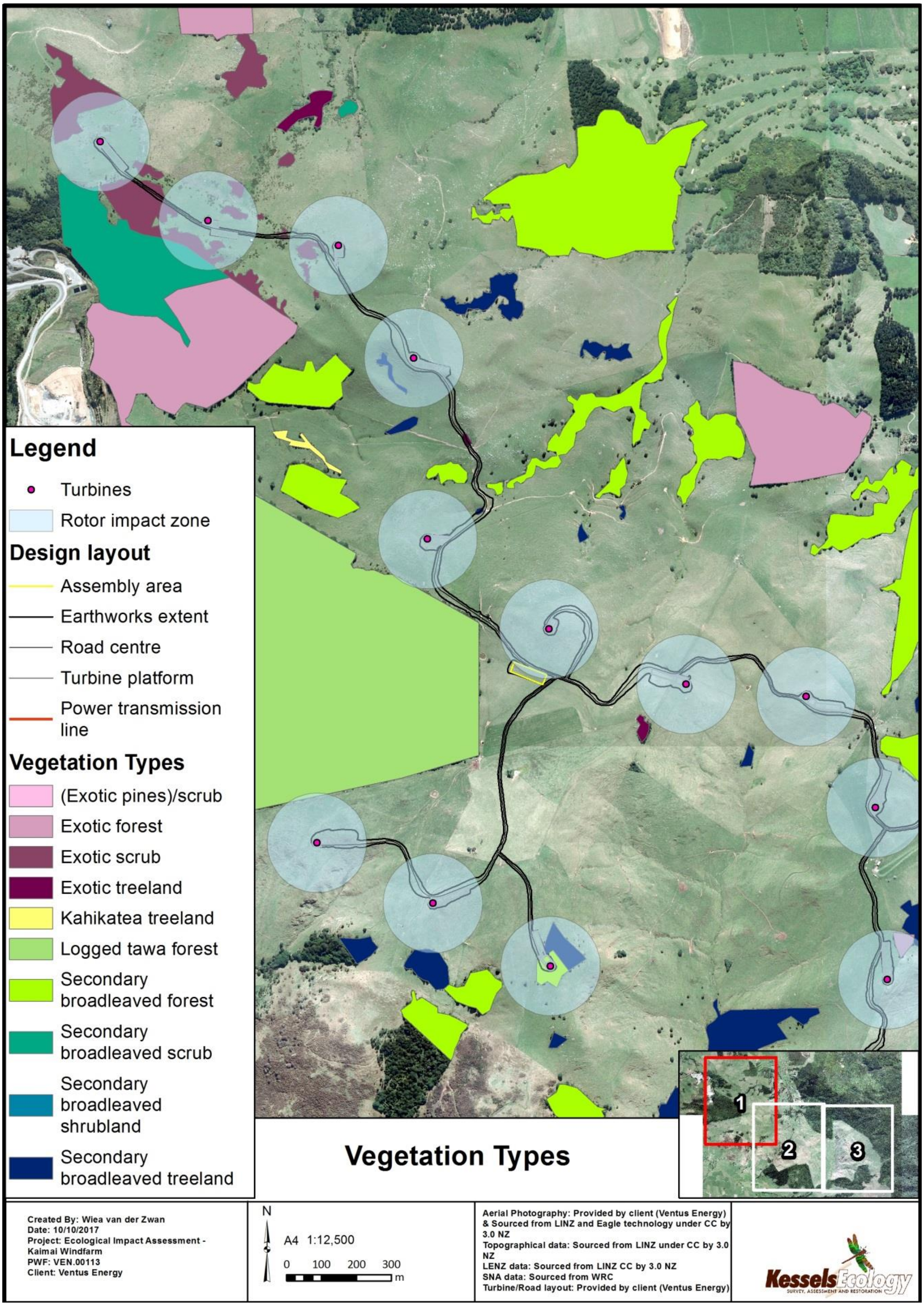

Figure 23. Vegetation matrix – map section 1.

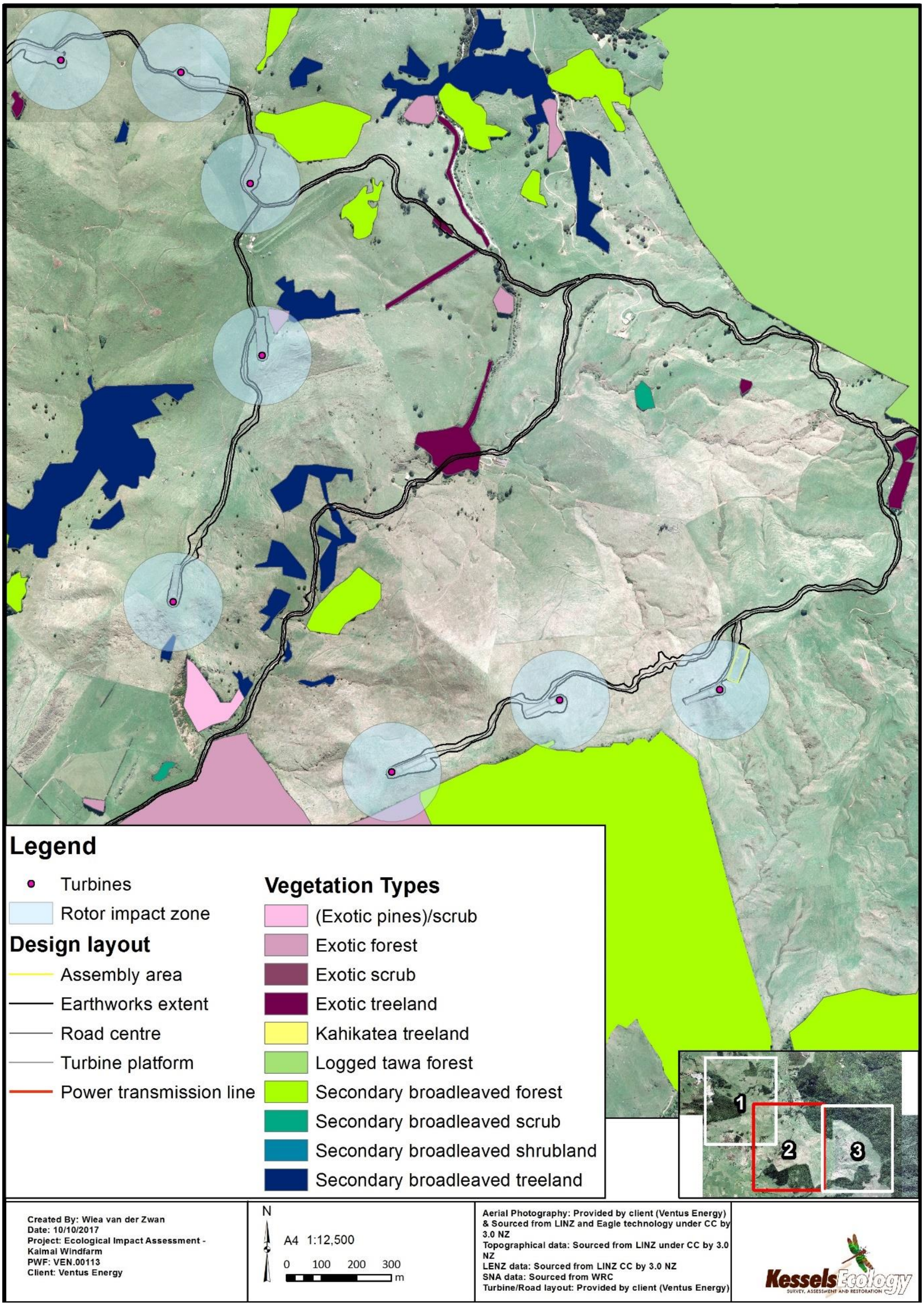

Figure 24. Vegetation matrix – map section 2.

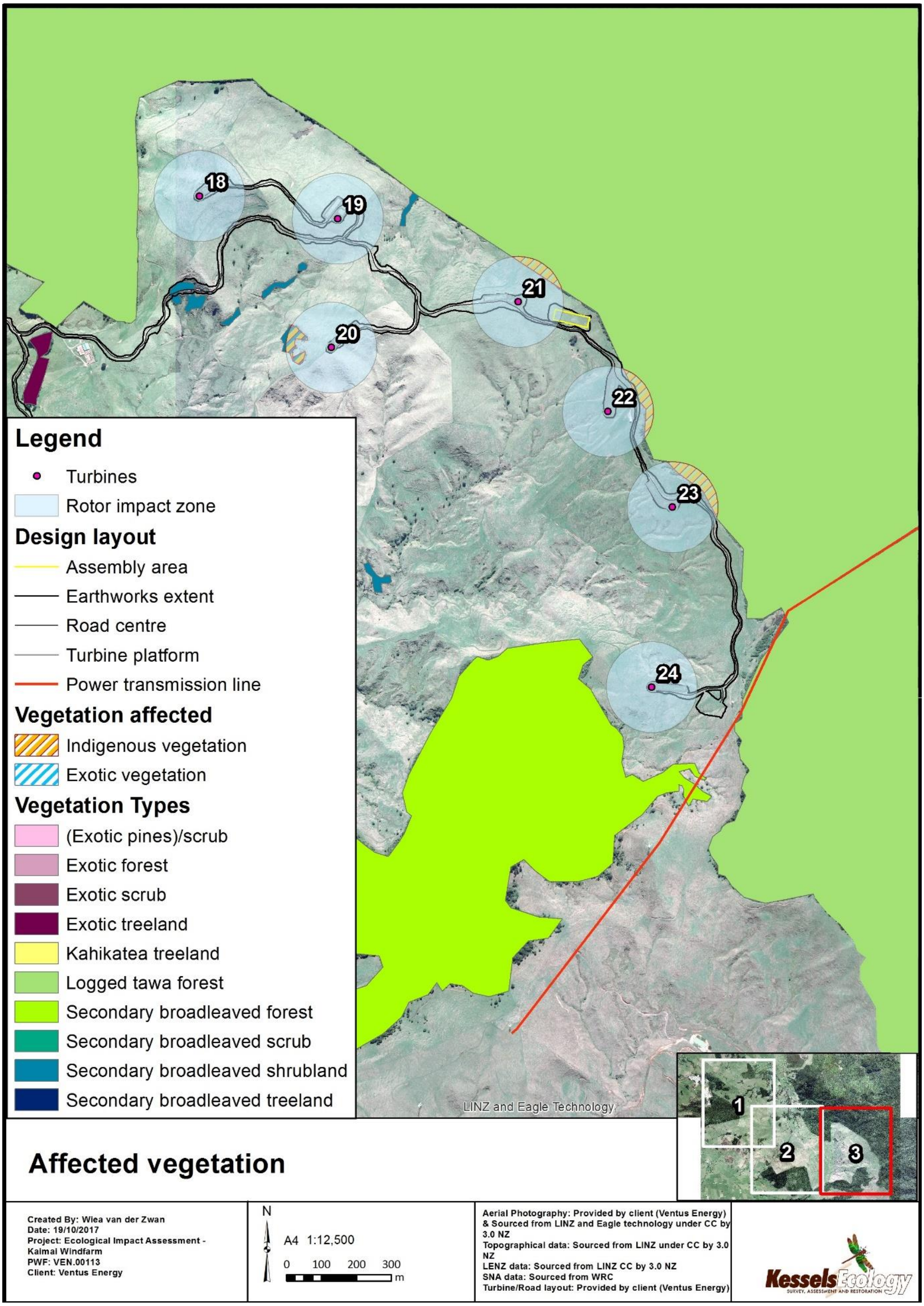

Figure 25. Vegetation matrix – map section 3.

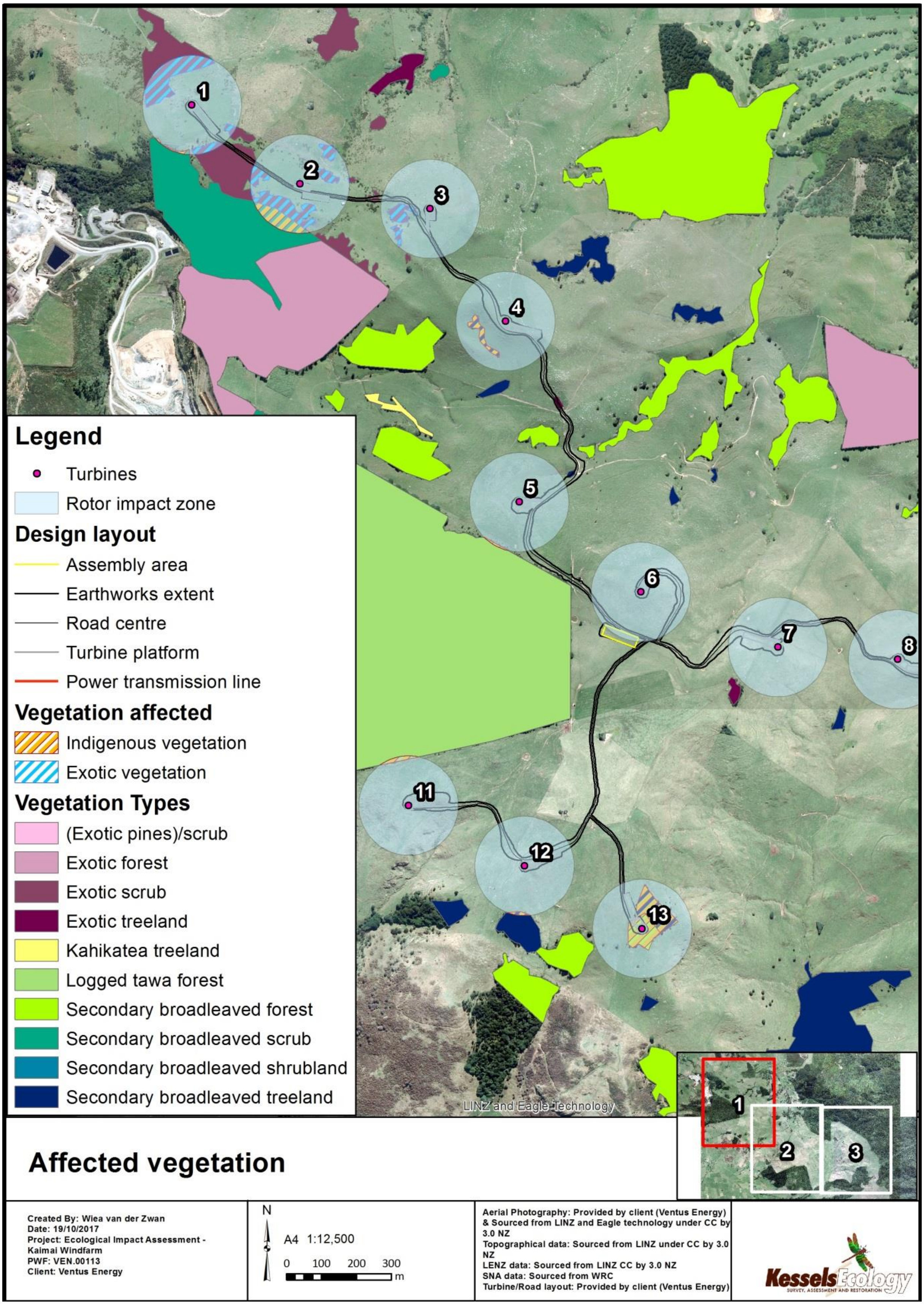

Figure 26. Affected vegetation matrix – map section 1.

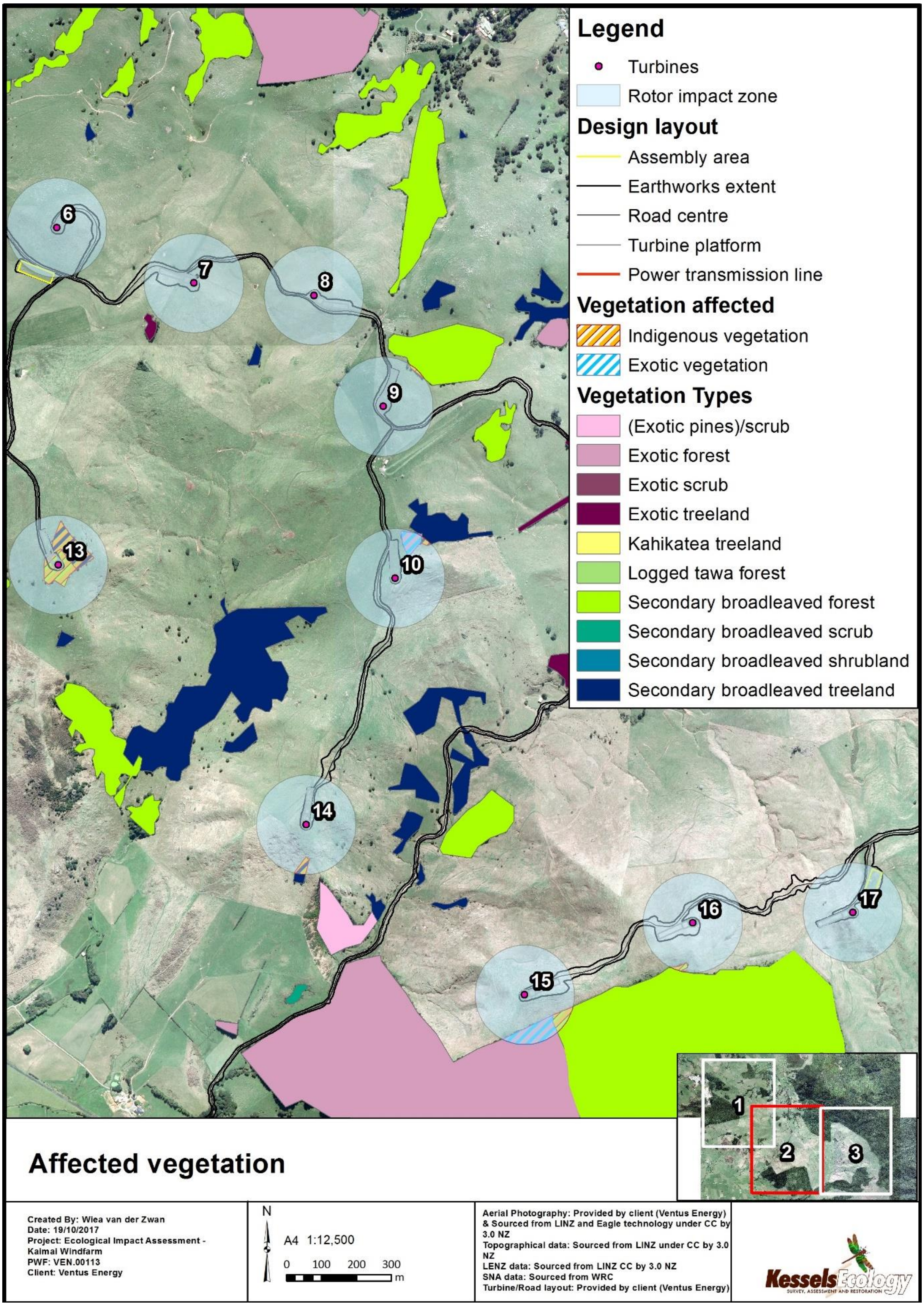

Figure 27. Affected vegetation matrix – map section 2.

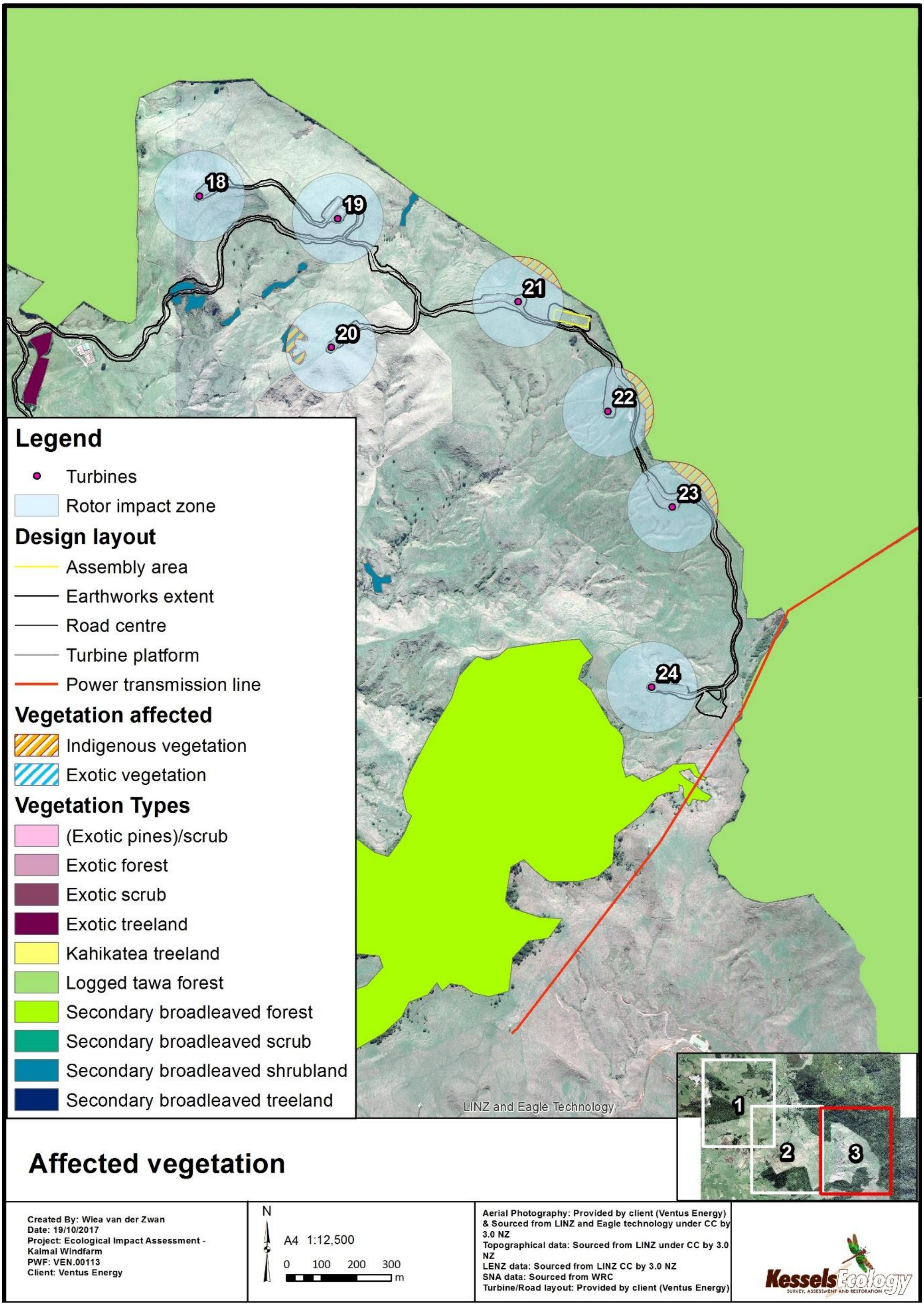

Figure 28. Affected vegetation matrix – map section 3.

APPENDIX V
Botanical Species List

This list was compiled during the visit in March 2017.

* denotes a non-native species

Gymnosperm Trees & Shrubs

Radiata pine*	**Pinus radiata*
Rimu	*Dacrydium cupressinum*
Totara	*Podocarpus totara*
Kahikatea	*Dacrycarpus dacrydioides*

Monocotyledonous trees and shrubs

Cabbage tree	*Cordyline australis*
Nikau	*Rhopalostylis sapida*
Tank lily	*Astelia hastate*
Kiekie	*Freycinetia banksii*

Dicotyledonous trees and shrubs

Titoki	*Alectryon excelsus* subsp. *excelsus*
Tawa	*Beilschmiedia tawa*
Rangiora	*Brachyglottis repanda*
Marbleleaf	*Carpodetus serratus*
Kanono	*Coprosma grandifolia*
Macrocarpa*	**Cupressus macrocarpa*
Kohekohe	*Dysoxylum spectabile*
Gum*	**Eucalyptus* sp.
Sun spurge*	**Euphorbia helioscopia*
Ash*	**Fraxinus excelsior*
Hangehange	*Geniostoma ligustrifolium* var. *ligustrifolium*
Koromiko	*Hebe stricta*
Lacebark	*Hoheria sexstylosa*
Rewarewa	*Knightia excelsa*
Pukatea	*Kunzea ericoides*
Kanuka	*Laurelia novae-zelandiae*
Manuka	*Leptospermum scoparium*
Mingimingi	*Leucopogon fasciculatus*
Mangeao	*Litsea calicaris*
Mahoe	*Melicytus ramiflorus*
Puka	*Meryta sinclairii*
Inkweed*	**Phytolacca octandra*
Kawakawa	*Piper excelsum* subsp.*excelsum*
Karo	*Pittosporum crassifolium*
Lemonwood	*Pittosporum eugenioides*
Karo	*Pittosporum ralphii*
Kohuhu	*Pittosporum tenuifolium*
Lancewood	*Pseudopanax crassifolius*
Fivefinger	*Pseudopanax arboreus*
Pate	*Schefflera digitata*
Kowhai	*Sophora* sp.
Gorse*	**Ulex europaeus*
Puriri	*Vitex lucens*

Dicotyledonous lianes and related trailing plants

Rata	*Metrosideros* sp.
Pohuehue	*Muehlenbeckia australis*

Monocotyledonous lianes

Supplejack	*Ripogonum scandens*

Ferns

Rasp fern	*Blechnum parrisiae*
Hard fern	*Blechnum* sp.
Wheki	*Dicksonia squarossa*
Silver fern	*Cyathea dealbata*
Kowaowao	*Microsporum pustulatum* subsp. *pustulatum*
Gully fern	*Pneumatopteris pennigera*
Pyrrosia	*Pyrrosia eleagnifolia*
Ladder fern	*Nephrolepis cordifolia*
Golden tree fern	*Dicksonia fibrosa*

Grasses

Pasture grasses	Loliinae

Rushes and allied plants

Soft rush*	**Juncus effusus*
Purei	*Carex secta*
Forest sedge	*Carex lambertiana*

Monocotyledonous herbs

Harakeke	*Phormium tenax*
Bush flax	*Astelia fragrans*

Dicotyledonous herbs - including composites

Narrow-leaved plantain*	**Plantago lanceolata*
Creeping buttercup*	**Ranunculus repens*