ENGINEERING CONSULTANTS

Kaimai Wind Farm

Civil Engineering Peer Review

KAIMAI WIND FARM LTD

Project reference: 13969

May 2018

KAIMAI WIND FARM

KAIMAI WIND FARM CIVIL ENGINEERING PEER REVIEW, PAEROA

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1.0 INTRODUCTION

1.1 Project Background

Long-term projections on New Zealand's electricity demand indicate sustained growth over the medium to long-term. This increase must be met by sustainable growth in power generation capacity, and national government has provided direction and commitment toward the growth of capacity particularly from renewable sources. Latest projections indicate that up to 52% of new bulk energy sources to the New Zealand Grid up to 2026 would need to be sourced from wind power.

The proposed Kaimai Wind Farm development seeks to harness renewable wind energy within the upper North Island region close to Auckland, Hamilton and Tauranga demand centres, to supply an additional 100MW power capacity into the supply grid to this area. Typically the following criteria would be assessed to determine the suitability of a proposed wind farm site –

- Availability of a reliable wind source
- Availability of suitable land for construction of turbines
- Close proximity to locations of high energy demand
- Suitable distance from large population centres
- Practical access for transporting equipment and materials to the site
- Ability to connect to the national grid, and
- Avoidance of sensitive environmental areas

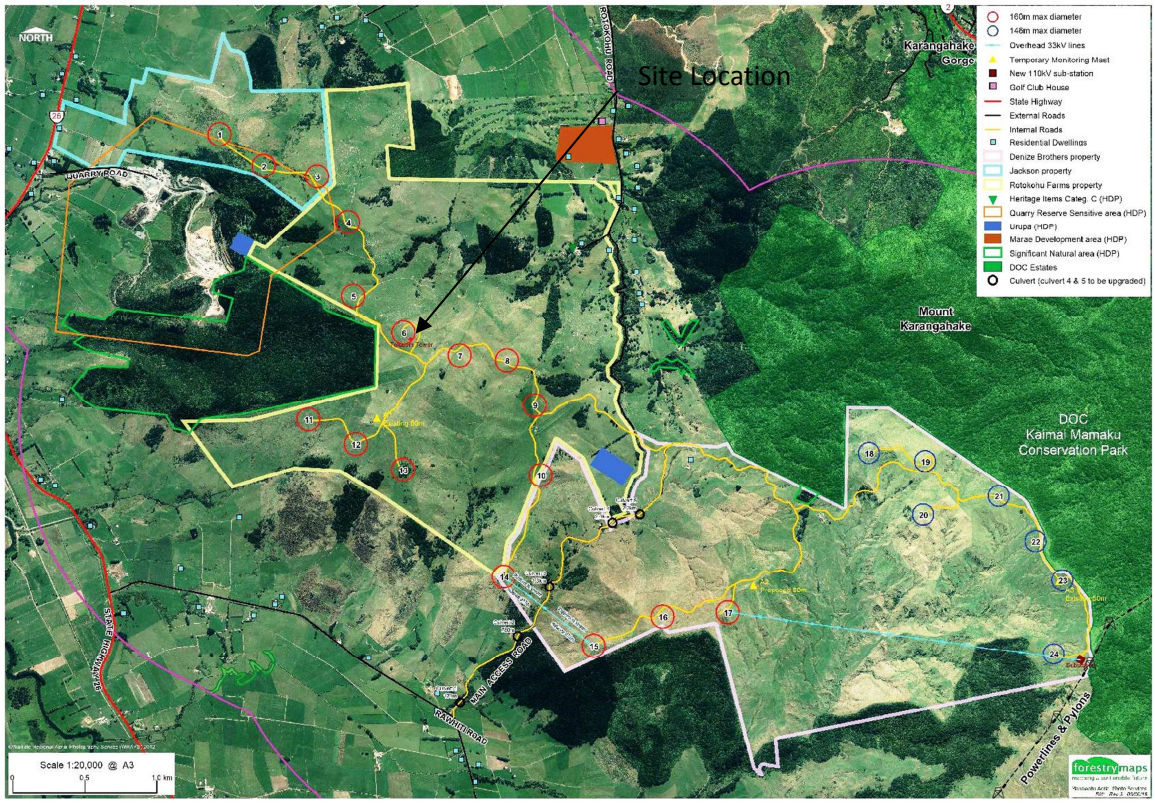

Figure 1: Site location and layout (Courtesy of Forestry Maps and Ventus Energy)

Kaimai Wind Farm Ltd have undertaken a broad range of studies to assess these any many other factors relating to the suitability, practicality and sustainability of the proposed wind farm, situated on the northern slopes of the Kaimai ranges, some 7km south of Paeroa and located within three privately owned farms, as indicated on the above site location and layout plan (Figure 1).

1.2 Scope of Work

Tiaki Engineering Consultants Ltd (TECL) has been engaged to undertake a broad peer review of the various civil engineering assessment studies, reports and preliminary designs completed by various parties in the development of the project concept, prior to commencing the process for application for Resource Consent from the Waikato Regional and Hauraki District councils.

The peer review therefore reviews the preliminary work carried out in assessing the suitability of the site from an engineering and construction practicality viewpoint, as well as identifying engineering risks associated with the construction, prior to Resource Consent application.

The report summarises the main items identified during the peer review process for further discussion and comment, and also seeks to provide consistency in approach and standard between the various engineering studies completed. It is further noted that on 23rd May the proposed turbine specifications for the installation were changed, and that all related reports were to be updated for the new specifications as required.

2.0 GEOTECHNICAL INVESTIGATION AND CONSIDERATIONS

A geotechnical engineering investigation exercise and report was carried out by KGA Geotechnical in 2016, including site investigation at each of the proposed twenty-four turbine sites and the electrical sub-station site, and general recommendations for the proposed access road upgrades. The investigation included a desktop study of aerial photos and published geotechnical maps, a detailed on site visual inspection, and selected sub-surface testing using hand operated equipment.

The report included assessment of Seismic design parameters considered applicable to the site, general site stability, settlement potential, founding parameters, drainage, access way and cable trench considerations, as well as the expected potential for sourcing roading and platform aggregate within the course of construction excavation.

The Table below provides a brief overall site summary as a geotechnical risk matrix for all twenty-four turbine sites identified. RZG have confirmed a similar matrix to be included within their report for the purposes of high level assessment.

Table 1: Description

Turbine	Historic Slope Instability	Shallow Rock Noted <3m	Creation of Platform for Turbine & Crane	Suspect Founding Conditions	Access Track Considerations
1					
2					
3	Yes	Yes	Yes		
4		Yes	Yes		
5			Yes	Yes	
6			Yes		
7			Yes		
8		Yes			
9		Yes			
10		Yes	Yes		
11	Yes	Yes	Yes		
12			Yes		
13		Yes	Yes		
14	Yes	Yes	Yes		Yes
15	Yes		Yes		
16	Yes		Yes		
17	Yes		Yes		
18	Yes		Yes		
19			Yes		
20	Yes		Yes		
21			Yes		
22	Yes		Yes	Yes	
23	Yes		Yes	Yes	
24	Yes		Yes		

In general the assessment report was suitable as an initial investigation for the purposes of feasibility assessment and Resource Consent application. Following initial review, the following potential issues were raised –

- It is important that there is consistency between the geotechnical recommendations and the other roadway and construction reports in terms of requirements such as maximum cut and fill slopes to platforms and roadways, assessment of deep road cuttings and steep side embankments at crest curves and platform sites, and estimated potential volume of rock which may be won during construction activities that can be used for crane platforms, laydown areas and road metalling. The geotechnical report should include some commentary on expected retaining wall solutions in areas of large cut and fill typically at platform and laydown area sites, as well as particular sections of roadway. In discussion with KZG, it is expected that a minimal percentage of metal required on the site will be won during roadworks operations, however the location of potential borrow pits and spoil areas has been determined, and will be included within the report.
- Although there have been some discussion on typically conservative foundation sizes for the turbines with the suppliers, further work is required to assess on-site conditions against supplier assumptions and minimum requirements for bearing capacity, etc. It is however expected that preliminary foundation sizes have been conservatively estimated. Foundation design assessment for each specific site will form an important part of the detailed design stage and will require individual assessment for each turbine.
- The characteristics of the proposed typical rock layers for founding are unclear at this preliminary stage, as only indicative refusal depths have been verified to date. It is expected that deep borehole drilling will only take place during detailed design stage, and the

suitability of the underlying rock for potential dowel anchorage assessed thereafter. Again, detailed foundation assessment and design will be required for each unique turbine site at detailed design stage, and RZG have confirmed that they will include recommendations within the preliminary assessment of the level of further investigation, testing and geotechnical design required for each site at the following detailed design stage.

- Although some of the general seismic characteristics of the site location, and underlying soil conditions are indicated in the geotechnical report, none of the engineering reports viewed to date discuss the expected Importance Levels and Design Life of the proposed facility, both of which will influence the design loading magnitude of seismic effects on the turbines, in terms of NZS1170 Part 0 design Annual Probabilities of Exceedance. It is therefore currently unclear as to what parameters have been used to assess the nominal foundation sizes, and whether this has been assessed against New Zealand Standards. The RZG report is to be updated to include information such as the expected Design Life, Importance Level, peak ground accelerations and resultant seismic design actions and requirements applicable to the site in general.
- Although not specifically related to the geotechnical aspects of the project, the turbine supplier will need to undergo significant design verification checks and review to ensure that the supplied turbines, ie blades and stem, are capable of resisting the local design seismic loading effects specific to the site conditions, in accordance with the requirements of New Zealand Standards and Codes of Practise.
- The geotechnical report should propose the level of geotechnical investigation, testing, verification and PS4 sign-off required for each individual turbine site during construction (In addition to the detailed geotechnical investigation and design process), to assist in formalising any Resource Consent conditions for on-site verification and sign-off of foundation platforms.

3.0 SEDIMENT CONTROL, STORMWATER AND CULVERT ASSESSMENTS

An engineering investigation report was carried out by Civil Engineering Services Ltd in October 2017, including site investigation and visual assessment at each of the proposed sites, detailing of general siltation mitigation proposals and solutions suitable to a typical discreet turbine site and typical roadway formations, as well as a separate assessment report of 4no culvert crossings identified along the main access roadway from State Highway 26 to the south of the site (Road One).

Following review of the reports completed to date and discussions between Civil Engineering Services Ltd, the following areas were discussed for further investigation and inclusion in preliminary assessments during the Resource Consent appraisal process or at detailed design stage as required –

- Although the sediment control and siltation mitigation proposals are well described and outlined within the report, it was agreed that a typical turbine site layout plan would be useful considering the similarity in site layouts, detailing typical arrangements of foundation excavations, water cut offs, topsoil bunding, rock check dams and silt fences, sediment pits and decant ponds, etc in relation to the adjacent crane pads and laydown areas. A typical layout drawing plan would enable better understanding of the logistics required for each discreet site, and facilitate better review and discussion during the Resource Consenting process.

- Further to the initial site investigation of culvert crossings, an additional fifth culvert crossing was discovered on site by the farmer at approximately chainage 2200m along 'Road One'. This is to be investigated and included within the assessment report by Civil Engineering Services Ltd.

- Roadway long-section preliminary designs completed after the culvert crossing assessment report indicate some filling and raising of the roadway at certain sag curves along 'Roadway One', including some raising of road levels over culvert crossings assessed. These raised roadways should be taken into consideration when assessing some of the culvert crossings which are assumed to overtop during 2 year storm events or greater for final design purposes and have been assessed on the basis of causeway design, as raised headwall levels would increase backflow behind the culvert and cause potential flooding or erosion issues elsewhere adjacent the roadway.

4.0 ACCESS ROADWAY NETWORK DESIGN

Preliminary engineering designs and drawings were carried out by Tektus Consultants Ltd in October 2017 for the upgrading of existing farm access roadways and tracks to a gravel / metal surfaced double access lane 6m wide roadway, which would be suitable for the construction access demands and trip frequencies of the individual turbine and substation sites, as well as for the long-term accessibility and maintenance requirements of the facility. It is noted that the full wind farm of 24no turbines is located across three adjacent privately owned farms, and that in general most of the proposed roadway access upgrades follow existing farm track basic alignments.

The roadway does however traverse reasonably steep and contoured hilly terrain which poses a number of challenges both for the construction of the roadway, as well as creating a reasonable and practical access route to all 25 discreet sites during the construction period for the intended deliveries. In this regard, the following items were noted for discussion –

- The roadway design longsections have a number of slopes at 15% (1 vertical in 6.7 horizontal) and an individual steepest section of 16.2% (1 vertical in 6.2 horizontal), which is steeper than the recommended 1 in 8 slopes mentioned within the Construction Report. It is recommended that this be investigated further with intended transport companies or Tranzcarr to verify that delivery of large and heavy components are possible at these slopes, particularly in potentially wet conditions.
- Again, some correlation with the geotechnical report is required to ensure limitations are not exceeded with respect to maximum allowable cut and fill slopes, limitations to deep cutting areas at certain roadway crowns, and potential sequencing of roadway construction to make best use of potential gravel material borrow areas in roadway cuttings. Retaining structures may be required in certain areas.
- In terms of roadway geometry, there are some unusual practical requirements to be considered with respect to the delivery of the seventy-two no. 78m length single unit turbine blades to the individual turbine sites. Tranzcarr Transportation studies have only

assessed routes to the entranceway on SH26, however restrictions to transport to individual sites will be governed by the internal access route geometry. Vertical alignment over the 78m blade length at the crest of certain roadway sections are of concern, as are horizontal curves where steep embankment cuttings are present to the inside of the curve. It is understood that each blade weight is approximately 20t, and is not feasible to perform any airlift operations of the blades via helicopter. It is strongly recommended that Tranzcarr assess the designed internal roadway and adjacent embankment geometry to confirm the transportability and manoeuvrability of the 78m long single-piece blades along these roads.

- The wind farm construction reports as a whole should indicate the degree of possible variability in position of each wind turbine site, and if this will have any impact on final access roadway route selection.

5.0 CONSTRUCTION CONSIDERATIONS

An overall engineering assessment report was carried out by Energy3 in March 2018, dealing primarily with the practical aspects of the construction phase of the wind farm installation, reviewing the preliminary geotechnical parameters identified, access and roadway construction requirements and potential issues, typical preliminary foundation details provided to date and construction requirements for these, as well as the craneage and laydown area requirements for each discreet turbine site and the single substation site.

The Construction Report was reviewed by Tiaki in an attempt to create consistency in parameters across the various civil engineering related reports, as well as identify any additional considerations required from a practical perspective in the design and construction methodology of the facility, which may require further input or consideration at Resource Consent stage. Following this review process, the following items were identified for further discussion and consideration –

- In general it is recommended that Heritage New Zealand, local iwi leadership structures and mana whenua, and the general public be engaged prior to formal application for Resource Consent, to ensure no unforeseen opposition to the planned project at consent stage.
- Although the planned wind farm site is remote, in an agricultural area and situated on privately owned land, the project involves significant construction disruptions in the district. The report should, for completeness, include planned limitations to noise effects on the site, surrounds and accessways, as well as daily hours of work, any weekend restrictions and expected overall construction project duration. These requirements would normally be included within Resource Consent conditions.
- The construction report should give consideration to the expected large volumes of concrete placement for each turbine foundation, in terms of volume of supply over a single day, access restrictions for concrete truck volumes to a single point, and seasonal issues over winter periods for mass concrete placements. It may be beneficial to assess the possibility of establishing a concrete batching plant on or near site rather than ready-mixed concrete from surrounding town centres, given the large volumes and transport challenges involved.
- Mention should be made within this report of a Traffic Management Plan requiring district and other local road authority approval prior to the commencement of construction activities.

- As mentioned within the roadway portion of the review above, the Tranzcarr report deals with the transportation of the turbine blades to the access point to the site from SH26. It is recommended that Transcarr be engaged again to include an assessment of the internal access roads on the farms to each of the 24 individual turbine sites, as this is expected to be the critical area in terms of manoeuvrability of the 78m long blades over vertical crest curves, and around horizontal bends with cut embankments on the inside of the curve. It is understood that each blade weight is approximately 20t, and is not feasible to perform any airlift operations of the blades via helicopter.
- Co-ordination of issues raised within other civil disciplines of this report should be updated within the Construction Report, such as the basis of preliminary foundation sizes against local conditions, engineered backfill over foundations for design stability requirements, suitability of rock founding layers, assessment of local design parameters to New Zealand Standards and Codes of Practice in design, roadway alignment and side slope limitations, possible retaining wall solutions in selected areas, expected volume of gravel material available to cut on site and suitable for metalling of roadways, platforms and laydown areas, general roadway geometric and capacity design standards for construction traffic requirements, etc.
- The report should include some indication of the ongoing maintenance requirements and responsibilities of the various parties involved within publicly accessible and private roadways on the farms, once upgrading of the access roadways and construction of the wind farm turbines and substation are completed. If Kaimai Wind Farms Ltd is to maintain roadways and carry out periodic regrading and reshingling of roads, this should probably be mentioned in the report as it may be a consent condition.
- Expected nett cut and fill volumes, and nett spoil off of the site, should be estimated and included in the report, as this has transportation and environmental implications.
- It should be noted in the Construction Report that two of the existing culverts are recommended for upgrade from a hydraulic capacity viewpoint, to bring their capacity up to a minimum of a 2 year storm event. The remainder of the culvert crossings should be inspected by a structural engineer prior to commencement of construction heavy traffic. Additionally at detailed design stage, the ability of existing culvert crossings to be overtopped as a causeway during larger storm events needs to be assessed against proposed lifting of roadway levels across vertical sag curves.

6.0 DISCUSSIONS AND RECOMMENDATIONS

In general the civil engineering related reports are completed to between a feasibility and preliminary design stage, and are suitable for the purposes of supporting documentation for Resource Consent application. Some correlation and consistency is required between reports which were developed in parallel to ensure that engineering design parameters and limits are uniform across all areas of the design.

Additional information has been identified in certain of the reports which can be readily included, which may assist in the Resource Consent review process, and formulation of consent conditions.

Certain design requirements and considerations have been highlighted at this stage which may require adjustment to the final design approach. In particular, the practicality of transportation and

delivery of the 78m long wind turbine blades along the internal roadways requires additional investigation in terms of slope steepness, vertical clearance over crest curves, and manoeuvrability around tight horizontal curves in cuttings or where there are steep embankments on the inside of curves. Ensuring that the design of all proprietary equipment associated with the turbines meets the seismic requirements of New Zealand Standards and the local conditions present at the site will also require careful consideration during the detailed design stage.

In general it is recommended that Heritage New Zealand, local iwi leadership structures and mana whenua, and public participation hearings be carried out prior to formal application for Resource Consent, to ensure no unforeseen opposition and delays to the planned project at consent stage.

7.0 ADDENDUM NOTES

Subsequent to initial peer review and co-ordination processes, the following updates were made to civil designs and drawings –

- Indicative corner easing of the roadway for 55m turning radius to accommodate transport of 78m long blades on the roadway.
- Typical turning area details for the transporters.
- Indicative location of two lattice towers next to the electrical sub-station.
- Access roadway shown entirely within the road reserve.
- Quarries removed from the site layout plan drawings.
- Earthworks volumes estimates updated to include the above adjustments.

The following have therefore been noted and updated prior to Resource Consent Application –

1. Memorandum -Kaimai Turbine Dimensions - rev4; 21 May 2018; Kaimai Windfarm Ltd

2. Civil Engineering Drawings - Resource Consent Issue; Rev A; Tektus Consultants; Jun 2018

8.0 APPLICABILITY

This report has been prepared for the benefit of **Kaimai Wind Farm Ltd** with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

If you require any additional engineering input for this project or have any questions or queries please do not hesitate to contact us.

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