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Glen Massey Wind Farm – Fast Track Referral Project

Summary of actual or potential adverse effects on the environment

The known and anticipated adverse effects of the project are those typically associated with the establishment of a large-scale windfarm. The Applicant has received advice from the technical experts in respect of these matters. At a high-level the actual or potential effects are:

- **Earthworks effects –** these can be managed in terms of the Waikato District Council ("WDC") and Waikato Regional Council ("WRC") rules and best practice methodologies (consistent with WRC guidelines) so as to minimise the loss of sediment into the adjacent stream network and the potential for erosion (e.g. silt fences, sediment retention ponds, re-grassing and stabilisation at completion). **Attachment C** summarises how these works are anticipated to be undertaken on Site.

- **Construction Effects (including transportation effects) –** All dust and noise to be generated during the construction period will be suitably managed to minimise emissions through implementation of best practice methodologies and use of the relevant New Zealand Standards. Any increase in traffic volumes during the construction phase and any upgrades required to local roads for the safe transport of the turbines can be addressed at the time of resource consent. Such effects are temporary. Management plans (ie. dust, noise, construction traffic) will be prepared. Refer to **Attachment C** for a summary on how it is anticipated that this will be managed within the site.

- **Transportation Effects –** Any increase in traffic volumes during the construction phase and any upgrades required to local roads for the safe transport of the turbine component can be addressed at the time of resource consent. Such effects are temporary. Construction management plans will be prepared. Refer to **Attachment E** for the Turbine Component Transportation Assessment.

- **Effects on and from natural hazards** - geotechnical experts will confirm that the area is physically suitable for the intended development, namely with respect to earthworks, slope stability, and the bearing capacity of the turbine foundations.

- **Effects on ecology and indigenous biodiversity** - the applicant's ecological expert confirms (refer **Attachment A**) that adverse effects of the construction and longer term operation of the windfarm can be suitably managed. Any potential adverse ecological effects will likely require the development of survey, monitoring, and management plans for bats, lizards, and avifauna, with it being likely that an Ecological Mitigation and Offsetting Plan will be required to address any residual effects. Their necessity and subsequent preparation will be managed through the resource consent process. Their assessment goes on to comment that most of the proposed wind farm site has a cover of either exotic pasture currently used for grazing, or radiata pine plantation forest, both of which are of relatively low ecological value. However, they note there may be some indigenous forest and scrub, of moderate to high ecological value, within the proposed footprint of the required works which would require further evaluation and ground truthing. In this respect, the applicant will ensure that all turbines, earthworks, infrastructure and access tracks will be located outside of such areas, and all SNAs present within the Site. These significant areas of indigenous vegetation will remain protected and no native vegetation removal is anticipated. The siting of the turbines will be achieved so as to minimise bird strike.

- **Landscape, natural and rural character and visual amenity effects –** the applicant has received advice from a landscape and visual expert commenting that a windfarm can be supported from a landscape character and visual effects perspective. The Site is located in a notably low density rural area with limited public viewing potential, and despite its proximity to an adjacent ridgeline, it is located in an area already modified by farming and forestry. The continued operation of the existing farming activities over a large portion of the Site and the proposed spacing of the turbines it is anticipated that the openness and rural character of the Site can be maintained. The applicant will ensure that all turbines, earthworks, infrastructure and access tracks will be located outside of the ONFs present within the Site, and the adjacent DoC designated reserve (Te Puroa Scenic Reserve).

- **Acoustic effects –** The applicants acoustic expert (refer Att**achment** B) has undertaken a desktop assessment of the noise effects associated with the operation of the windfarm over time and has indicated that there is potential for the audible environment to be compromised by the proposal at a number of its nearest receivers. However, compliance with the New Zealand Standard NZS 6808-2010 Acoustics - Wind farm noise (NZS 6808) 40dB limit, is able to be achieved. The applicant confirms that further refinement to the proposal and the implementation of best practice methodologies (i.e. turbine selection and operational controls), can and will be made prior to the lodgement of any resource consent application, to maintain compliance with the relevant NZS noise limits, and an acceptable level of residential amenity. Broadly speaking, the Site is located in a low density rural area with only very few residential dwellings (outside of the Site) located in its very close proximity.

- **Cultural heritage, effects on Mana Whenua Values and archaeology –** the applicant has consulted/engaged with relevant iwi (as determined by Waikato District Council) and they will continue to work collaboratively with them through the preparation of the application. No archaeological sites are recorded in the Waikato District Plan within the application site. Accidental discovery protocols will be implemented should earthworks reveal any unrecorded archaeological sites.

- **Effects on highly productive land –** LUC mapping confirms that no land within the site is considered to be "Highly Productive Land" with the majority of the site being LUC 6, though ratings do range from 4 to 6.

- **Effects on Infrastructure –** the location of the Site is immediately adjacent to the 220kV National Grid. This ensures that there will be very little new or upgraded infrastructure required beyond the application Site to enable the transmission of generated power back to the national grid. Please refer to **Attachment D** for detail on the design details.

- **Climate change** - The location is favourable in terms of minimising works required to enable transmission of the power generated back to the national network. Further, the generation of renewable energy directly addresses climate change.

  Inclusions:

  Attachment A: Ecological Assessment
  Attachment B: Acoustic Assessment.
  Attachment C: Construction Concept Assessment
  Attachment D: Sub-Station Design Concept Assessment
  Attachment E: Transportation Concept Assessment

Desktop Assessment of Ecological Values and Constraints for the Proposed Glen Massey Wind Farm, Waikato

Contract Report No. 7212

Providing outstanding ecological services to sustain and improve our environments

Wildlands

Desktop Assessment of Ecological Values and Constraints for the Proposed Glen Massey Wind Farm, Waikato

Contract Report No. 7212

May 2024

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Executive summary

This report addresses potential ecological values and constraints at the proposed Glen Massey Wind Farm site, in the Waikato District. Desktop resources such as aerial imagery and online database records were used to assess values and constraints.

The proposed wind farm site is situated In hill country 5-10 kilometres southwest of Ngāruawāhia, within Raglan Ecological District. Like most of the wider Waikato Region, this Ecological District is mostly highly modified but does nevertheless have *c.*18% indigenous vegetation cover remaining.

Most of the proposed Glen Massey Wind Farm site has a cover of either exotic pasture currently used for grazing, or radiata pine plantation forest, both of which are of relatively low ecological value from an indigenous biodiversity perspective. Indigenous-dominant vegetation, and potential wetlands, which are potentially of moderate to high ecological value, are present within the proposed footprint will require ground-truthing but it is likely to be feasible to avoid any such areas which are currently within the proposed development footprint. Wetland delineation is also required for wetlands which meet the definition of 'natural inland wetland' as per the NPS-FM 2020 that are within 100 metres of the proposed development footprint. The client intends to avoid all indigenous vegetation within the proposed development footprint, therefore indigenous vegetation removal may not be required for development of the wind farm.

Although there are few records of indigenous fauna across the site, it is likely that species such as kārearea (bush falcon; Threatened-Nationally Increasing), long-tailed bats (Threatened-Nationally Critical), and elegant gecko (At Risk-Declining), utilise habitats at the site. Field surveys are required for Threatened and/or At Risk plants, avifauna, bats, and lizards.

Construction and post-construction operational phases of the wind farm have the potential for some adverse effects on indigenous vegetation and habitat types, avifauna, bats, lizards, freshwater fish and invertebrates, and terrestrial invertebrates. Of these taxa, indigenous bats and migrating shorebirds could be at the greatest risk of adverse effects. Previous radar surveys undertaken as part of the pre-development migratory shorebird monitoring for the consented Hauāuru Mā Raki Wind Farm indicated that more shorebird bird activity occurs at the northern end of the Hauāuru Mā Raki site - *c.*40 kilometres northwest of the proposed Glenn Massey site - rather than the southern end of the Hauāuru Mā Raki site, which is *c.*18 kilometres west of the proposed Glenn Massey site. This may indicate that shorebird migration activity in the vicinity of the proposed Glen Massey site is less than the consented Hauāuru Mā Raki site. This requires further evaluation as there is limited data on bird movements in the Glen Massey area.

Management of potential ecological effects will also likely require the development of survey, monitoring, and management plans for bats, lizards, and avifauna. It is also likely that an Ecological Mitigation and Offsetting Plan will be required to address any residual ecological effects.

The overall ecological risk of the proposed Glen Massey Wind Farm is likely to be less than the nearby consented Hauāuru Mā Raki site, especially for migrating shorebird populations. Subject to consideration of scale and site-specific character, ecological effects at the Glenn Massey site are likely to be similar to the operational Te Uku Wind Farm.

Contents

1.0 Introduction

Ventus Energy (NZ) Ltd propose to develop the Glen Massey Wind Farm (the 'Site'), located about seven kilometres southwest of Ngāruawāhia, in the Waikato District (see Figure 1). The proposed wind farm will comprise 41 wind turbines, located on two properties: Pukemiro Farms and Oji Fibre Solutions Ngāruawāhia Forest. Ventus Energy commissioned Wildland Consultants to provide a desktop assessment of the ecological values and constraints of the proposed Glen Massey Wind Farm.

This report outlines the findings of the desktop assessment and provides:

- Maps and descriptions of the vegetation and habitat types present.
- Descriptions of the fauna that is present (or likely to be present).
- An assessment of the ecological values and constraints.
- Descriptions of the potential ecological effects resulting from the proposed works.
- Opportunities to avoid, minimise, or mitigate potential adverse ecological effects.
- Possible future monitoring requirements.

2.0 Overview of proposed works

The following section has been compiled from information provided by the client. The general proposed positioning and size of the 41 wind turbines (WT) at the proposed Glen Massey Wind Farm are as follows:

- Proposed locations for each of the 41 wind turbines are shown in Figure 1.
- Turbines will be constructed in two stages, with 24 turbines in Stage 1 (WT1-24) and 17 turbines in Stage 2 (WT25-41).
- All wind turbines will be positioned at a minimum of 85 metres from adjoining property boundaries.
- Turbine rotor diameter of 185 metres, with a hub height of 230 metres.
- Construction of roading, and turbine foundations.
- Electrical reticulation, including underground cables.
- One substation is to be located near WT1.

All areas directly to be affected by the proposed works – including proposed turbine locations and proposed access roads[1] - are hereafter referred to as the 'development footprint' for the purposes of this assessment.

3.0 Methods

3.1 Existing information

Relevant existing information about the site and ecological reports on nearby areas, was collated and reviewed. Reports reviewed included:

[1] The client-provided shapefile of the wind farm layout did not provide an indication of road width, nor wind turbine microsite diameter and an arbitrary road width of 10 metres and a microsite diameter of 200 metres has been used to determine the total development footprint across the site.

- Natural area identification and assessment in 25 plantation forests managed by PF Olsen Ltd in the Central North Island (Wildland Consultants 2022).
- Contact Wind Ltd – Hauāuru mā raki – Waikato Wind Farm. Assessment of ecological effects (Kessels and Associates Ltd 2008).

3.2 Desktop vegetation and habitat mapping

Land Information New Zealand (LINZ) aerial imagery and Land Cover Database (LCDB; Version 5) mapping were used to identify and map broad vegetation and habitat types at the proposed wind farm site (at a scale of 1:5,000).

The area mapped included a 100 metre buffer zone around the proposed development footprint. At the proposed turbine locations, a 100 metre radius buffer circle (centred on the proposed turbine location) which forms the turbine microsite was mapped. The total area mapped is hereafter referred to as the 'buffer'.

Wildland Consultants (2022) has been used to provide an indication of the potential vegetation and habitats present, but the specific composition of vegetation types cannot be determined without a site visit. Potential wetlands, in particular, cannot be reliably delineated or described using aerial imagery.

3.3 Fauna records

The following databases and resources were used to search for records of vascular flora, freshwater fauna, avifauna, bats, herpetofauna, and invertebrates in the proximity to the proposed wind farm site:

Vascular Flora

Wildland Consultants (2022) and plant lists available on the New Zealand Plant Conservation Network (NZPCN) website were searched for records of Threatened and At Risk species within five kilometres of the site.

Avifauna

- Avifauna records within 10 kilometres of the proposed wind farm site were compiled from eBird (ebird.org, records accessed April 2022) and iNaturalist (inaturalist.nz). Dates for the eBird records from this search range from 1948 to 2024, while those on iNaturalist are all since 2012.
- The New Zealand Bird Atlas maintained by Cornell University, which holds bird records in 10 × 10 kilometre grid squares within New Zealand (2019-2024). Bird records were obtained for the two grid squares that are nearest to the proposed site.

The authors' knowledge was used to compile a list of any species that may have been missing from the survey data that was available.

Bats

- The Department of Conservation bat database (most recent update – August 2023) for bat records.

Herpetofauna

- The Department of Conservation Bioweb Herpetofauna database (most recent update – August 2023) for records of lizards and frogs.

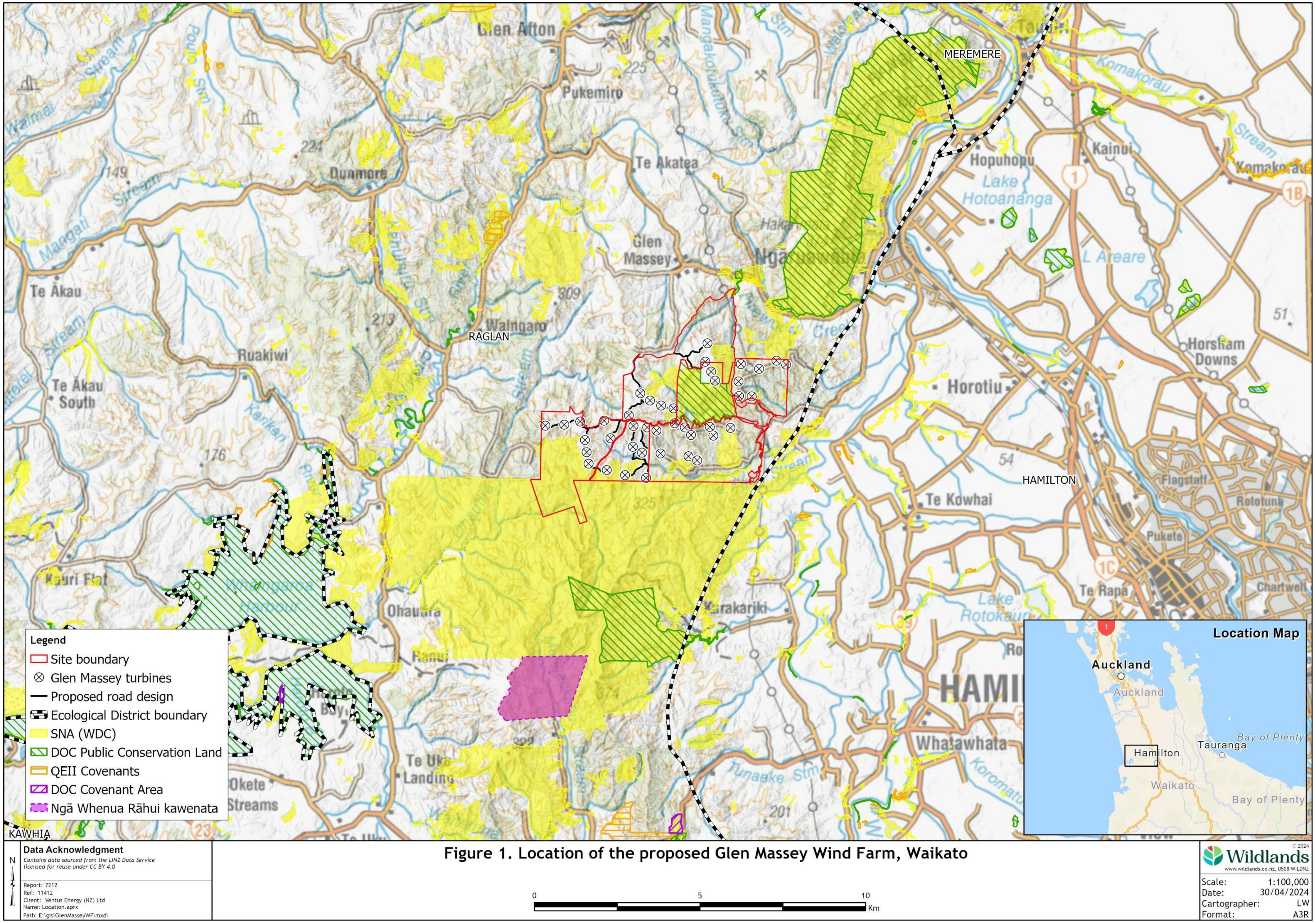


Figure 1. Location of the proposed Glen Massey Wind Farm, Waikato

Freshwater fauna

- The New Zealand Freshwater Fish Database[2] (NZFFD, Stoffels 2022) was accessed for records of indigenous and exotic freshwater fish and freshwater invertebrates

Terrestrial invertebrates

- The Global Biodiversity Information Facility (GBIF.org 2024[3]) was searched online for terrestrial invertebrate species records. To filter the data, a polygon was drawn encompassing the site plus an area within five kilometres from the site perimeter. The scientific name filter was also applied, using the terms Arachnida, Athoracophoridae, Rhytididae, Insecta, and Onychophora to represent spiders, leaf-veined slugs, indigenous giant land snails, insects, and velvet worms respectively. From the records retrieved by the GBIF search, freshwater invertebrates were removed.

Threat rankings

The most recent species threat classifications were used for indigenous bats (O'Donnell *et al.* 2023), birds (Robertson *et al.* 2021), vascular plants (de Lange *et al.* 2018), freshwater fish (Dunn *et al.* 2018), freshwater invertebrates (Grainger *et al.* 2018), and reptiles (Hitchmough *et al.* 2021).

4.0 Statutory Context

4.1 National Policy Statements and Environmental Standards

The National Policy Statement for Freshwater Management 2020 (NPS-FM) and the National Environmental Standards for Freshwater 2020 (NES-F) are both ecologically-relevant statutory documents that are applicable to the proposed wind farm development. The NPS-FM provides objectives and policies on how local authorities should manage freshwater under the Resource Management Act 1991. The NES-F, which sits under the NPS-FM, provides standards to regulate activities that pose risks to the health of freshwater ecosystems such as streams, rivers, and natural inland wetlands.

<u>National Policy Statement for Freshwater Management 2020</u>

The National Policy Statement for Freshwater Management (NPS-FM) defines a 'natural inland wetland' as a wetland (as defined in the Act) that is not:

(a) in the coastal marine area; or
(b) a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland; or
(c) a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or
(d) a geothermal wetland;
(e) a wetland that:
    (i) is within an area of pasture used for grazing; *and*
    (ii) has vegetation cover comprising more than 50% exotic pasture species (as identified in the National List of Exotic Pasture Species using the Pasture Exclusion Assessment Methodology (see clause 1.8)); unless

[2] https://nzffdms.niwa.co.nz/search Accessed 22 August 2023.
3 GBIF.org (24 April 2024) GBIF Occurrence Download https://doi.org/10.15468/dl.z9hd5v

(iii) the wetland is a location of a habitat of a threatened species identified under clause 3.8 of this National Policy Statement, in which case the exclusion (e) does not apply.

Policy 9 of the NPS-FM provides for the protection of habitats of indigenous freshwater species.

4.2 Waikato Regional Council

The proposed Glen Massey Wind Farm site is located within the Waikato Region and is subject to the provisions in the Waikato Regional Plan 2024 and Waikato Regional Policy Statement 2023.

The Waikato Regional Policy Statement identifies policies and methods of implementation for maintaining or enhancing indigenous biodiversity and protection of significant indigenous vegetation and significant habitats for indigenous fauna. In particular, Part 3 (ECO) of the Waikato Regional Policy Statement refer to for Ecosystems and Indigenous Biodiversity.

4.3 Waikato District Council

The site is entirely within the Waikato District, and is zoned as 'rural' in the Waikato District Plan.

The District Plan includes provisions for the protection of significant indigenous vegetation and significant habitats of indigenous fauna within the District. This includes implementing measures to avoid, or remedy, or mitigate, or if necessary, offset, the adverse effects of activities, such as vegetation clearance and habitat disturbance. Vegetation clearance or earthworks within a Significant Natural Area (SNA) have an activity status under the District Plan.

Forty-six significant natural areas (SNAs) identified in the District Plan are located within five kilometres of the buffer.

The Operative District Plan identifies outstanding natural features and landscapes as Landscape Policy Area and includes provisions for the recognition and protection of such areas from the adverse effects of inappropriate subdivision use and development. A small part of the mapped buffer overlaps with a Landscape Policy Area identified in the Operative District Plan, with the overlap area nearest to WT20 and WT21.

5.0 Ecological Context

5.1 General

The proposed Glen Massey Wind Farm site is located about eight kilometres from Raglan Harbour at the closest point and *c.*15 kilometres at its most inland extent. The west coast of the North Island is located *c.*17 kilometres west of the site.

The site is mostly situated moderate to steep hill country over an elevational range of *c.*140-270 metres above sea level (asl). The site is situated across two main catchments: the Raglan Harbour catchment and the Waikato River catchment, with small tributaries within the site draining into both of these catchments. The proposed Glen Massey Wind Farm is located *c.*15 kilometres east of the consented, but since mothballed, Hauāuru–Mā Raki - Waikato Wind Farm. The proposed wind farm is also located *c.*18 kilometres northeast of the consented and now operational Te Uku Wind Farm which comprises 28 wind turbines.

Most of the site currently comprises large areas of pastoral farmland, primarily used for drystock farming, and large tracts of plantation radiata pine (*Pinus radiata*) forest. Fragments of indigenous forest and scrub are scattered throughout these areas. Seven dwellings, accessed from Wilton Collieries Road, are located in the northern parts of the site.

5.2 Raglan Ecological District

The proposed Glen Massey Wind Farm site is located within Raglan Ecological District. The following information was sourced from McEwen (1987) and Regnier and Clarkson (1988).

Raglan Ecological District encompasses approximately 132,000 hectares of rolling to broken hill country between Port Waikato and the southern reaches of Raglan Harbour. The hills are generally between 100-200 metres above sea level (a.s.l.), with the highest points being on the Hakarimata Range and Mt Kokako at c.370 metres a.s.l. Raglan Ecological District experiences relatively warm, humid summers and mild winters. Rainfall is between 1,400-1,600 millimetres per annum. The prevailing winds are westerly and often increase in strength in the afternoons.

Low ranges in the east and northwestern tip of the District are formed by marine siltstone, mudstone, and conglomerate. Sandstone, siltstone, and limestone is present over the older rocks in the west and northeast, and form prominent bluffs alongside steep valleys with some tomos in limestone areas. Basalt outcrops occur around the Waikaretu Valley, and eroded basalt cones remain near Ngatutura and Onewhero. Dunes extend along the coast becoming patchier in the north.

The soils of the Ecological District reflect its diverse geology. Old volcanic ash is a major contributor to soil formation in this district. Clays and loams occur on relatively high and steep land, while soils on the moderately steep to lower elevation land comprise a variety of clay loams and silt loams depending on topography and weathering. Clayey but well-drained loams, with a high proportion of strongly weathered volcanic ashes, occur on the slopes south of Raglan Harbour, whilst more silty loams with less weathered ashes occur on rolling land. Well-developed sandy soils occur on the coastal dunes.

Raglan Ecological District was originally predominantly forest-covered with coastal, semi-coastal, and lowland zones. Extensive wetland, estuarine, sand dune, and coastal shrubland communities would also have occurred in places.

Podocarp-broadleaved species forest is the dominant indigenous forest type in Raglan Ecological District. Tawa, kohekohe (*Didymocheton spectabilis*), pukatea (*Laurelia novae-zelandiae*) and podocarps dominate the canopy. Local kauri and hard beech (*Fuscospora truncata*) occur on the Hakarimata Range. Semi-coastal forest of pūriri (*Vitex lucens*), kohekohe, and taraire (*Beilschmiedia tarairi*) occurs locally in the northern part of the district. Kahikatea forests would have occurred in poorly drained areas, although most of the wetlands have now been drained and modified.

Approximately 90,500 hectares (c.68%) of the Ecological District is currently high producing exotic grassland, and indigenous vegetation currently covers c.23,500 hectares (c.18%) of the Ecological District. Mānuka-kānuka scrub (c.6%), indigenous broadleaved hardwood scrub (c.1%), and indigenous forest (c.11%) are the indigenous vegetation types with the greatest total cover in the Ecological District (LCDBv5.0; Landcare Research 2020). The largest remaining forest remnants cover the Hakarimata Range and Mt Kōkako.

5.3 Threatened Environments Classification

Threatened Environment Classification is a geospatial mapping database that provides an indication of how much indigenous vegetation remains within an area and/or the proportion of remaining indigenous vegetation which is legally protected. Table 1 lists the Threatened Environment categories underlying the buffer area mapped for the proposed wind farm.

Table 1 – Threatened Environment categories underlying the proposed Glen Massey Wind Farm site.

Threatened Environment Category	Criterion	Glen Massey Wind Farm site	
		Area (ha)	% of site
Acutely Threatened	<10% indigenous cover remaining.	110.7	17.4
Chronically Threatened	10-20% indigenous cover remaining.	17.9	2.8
At Risk	20-30% indigenous cover remaining.	16.6	2.6
Critically Under protected	>30% indigenous cover remaining and <10% legally protected.	0.0	0.0
Under Protected	>30% indigenous cover remaining and 10-20% legally protected.	0.1	<0.1
No Threat Category	>30% indigenous cover and >20% legally protected.	492.0	77.2

5.4 Protected areas

Multiple legislative and planning instruments exist for the purpose of protecting indigenous biodiversity on private land. These include QEII Open Space Covenants and Ngā Whenua Rāhui kawenata, as well as local government instruments such as Significant Natural Areas and Landscape Policy Areas. Public conservation areas are also protected by Acts such as the Conservation Act 1987.

Protected areas that are located within five kilometres of the proposed Glen Massey Wind Farm site are listed below in Table 2 (excluding SNAs) and mapped in Figure 1:

Table 2 – Protected areas located within five kilometres of the proposed Glen Massey Wind Farm site.

Protected Area Name/identifier	Protected Area Type
Paiaka Domain Recreation Reserve	• Department of Conservation
Toretorea Stream Recreation Reserve	• Department of Conservation
Te Puroa Scenic Reserve	• Department of Conservation
Marginal Strip - Firewood Creek	• Department of Conservation
Karakariki Scenic Reserve	• Department of Conservation
Marginal Strip - Mangaotama Stream	• Department of Conservation
Marginal Strip - Waipa River Sager Road	• Department of Conservation
Marginal Strip - Waipa River	• Department of Conservation
Marginal Strip - Waingaro River	• Department of Conservation
Hakarimata Scenic Reserve	• Department of Conservation
5-03-059B	• QEII Open Space Covenant
5-03-138	• QEII Open Space Covenant
5-03-059A	• QEII Open Space Covenant
5-03-448	• QEII Open Space Covenant
5-03-385	• QEII Open Space Covenant
5-03-948	• QEII Open Space Covenant
5-03-1005	• QEII Open Space Covenant

6.0 Vegetation and habitats

Seven broad vegetation and habitat types are present within the proposed Glen Massey Wind Farm buffer zone:

1. Indigenous forest and scrub
2. Indigenous treeland
3. Exotic forest
4. Exotic scrub
5. Exotic grassland, rural infrastructure, and dwellings
6. Potential wetlands
7. Ponds

These types are described further below and in Figure 2.

6.1 Type descriptions

6.1.1 Vegetation Type 1: Indigenous forest and scrub

This type includes areas that are mapped in the LCDB as 'indigenous forest', and 'broadleaved indigenous hardwoods', and 'mānuka and/or kānuka', as well as small fragments that were identified based on assessment of aerial imagery. Indigenous plant species form most of the vegetation cover of this type.

Larger and higher quality examples of this vegetation and habitat type typically comprise indigenous secondary forest on the margins dominated by taller stature species, such as kānuka (*Kunzea robusta*), māhoe (*Melicytus ramiflorus* subsp. *ramiflorus*), and rewarewa (*Knightia excelsa*), which transitions to modified mature indigenous forest away from margins. These areas of forest (*c.*15-25 metres tall) typically comprise mature rewarewa, tawa (*Belischmiedia tawa*) and kānuka. Podocarps present include kahikatea, rimu (*Dacrydium cupressinum),* mataī (*Prumnopitys taxifolia*), and miro (*Pectinopitys ferruginea*), some of which are mature, emergent trees *c.*30 metres tall. Kahikatea occurs frequently alongside watercourses, and scattered throughout the rest of the forest, along with rimu.

Canopy gaps are filled with frequently occurring mamaku (*Sphaeropteris medullaris*) and nīkau (*Rhopalostylis sapida*; *c.*10-15 metres tall). Indigenous trees, treeferns, and shrubs present in the understorey include porokaiwhiri/pigeonwood (*Hedycarya arborea*), horoeka (*Pseudopanax crassifolius*), whekī (*Dicksonia squarrosa*), ponga (*Cyathea dealbata*), kanono (*Coprosma grandifolia*), kawakawa (*Piper excelsum* subsp. *excelsum*), rangiora (*Brachyglottis repanda*), taurepo (*Rhabdothamnus solandri*), tī ngahere (*Cordyline banksii*), hangehange (*Geniostoma rupestre* var. *ligustrifolium*), māhoe, patē (*Schefflera digitata*), and saplings of the rewarewa and tawa.

Small and fragmented and/or margin areas of this vegetation type typically comprise common early successional indigenous species such as mānuka (*Leptospermum scoparium* agg.), kānuka, māhoe, kawakawa (*Piper excelsum* var. *excelsum*), and mamaku. Treefernland dominated by mamaku occurs in places such as below the powerlines on the eastern side of the site. Margins are likely to include scattered exotic pest plant species such as gorse (*Ulex europaeus*) and pampas (*Cortaderia selloana*), Spanish heath (*Erica lusitanica*), Chinese privet (*Ligustrum sinense*), and wilding radiata pine, as well as rank pasture grass species such as Yorkshire fog (*Holcus lanatus*), and tall fescue (*Lolium arundinaceum* subsp. *arundinaceum*).

6.1.2 Vegetation Type 2: Indigenous treeland

Several areas of indigenous treeland comprise a discontinuous canopy of trees (such as kahikatea, māhoe, and kānuka), scattered above rank exotic grasses.

6.1.3 Vegetation Type 3: Exotic forest

This type includes areas that are mapped in LCDB as 'exotic forest' and 'forest – harvested'. The dominant vegetation cover is radiata pine (*Pinus radiata*) plantation forest. Areas adjacent to indigenous forest and scrub remnants often have dense understories that include a mix of mamaku, whekī, tī ngahere, māhoe, ponga, hangehange, kōhūhū (*Pittosporum tenuifolium*), mingimingi (*Leucopogon fasciculatus*), and patē. Pampas and exotic grasses are common on road margins and in skid sites.

6.1.4 Vegetation Type 4: Exotic scrub

Areas of exotic scrub are typically dominated by gorse or broom (*Cytisus scoparius*), and are often present on the margins of exotic forest, or indigenous forest and scrub. Blackberry (Rubus fruticosus agg.) may be present occasionally. Some of these areas are mapped in the LCDB as 'gorse and/or broom', but most were identified from the aerial imagery. The extent and species composition of exotic scrub habitats may change frequently as a result of plantation forest and pasture management.

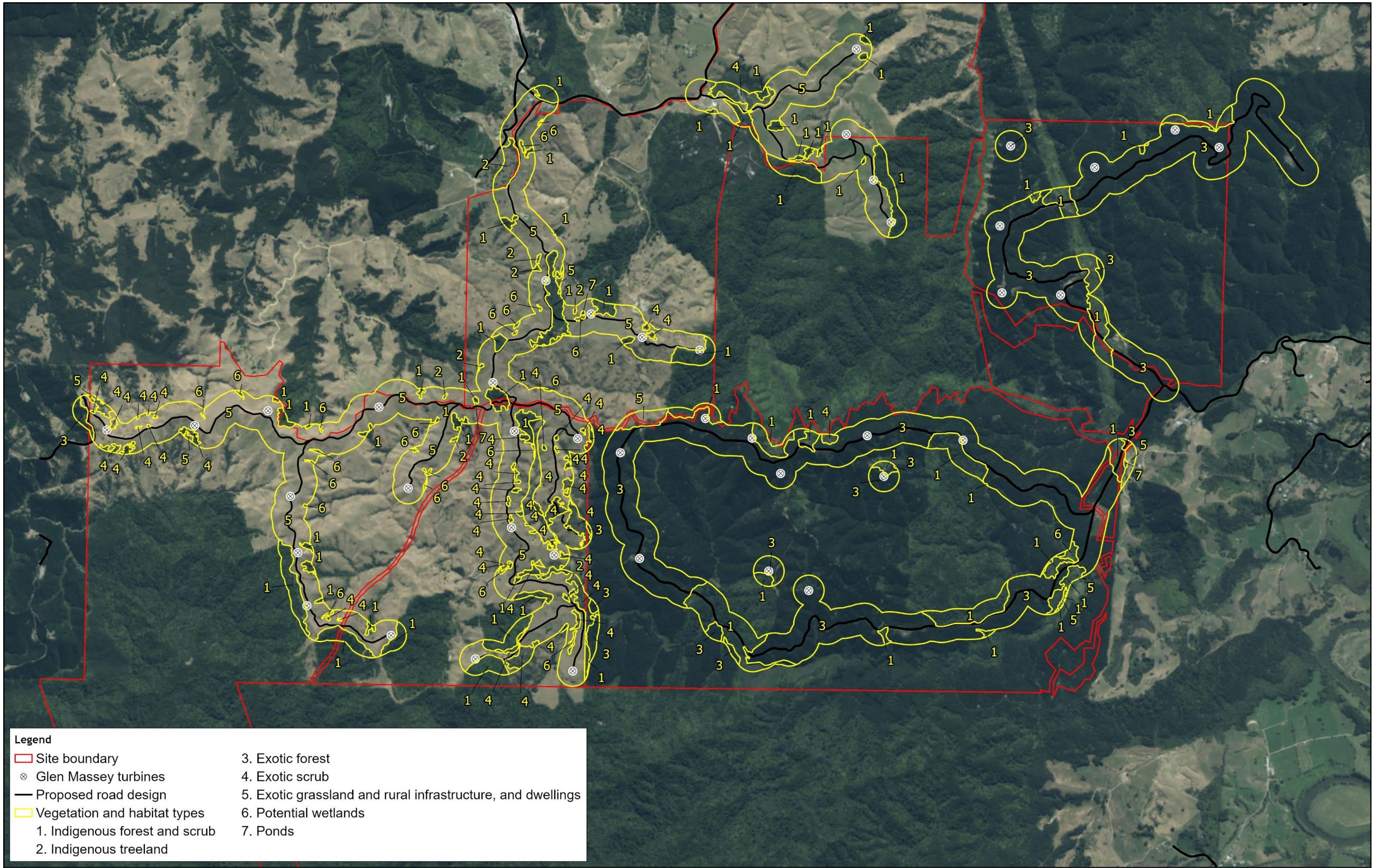
6.1.5 Vegetation Type 5: Exotic grassland, rural infrastructure, and dwellings

Extensive parts of the site that are mapped as exotic grassland (both high producing and low producing) in the LCDB, are also visible in aerial imagery. Most of the areas mapped as exotic grassland at this site are classed as 'high producing exotic grassland' in the LCDB and are described as being intensively managed for grazing, typically comprising clover (*Trifolium* spp.), ryegrass (*Lolium perenne*), and cocksfoot (*Dactylis glomerata*). 'Low producing grassland' areas in the LCDB, are managed for low-intensity grazing or non-agricultural use, and are likely to be dominated by browntop (*Agrostis capillaris*), sweet vernal (*Anthoxanthum odoratum*), fescue (*Festuca* spp.), and Yorkshire fog (*Holcus lanatus*).

Existing farm and forestry access tracks are often included in this type. Rural infrastructure such as farm sheds, buildings, and rural public roads are also present. At least one residential dwelling is present within the Pukemiro Farm part of the site, along with associated gardens, lawns, and/or shelterbelts that may surround the dwelling.

6.1.6 Vegetation Type 6: Potential wetlands

Aerial imagery was used to identify areas of potential wetland. Wetlands may be present around the margins of natural streams and seepages in the heads of gullies. Some of these may meet the criteria of 'natural inland wetlands'. Indigenous rushes such as *Juncus edgariae* may be present. Exotic wetland species that could be present include soft rush (*Juncus effusus* var. *effusus*), willow (*Salix* sp.), and water pepper (*Persicaria hydropiper*). However, in some cases, these areas are likely to be dominated by exotic pasture species and therefore would not qualify as 'natural inland wetlands' under the National Policy Statement for Freshwater Management (NPS-FM). Areas with indigenous dominant hydrophytic vegetation could meet the criteria of 'natural inland wetland.'



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Data Acknowledgment
Map contains data sourced from LINZ
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Report: 7212
Client: Ventus Energy (NZ) Ltd
Ref: 11412
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File: Vegetation.mxd

Figure 2. Vegetation and habitat types within the proposed Glen Massey Wind Farm, Waikato

0 500 1,000 m

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Scale: 1:22,500
Date: 29/04/2024
Cartographer: LW
Format: A3R

The southeastern-most area within Ngāruawāhia Forest is likely to include kahikatea (*c.*10-20 metres tall), scattered above a dense cover of rautahi (*Carex geminata* agg.) and *Carex virgata* (Wildland Consultants 2022).

It should be noted that a site visit is required to formally assess the hydrology, soils, and vegetation of these areas, as per national protocols for wetland delineation (Ministry for the Environment 2022), in order confirm whether or not these areas meet the criteria for 'natural inland wetland' under the NPS-FM.

6.1.7 Vegetation Type 7: Ponds

A few ponds are present that appear to be dams created for stock water. Wetlands may be present around these ponds, although they are unlikely to meet the definition of 'natural inland wetlands' under the NPS-FM, because they are likely to be dominated by exotic pasture species and they have developed around a constructed water body.

7.0 Flora

There are records of 126 vascular plant species from Ngāruawāhia Forest (Wildland Consultants 2022). The NZPCN website (records accessed April 2024) also has plant lists for three locations approximately within five kilometres of the proposed Glen Massey Wind Farm site, including:

- Te Puroa Scenic Reserve – Q732 (Sinclair 1973).
- Te Puroa Scenic Reserve – Q897 (Irving 1985).
- Toretorea Stream Recreation Reserve – Q893 (Irving and Skinner 1984)

A total of 11 Threatened and At Risk plant species, as per de Lange *et al.* (2018), have been recorded at these sites. Most of these are myrtle species (Myrtaceae plant family) and therefore do not require special consideration, or they are unlikely to be present within the buffer zone at the Glen Massey site (Table 3).

Table 3 – Threatened and At Risk plants recorded within or close to the proposed Glen Massey Wind Farm site, and the vegetation and habitat types in which they were recorded. Threat status rankings are from de Lange *et al.* 2018.

Species	Common Name	Threat Status	Habitat Type	Location Recorded	Reference
Kunzea robusta	Kānuka*[1]	Threatened-Nationally Vulnerable	Indigenous forest and scrub	• Ngāruawāhia Forest (Oji) • Te Puroa Scenic Reserve	• Wildland Consultants (2022) • Irving (1985)
Leptospermum scoparium var. *scoparium*	Mānuka*	At Risk-Declining	Indigenous forest and scrub	• Ngāruawāhia Forest (Oji) • Te Puroa Scenic Reserve	• Wildland Consultants (2022) • Irving (1985)
Lophomyrtus bullata	Ramarama[1]	Threatened-Nationally Critical	Indigenous forest and scrub	• Ngāruawāhia Forest (Oji) • Te Puroa Scenic Reserve	• Wildland Consultants (2022) • Irving (1985) • Sinclair (1973)
Metrosideros albiflora	Akatea*	Threatened-Nationally Vulnerable	Indigenous forest and scrub	• Te Puroa Scenic Reserve	• Irving (1985)

Species	Common Name	Threat Status	Habitat Type	Location Recorded	Reference
Metrosideros carminea	Carmine rātā*	Threatened-Nationally Vulnerable	Indigenous forest and scrub	• Te Puroa Scenic Reserve	• Sinclair (1973)
Metrosideros diffusa	Rātā*	Threatened-Nationally Vulnerable	Indigenous forest and scrub	• Ngāruawāhia Forest (Oji) • Te Puroa Scenic Reserve • Toretorea Stream Recreation Reserve	• Wildland Consultants (2022) • Irving (1985) • Sinclair (1973) • Irving and Skinner (1985)
Metrosideros fulgens	Rātā*	Threatened-Nationally Vulnerable	Indigenous forest and scrub	• Ngāruawāhia Forest (Oji) • Te Puroa Scenic Reserve	• Wildland Consultants (2022) • Irving (1985)
Metrosideros perforata	Aka*	Threatened-Nationally Vulnerable	Indigenous forest and scrub	• Ngāruawāhia Forest (Oji) • Te Puroa Scenic Reserve • Toretorea Stream Recreation Reserve	• Wildland Consultants (2022) • Irving (1985) • Sinclair (1973) • Irving and Skinner (1985)
Metrosideros robusta	Northern rātā*[1]	Threatened-Nationally Vulnerable	Indigenous forest	• Te Puroa Scenic Reserve	• Sinclair (1973)
Ptisana salicina	Para/king fern[1]	At Risk-Declining	Indigenous forest and scrub	• Te Puroa Scenic Reserve	• Irving (1985)
Solanum aviculare var. *aviculare*	Poroporo[1]	Threatened-Nationally Vulnerable	Regenerating indigenous scrub	• Te Puroa Scenic Reserve	• Irving (1985)

1 Unlikely to be present within the mapped buffer at Glen Massey.

* The threat status of these species, which are members of the Myrtle family, have been raised as a precautionary response to the arrival of myrtle rust (*Austropuccinia psidii*) in Aotearoa New Zealand. However, these species remain widespread throughout their respective ranges and do not require special consideration.

8.0 Avifauna

A total of 48 indigenous bird species and 25 introduced bird species have been recorded at, or near, the proposed wind farm site (see Table 9 in Appendix 1). Many of the species listed in Table 9 are of limited relevance from a conservation perspective, such as introduced species, or visiting indigenous species that are very rarely present. Hybrid complexes (all with parent introduced species) such as mallard × grey duck hybrids and avian escapees that are not confirmed as wild in Aotearoa New Zealand were not assessed in the total counts for conservation status and none of these are of ecological concern for the protection of indigenous biodiversity.

All indigenous species were assessed for their potential to use the Glen Massey Wind Farm site (see Table 10 in Appendix 1). Twenty species were identified as having a high likelihood of being present regularly at the proposed wind farm site, and nine species have a moderate likelihood of being present. The other species are either relatively rare, are mostly present in habitat that will not be impacted by wind farms, or are vagrants in the survey area.

9.0 Bats

A search of the Department of Conservation's Bat Database found numerous records of long-tailed bats (*Chalinolobus tuberculatus*; Threatened-Nationally Critical) records within 25 kilometres of the proposed Wind Farm site.

The closest records are about two kilometres to the northeast of WT27 and WT28 at the southern end of Hakarimata Scenic Reserve and near Waingaro Quarry. Other recent detections have been recorded about three kilometres east of the site, near Te Kowhai. Long-tailed bats have also been recorded around several urban areas, including Taupiri, Raglan, and Hamilton, which are within the *c.*19 kilometre home range of long-tailed bats (O'Donnell 2005). Overall, it is likely that long-tailed bats utilise the proposed Glen Massey Wind Farm site.

No records of central lesser short-tailed bat (*Mystacina tuberculata rhyacobia*; At Risk-Declining) are known from nearby.

10.0 Herpetofauna

A search of the Department of Conservation Herpetofauna database returned the records of three At Risk indigenous lizard species (Table 4).

Table 4 – Records of indigenous herpetofauna within 10 kilometres of the proposed Glen Massey Wind Farm site in the last 20 years. Threat rankings are as per Hitchmough *et al.* (2021) and habitat information is from Van Winkle *et al.* (2018). Species with a high likelihood of presence are shown in bold.

Species	Common Name	Threat Status	Closest record	Number of records	Preferred Habitat	Likelihood of Presence
Dactylocnemis pacificus	Pacific gecko	Not Threatened	-	0	Indigenous swamp, scrub, and forest, rocky coast, dunes, rocky outcrops	Moderate
Mokopirirakau granulatus	Forest gecko	At Risk-Declining	-	0	Indigenous forest, scrub, and treeland	Moderate
Naultinus elegans	**Elegnant gecko**	**At Risk-Declining**	**Within site**	**1 (recorded in 1982 but not since)**	**Indigenous scrub, mānuka/kānuka shrubland, lowland forest**	**High**
Oligosoma aeneum	**Copper skink**	**At Risk-Declining**	**8.4 kilometres**	**3**	**Leaf-litter, dense understorey vegetation, rank grass, woody debris, rocks**	**High**
Oligosoma ornatum	**Ornate skink**	**At Risk-Declining**	**7.5 kilometres**	**2**	**Indigenous forest, shrubland, and grassland, damp leaf litter, rock/log piles, dense ground vegetation**	**High**
Oligosoma robinsoni	Crenulate skink	At Risk-Declining	-	0	Rock piles, grassland, flaxland, shrubland, forest margin	Moderate

There is a high likelihood that both copper skink (*Oligosoma aeneum*) and ornate skink (*O. ornatum*) are present at the proposed wind farm site as habitat suitable is available for both species. Copper skink and ornate skink utilise diverse terrestrial habitats, including forest, scrub, and shrub or grassland vegetation where dense groundcover is available. Elegant gecko (*Naultinus elegans*) is also highly likely to be present within indigenous vegetation.

Three additional indigenous lizard species are known to be present in Raglan Ecological District and nearby and adjacent Hamilton Ecological District: forest gecko (*Mokopirirakau granulatus*), pacific gecko (*Dactylocnemis pacificus*), and crenulate skink (*Oligosoma robinsoni*) (Table 4). Elegant and forest geckos are arboreal and prefer indigenous-dominant habitat, especially forest and scrub. Pacific gecko utilises both arboreal and terrestrial habitat, also prefering indigenous-dominant vegetation. Crenulate skink is a terrestrial and highly heliothermic species, meaning that they prefer more open habitats with good basking sites near cover such as grass, ferns, or logs. These species have a moderate likelihood of being present based on habitat availability.

The invasive plague skink (*Lampropholis delicata*) and exotic frogs (*Ranoidea* spp. and *Litoria* sp.) have also been recorded near the site.

11.0 Freshwater habitats and species

Most of the proposed Glen Massey Wind Farm site drains east into the Waipa subcatchment which joins the Waikato River northeast of Ngāruawāhia. The New Zealand Freshwater Fish Database (Stoffels 2022) holds 5,815 records for the entire Waikato catchment. Of those, 157 records are from the Waipa subcatchment and 60 are from the streams and tributaries associated with the proposed wind farm site or directly up-stream of them. Twenty-four species of freshwater fish and invertebrates (Table 5), not including unidentified fish, have been recorded in the Waipa subcatchment. Fourteen of these are indigenous species, with five classified as At Risk-Declining and two as Threatened-Nationally Vulnerable (as per Dunn *et al.* 2017 and Grainger *et al.* 2018).

Table 5 – New Zealand Freshwater Fish Database records for the Waipa catchment. Threat rankings are as per Dunn *et al.* 2017 and Grainger *et al.* 2018. Species recorded from the 60 record sites directly connected to the proposed wind farm site and upstream of it are shown in **bold** with the minimum number of occurrences listed. * denotes species recorded within the greater Waikato River catchment.

Scientific Name	Common Name	Threat Ranking	Number of Occurrences in the NZFFD
Ameiurus nebulosus	**Brown bullhead catfish**	**Introduced and Naturalised**	**8**
Anguilla	**Unidentified eel**		**9**
Anguilla australis	**Shortfin eel**	**Not Threatened**	**9**
Anguilla dieffenbachii	**Longfin eel**	**At Risk-Declining**	**12**
Carassius auratus	**Goldfish**	**Introduced and Naturalised**	**5**
Cheimarrichthys fosteri	Torrentfish	At Risk-Declining	*
Cyprinus carpio	**Koi carp**	**Introduced and Naturalised**	**5**
Galaxias	**Unidentified galaxiid**		**3**
***Galaxias* aff. *divergens* "northern"**	**Dwarf galaxias**	**At Risk-Declining**	**14**
Galaxias argenteus	**Giant kokopu**	**At Risk-Declining**	**2**
Galaxias brevipinnis	Koaro	At Risk-Declining	*
Galaxias fasciatus	**Banded kokopu**	**Not Threatened**	**6**
Galaxias maculatus	**Inanga**	**At Risk-Declining**	**7**
Galaxias postvectis	**Shortjaw kokopu**	**Threatened-Nationally Vulnerable**	**1**

Scientific Name	Common Name	Threat Ranking	Number of Occurrences in the NZFFD
Gambusia affinis	Gambusia	Introduced and naturalised	17
Geotria australis	**Lamprey**	**Threatened-Nationally Vulnerable**	**23**
Gobiomorphus	**Unidentified bully**		**6**
Gobiomorphus basalis	**Crans bully**	**Not Threatened**	**7**
Gobiomorphus cotidianus	**Common bully**	**Not Threatened**	**14**
Gobiomorphus huttoni	**Redfin bully**	**Not Threatened**	**1**
Mugil cephalus	Grey mullet	Not Threatened	*
Neochanna diversus	**Black mudfish**	**At Risk-Declining**	**4**
Oncorhynchus mykiss	Rainbow trout	Introduced and naturalised	*
Paranephrops planifrons	**Kōura**	**Not Threatened**	**8**
Retropinna retropinna	**Common smelt**	**Not Threatened**	**8**
Salmo	Unidentified salmonid		*
Salmo trutta	Brown trout	Introduced and naturalised	*
Scardinius erythrophthalmus	**Rudd**	**Introduced and naturalised**	**6**

The balance of the proposed wind farm site drains west into the Ohautira catchment, which drains into Raglan Harbour. The New Zealand Freshwater Fish Database (Stoffels 2022) holds seven records for the Ohautira catchment. These records cover just two sites in the lower catchment and two sites in the mid-catchment, but no records in the headwaters/upper catchment where the proposed wind farm is to be developed. Ten species of freshwater fish and invertebrates (Table 6), not including unidentified fish, have been recorded in the Ohautira catchment. Ten of these are indigenous species, with three classified as At Risk-Declining (as per Dunn *et al.* 2017 and Grainger *et al.* 2018).

Table 6 – New Zealand Freshwater Fish Database records for the Ohautira catchment. Threat rankings are as per Dunn *et al.* 2017 and Grainger *et al.* 2018.

Scientific Name	Common Name	Threat Ranking	Number of Occurrences in the NZFFD
Aldrichetta forsteri	Yellow-eyed mullet	Not Threatened	2
Anguilla	Unidentified eel		3
Anguilla australis	Shortfin eel	Not Threatened	3
Anguilla dieffenbachii	Longfin eel	At Risk-Declining	5
Galaxias fasciatus	Bakōkopuokopu	Not Threatened	5
Galaxiasīnangaatus	Inanga	At Risk-Declining	3
Gobiomorphus cotidianus	Common bully	Not Threatened	3
Gobiomorphus huttoni	Redfin bully	Not Threatened	4
Paranephrops planifrons	Kōura	Not Threatened	4
Retropinna retropinna	Common smelt	Not Threatened	3
Salmo trutta	Brown trout	Introduced and naturalised	2

The proposed wind farm site is situated within the headwaters of each of these catchments which retain high value habitat for indigenous fish and invertebrates.

12.0 Terrestrial invertebrates

The GBIF search retrieved records of 169 terrestrial invertebrates that met the search terms. The invertebrate fauna was characterised mainly by beetles, flies, true bugs, bees, wasps, ants, and moths and butterflies. Of these, 141 had been identified to a level at which they could be assessed. The invertebrate fauna was a mixture of indigenous and exotic species. Notable species are presented in Table 7.

Table 7 – Notable invertebrate species recorded within five kilometres of the proposed Glen Massey Wind Farm site.

Species Name	Common Name	Threat Classification	Notability	Likelihood of Being On-Site
Vanessa gonerilla	New Zealand red admiral	Not assessed	Declining due to habitat loss	
Rhytida greenwoodi	Carnivorous land snail	Not Threatened (Walker *et al.* 2022)	Short-range endemic, vulnerable to predation by introduced species, and habitat modification	

13.0 Ecological values and contraints

13.1 Vegetation and habitats

Overview

Vegetation and habitat types listed in Table 8 are present within the buffer zone mapped at the site.

Table 8 – Vegetation and habitat types mapped within the Glen Massey Wind Farm buffer zone. Overall ecological values of each vegetation type and the area of each vegetation type within the buffer zone and the development footprint are also included.

Vegetation and Habitat Type	Likely Ecological Value	Area Within Buffer Zone (hectares)	Area Potentially Within Proposed Development Footprint (hectares)[1]
1. Indigenous forest and scrub	Moderate to high	92.6	21.6
2. Indigenous treeland	Moderate	4.3	0.3
3. Exotic forest	Low	246.7	58.4
4. Exotic scrub	Low	19.6	2.7
5. Exotic grassland, rural infrastructure, and dwellings	Low	270.8	72.2
6. Potential wetlands	Low to high	2.9	0.2
7. Ponds	Low	0.2	0.1
Total	-	**637.0**	**155.5**

1. Although indigenous vegetation and habitat types have been mapped within the proposed development footprint, the client intends that all indigenous vegetation will be avoided within the proposed development footprint, therefore no indigenous vegetation will be removed (Glenn Starr, Ventus Energy, pers. comm., 2024).

Type 1: Indigenous forest and scrub

Areas of Vegetation and Habitat Type 1 are potentially of **moderate to high ecological value,** overall. These areas of secondary indigenous forest and scrub and/or modified forest are representative of indigenous tall forest which has been greatly reduced in extent in Raglan Ecological District since the arrival of humans in Aotearoa New Zealand, mostly due to the historic clearance of indigenous forest for the development of pastoral farmland. LCDB classes 'indigenous forest', which Vegetation Type 1 is representative of, have been reduced to *c.*11% of the total vegetation cover of the Ecological District. (Prior to the arrival of humans, indigenous tall forest would have covered most of the Ecological District.)

Type 2: Indigenous treeland

Areas of Vegetation and Habitat Type 2 are likely to be of **moderate ecological value** overall, but could be of **high ecological value** if these areas provide habitat for Threatened or At Risk indigenous plants and/or fauna. Areas of Vegetation and Habitat Type 2 could be partially representative of indigenous tall forest, albeit these areas are severely degraded and/or are in a regenerative state.

Types 3-5, and 7

Vegetation and Habitat Types 3, 4, 5, and 7 are likely to be of **low ecological value** overall. Areas of grazing land, exotic forest, and ponds which are included in these vegetation types, are likely to provide habitat for indigenous plants and fauna, however the indigenous species likely to be present are likely to be common and widespread in the Ecological District and wider Waikato Region. However, the presence of Threatened or At Risk species within Vegetation Types 3-5, and 7 could potentially elevate **ecological values from low to high**. The ecological values of Vegetation Type 7 could also be elevated from **low to high** if these areas were to meet the definition of 'natural inland wetlands' under the NPS-FM.

Type 6: Potential wetlands

Vegetation and Habitat Type 6 provides an indication of areas that could meet the criteria of 'natural inland wetland' as per the NPS-FM 2020. Natural inland wetlands at the site could be of **high to very high ecological value** depending on the indigenous species present and vegetation cover. Earthworks or vegetation clearance undertaken in close proximity to natural inland wetlands, along with inadequate mitigation measures, could result in significant adverse effects by altering wetland hydrology. Hydrology changes could affect indigenous wetland vegetation present, and subsequently harm indigenous fauna present that utilise wetland habitat.

Seepage wetlands dominated by indigenous vegetation are a naturally uncommon ecosystem type and are classified as endangered at a national-level in Aotearoa New Zealand (Williams *et al.* 2007, Holdaway *et al.* 2012). It should be noted that a field inspection will be required to formally assess the hydrology, soils, and vegetation of these areas in order confirm whether or not these areas meet the criteria for 'natural inland wetland' under the NPS-FM 2020.

Summary

Removal of **moderate to high ecological value** vegetation and habitat types could have adverse effects on indigenous plants and fauna, including any species that have threat rankings. As shown in Table 8, the following vegetation types potentially of **moderate to high ecological** value are located within the proposed development footprint and could be removed during the construction process:

- Indigenous forest and scrub – up to *c.*21.6 hectares.
- Indigenous treeland – up to *c.*0.3 hectares.
- Potential wetlands – up to *c.*0.2 hectares.

However, it is important to note that it is highly likely that the total area removed of each of the three vegetation types listed above will be considerably less than stated as the intention is to avoid the removal of indigenous vegetation (Glenn Starr, Ventus Energy, pers. comm., 2024).

13.2 Flora

Eleven indigenous plant species with threat rankings (as per de Lange *et al.* 2018) have been recorded within five kilometres of the mapped buffer zone. However, two of these species, poroporo (*Solanum aviculare* var. *aviculare*) and para (king fern, *Ptisana salicina*), are unlikely to be present within the mapped buffer at the proposed wind farm. The other nine species are myrtles (Myrtaceae family) and therefore do not require special consideration.

It is possible that other indigenous plant species with threat rankings (as per de Lange *et al.* 2018) are also present within the buffer zone but a field survey is required to determine whether any of these species are present.

13.3 Avifauna

Twenty-one of the 29 indigenous species that are considered highly or moderately likely to be present at the proposed Wind Farm site are classified as Not Threatened species (as per Roberston *et al.* 2021) such as tētē-moritoiti (grey teal, *Anas gracilis*), kererū (New Zealand pigeon, *Hemiphaga novaeseelandiae*), and korimako (bellbird, *Anthornis melanura melanura*) (see Table 10 in Appendix 1). As these are Not Threatened species, occasional bird strike is very unlikely to result in population-level effects.

Threatened or At Risk species that are moderately or highly likely to be present include:

- Weweia (New Zealand dabchick, *Poliocephalus rufopectus*).
- Pūweto (spotless crake, *Zapornia tabuensis*).
- Kawaupaka (little shag, *Microcarbo melanoleucos brevirostris*).
- Māpunga (black shag, *Phalacrocorax carbo novaehollandiae*).
- Matuku-hūrepo (Australasian bittern, *Botaurus poiciloptilus*).
- Kārearea (bush falcon, *Falco novaezelandiae ferox*).
- Kōroātito (North Island fernbird, *Poodytes punctatus vealeae*).
- Pīhoihoi (*Anthus novaeseelandiae novaeseelandiae*).

Vegetation clearance during and following construction, and collisions with turbine blades during operation, are the most likely adverse effects of the proposed wind farm development on avifauna. Vegetation clearance during the breeding season (August to March) could disturb nesting forest birds and destroy eggs or chicks of many species.

Movement of birds between key habitats is one of the key activities of which birds are potentially at the greatest risk of collision with wind turbine blades. A major consideration is the migratory movement of shore birds between key estuarine habitats of the wider Waikato and south Auckland Regions, with some of these sites being of international importance site for wading birds, for example Miranda, Manukau Harbour, and the west coast estuary systems of Port Waikato, Raglan Harbour, and Kawhia Harbour. Bird species that are known or thought to migrate from west coast estuary systems and/or the coastline to the Firth of Thames include tōrea (South Island pied oyster catcher, *Haematopus finschi*), wrybill (*Anarhynchus frontalis*; Threatened-Nationally Increasing), and kuaka (eastern bar-tailed godwit, *Limosa lapponica baueri*; At Risk-Declining) (Kessels and Associates 2008).

Due to the distance of the proposed wind farm from the coast (*c.*17 kilometres from the west coast of the North Island and *c.*60 kilometres southwest of the Firth of Thames), potential effects on coastal and estuarine avifauna will depend on the exact routes used by these species when they cross from the west coast to the Firth of Thames. Radar surveys have previously been undertaken to evaluate bird movements as part of the pre-development shorebird monitoring for the consented Hauāuru Mā Raki Wind Farm. As part of these surveys, the nearest of the two radar stations was positioned *c.*18 kilometres west of the proposed Glen Massey Wind Farm site, with another radar station *c.*40 kilometres northwest of the proposed Glen Massey site (Kessels and Associates 2009). Findings from the radar surveys indicated that there was more bird activity in the northern part of the Hauāuru Mā Raki site (i.e. recorded by the northern radar unit), than the southern end of the site (Kessels and Associates 2009). This may indicate that bird migratory activity in the vicinity of the proposed Glen Massey site is like to be less than the consented Hauāuru Mā Raki Wind Farm, although there is limited data on bird movements in the Glen Massey area. It is likely, however, subject to consideration of scale and specific site character, that potential effects associated with the Glenn Massey site are likely to be similar to the operational Te Uku Wind Farm.

Eight species ranked in Robertson *et al.* (2021) that were identified as being highly or moderately likely to be present at the wind farm site are discussed further in Appendix 2.

13.4 Bats

It is likely that long-tailed bats (Threatened-Nationally Critical) utilise the proposed Glen Massey Wind Farm site, but it is very unlikely that central lesser short-tailed bat (At Risk-Declining) utilise the wind farm site.

Bats can potentially be adversely affected by the construction and operation of wind farms if they roost or forage nearby, with blade strike being a risk to bats during wind farm operation. A review of bird and bat mortality at 180 wind farms overseas by Hötker *et al.* (2006) found that turbines in woodland sites caused more bat mortality than turbines in open areas, but it is unknown whether the results of this overseas study are applicable to bats in Aotearoa New Zealand. Bats have also been shown to be killed by barometric effects when a rapid air-pressure reduction produced by rotating turbine blades causes barotrauma and subsequent bat mortality.

Bats are absolutely protected under the Wildlife Act (1953) and it is an offence to injure or kill any bats present without a Wildlife Act Authority.

A season spring to Autumn survey (1 November-30 April) for bats could be undertaken to help attain a better indication of bat use of the site.

13.5 Herpetofauna

Six indigenous lizard species could potentially be present, and three of those species have a high likelihood of being present within the proposed wind farm site, with all three of those species being classified as At Risk by Hitchmough *et al.* (2021).

Indigenous forest and scrub (Vegetation Type 1) and indigenous treeland (Vegetation Type 2) provide habitat suitable for indigenous lizard species. Therefore areas of these two vegetation types are of **moderate to high ecological value** because indigenous lizards, including species with threat rankings as per Hitchmough *et al* (2021), may be present within these habitats.

As mentioned in Section 13.1 above, some clearance of indigenous treeland (Vegetation Type 2) could potentially be removed during construction of the proposed Wind Farm. Removal of indigenous vegetation which provides habitat suitable for indigenous lizards could potentially have adverse effects on lizards, if present, along the following lines:

- Injuries and/or deaths of individual lizards.
- Permanent displacement and social disturbance of individuals and populations.
- Permanent loss and modification of habitat.
- Increased predation risk due to increased movements by introduced predatory mammals along newly-formed roads and tracks.
- Disturbance during construction including dust/vibration and noise and increased traffic on existing and new roads.

Lizards are absolutely protected under the Wildlife Act (1953) and it is therefore an offence to injure or kill any lizards present without a Wildlife Act Authority.

13.6 Freshwater species and habitats

Waterways in the proposed Glen Massey Wind Farm site are headwaters that are part of the Waipa River and Ohautira Stream subcatchments which provide **high ecological value** habitats for fish and invertebrates. Twelve indigenous freshwater species with threat rankings as per Dunn *et al.* 2018 and Grainger *et al.* 2018 have been recorded within waterways that drain the site (see Tables 5 and 6).

Freshwater systems are sensitive to sedimentation, and alterations to hydrology caused by earthworks and/or vegetation clearance can lead to adverse effects on indigenous freshwater fish and invertebrate species. The likely environmental conditions of the site, i.e. high rainfall with very strong winds and silt-rich soils, mean that the site is possibly at high risk of erosion and sediment loss.

It should be noted that the proposed development footprint appears to directly cross waterways and/or wetlands at multiple points. Any new crossings that are created could potentially interfere with fish passage (e.g. if perched culverts are installed or flow is channelled).

The balance of the earthworks and construction associated with the proposed development footprint, which includes almost the entirety of the development footprint, will not directly affect existing waterways.

13.7 Terrestrial invertebrates

Indigenous invertebrates present within the proposed development footprint will be adversely affected by the disturbance and/or removal of vegetation, particularly indigenous vegetation and habitat types. As shown in Table 8 above, *c.*21.6 hectares of indigenous forest and scrub and *c.*0.3 hectares of indigenous treeland are within the proposed development footprint and could be removed as part of the development. These may be important habitats for indigenous invertebrate biodiversity.

14.0 Measures to address potential ecological effects

14.1 Vegetation and habitats

<u>Ground-truthing</u>

A field survey is required to 'ground-truth' the vegetation and habitat types that are within the proposed development footprint. Ground-truthing will determine the extent of the vegetation and habitat types present, and the species and structral composition of these types, which will further inform the evaluation of relative ecological values.

Potential Wetlands

Potential wetland areas (Vegetation Type 6) within 100 metres of the proposed development footprint will also require 'ground-truthing', with areas meeting the criteria for 'natural inland wetland' under the NPS-FM 2020 requiring delineation. Vegetation clearance and earthworks outside of, but within a 10 metre setback from, a natural inland wetland, or earthworks outside of, but within a 100 metre setback from, a natural inland wetland are *non-complying activities* under the NES-F. However, it should be noted that specified infrastructure, which may include this project, has a *discretionary activities* pathway under the NES-F.

Potential Footprint Effects

Repositioning the proposed roading network and microsites (i.e the development footprint) to directly avoid areas of indigenous forest and scrub, indigenous treeland, and potential wetlands is suggested and may be feasible. As most of the proposed development footprint will utilise areas of low ecological value, such as grazing land and plantation radiata pine forest, within the site, altering the development footprint to avoid areas of moderate to high ecological value may be feasible. Repositioning of the construction footprint so that there is an additional buffer between 'natural inland wetlands' and any part of the proposed development footprint is also suggested and may also be feasible.

The client intends that site development will avoid all indigenous vegetation within the proposed development footprint, therefore no indigenous vegetation may be removed during the construction phase (Glenn Starr, Ventus Energy, pers. comm., 2024).

A Mitigation and Offset Plan is likely to be required to address adverse effects if indigenous vegetation is removed as part of the wind farm development, to ensure that there is no net loss of indigenous biodiversity.

14.2 Flora

The 'ground-truthing' surveys mentioned above in Section 14.1 will provide an opportunity to identify any Threatened and/or At Risk indigenous plant species in Vegetation Types 1, 2, and 6, which will also inform the ecological values of these areas. Repositioning of the proposed development footprint to directly avoid vegetation types that hold Threatened and/or At Risk indigenous plant species is suggested. As most of the proposed development footprint will utilise areas of low ecological value, altering the development footprint to avoid areas of moderate to high ecological value may be feasible.

14.3 Avifauna

Construction and operation of wind turbines will potentially adversely effect birds that utilise the site. It is unlikely that adverse effects on birds can be avoided, however it is possible that adverse effects can be mitigated.

Baseline avifauna surveys across multiple seasons are needed to more accurately assess which bird species utilise habitats at the site, or migrate through the site, as migration paths and flight altitude is largely unknown for many species and no bird surveys have been undertaken at the proposed wind farm site. Depending on which bird species are recorded, and if any those recorded species have a Threatened or At Risk ranking as per Robertson *et al.* (2021), an avifauna management plan will be needed to determine what actions are required to mitigate effects of the wind farm on birds.

If any significant wetlands are found in the field survey, these wetland areas should be surveyed for matuku-hūrepo/Australasian bittern. Indigenous forest birds may nest in woody habitats within the proposed development footprint. Adverse effects on these species can be mitigated by avoiding clearance and construction during the breeding season (September–March) and checking for nests prior to any clearance.

14.4 Bats

Operation of wind turbines could potentially adversely affect any bats that utilise the site. It is unlikely that adverse effects on bats can be avoided, but it is possible that adverse effects can be mitigated.

Baseline acoustic bat surveys are needed to determine if bats are present, and if bats are detected, roost site surveys and a Bat Management Plan (BMP) will be required. A BMP will be needed to comprehensively determine what actions are required to mitigate, offset, or compensate for the adverse effects of the wind farm on bats. Management actions could include operational avoidance of bats, and site management (habitat enhancement, pest management, monitoring) at specific sites. A BMP should be prepared and implemented by a qualified bat ecologist, to ensure that appropriate wildlife management actions are implemented.

Repositioning of some proposed wind turbine locations may be required to address potential effects on bats.

14.5 Herpetofauna

The 'ground-truthing' vegetation surveys mentioned above in Section 14.1 above will provide an indication of the habitat values for indigenous lizards of Vegetation Types 1 and 2 within the proposed development footprint. As legally-protected lizard species have been identified as being potentially present, targeted surveys are required in order to confirm whether indigenous lizards are present within areas of Vegetation Types 1 and 2 within the proposed development footprint. As also mentioned above in Section 14.1, repositioning the proposed development footprint to avoid areas of Vegetation Types 1 and 2 could be considered.

If lizards are identified as being present and adverse effects on them are unavoidable, a Lizard Management Plan (LMP) and associated Wildlife Act Authority (permit) will be required. A LMP should provide a comprehensive plan that clearly avoids, mitigates, offsets or compensates for the losses of lizard populations and their habitats. Management actions could include avoidance and/or relocation of lizards, and site management (habitat enhancement, pest management, monitoring) at specific sites. A LMP must be prepared and implemented by a qualified and permitted ecologist/herpetologist, to ensure the appropriate management actions are implemented.

For Not Threatened or At Risk species present, adverse effects on Not Threatened or At Risk lizards can likely be mitigated by undertaking a lizard salvage operation. If any Threatened lizards are found, avoidance of these populations and their habitat will be required. If no lizards are detected during targeted surveys, a Lizard Discovery Protocol can be developed as part of a LMP if there are incidental lizard discoveries during construction.

Plague skink has been recorded within about four kilometres of the site. Any plants or timber brought into the site should be inspected for live plague skinks and their eggs to prevent introduction of this invasive species to the site.

14.6 Freshwater habitats and species

Baseline freshwater fish and invertebrate surveys should be undertaken within on-site tributaries of the Ohautira Stream to determine which species are present as there are no NZFFD records from the upper reaches of this catchment.

Although most/almost the entirety of earthworks and construction associated with the development footprint is outside of existing waterways and wetlands, a robust sediment management plan will be required to avoid sedimentation of streams or waterbodies within and surrounding the site. Areas of the proposed development footprint that are to cross any streams within the site must allow for sufficient fish passage as per the NES-F 2020. A vegetation buffer – preferrably 20 metres or more - around natural waterways is also beneficial, to ensure that streams remain shaded, thereby retaining suitable instream conditions for indigenous freshwater fish and invertebrates.

14.7 Terrestrial invertebrates

Due to the limitations of a desktop survey, a field survey is required before measures to address effects can be suggested. As most of the proposed development footprint will utilise areas of low ecological value, altering the development footprint to avoid areas of moderate to high ecological value may be feasible.

15.0 Surveys, monitoring, and reporting

The following monitoring is likely to be required if the proposed Glen Massey Wind Farm is consented:

Avifauna

- Development and implementation of a avifauna monitoring plan which includes seasonal pre-construction baseline surveys, and construction and post-construction phase monitoring, including avifauna mortality monitoring.

Bats

- Development and implementation of a bat monitoring plan which includes seasonal pre-construction baseline surveys, and construction and post-construction phase monitoring, including bat mortality monitoring.

Freshwater fish and invertebrates

- Development and implementation of a freshwater fish and invertebrate monitoring plan which includes pre-construction baseline surveys, and construction and post-construction phase monitoring.
- Development and implementation of a freshwater enivironmental monitoring plan which includes pre-construction baseline surveys, and construction and post-construction phase monitoring.

16.0 Mitigation and offsetting

Subject to the footprint effects of a final layout design on indigenous vegetation, habitats, and species, a Mitigation and Offset Plan is likely to be required to address adverse effects and ensure that there is no net loss of indigenous biodiversity.

17.0 Conclusion

Most of the proposed wind farm site has a cover of either exotic pasture currently used for grazing, or radiata pine plantation forest, both of which are of relatively low ecological value. Indigenous forest and scrub – of moderate to high ecological value is present within parts of the proposed footprint and requires further evaluation. Indigenous-dominant vegetation and habitat types, and potential wetland areas, require ground-truthing and it is likely to be feasible to avoid areas that are currently within the proposed development footprint. The client intends to avoid clearance of indigenous vegetation, therefore there may be no indigenous vegetation clearance as part of the development.

Although there are few records of indigenous fauna across the site, it is likely that a range of indigenous fauna utilise habitats within the proposed development footprint. Field surveys are required for Threatened and/or At Risk plants, avifauna, bats, and lizards. Wetland delineation is also required for wetlands that meet the definition of 'natural inland wetland' as per the NPS-FM 2020 that are within 100 metres of the proposed development footprint.

Construction and the post-construction operational phases of the wind farm will require management to avoid adverse effects on indigenous vegetation and habitat types, avifauna, bats, lizards, freshwater fish and invertebrates, and terrestrial invertebrates. Management of potential ecological effects will also likely require the development of survey, monitoring, and management plans for bats, lizards, and avifauna. It is also likely that an Ecological Mitigation and Offsetting Plan will be required to address any residual ecological effects.

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Appendix 1

Bird species records

Table 9 – All avifauna recorded in eBird within 15 kilometres, or within the two adjacent grid squares in the New Zealand Bird Atlas project (June 2019 to March 2024) within or close to the proposed Glen Massey Wind Farm site. Birds are listed by the taxonomic grouping of Order. Y denotes present. New Zealand status (as per Robertson *et al.* 2021 refers to their status on a national basis. Endemism is based on breeding status at a species level.

Common Name	Species	NZ Status	Grid Squares			Not Recorded, but Likely to be Present/Notes
			Within 15 km	AL70	AL69	
Number of checklists: June 2019-April 2024				34	40	
Swans, Ducks, Geese (Anseriformes)						
Kakīānau/black swan	*Cygnus atratus*	**Indigenous**	Y	Y		
Canada goose	*Branta candensis*	Introduced	Y	Y	Y	
Kuihi/greylag goose/feral goose	*Anser anser*	Introduced	Y	Y		
Pūtangitangi/paradise shelduck	*Tadorna variegata*	**Endemic**	Y	Y	Y	
Tētē-moroiti/grey teal	*Anas gracilis*	**Indigenous**	Y	Y		
Pāteke/brown teal	*Anas chlorotis*	**Indigenous**				Several recent records near Mercer and Tuakau (e.g. Colin Miskelly, Waikato River, near Mercer December 2023)
Rakiraki/mallard	*Anas playrhynchos*	Introduced	Y	Y	Y	
Pārera/grey duck	*Anas superciliosa*	**Indigenous**	Y	Y		
Mallard × grey duck hybrid		Hybrid complex	Y	Y	Y	
Kuruwhengi/Australasian shoveler	*Spatula rhynchotis*	**Indigenous**	Y	Y		
Pāpango/New Zealand scaup	*Aythya novaeseelandiae*	**Endemic**	Y			
Muscovy duck[1]	*Cairina moschata*	Introduced, see note 1	Y		Y	
Quails, pheasants and turkeys (Galliformes)						
Tikaokao/California quail	*Callipepla californica*	Introduced	Y	Y		
Pīkao/Peafowl	*Pavo cristatus*	Introduced	Y	Y	Y	
Common pheasant	*Phasianus colchicus*	Introduced	Y	Y	Y	
Korukoru/Wild turkey	*Meleagris gallopavo*	Introduced	Y		Y	
Red Junglefowl	*Gallus gallus*	Introduced, see note 1	Y		Y	
Grebes (Podicepiformes)						
Weweia/New Zealand dabchick	*Poliocephalus rufopectus*	**Endemic**	Y	Y		

Common Name	Species	NZ Status	Grid Squares			Not Recorded, but Likely to be Present/Notes
			Within 15 km	AL70	AL69	
Pigeons and doves (Columbiformes)						
Kererū Aropari/Rock pigeon	*Columba livia*	Introduced	Y	Y		
Kererū/New Zealand pigeon	*Hemiphaga novaeseelandiae*	**Endemic**	Y	Y	Y	
Spotted dove	*Streptopelia chinensis tigrina*	Introduced	Y	Y		
Barbery dove/African-collared dove	*Streptopelia risoria*	Introduced				Not recorded at wind farm site, but records to east, particularly urban areas and farmland.
Cuckoos (Cuculiformes)						
Pīpīwharauroa/shining cuckoo	*Chrysococcyx lucidus lucidus*	**Indigenous -migrant**	Y	Y		
Koekoeā/long-tailed cuckoo	*Eudynamys taitensi*	**Endemic -migrant**				One record near Glen Massey in November 2019 (Liam Ballard) in Grid Square AK70. May be under-surveyed for in pine plantations in eastern Waikato.
Adzebills, rails and cranes (Gruiformes)						
Pūweto/spotless crake	*Zapornia tabuensis*	**Indigenous**	Y			
Pūkeko	*Porphyrio melanotus melanotus*	**Indigenous**	Y	Y	Y	
Australian coot	*Fulica atra australis*	**Indigenous**	Y			
Moho-pererū/banded rail	*Gallirallus philippensis assimilis*	**Indigenous**	Y			Nearest recent record since June 2019 in the NZ Bird Atlas Programme from Kawhia Harbour.
Waders, skuas, gulls and terns (Charadriiformes)						
Tōrea pango/variable oystercatcher	*Haematopus unicolor*	**Endemic**	Y		Y	Coastal/estuarine species
Tōrea/South Island pied oystercatcher	*Haematopus finschi*	**Endemic**	Y		Y	
Poaka/pied stilt	*Himantopus himantopus leucocephalus*	**Indigenous**	Y	Y		
Pohowera/banded dotterel	*Charadrius bicinctus bicinctus*	**Endemic**	Y			No recent (since 2019) inland records northwest of Hamilton
Spur-winged plover/masked lapwing	*Vanellus miles novaehollandiae*	**Indigenous**	Y	Y	Y	
Kuaka, eastern bar-tailed godwit	*Limosa lapponica baueri*	**Indigenous- migrant**	Y			Nearest seasonal populations at Miranda, Port Waikato, Raglan and Kawhia Harbours. Estuarine and coastal species.
Tarāpunga/red-billed gull	*Chroicocephalus novaehollandiae scopulinus*	**Indigenous**	Y			Relatively rare at inland sites northwest of Hamilton.
Tarāpuka/black-billed gull	*Chroicocephalus bulleri*	**Endemic**				Not recorded from wind farm site. Rare visitor to northern inland Waikato e.g. one

Common Name	Species	NZ Status	Grid Squares			Not Recorded, but Likely to be Present/Notes
			Within 15 km	AL70	AL69	
						recorded near Huntly in May 2019 by Russell Cannings.
Karoro/southern black-backed gull	*Larus dominicanus dominicanus*	**Indigenous**	Y		Y	
Taranui/Caspian tern	*Hydroprogne caspia*	**Indigenous**	Y		Y	Northern inland Waikato records mostly associated with small lakes and Waikato River
Tara/white-fronted tern	*Sterna striata striata*	**Indigenous**	Y			A coastal species, rare inland record, particularly near the Waikato River upstream of Meremere.
Frigatebirds, gannets, darters, and cormorants (Phalacrocoracidae)						
Kawaupaka/little shag/little pied shag	*Microcarbo melanoleucos brevirostris*	**Indigenous**	Y	Y	Y	
Māpunga/black shag	*Phalacrocorax carbo novaehollandiae*	**Indigenous**	Y	Y	Y	
Kāruhiruhi/pied shag	*Phalacrocorax varius varius*	**Indigenous**	Y	Y	Y	
Kawau tūī/little black shag	*Phalacrocorax sulcirostris*	**Indigenous**	Y	Y		
Pelicans, herons, ibises (Pelecaniformes)						
Matuku moana/white-faced heron	*Egretta novaehollandiae*	**Indigenous**	Y	Y	Y	
Matuku-hūrepo/Australasian bittern	*Botaurus poiciloptilus*	**Indigenous**	Y			Widespread in Waikato Region, particularly in lowland wetlands east of the proposed wind farm and coastal sites.
Kōtuku ngutupapa/royal spoonbill	*Platalea regia*	**Indigenous**	Y		Y	
Kites, Hawks, and Eagles (Accipitriformes)						
Kāhu/swamp harrier	*Circus approximans*	**Indigenous**	Y	Y	Y	
Owls (Strigiformes)						
Ruru/morepork	*Ninox novaeseelandiae novaeseelandiae*	**Indigenous**	Y	Y		
Rollers and kingfishers (Coraciiformes)						
Kōtare/New Zealand kingfisher	*Todiramphus sanctus vagans*	**Indigenous**	Y	Y	Y	
Falcons (Falconiformes)						
Kārearea/bush falcon	*Falco novaeseelandiae ferox*	**Endemic**	Y			
Parrots (Psittaciformes)						
Kākā/North Island kākā	*Nestor meridionalis septentrionalis*	**Endemic**	Y	Y		
Kākā uhi whero/Eastern rosella	*Platycercus eximius*	Introduced	Y	Y	Y	
Sulphur-crested cockatoo	*Cacatua galerita*	Introduced	Y	Y	Y	

Common Name	Species	NZ Status	Grid Squares			Not Recorded, but Likely to be Present/Notes
			Within 15 km	AL70	AL69	
Perching birds (Passeriformes)						
Korimako/bellbird	*Anthornis melanura melanura*	**Endemic**	Y			
Tūī	*Prosthemadera novaeseelandiae novaeseelandiae*	**Endemic**	Y	Y	Y	
Riroriro/grey warbler	*Gerygone igata*	**Endemic**	Y	Y	Y	
Pīwakawaka/North Island fantail	*Rhipidura fuliginosa placabilis*	**Endemic**	Y	Y	Y	
Makipai/Australian magpie	*Gymnorhina tibicen*	Introduced	Y	Y	Y	
Miromiro/North Island tomtit	*Petroica macrocephala toitoi*	**Endemic**	Y			
Toutouwai/North Island robin	*Petroica longipes*	**Endemic**	Y			
Kairaka/Eurasian skylark	*Alauda arvensis*	Introduced	Y	Y	Y	
Koroātito/North Island fernbird	*Poodytes punctatus vealeae*	**Endemic**	Y			
Warou/welcome swallow	*Hirundo neoxena neoxena*	**Indigenous**	Y	Y	Y	
Tauhou/silvereye	*Zosterops lateralis lateralis*	**Indigenous**	Y	Y	Y	
Tāringi/common starling	*Sturnus vulgaris*	Introduced	Y	Y	Y	
Maina/common myna	*Acridotheres tristis*	Introduced	Y	Y	Y	
Manu pango/Eurasian blackbird	*Turdus merula merula*	Introduced	Y	Y	Y	
Manu kai-hua-raku/song thrush	*Tudus philomelos*	Introduced	Y	Y	Y	
Dunnock	*Pruella modularis*	Introduced	Y		Y	
Tiu/house sparrow	*Passer domesticus*	Introduced	Y	Y	Y	
Pīhoihoi/New Zealand pipit	*Anthus novaeseelandiae novaeseelandiae*	**Endemic**	Y			
Pahirini/chaffinch	*Fringilla coelebs*	Introduced	Y	Y	Y	
European greenfinch	*Chloris chloris*	Introduced	Y	Y	Y	
Common redpoll	*Acanthis flammea*	Introduced	Y	Y		
Kōurarini/European goldfinch	*Careduelis carduelis britannica*	Introduced	Y	Y	Y	
Hurukōwhai/yellowhammer	*Emberiza citrinella*	Introduced	Y	Y	Y	

Table 10 –Assessment of potential habitat use and likelihood of use of the proposed wind farm site for indigenous birds listed in Table 9. Threat rankings are as per Robertson *et al.* (2021). Habitat usage and range/migration information is from New Zealand Birds Onine, eBird, and Heather and Robertson (2015), and wider literature. Birds are listed by taxonomic Order.

Common Name	Threat Status	Habitat Type(s)	Habitat Usage and Range/Migration	Likelihood of Species Presence at Wind Farm Site
Swans, ducks, and geese (Anseriformes)				
Kakīānau/black swan	Not Threatened	Open water, farmland	Widespread in the lowlands surrounding the wind farm site. Probably more abundant on the lowland flats than the hill country. While many birds are sedentary particularly for large parts of their life-cycle, some birds are known to travel considerable distances (Marchant and Higgins 1990). Will also travel at night and over land. May occasionally utilise farm ponds and adjacent pasture in the area. Potential occasional impacts with wind farm infrastructure, but a common and widespread species in Aotearoa New Zealand.	**Moderate**
Pūtangitangi/paradise shelduck	Not Threatened	Wetlands, open habitat, farmland	Widespread in the lowland and hill country surrounding the proposed wind farm site. Utilises diverse habitats such as farm ponds, wetlands, and farmland. Few records in the hill country on the proposed site, but this is probably a lack of survey effort. Likely to be occasional impacts with wind farm infrastructure, but a common non-threatened indigenous species. Internationally, wind farm fatalities are known for other species of shelduck.	**High**
Tētē-moroiti/grey teal	Not Threatened	Open water	Highly mobile, no records in the hill country near Glen Massey, but this is likely to be a lack of survey effort. Likely to be present on farm ponds. Most records, and there are plenty, and in the lowlands to the east of the proposed wind farm site. Potential occasional impacts with wind farm infrastructure, but a non-threatened and widespread species in Aotearoa New Zealand.	**Moderate**
Pāteke/brown teal	Threatened-Nationally Increasing	Wide range including wet forests, extensive and occluded swamps, slow-flowing streams, lakes and estuaries. Farm habitats (Williams 2013)	Often crepuscular to nocturnal habitat. Movement habitats are probably quite variable due to changing habitats in different environments and are not well understood. While the population is considered low for this part of the Waikato, the chances of establishment may have significant impacts on any birds trying to establish in this region.	Low due to very small population in the northwestern Waikato.
Pārera/grey duck	Threatened – Nationally Vulnerable	Open water	Recent records, particularly near Lake Whangape to the northwest of the proposed wind farm site. Pure birds are now very rare and limited suitable habitat (Williams 2013). No records from Hill Country near Glen Massey, although this may be due to the lack of survey effort. Likely to be occasionally present in farm ponds and forested headwater catchments.	Low- due to rarity and high hybridisation with mallard
Kuruwhengi/Australasian shoveler	Not Threatened	Open water	Most records in lower country to the west of the wind farm. No records on the hill country near the proposed wind farm, but this may be related to lack of survey effort. May be present on farm ponds. Shoveler can travel considerable distances and movement.	**Moderate**
Pāpango/New Zealand scaup	Not Threatened	Open water	Usually open water habitat only, and otherwise flying between these areas. No records on their hill country near Glen Massey. May occasionally use farm ponds.	**Moderate**
Grebes (Podicepiformes)				

Common Name	Threat Status	Habitat Type(s)	Habitat Usage and Range/Migration	Likelihood of Species Presence at Wind Farm Site
Weweia/New Zealand dabchick	Threatened – Nationally Increasing	Open water	Open water species. Two recent records in farmland hill country near Glen Massey. May occasionally utilise farm ponds in the vicinity of the wind farm. Movements between preferred habitats are poorly understood, but are thought to be mostly undertaken at night (Marchant and Higgins 1990).	**Moderate**
Pigeons and doves (Columbiformes)				
Kererū/New Zealand pigeon	Not Threatened	Forests (indigenous and exotic), shelterbelts, and preferred trees and shrubs amongst pasture.	Scattered records in the hill county around Glen Massey, indicates the use of the site by this species, but there are few bird records from the immediate wind farm site. Known to regularly fly between preferred food sources. Engage in flight displays up to 50 metres above canopy. Kererū are highly dispersive when searching for seasonal food and may be at risk from bird strike during flight displays. Wildland Consultants (2019) reports that they were observed occasionally flying at turbine height at Turitea (another wind farm in the southern North Island), although this was mainly restricted to indigenous forest, which is also present near turbines at the proposed Glen Massey Wind Farm site.	**High**
Cuckoos (Cuculiformes)				
Pīpīwharauroa/shining cuckoo	Not Threatened	Forest	A few records on eBird show seasonal use of the hill country near the proposed Glen Massey Wind Fam site, and are also many records throughout the Waikato Region. Migration routes and flight altitudes unknown, but migration is probably mostly at night (Higgins 1999). They are generally present in spring, summer and autumn only in Aotearoa New Zealand. Only rare records of overwintering birds. Migrations are probably mostly at night time with most departures probably January to April, and arrivals a range of dates from June to November, peaking in October with considerably variation related to weather patterns (e.g. Higgins 1999, Gill 1983). Known to be vulnerable to window-collisions. Migrating pīpīwharauroa/shining cuckoo could be at risk of collision, especially in bad weather or at night.	**High**
Koekoeā/long-tailed cuckoo			One record near Glen Massey in November 2019 (Liam Ballard) in Grid Square AK70. May be under-surveyed for in pine plantations in eastern Waikato. There are few pōpokatea/whitehead records in the hills west of Hamilton and north of Pirongia Forest Park. This indicates that numbers are likely to be low in the northwestern Waikato region. The pōpokotea records (since June 2019) are all in the Hikarimata Scenic Reserve near Ngaruawahia and all DOC Tier 1 records from October 2019. Pōpokotea are the only host for koekoeā in the North Island, with koekoeā being a broad parasite (lay their eggs in other species of bird nest and the host species also raise the chicks to fledging). Because of this, the risk to this species based on existing evidence is considered low due to the low number of records and the low abundance of the host species in the region.	Low (based on expected low abundance in the wind farm area)
Adzebills, rails, and cranes (Gruiformes)				
Pūweto/spotless crake	At Risk – Declining	Wetlands	All recent records in the New Zealand Bird Atlas scheme (since 2019) are well to the east of the proposed wind farm in wetlands in the plains near Hamilton. However, this is a cryptic species that may not have been surveyed for. Could potentially be present in any suitable wetlands if present, particularly those with raupō (*Typha orientalis*). Movements between preferred sites are poorly understood.	**High**
Pūkeko	Not Threatened	Wetlands, open habitats such as farmland.	Utilises diverse habitats, overland flights mostly at night. Occasionally recorded making long-distance flights at night. This is mainly a wetland species, whereas most of the turbines are located on the ridgetops. Despite the lack of records around the proposed wind farm site, this species is very likely to be common at this site.	**High**

Common Name	Threat Status	Habitat Type(s)	Habitat Usage and Range/Migration	Likelihood of Species Presence at Wind Farm Site
Australian coot	At Risk – Naturally Uncommon	Open water	All records of this species in the flat land well to the east of the proposed wind farm. May occasionally utilise farm ponds in the vicinity of the wind farm. There are no records of Australian coot in the hill country between Hamilton and the coast.	Low
Waders, skuas, gulls, and terns (Charadriiformes)				
Tōrea pango/Variable oystercatcher	At Risk - Recovering	Mostly a coastal species.	Mostly a coastal species, unlikely to utilise habitats near the proposed wind farm. The main threat is flights between significant coastal sites, particularly the key large estuaries in the Waikato and South Auckland Region.	Low
Tōrea/South Island pied oystercatcher	At Risk - Declining	Mostly coastal in non-breeding season, but also present in open country such as farmland and sports fields.	Migration routes unknown but generally travel along west coast of North Island, well away from the wind farm. Several records of birds on the near Hamilton, but none from the hill country near the wind farm. In the North Island generally a coastal species. The key threat is any flight paths between the key estuarine habitats in the Waikato and South Auckland region.	Low
Poaka/pied stilt	Not Threatened	Wetlands, braided rivers, wet farmland.	Migratory routes are thought to be mostly coastal. Utilise wetland habitats around the plains around Hamilton. Around 50% of population migrates along west coast of North Island. Likely to be present in suitable wet farmland habitats near the proposed wind farm.	**Moderate**
Pohowera/banded dotterel	At Risk - Declining	Riparian	The nearest records are from Raglan Harbour. North Island populations migrate among riparian and coastal habitats. No recent records of this species from the Glen Massey Hill country, or in inland sites in the flat lowland near Hamilton.	Low
Wrybill	Threatened - Nationally increasing	Coastal, rivers	Nearest record is Raglan Harbour. In the North Island restricted to coastal estuarine habitats. Not likely to be present in inland hill country in the northwestern Waikato, unless travelling between estuarine sites.	Low
Spur-winged plover/masked lapwing	Not Threatened	Wetlands, open habitat such as farmland, sports fields and river flats.	Utilise riparian, and pasture habitats and open urban habitats. Likely to be abundant in the wind farm site, but few records due to lack of survey effort. Wildland Consultants (2019) recorded occasionally flying at turbine height at Turitea (another wind farm site near Palmerston North), particularly when disturbed. Not a threatened species, therefore turbine blade strike is unlikely to cause population effects	**High**
Kuaka/eastern bar-tailed godwit	At Risk-Declining	Coastal, estuarine and beaches. Roost on terrestrial margin habitat.	Coastal species, very unlikely to be present at an inland hill country site unless flying between estuarine sites.	Low
Tarāpunga/red-billed gull	At Risk - Declining	Coastal, riparian, developed landscapes	Mostly a coastal species in northern Waikato. Almost all records in the vicinity of the widen farm are near Palmerston North. A gull species more typical of coastal habitats and larger inland lakes.	Low
Tarāpuka/black-billed gull	At Risk - Declining	Riparian and developed landscapes	Very few records inland in the northern Waikato.	Low due to few records from the lower North Island axial range**s.**
Karoro/southern black-backed gull	Not Threatened	Coastal, rivers, open habitat, farmland, open developed sites, open water	A relatively abundant species in the wider Hamilton and Glen Massey area. The few records from the actual proposed wind farm site probably relates to a lack of survey effort and is likely to be abundant at the wind farm site. Wildland Consultants (2019) reported karoro flying occasionally within the rotor zone across a wind farm site near Palmerston North. Not a threatened species, therefore turbine blade strike is unlikely to cause population effects.	**High**

Common Name	Threat Status	Habitat Type(s)	Habitat Usage and Range/Migration	Likelihood of Species Presence at Wind Farm Site
Taranui/Caspian tern	Threatened - Nationally Vulnerable	Coastal, riparian and larger inland open water bodies	Often a coastal and large lake species, but many records along the Waikato River and large lakes on the plains near and north of Hamilton. Unlikely to utilise hill country west of the plains on a regular basis.	Low
Tara/white-fronted tern	At Risk-Declining	Coastal, pelagic	Mostly a coastal species. A few records inland, particularly along the Waikato River, all north of Meremere.	Low
Frigatebirds, gannets, darters, and cormorants (Phalacrocoracidae)				
Kawaupaka/little shag or little pied shag	At Risk - Relict	Rivers, open water	Most records are from the lower altitude flat land near Hamilton to Ngaruawahia, but may be present in farm ponds. Can occasionally nest in gorges inland, but more abundant in other habitats. If birds are moving between preferred breeding zone, this species often flies within the potential turbine collision zone.	**Moderate**
Māpunga/black shag	At Risk - Relict	Rivers, open water	Regularly flies over land between roosting and foraging sites. Some records in the hill country near Glen Massey in the last five years.	**Moderate**
Kāruhiruhi/pied shag	At Risk - Recovering	Rivers, open water	Numerous records at Raglan Harbour and inland lakes and major rivers between Hamilton and Ngaruawahia. The habitats for this species are generally more suited to the lower flat lands and coastal sites than the hill country near Glen Massey.	Low
Kawau tūī/little black shag	At Risk - Naturally Uncommon	Rivers, open water	No records in the hill country near the wind farm site. The habitats for this species are generally more suited to the lower flat lands than the hill country near Glen Massey.	Low
Pelicans, herons, and ibises (Pelecaniformes)				
Matuku moana/white-faced heron	Not Threatened	Rivers, open water, farmland	Utilises diverse wetland and open habitats. Some records near Glen Massey, but many more near the flat country and farmland. Birds could potentially fly between preferred habitats in the impact zone of the wind farm turbines, although based on abundances this is likely to be a relatively rare event.	Moderate
Matuku-hūrepo/Australasian bittern	Threatened - Nationally Critical	Wetlands	Several coastal records > 5 kilometres from the wind farm site particularly in wetlands near Hamilton. Movements between preferred habitats in this region are poorly understood, but is probably more abundant in the region than has been reported for. Any suitable wetlands in the vicinity of the wind farm should be surveyed for this species due to its conservation concern.	**Moderate**
Kōtuku ngutupapa/royal spoonbill	At Risk - Naturally Uncommon	Open water	Numerous records in nearby estuarine harbours and plains north of Hamilton, but no records from the hill country near Glen Massey. Will travel long distances between coastal foraging sites.	Low
Kites, Hawks, and Eagles (Accipitriformes)				
Kāhu/swamp harrier	Not Threatened	Open habitat, hunts over wide parts of the landscape on the wing	Soaring flight, hunts over open habitats. Likely to be abundant throughout the hill country near Waverley. International evidence indicates harriers which fly by soaring and gliding may be vulnerable to collisions with turbines. Known to have previously been killed on wind farms in NZ.	**High**
Owls (Strigiformes)				
Ruru/morepork	Not Threatened	Forest, open habitats with shelter belts.	A few inland records in the hill country west of Hamilton, but probably few night surveys at the proposed wind farm site. No records near the proposed wind farm site at Waverley, but this is probably a lack of nocturnal bird survey effort. Utilises indigenous and exotic forest habitats and can hunt in open habitats such as those near the proposed wind farm. Internationally, owl species are known to collide with turbine blades. Not a threatened species, therefore turbine blade strike is unlikely to cause population effects.	**High**
Rollers and kingfishers (Coraciiformes				

Common Name	Threat Status	Habitat Type(s)	Habitat Usage and Range/Migration	Likelihood of Species Presence at Wind Farm Site
Kōtare/New Zealand sacred kingfisher	Not Threatened	Forest, open habitat	Likely to be abundant in the proposed wind farm area. Known to utilise indigenous forest and exotic forestry and a wide range of open developed habitats. There appears to be altitudinal movement in winter between inland higher country and forest habitats to lowland farms the coast (McKinlay 2013). Known to frequently use elevated perches, including artificial structures such as powerlines and posts, and at least one kōtare/kingfisher has been a collision fatality at a New Zealand wind farm. Not a threatened species, therefore turbine blade strike is unlikely to cause population effects.	**High**
Falcons (falconiformes)				
Kārearea/bush falcon	Threatened - Nationally Increasing	Forest	Few records in the hill country northwest of Hamilton, but this may be partly a result of lack of survey effort. A number of records in more populated areas such as between Hamilton and Ngaruawahia and Raglan Harbour. Based on this, they are likely to be present at the wind farm site. There are no confirmed reports of kārearea being killed by wind farms (Wildland Consultants 2019).	**High**
Parrots (Psittaciformes)				
Kākā/North Island kākā	At Risk - Recovering	Forest	Based on an assessment of observations on eBird in the northwestern Waikato, probably a rare visitor to the region with most observations near populated areas between Hamilton and Ngaruawahia, and Raglan Harbour. Most records between April and October.	Low, due to the rarity in the hill country near Glen Massey. Conspicuous species.
Perching birds (Passeriformes)				
Korimako/bellbird	Not Threatened	Forest (indigenous and plantation) shelter belts, parks and gardens	Probably abundant in forest habitats near Glen Massey and surrounding hill country. Known to move between preferred habitats seasonally. Unlikely to fly high above forest habitats and be a risk of turbine collision. Rare in northwestern Waikato compared with other parts of Aotearoa New Zealand.	**High**
Tūī	Not Threatened	Forest (indigenous and plantation) shelter belts, parks and gardens	Fly high above canopy during courtship displays and seasonal movements; numerous records within site and surrounding area. Many records in the greater area of the proposed wind farm in the last five years. Not a threatened species, thus bird strike unlikely to cause population effects.	**High**
Riroriro/grey warbler	Not Threatened	Forest, scrub, farmland, shelterbelts and gardens	Occur widely in forest and scrub; records within site and surrounding area. Birds probably mostly keep below the turbine risk flight zone. The low number of records from the wind farm site shows the lack of bird survey effort in the area.	**High**
Pīwakawaka/North Island fantail	Not Threatened	Forest, shrubland, scrub, farmland with shelterbelts, gardens and parkland	Likely to be abundant in the proposed wind farm site. Occur widely in forest and shrubland habitats. Good avoidance abilities and a relatively common species. The low number of records from the wind farm site shows the lack of bird survey effort in the area.	**High**
Miromiro/North Island tomtit	Not Threatened	Forest, scrub, shrubland and farmland with shelterbelts.	Likely to be uncommon in the area if present at all, with the nearest record near Raglan Harbour. Utilises indigenous and exotic forest habitats. Unlikely to fly much above the forest canopy into the turbine strike zone. Also, no records in the part of the Waikato the wind farm occurs in the previous atlas assessment (1999-2004, Robertson et al	Low
Toutouwai/North Island robin	At Risk - Declining	Forest	Unlikely to currently be present at the wind farm site or if present in very low numbers. The nearest recent records near Tamahere and Pirongia and not recorded from the wind farm area between 1999 and 2004 in the previous atlas assessment (Robertson *et al.* 2007). Utilises indigenous and exotic forestry habitats. Unlikely to fly much above the forest canopy into the turbine strike zone.	Low

Common Name	Threat Status	Habitat Type(s)	Habitat Usage and Range/Migration	Likelihood of Species Presence at Wind Farm Site
Warou/welcome swallow	Not Threatened	Wetlands, rivers, open habitat, farmland	Likely abundant at the proposed wind farm site. Utilise pasture and riparian habitats; numerous records within site and surrounding area. Highly manoeuvrable aerial feeder. However, mortality has been reported from overseas wind farms (Kingsley and Whittam 2005).	**High**
Koroātito/North Island fernbird	At Risk-Declining	Wetlands, shrubland, scrub.	Recorded from wetlands on the plains near and north of Hamilton. No records from the wind farm site itself. Unlikely to fly high enough to be adversely affected by wind turbines. Movements between sites are not well understood. Any suitable wetlands should be surveyed for this species.	**Moderate**
Tauhou/silvereye	Not Threatened	Diverse range of habitats from forest to farmland with shelterbelts, and parks and gardens, and wetlands.	Follow seasonal food resources but migration paths unknown; numerous records within site and surrounding area. Previous bird strike deaths have been recorded for this species. Not a threatened species, thus bird strike unlikely to cause population effects. Likely to be abundant in woody habitats surrounding the proposed wind farm.	**High**
Pīhoihoi/New Zealand pipit	At Risk - Declining	Open habitat	A few records in open habitat to south of the proposed wind farm in the last five years. Fly at turbine height during courtship displays and long-distance movements, utilise pasture habitats	**High**

Appendix 2

Threatened or At Risk bird species as per Robertson *et al.* (2021) that are highly or moderately likely to be present at the Glen Massey Wind Farm site

Matuku-hūrepo/Australasian bittern (Threatened-Nationally Critical)

While there are relatively few bittern records in the vicinity of the proposed Glen Massey wind farm, the routes bittern travel between key habitats within this area are not well understood. Bitten are known to use both the lowland Waikato wetlands to the north of Hamilton, and also estuarine harbour habitats of the western Waikato. Numbers of bittern in Whangamarino Wetland are thought to have declined markedly since the 1980s (Williams 2013). This population was considered a stronghold for bittern in Aotearoa New Zealand. The national population may be fewer than 1,000 birds. It is highly likely that bittern may fly between its preferred habitat. The risk is considered at this part of the assessment somewhat lower than if there were more bittern records in the Glen Massey hill country.

Key threats to bittern have been habitat loss (particularly the drainage of wetlands), the impacts of mammalian predators, poor water quality, and food availability. Bittern do fly at heights that put them at risk within the turbine blade sweep zone. Bittern have been shown to travel long distances. Radio-tracking studies in Australia have shown that bitterns can move over 550 kilometres within a short amount of time (11 days). However, radio-tracking studies in Aotearoa New Zealand suggest bitterns have smaller home ranges and make fewer long trips, than their Australian counterparts (Williams 2013).

Kārearea/New Zealand 'bush' falcon (Threatened-Nationally Increasing)

Kārearea may potentially breed in the vicinity of any part of the Glen Massey hill country on an occasional basis. Whilst kārearea are a relatively maneuverable species and are thought to be able to avoid wind farm structures, they are known to become 'prey fixed' when in pursuit. Therefore, if kārearea were hunting within a wind farm, there would be the potential for them to collide with turbine blades (Seaton 2007). In addition, fledgling raptors, through their naivety and poor flying skills, may also be prone to blade strike (Powlesland 2009). Collision risk monitoring undertaken at another wind farm in New Zealand, estimated that the potential collision rate of falcons to turbines could be as high as one collision approximately every 4-5 years (Golder Associates 2012).

Transmission lines to be constructed as part of the wind farm infrastructure may also have a negative impact on kārearea as electrocution has been recorded as a major problem in areas where many uninsulated power lines are present (Seaton and Hyde 2013). This can be prevented by ensuring that lines are hung below the isolators to reduce the potential for birds coming into contact with active lines.

Despite the fact that no known kārearea falcon fatalities have been recorded as a result of wind farm operation in New Zealand, this species has been recorded at the location of other wind farm sites flying at turbine blade height. This species should be considered to be at a moderate risk of bird strike fatalities, and therefore require measures to avoid, remedy, or mitigate potential impacts.

Pīhoihoi/New Zealand pipit (At Risk-Declining)

Pīhoihoi are most likely to utilise open habitats, along roads and within pastoral and shrubland habitats in the vicinity of the proposed Glen Massey Wind Farm. They are likely to be a relatively common species in the area. Whilst pīhoihoi rarely fly more than 10 metres above the ground, they are known to occasionally fly at heights of more than 40 metres during courtship or long-distance movements (Powlesland 2009). This species may be at low risk of collision with turbine blades.

Pīhoihoi may nest within grazed pasture grassland, although this is not their preferred nesting habitat, and along gravel road and track margins in rank grass, and other open habitats within the wind farm site. This means that construction of the wind farm in open and more pastoral habitats may temporarily affect the success of pipit nests, especially if construction activities occur during the pipit of nesting season August-March (Beauchamp 2013).

Weweia/New Zealand dabchick (Threatened-Nationally Increasing)

Weweia may occasionally utilise open water habitats, such as farm ponds, within or near to the proposed wind farm site and may be at risk when flying between preferred open water habitats. There are no records of weweia from the proposed wind farm footprint, but this species is present in lowland habitat within 10 kilometres of the site, so the likelihood of presence is considered moderate, and chance of birds being at risk from turbine collision as relatively low. Movements of this species are poorly understood as it is believed that they mostly move between preferred habitats at night and this is seldom observed, but it is known that birds can cover considerable distances such as Cook Strait. The estimated population of this species in Heather *et al.* (2015) of 1900-2000 birds is likely an underestimate as the birds have expanded their range in recent years into the South Island where they had become extinct.

Pūweto/spotless crake (At Risk-Declining)

This species may occasionally utilise wetlands near the proposed wind farm and may be at risk when flying between preferred open water habitats. Similar to weweia, the movements of this species are poorly understood as it is believed that they mostly move between preferred habitats at night and this is not readily observed.

Koroātito/North Island fernbird (At Risk-Declining)

This species may occasionally utilise wetlands near the proposed wind farm and may be at risk when flying between preferred open water habitats. However, this species is often a weak flier so strike with turbines is unlikely. Movements of this species are poorly understood as it is believed that they mostly move between preferred habitats at night and this is not readily observed.

Kawaupaku/little shag and māpunga/black shag (both At Risk-Relict)

There are a few records of these two shag species in the hill country near Glen Massey. This indicates that they are likely to be relatively rare at the proposed wind farm site, and better habitats for these species are present near open water ponds and rivers on the Waikato lowlands than the Glen Massey hill country. The main to risk shag species would be collision with wind turbines when flying between preferred habitat types, and observations of shags elsewhere show that they regularly fly at the range of heights that would be at risk of turbine collision. Due to the low number of records of these species in the vicinity of the proposed wind farm, and preferred habitats elsewhere, the risk to shag species would be moderate at worst.

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Wildlands

Project	Glen Massey Wind Farm
Subject	Preliminary noise modelling
Attention	Glenn Starr
Date	3 May 2024
Prepared by	Michael Smith, Principal Acoustics Engineer

1 Introduction

Glen Massey Wind Farm Ltd is proposing a wind farm approximately 16 km north-west of Hamilton, and wishes to obtain environmental approvals through the fast track consenting process. Altissimo Consulting has been engaged to conduct preliminary noise modelling to demonstrate the project's feasibility. Further assessments will be required prior to the application being lodged.

2 Criteria

New Zealand Standard NZS 6808:2010 (**NZS 6808**, the **Standard**) has been used for all recent large-scale wind farm projects in New Zealand. The fundamental methodology is consistent with international industry practice.

The Standard provides guidance for the following:

- Criteria
- Prediction method
- Method for measuring the existing sound levels for setting a baseline for compliance measurements.

The Standard includes a recommended limit of 40 dB L_{A90}. The critical feature of NZS 6808 compared to the district plan noise limits is that the L_{A90} metric is used, which is essentially able to filter out short-term noise sources, such as wind, and allows unattended long-term measurements which would otherwise be affected by other sources.

The Standard also allows the noise limit to rise above the background sound at higher wind speeds. At times this increase has been interpreted as allowing more wind farm noise as the sound is 'masked' by background sound[1], although it is also a method to demonstrate compliance when wind farm sound is at or below the background level.

There is also a provision for a more stringent noise limit (35 dB L_{A90}) when justified by special local circumstances, for example, when an area is identified as particularly quiet by a district plan.

3 Predicted noise levels

3.1 Noise modelling methodology

Wind farm noise in the form of contours and levels have been predicted using computer noise modelling. Input data used in the model and results are detailed below. NZS 6808 refers to ISO 9613-2:1996 as an appropriate method for calculating wind farm sound levels. The ISO 9613-2 algorithm assumes favourable propagation in all

[1] See NZS 6808:2010 at Section 5.1.4

directions, which can be considered as light downwind conditions in all directions simultaneously. While this is not physically possible, it provides a conservative assessment.

Table 1 Noise modelling parameters

Modelling parameter	Value
Software package	Predictor v2024
Propagation algorithm	ISO 9613-2
Ground absorption	0.5
Terrain source and resolution	LINZ, 5m contour interval
Air temperature	10°C
Humidity	70%
Dwellings	As identified by Manawatu Aerial Photo Services
Receiver type	Free field
Receiver height	1.5m – ground floor
Contour type	Free field
Contour resolution	50m

3.2 Turbine details

No turbine selections have been made, however the following turbine parameters have been used to evaluate the project's feasibility.

Table 2 Turbine parameters

Parameter	Value
Hub height	142.5 m AGL
Blade length	87.5 m
Tip height	230 m AGL
Electrical power	6.5-7.5 MW
Sound power	108.1 dB L_{WA}

The following spectrum has been used for modelling.

Table 3 Turbine sound power levels (L_{WA})

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	A
91.2	96.8	100.4	102.3	99.5	95.8	83.8	108.1

The locations of the turbines are listed Table 4. Modelling has been undertaken only for Stages 1 ad 2 together.

Table 4 Turbine locations (NZTM)

Turbine	Stage	Easting	Northing
1	1	1,783,539	5,826,169
2	1	1,783,473	5,825,612
3	1	1,783,651	5,825,314
4	1	1,783,766	5,825,039
5	1	1,781,510	5,824,656
6	1	1,781,805	5,824,439
7	1	1,782,139	5,824,286
8	1	1,782,515	5,824,202
9	1	1,781,164	5,823,990
10	1	1,781,304	5,823,673
11	1	1,781,718	5,823,625
12	1	1,780,419	5,823,830
13	1	1,780,610	5,823,300
14	1	1,781,285	5,823,043
15	1	1,781,564	5,822,863
16	1	1,778,642	5,823,681
17	1	1,779,215	5,823,709
18	1	1,779,694	5,823,806
19	1	1,779,841	5,823,247
20	1	1,779,889	5,822,879
21	1	1,779,948	5,822,532
22	1	1,780,498	5,822,338
23	1	1,781,049	5,822,184
24	1	1,781,685	5,822,105
25	2	1,784,546	5,825,537
26	2	1,785,096	5,825,396
27	2	1,785,621	5,825,641
28	2	1,785,909	5,825,527
29	2	1,784,476	5,825,014
30	2	1,784,490	5,824,577
31	2	1,784,873	5,824,563
32	2	1,782,552	5,823,756
33	2	1,782,857	5,823,627
34	2	1,783,043	5,823,396
35	2	1,783,609	5,823,643
36	2	1,784,235	5,823,613
37	2	1,783,718	5,823,377

Turbine	Stage	Easting	Northing
38	2	1,782,966	5,822,758
39	2	1,783,227	5,822,631
40	2	1,781,996	5,823,532
41	2	1,782,121	5,822,841

3.3 Results

The number of dwellings in three different noise ranges are summarised in Table 5. Noise contours are appended to this letter.

Table 5 Summary of noise levels

Noise level range	Number of dwellings	Description
>40dB	0	Exceeds upper NZS 6808 noise limit. Affected party approval likely to be required if wind farm cannot be redesigned to reduce noise levels
35-40 dB	26	Exceeds High Amenity noise limit from NZS 6808. Likely to be more than minor noise effects, and submissions in opposition.
30-35 dB	49	Likely to be minor noise effects and submissions, but low consenting risk.

4 Discussion

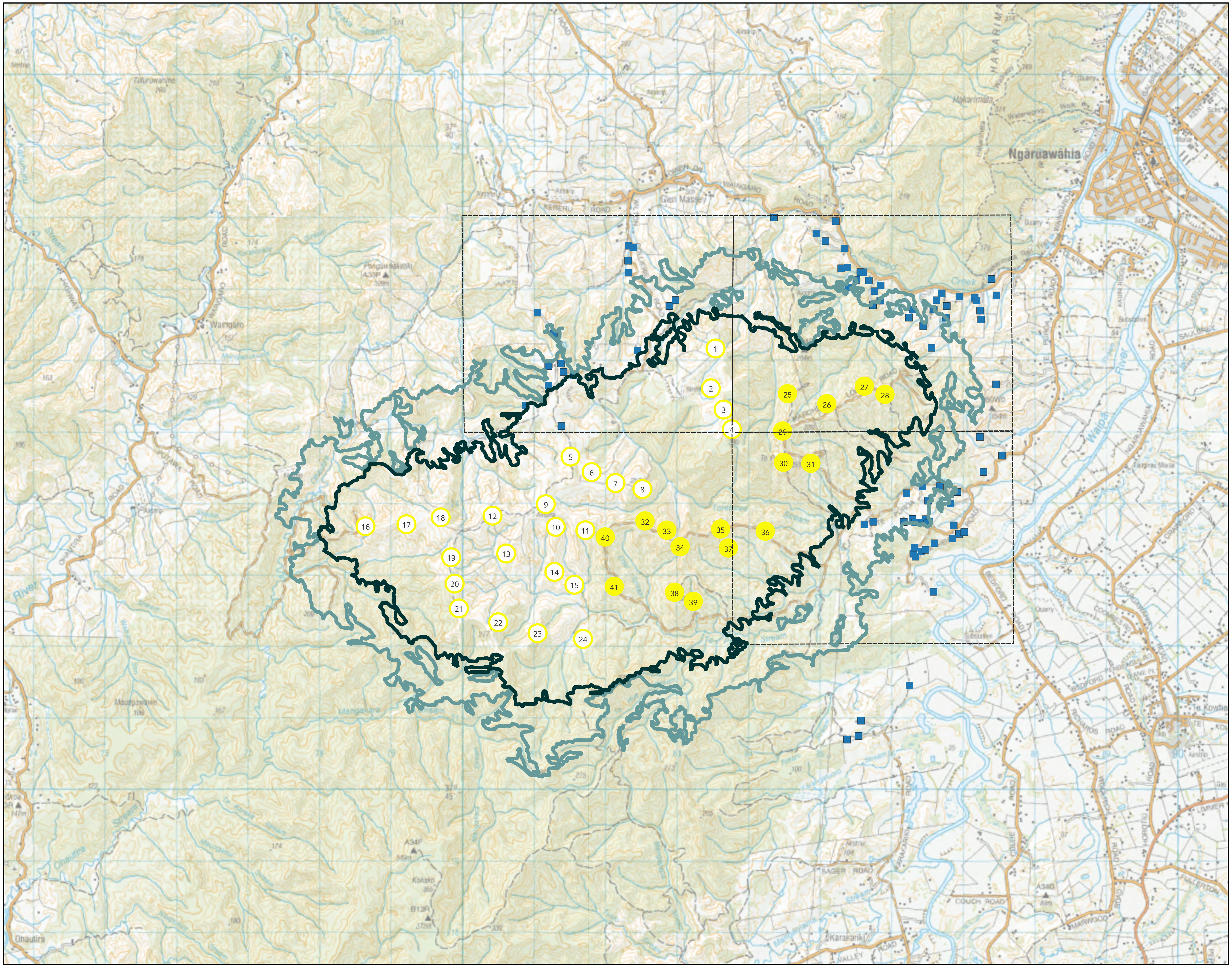
The proposed wind farm has predicted noise levels that comply with the primary noise limit from NZS 6808. Therefore, the wind farm should be considered 'feasible' from an acoustics perspective.

A full noise assessment will require an evaluation of the existing environment from a district plan policy and objectives perspective, as well as qualitative and quantitative investigation of the noise character of the area.

As the wind farm levels are predicted for 'downwind' conditions, the long term and seasonal wind roses should be reviewed as this may limit the frequency of the predicted noise levels occurring.

There is further scope to reduce noise levels at dwellings, should this be required. These include:

- Use Noise Modes which sacrifice power generation for lower noise emissions either all the time or under specified conditions (time of day, wind speed/direction) for some turbines
- Use an alternative turbine with lower sound power level
- Alter the wind farm layout



Project

Glen Massey Wind Farm

Client

Glen Massey Wind Farm Ltd

Title

Predicted sound levels, dB L_{A90}

Concept design for 41x turbines

(108 dB L_{WA})

Drawn

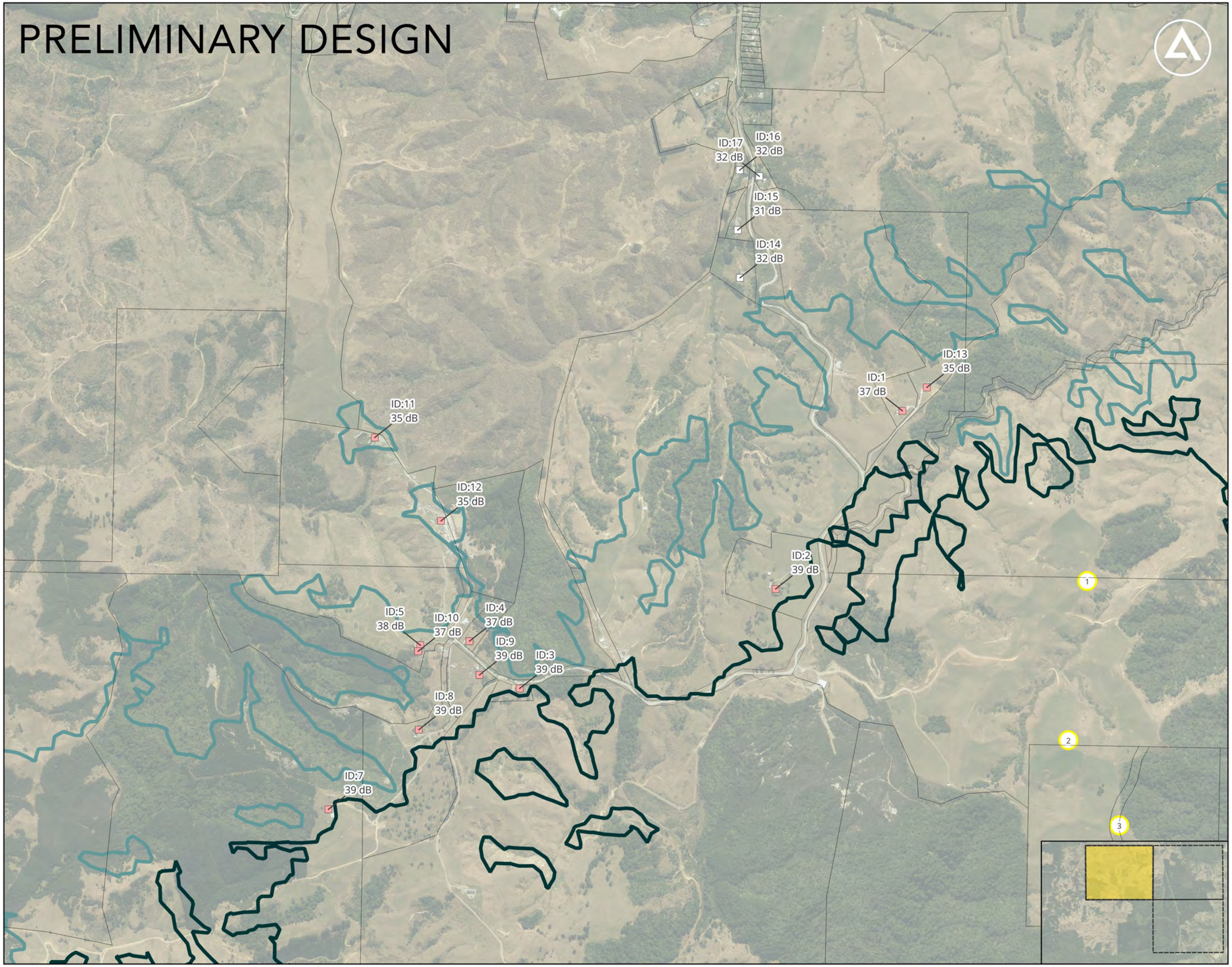
MS

Date

3 May 2024

ALTISSIMO CONSULTING

PRELIMINARY DESIGN



Legend

Turbines
- Stage 1
- Stage 2

Contour lines
- 35 dB
- 40 dB

Comments
Basemap, Building Outlines (C) LINZ

Scale 1:12500

Project
Glen Massey Wind Farm

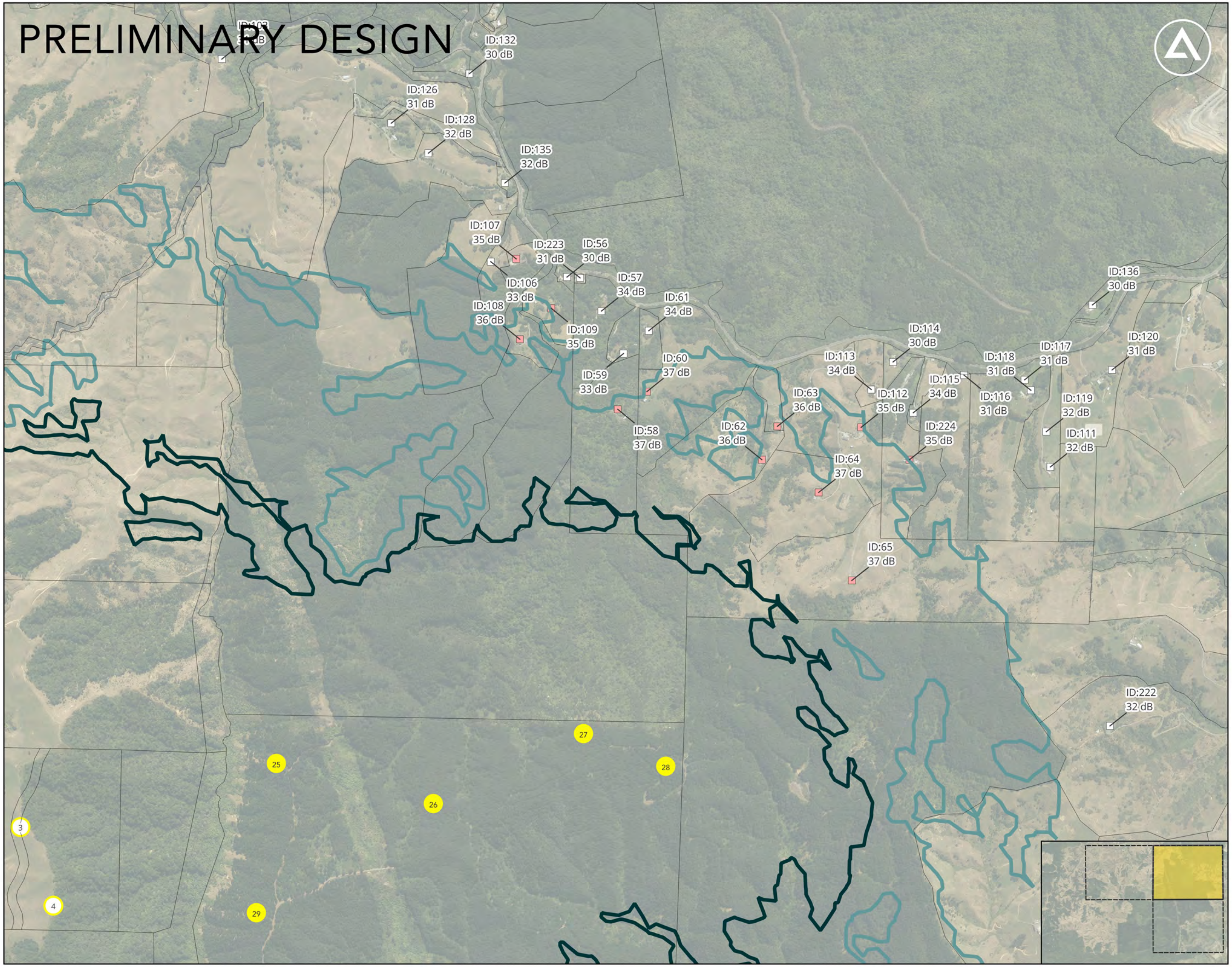
Client
Glen Massey Wind Farm Ltd

Title
Predicted sound levels, dB L_{A90}
Concept design for 41x 7.5MW turbines

Drawn
MS

Date
3 May 2024

ALTISSIMO CONSULTING



Legend

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Stage 2

Contour lines

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40 dB

Comments

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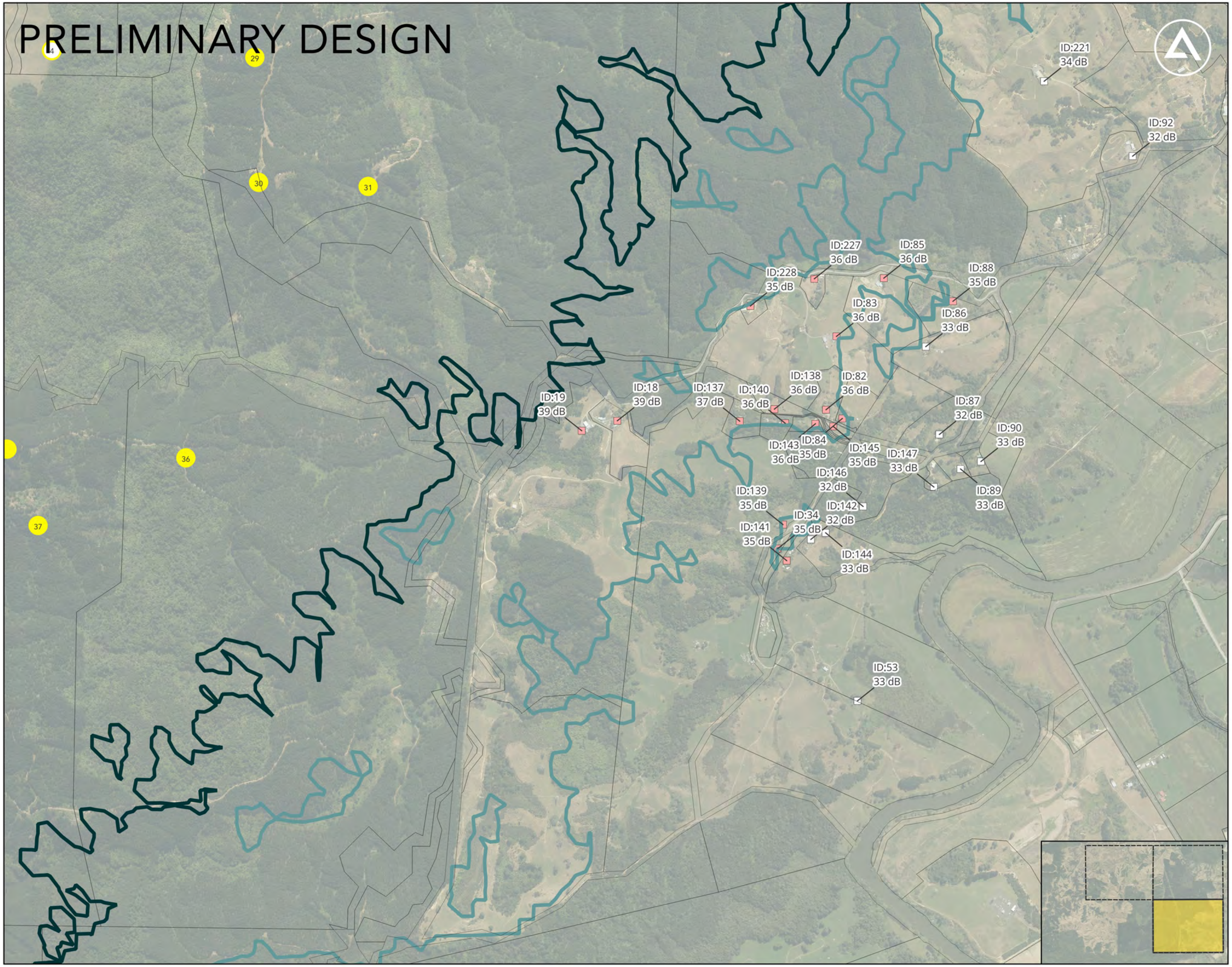

Legend

Turbines

- Stage 1
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Contour lines

- 35 dB
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Comments

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Predicted sound levels, dB L_{A90}
Concept design for 41x 7.5MW turbines

Drawn

MS

Date

3 May 2024

ALTISSIMO CONSULTING

Glen Massey Wind Farm

Construction Concept Report

Date: 2 May 2024
By: Glenn Starr

1. Introduction

This is a construction concept report for the proposed Glen Massey 315 MW wind farm, 20 km from Huntly. The report is developed to support an application to the MfE for a fast track consent process. The wind farm array straddles the 220 kV double circuit Huntly–Taumarunui A and Huntly-Straford line where a new sub-station will be constructed for connection. The project is to be built in 2 stages:

Stage 1 – 24 turbines – 180MW
Stage 2 – 17 turbines - 135MW

2. The Site

The site is in hill country 20km southwest of Huntly, Stage 1 is to built on existing pasture land while Stage 2 is to be located in an existing pine plantation. Stage 1 land rights are fully secured with complete set of documents to build the project, Stage 2 land is under exclusivity for 2 years.

3. Wind Turbines Procurement Strategy

Ventus Energy is in advanced negotiations for wind turbine supply from Envision. The flagship turbine from Envision is the 7.5MW – 171m diameter machine (soon to be 182m). This is the machine of choice for the Glen Massey project.

Ventus is currently negotiating procurement of Envision turbines on an on-going basis. This gives Envision confidence to commit to a support and maintenance team in NZ – that is a framework agreement. This is our principal procurement strategy for wind energy procurement.

https://www.envision-group.com/en/windturbines.html

4. Foundation Design

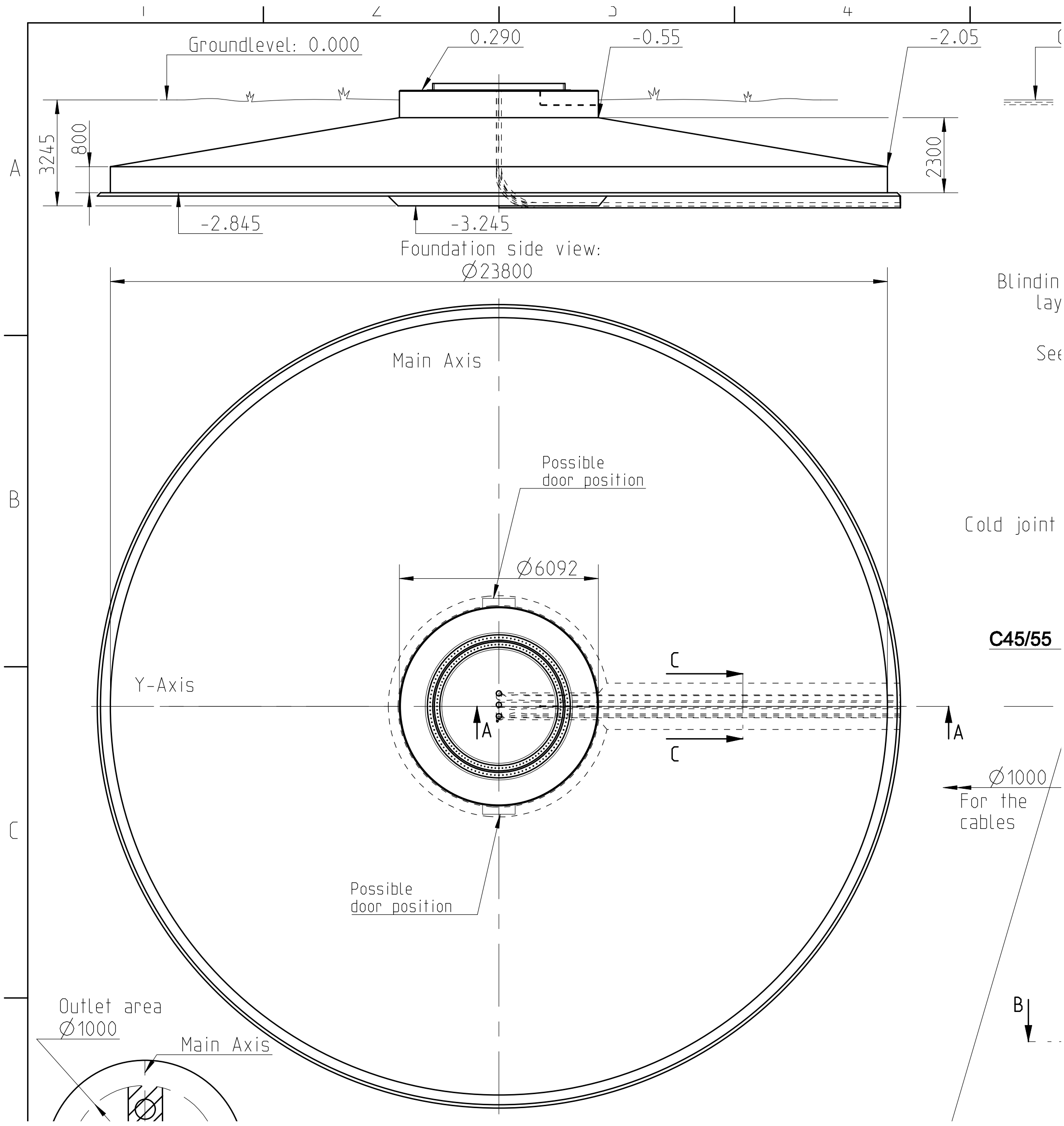
A conventional design approach is taken with large scale concrete foundations the default option. For the proposed turbines and the likely ground conditions these foundations will be up to 24m in diameter. Obviously detailed geotechnical investigations would occur prior to completion of the design.

The materials requires on this turbine design are:

Blinding concrete: 48m3

Main Structural Concrete: 683m3

Reinforcing Steel: 80t



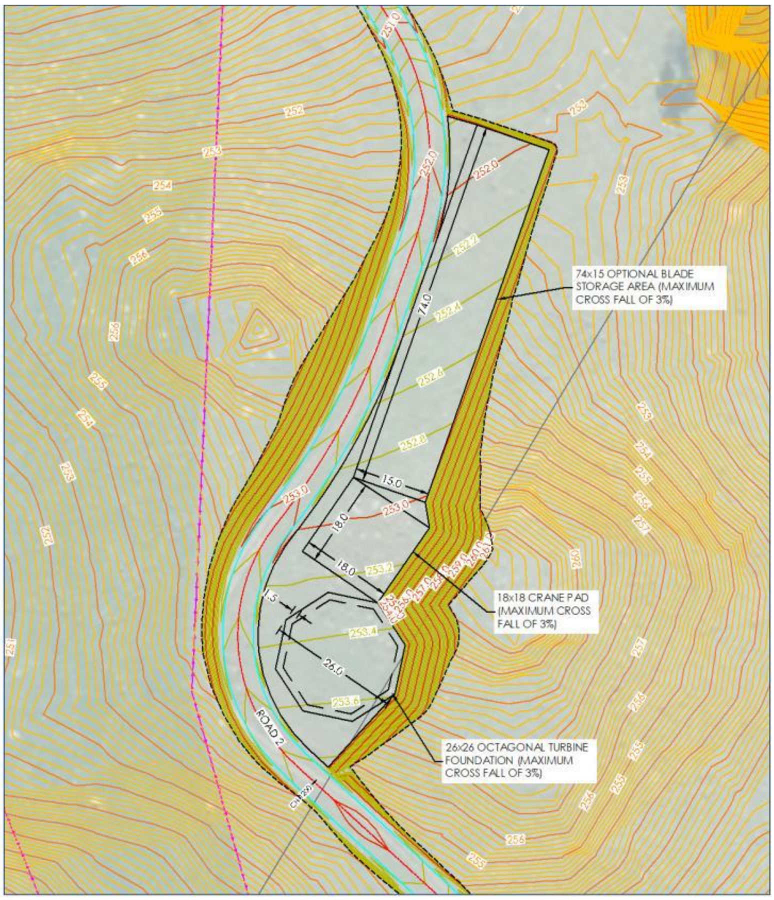
5. Platform and Storage Area Layout

5.1 <u>Turbine Platform</u>

The most efficient platform layout for construction has some laydown for the blades – which will be up to 90m long. The blades can extend off the end of the platform however.

The main crane platform needs to be of sufficient strength and size or the large lift crane. Also an area to permit the assembly of the main lift crane is needed.

A typical platform layout is below:



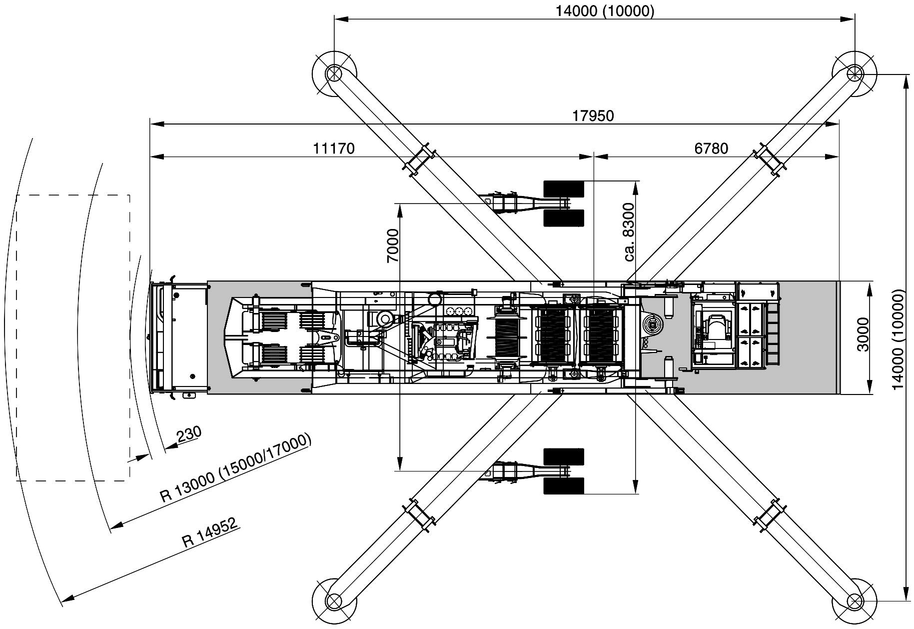
5.2 <u>Turbine Component Storage</u>

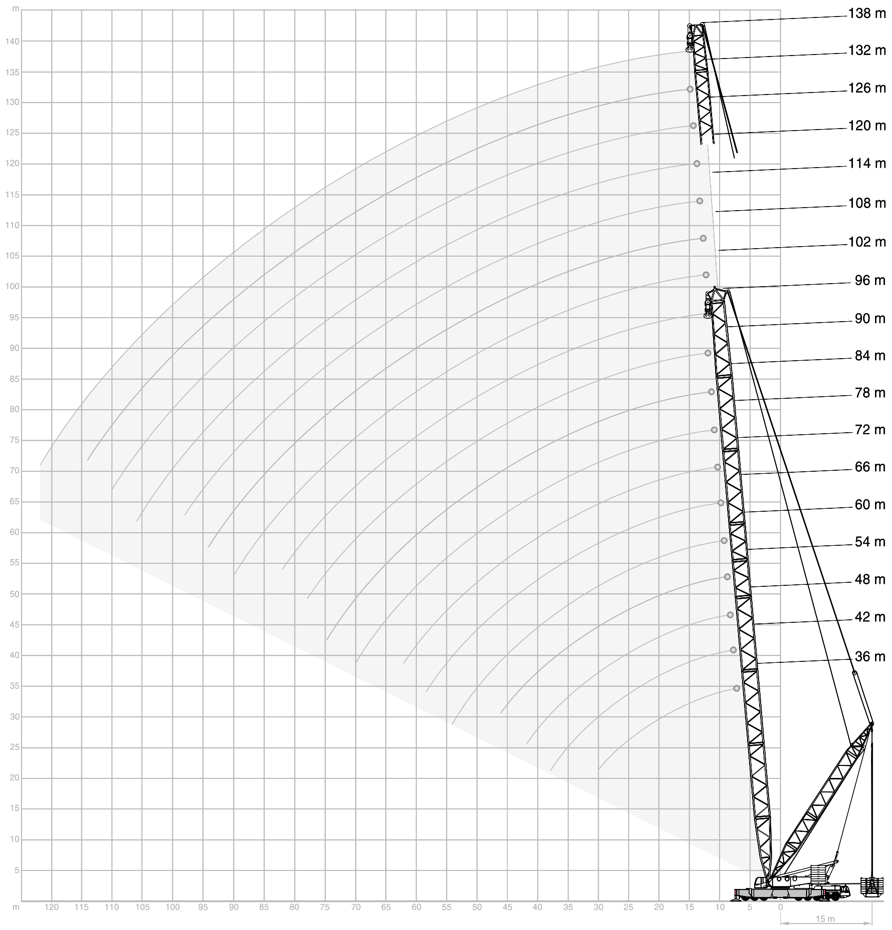
For efficiency of transport and to reduce effects on road users it is best practice to transport components directly form port to the site during the night hours in a transport convoy. To facilitate this transport storage three platforms are required on the site such as shown below:

A typical storage area layout is below:

6. Main Lift Crane

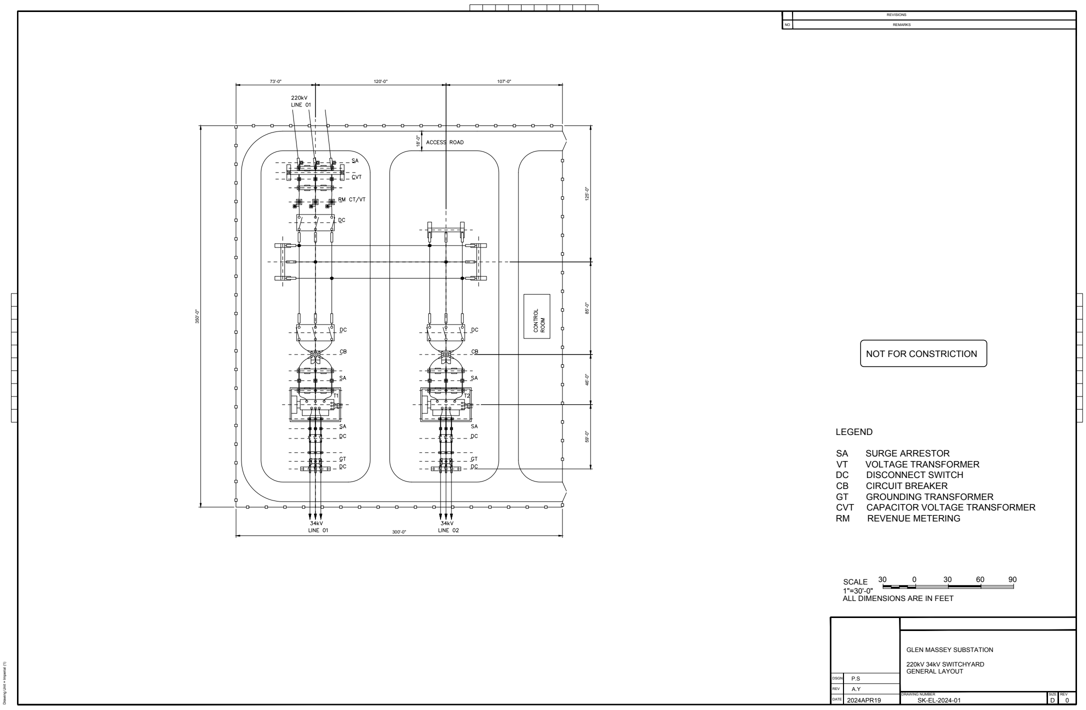
Our preferred crane provider has the Demag TC 2800 crane. Some dimensions shown below, the crane is capable of lifting the heaviest components and can be easily transported to site.





7. Sub-Station

A preliminary sub-station for the connection into the Transpower network has been completed by a specialist high voltage sub-station designer. It is based on two transformers and two circuits which can be installed as appropriate for a staged construction (2 stages).



8. Cable Trench

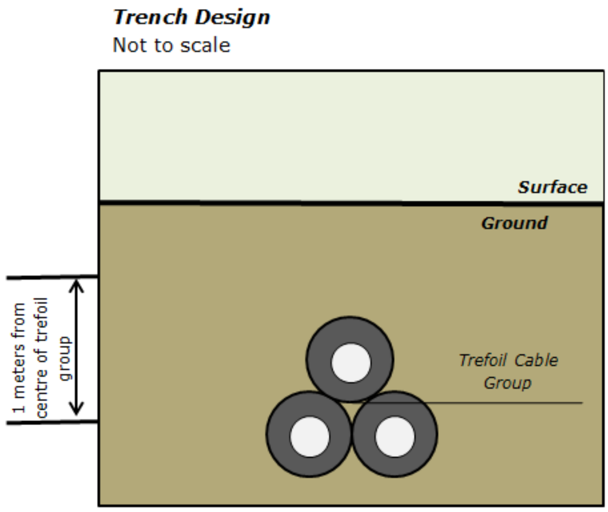
If soil resistivity is 1.2 K.m/W or better, then sifted natural fill can be used. If soil resistivity is not ideal than we suggest a backfill below and above the cables is used.

Current Ratings:

Air:	Trefoil- Bonded at both ends	430 A
Ground:	Trefoil- Bonded at both ends	350 A
Duct in Ground:	Trefoil- Bonded at both ends	309 A

Installation Conditions:

Maximum continuous conductor temperature :	90°C
Ambient air temperature:	30°C
Ambient soil temperature:	15°C
Soil thermal resistivity:	1.2 K.m/W



9. Pavements and Hardstands

The preliminary geotechnical investigation indicates that a CBR of 7% can generally be assumed for pavement design in weathered rock subgrades. However it should be noted that weaker material may exist in some locations such as ridge saddles and low points and a CBR estimate of 4% to 5% may be suitable for some soil types.

Current assumed pavement depths are based on experience at Te Apiti wind farm and the prelim pavement designs at Mt Cass and are as follows:

Roads & General Hardstands:

- 200mm thick GAP65 / GAP100 subbase
- 150mm thick GAP40 basecourse
- Blind road surface with GAP 20 or similar

Crane Pads:

- 500mm thick GAP65 / GAP100 subbase

10. Stormwater Management

The following stormwater provisions will be required:

- Road runoff to be discharged via sheet flow to adjacent vegetated areas where possible.
- Road culverts will be required below pavements to ensure stormwater runoff is taken away from cut slopes.
- Road culverts will be required on all existing concentrated flow paths which pass through the proposed road alignment in order to maintain natural overland flow paths and catchments.
- Concentrated flows from culverts should be returned to sheet flow via level spreaders where possible.
- Utilise erosion control devices to minimise sediment in stormwater discharges.

Upon the earthworks design being finalised a revised ESC plan will be submitted to the Waikato Regional Council.

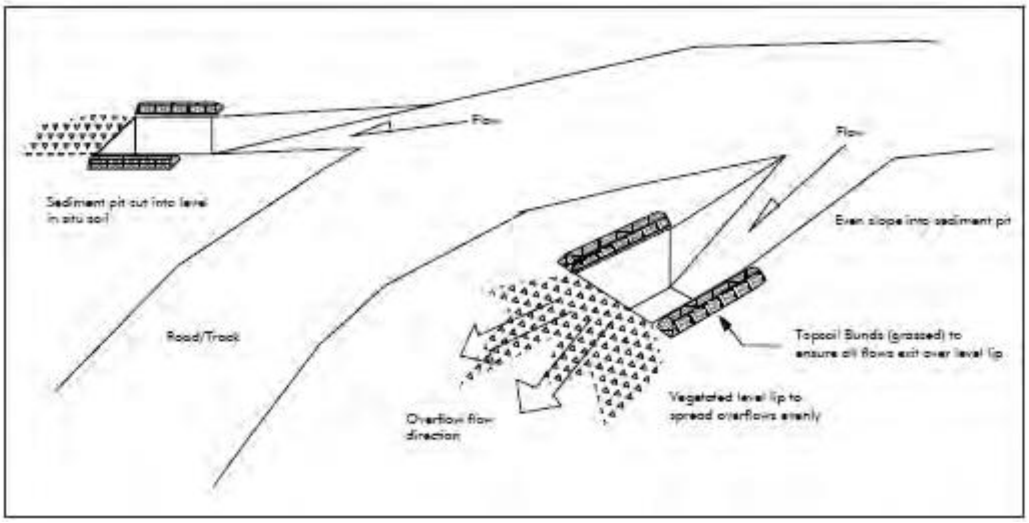


Figure 3: Sediment Pits design from WRC Guidelines

11. Bulk Earthworks Reinstatement

Areas where bulk earthworks have been carried out will require progressive reinstatement during the works. The scope of reinstatement is likely to include the following:

- Reinstatement of existing fencing and installation of new fences and gates.
- Reinstatement of topsoil and planting of pasture.
- Biocoir matting installation
- Planting, fertilising, watering and maintenance of trees and shrubs

12. Geometric Design of Roads

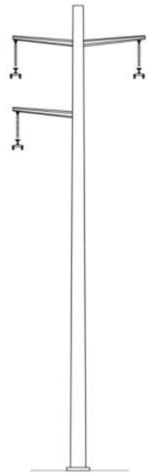
Blue Wallace have carried out a preliminary design for the access road as shown on the drawings based on the following parameters:

- Max vertical grade typically 18%
- Minimum crest curve radius = 135m
- Minimum sag curve radius = 250m
- Min horizontal centreline radius = 40m
- Minimum road width is 6m
- Shoulder width each side of road = 1.0m

These design parameters are generally consistent with the Mt Cass Wind Farm access road design.
Due to the road design being preliminary only no vehicle tracking analysis has been applied to the access road but some widening on tight corners has been applied and no earthworks benching for blade clearance has been applied.

13. Transmission Line for Hard Tee Option

Preferred design for the new overhead line is shown below. The single pole structure is preferred is due to cost, ease of installation and reduced visual impact.



www.tochalconsulting.com
E: info@tochalconsulting.com
P: 001.604.727.8124

Glen Massey Wind Farm

Connection Concept Report

Date: 22 March 2024
By: Ali Yazdani

1. Introduction

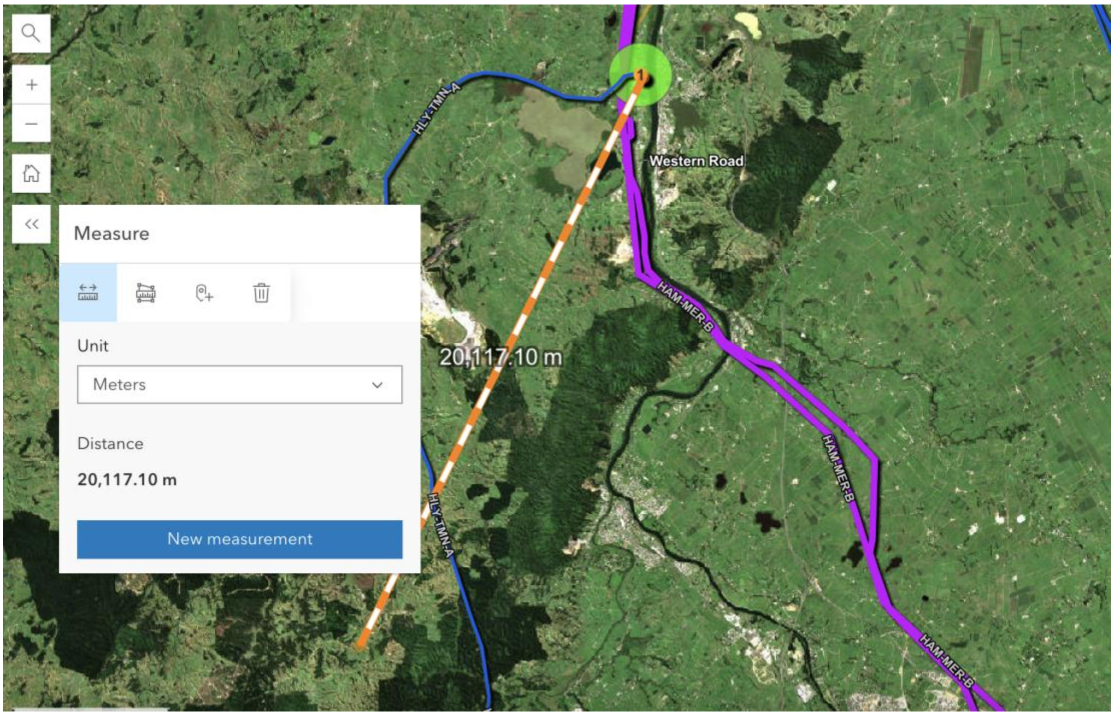
This is a conecpt report for the connection of a 315 MW wind farm, known as Glen Massey, 20 km from Huntly. The report is developed to support an application to Transpower.

The wind farm array straddles the 220 kV double circuit Huntly–Taumarunui A and Huntly-Straford line. The project is to be built in 2 stages:

Stage 1 – 24 turbines – 180MW
Stage 2 – 18 turbines - 135MW

2. The Site

The site is in hill country 20km southwest of Huntly, Stage 1 is to built on existing pasture land while Stage 2 is to be located in an existing pine plantation. Stage 1 land rights are fully secured with complete set of documents to build the project, Stage 2 land rights are under negotiation. Site Layout is attached.



3. Wind Turbines Procurement Strategy

Ventus Energy is in advanced negotiations for wind turbine supply from Envision. The flagship turbine from Envision is the 7.5MW – 171m diameter machine. This is the machine of choice for the Kaimai project. It is a conventional high speed generator DFIG design.

Ventus is currently negotiating procurement of Envision turbines on an on-going basis. This gives Envision confidence to commit to a support and maintenance team in NZ – that is a framework agreement. This is our principal procurement strategy for wind energy procurement.

https://www.envision-group.com/en/windturbines.html

4. Existing Transmission Lines

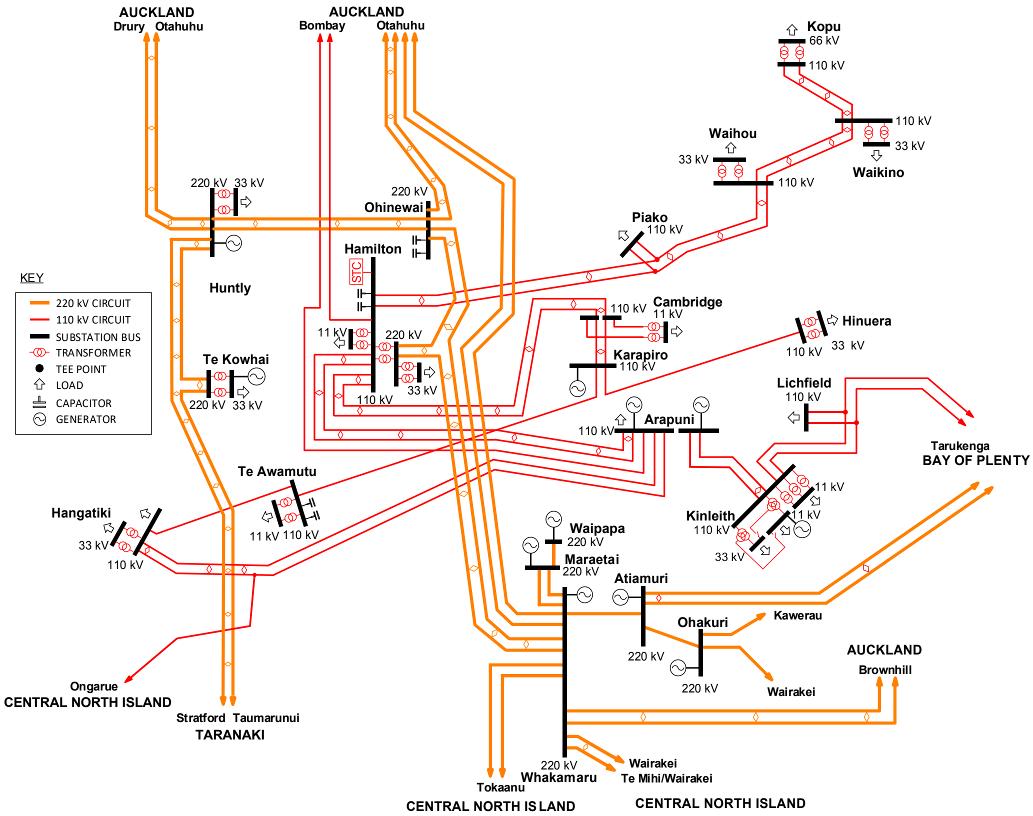
The wind farm could connect to either the Waikato to Taranaki interconnection transmission lines, which are in turn connected to a major, high capacity substation at Huntly. The interconnection line is made up of the following 220 kV double circuit transmission lines:

- SFD_TMN_TWH_HLY is rated at 469/481/492 MVA (summer/shoulder/winter)
- SFD-HLY has a static protection limit and is rated at 354/354/354 MVA (summer/shoulder/winter)
- Combined rating is therefore 823/835/846 MVA
- The rating of the SFD_HLY circuit will increase up to the rating of the other circuit when the protection limit is removed
- Conductor on both is ZebraGZ

This SFD transmission system likely has older protection systems, with outdated protection signalling to detect and clear any faults on the transmission system. Connecting any generation (especially as a Hard-T) may require a protection upgrade, with the extent and cost of the upgrade depending on the connection option chosen. Therefore connection to the TMN circuit seems the better option.

Transpower Planning Report 2023 shows the network as below:

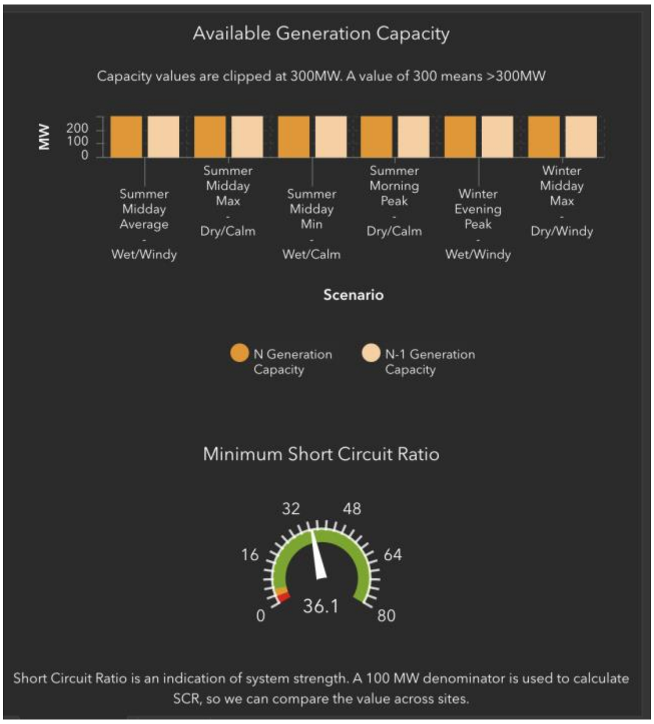
Figure 9-2: Waikato region transmission schematic



5. Sub-Stations

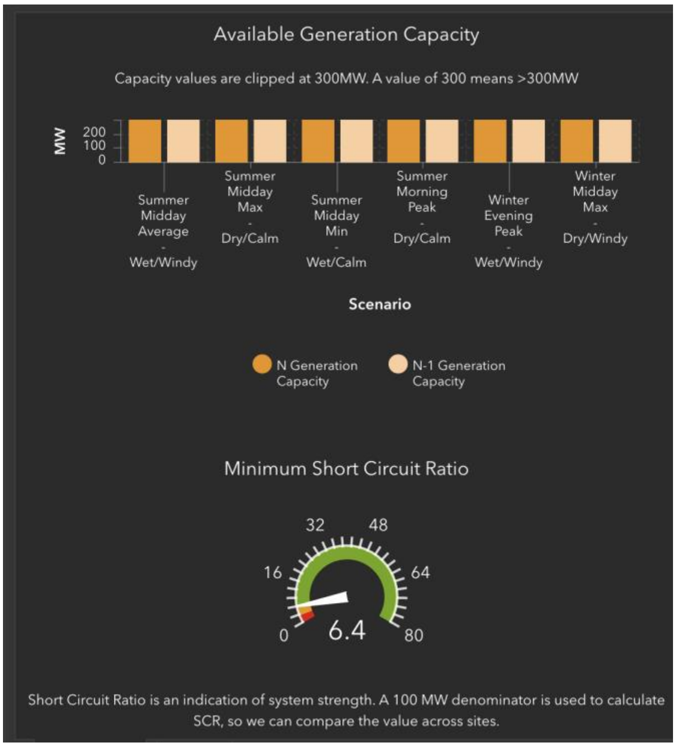
5.1 Huntly

The Huntly sub-station is robust with a high Short Circuit Ratio of 36.1 and showing over 300MVA of connection capacity. As the Huntly power station continues to reduce in output then even more export capacity will become available.



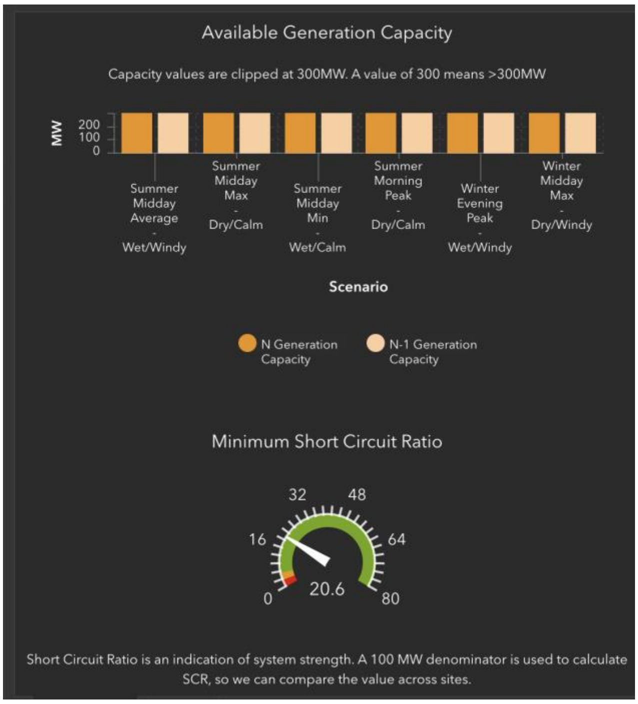
5.2 Taumaranui

The Taumaranui sub-station shows a low Short Circuit Ratio of 6.4. Further investigations are required here to manage the effects and ensure no degradation to the SCR. However there is good capacity for the unusual situation of southward power flows - showing over 300MVA of connection capacity.



5.3 Stratford

The Stratford sub-station shows a moderate Short Circuit Ratio of 20.6. Further investigations are required here to manage the effects. However, there is good capacity for the unusual situation of southward power flows - showing over 300MVA of connection capacity.



6. Local Demand

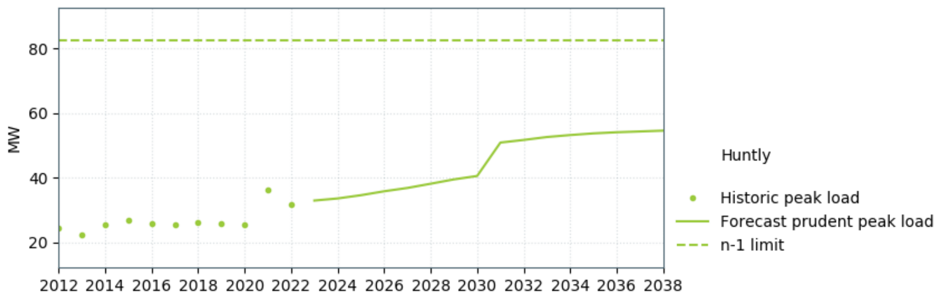
Local demand at Huntly is not large (at c. 40 MW at the expected time of generation) compared to the overall transmission capacity in the network. However, it may become a factor should other large generation plant (wind and solar) be connected in to the network.

9.5.7 Huntly supply capacity

Two 220/33 kV transformers supply Huntly's load, providing a total nominal installed capacity of 120 MVA. The transformers' capacity is presently limited by the 33 kV incomer cables.

Peak load at Huntly is within the n-1 capacity of the supply transformers for the forecast period (see Figure 9-15).

Figure 9-15: Huntly supply capacity



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

7. Generation Connections – Pending

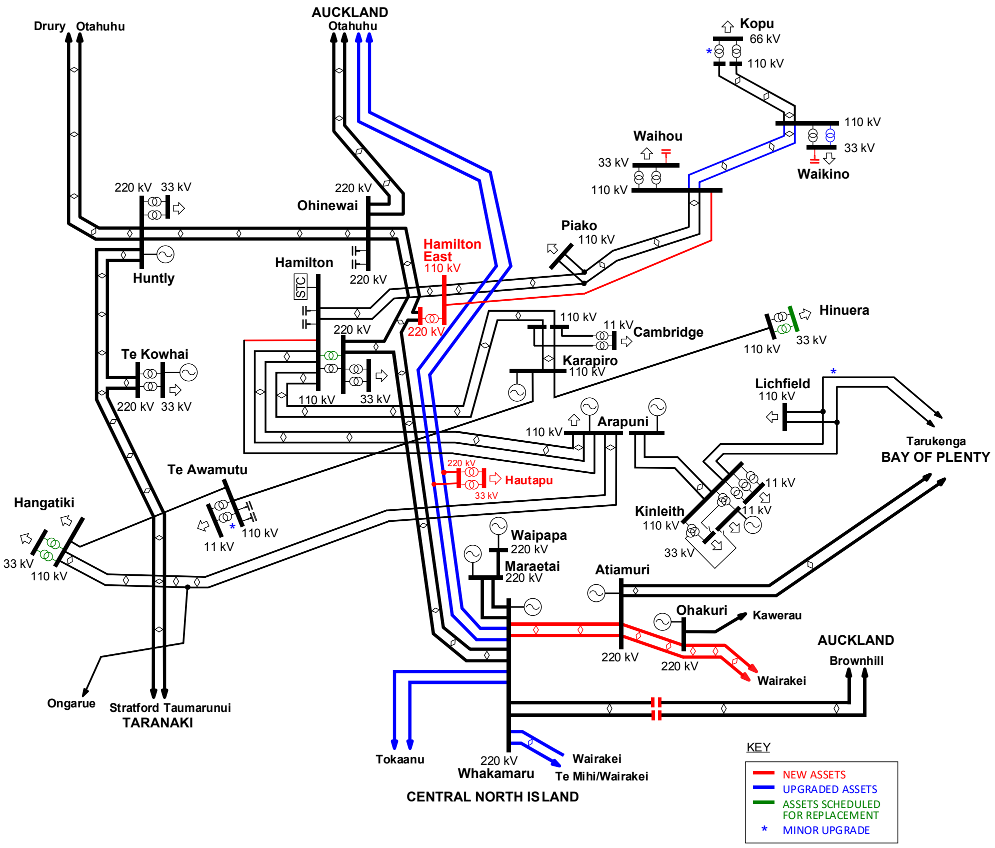
Competing applications in the Transpower queue are shown below. These may have an effect on the injection capacity available at the Huntly sub-station. More work and investigation is needed to understand the ultimate capacity at Huntly. The situation will be fluid as the 3 relevant projects progress up the queue.

	A	B	C	D	E	F
1	Connection location (substation or circuit)	Max MW	Connection voltage	Technology	Transpower stage	Sequence number
2	Tauhara	51	33	Geothermal	Delivery	
3	Waiotahe	58	110	Solar	Delivery	
4	Dannevirke	25	11	Solar	Delivery	
5	Edgecumbe	115	33	Solar	Delivery	
6	Waiotahe	35	110	Solar	Delivery	
7	Bream Bay	230	33	BESS + Solar	Delivery	
8	Edgecumbe	29	33	Solar	Delivery	
9	Karapiro	0	110	Hydro	Delivery	
10	Coleridge	0	66	Hydro	Delivery	
11	Waihou	200	110	Solar + Bess	Delivery	
12	Waipara	93	66	Wind	Investigation	
13	HLY_DEV	300	220	Solar	Investigation	
14	OTA_WKM	214	220	Solar	Investigation	
15	HLY_OTA	314	220	Solar	Investigation	
16	Waihou	100	33	Solar + Bess	Investigation	
17	WRK_WHI	400	220	Solar	Investigation	
18	Twizel	350	220	Solar	Investigation	
19	Maungatapere	73	110	Wind	Investigation	
20	HEN_MDN	200	220	Solar	Investigation	
21	HEN_MDN	200	220	Solar	Investigation	
22	Stratford	32	33	Solar	Investigation	
23	Huirangi	68	33	Solar	Investigation	
24	CHH_TWZ	300	220	Solar	Investigation	
25	Greytown	143	110	Solar	Investigation	
26	MGM_MST	90	110	Wind	Investigation	
27	BEN_ISL-A	300	220	Solar	Investigation	
28	Ohau A	222	220	Solar	Investigation	
29	Naseby	300	220	Solar + BESS	Investigation	
30	Tangiwai	100	11	Solar + BESS	Investigation	
31	Waipawa (North)	100	110	Solar + BESS	Investigation	
32	TWT_TWC, BPE_LTN	126	220	Wind	Investigation	
33	Masterton	100	110	Solar + Bess	Investigation	
34	Waipawa (South)	43	33	Solar	Investigation	
35	Marton	50	110	Solar + Bess	Investigation	
36	Opunake	70	110	Solar + Bess	Investigation	
37	Hinuera	80	110	Solar + Bess	Investigation	
38	Glenbrook	100	33	BESS	Investigation	
39	Huirangi	75	110	Solar + Bess	Investigation	
40	Bunnythorpe	300	220	Solar + Bess	Investigation ^	
41	Huntly	100	220	BESS	Investigation *	
42	Waipawa (South)	100	110	Solar + BESS	Investigation	
43	ROX_ISL-A	450	220	Solar + BESS	Investigation	

8. Upgrades

No upgrades to the relevant circuits and sub-stations are proposed in the Transpower Planning Report 2023

Figure 9-3: Possible Waikato transmission configuration in 2038



9. Existing System Capacity

There seems to be adequate transmission capacity to connect the 315 MW Glen Massey wind farm without any restrictions due to the capacity of the transmission system. The following should also be noted:

- If more generation, such as other wind farms or solar farms, connect to the Waikato-Taranaki Interconnection circuit then the output from the Glen Massey wind farm may need to be restricted at times to prevent circuits from overloading.

- There is adequate transmission capacity for the Glen Massey wind farm output at this point in time

10. Connection Options

There are two realistic potential options for connecting the Glen Massey wind farm to the grid.

The final option chosen, would depend on several factors, including:

- The costs
- Protection requirements of Transpower
- Timing of the progression of stage 2
- Securing the land agreements on Stage 2
- obtaining the required consents.
- Topography

Two connection options are described in the following sections:

10.1 <u>New Glen Massey Substation</u>

A dedicated 220 kV substation could be built in the vicinity of the and the 220kV double circuit transmission line. This would ideally be built in land of Stage 2 where the countors are not too steep. An indicative location is shown on the site layout.

Only one of the two circuits on the 220kV transmission line would need to be connected to the substation. If that circuit is out of service due to a fault or for maintenance, then output from the wind farm will not be possible in the direction of the fault.

The “connection” to the wind farm could either be a short 220 kV transmission line, or 220 kV transformers.

A protection study will determine if protection signalling is required due to the connection of Glen Massey. If so, additional communication infrastructure is likely to be needed between Glen Massey, Huntly, Stratford or Taumaranui.

10.2 Hard Tee Connection

It may be possible to “tee” connect the wind farm to one of the two circuits. A tee connection involves one 220 kV circuit from the wind farm connecting directly onto an existing circuit without a substation. This is often the least cost connection configuration, however, the following points need to be noted:

- Tee connections can cause difficulties with protection, and a specific protection study would need to be completed before committing to this option. It is usually necessary to replace the existing line protections at the other ends of the circuit.
- Very good communications would be required between Huntly/Taumaranui or Stratford and Glen Massey for the associated protection signalling. If the required communication system is not already in place, then this connection configuration could be more expensive than a new Glen Massey substation.
- If there is only a single tee connection, then the wind farm would be disconnected whenever the associated circuit was out of service due to a fault or for maintenance (ie n security). Maintenance would normally be scheduled primarily taking into account the requirements of the off-take customers and landowners (for line work), rather than the requirements of generators (such as the wind farm).

Connecting generation of 315 MW through a single tee connection, giving n security for circuit faults, is unusual in the New Zealand context however non uncommon in North America. Generation of this capacity or higher is normally connected with n-1 security for circuit faults.

Although appearing cheaper than a sub-station , as it requires two fewer circuit breaker bays and eliminates the 220 kV bus at the wind farm, this option requires duplicate communication for protection signalling to be established between the wind farm, Huntly and Taumaranui/Stratford. The cost and/or project risk for the duplicate communication infrastructure is currently being determined.

10.3 Ownership

Transpower will likely want to design and own any deviation or modification of the existing Huntly-Taumaranui line, and any new line section from the existing lines to the new substation. This is because the assets form part of the through transmission to other customers. Any other assets are conventionally owned by the wind farm. Glen Massey Wind Farm prefers to own the substation if at all possible.

10.4 Procurement

Ideally Glen Massey Wind Farm will procure most transmission equipment (and run the design and construction process). Long lead items will be procured first and directly – eg: Transformers. Depending on the connection option chosen – the amount of ownership possible and acceptable to Transpower will change.

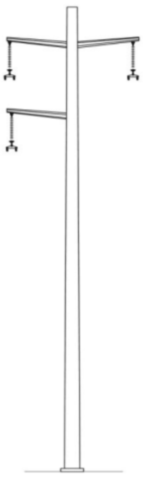
Wind Turbine procurement strategy is discussed above.

11. Transmission Line for Hard Tee Option

11.1 Wind turbine Locations

The map supplied shows approximate locations for the wind turbine generators. Turbines have been placed the fall over distance (height of turbines at 220m) from the existing and future overhead line.

Preferred design for the new overhead line is shown below. The single pole structure is preferred is due to cost, ease of installation and reduced visual impact.



11.2 Line Easement

Glen Massey Wind Farm Ltd has land rights for Stage 1 in hand to connect to the wind farm to the 220kV network along the route shown on the site layout. No extra easement rights are required.

12. Environmental Planning

12.1 Confirming customer /Transpower responsibilities

We understand that if Transpower is to own an asset, the preference is to own and manage the associated environmental designation/consenting processes to ensure that the site/route selection processes and statutory approval processes meet Transpower requirements.

Transpower's may wish to designate new assets because this strong rights of protection to keep the assets in place.

The applicant preference is to discuss and confirm early on with Transpower the consents required and to include within the consenting process of the wind farm.

Some preliminary design and confirmation of which connection option (following cost estimates) is needed before the consenting requirement is known.

12.2 Site and Route Selection Process Requirements

Notice of Requirement (NOR) will not be required for this connection as land rights are currently in place.

For the Hard-Tee option the landowner has agreed to the route shown on their land. With some of the route constructed with cable and some with overhead line.

For the Sub-Station (in and out) option the final siting still needs to be agreed with the land owner of Stage 2.

12.3 Overall Consent Strategy and Programme.

Intention is the for the overall project to be consented by the recently government announced fast track consent legislation. The following key milestones:

Oct to Nov 2023 – Site investigations and site layout

Jan 2024 – Iwi Consultation Meeting

Feb 2024 – Attempts to contact local runanga

March 2024 – Proposals received for bat monitoring

Sept 2024 – Bat and bird monitoring to begin

March 2025 – Bat and bird monitoring to conclude

May 2025 – Consent application submitted

Dec 2025 – Consent approved

2026 – Detailed site investigations and Project Design and Procurement

Q3 2027 – Beginning of Construction

2029 – Commissioning

13. Cost Estimate

Costings are shown in Attachment 4. This compares to very rough order of costs from conversations around other projects (and independent project developers) for a 300MVA 220kV sub-station is $40m +,- 50%.

Attached:

1. Site Layout for Stage 1 and 2
2. Land Right Document – front page and signing page
3. CV of Author and Technical Expert
4. Cost Estimates

WIND FARM INVESTIGATION LICENCE & EASEMENT AGREEMENT
dated this **16** day of **August** 2023

PARTIES

BETWEEN: **Pukemiro Farms Ltd** ("**Pukemiro**")

AND: **Glen Massey Wind Farm Limited** ("**GM**")

INTRODUCTION

A. GM wishes to investigate Pukemiro's property for suitable wind farm sites and, if such are located, to take appropriate easements in gross of an agreed easement area and thereafter construct such wind farms within the areas designated on the map attached as Schedule 3.

B. Pukemiro wishes to allow GM to conduct such investigations and to grant such easements, in return for rent and royalty payments from GM and the benefit of specific bonds during the construction of any wind farm and thereafter.

C. The parties wish to record the terms of their agreement as follows.

OPERATIVE PROVISIONS

1. References & Definitions:

"Easement" means an easement in gross granted by Pukemiro in favour of GM in the form attached to this agreement as the First Schedule.

"Electrical Works" means the Works, Electrical Installation, Electrical Appliances, Fittings and Associated Equipment, as those terms are defined in the Electricity Act 1992, and including for the avoidance of doubt all Windpower Equipment, presently or to be fixed or installed on, over or under the Land, or to be fixed or installed on, over or under the Land in substitution, addition or replacement for them, whether of the same or larger dimensions.

"Further Term" means an extension, if any, to the Initial Term granted pursuant to Clause 2.2.

"Initial Term" means the first 5 years of this agreement.

"Land" means the land comprised and described in the certificates of title listed in the Easement attached as the First Schedule but restricted in practice to that part of the Land shown on the Map in Appendix 3. The extent of Land is defined as the area required for the Electrical Works shown on the Map in Appendix 3 but subject to movement of a maximum 50m in any direction.

"Map" means the map attached as Schedule 3 showing the areas of interest to GM and the subject of this agreement and potential Easement.

"Royalty Agreement" means an agreement granted by Pukemiro in favour of GM in the form attached to this agreement as the Second Schedule.

"Term" means the term of this agreement granted pursuant to Clause 2, which includes the Initial Term and, if extended, the Further Term.

"**Windpower Equipment**" means all Electrical Works comprising wind driven electricity generation equipment and Windpower Facilities used in the exploitation of wind to produce electricity including but not limited to Wind Turbines, conductors, terminals, supply points, overhead and underground electrical transmission or distribution line towers, poles, pylons, electric transformers, power (including solar power)

5.

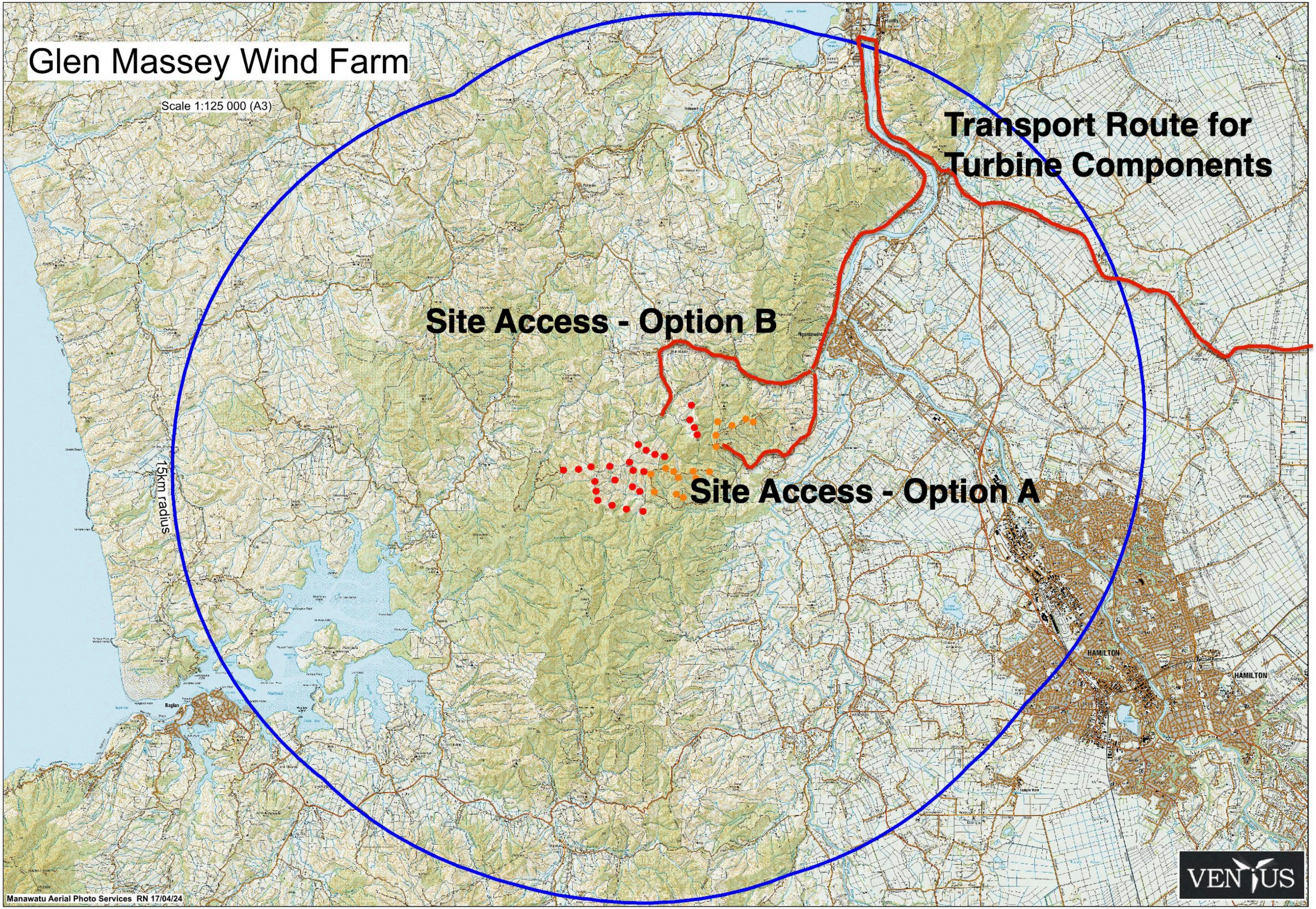
with any other person or company in relation to the potential future development of a wind farm on the Land.

9.7 **Sale of land:** If Pukemiro wishes to sell the Land to a third party during the Term, then Pukemiro covenants and undertakes to inform the new landowner of this licence and ensure that a condition of such sale is that the new landowner enter into an agreement with GM to effectively take over Pukemiro's obligations under this licence.

9.8 **Confidentiality:** The parties agree that the terms of this licence and any technical or commercial information is strictly confidential and that neither party will disclose terms to another party during the Term or afterwards without the written consent of GM.

Executed as an agreement.

Executed by **PUKEMIRO FARMS LTD** by its Directors	))))	______________________________ Signature of **Andrew Yeoman** ______________________________ Signature of **Director**
Executed by **GLEN MASSEY WIND FARM LIMITED** by its Director	)))))	______________________________ Signature of **Glenn Starr**


Glen Massey Wind Farm
Scale 1:125 000 (A3)
Transport Route for Turbine Components
Site Access - Option B
Site Access - Option A
15km radius
HAMILTON
HAMILTON
Raglan
Manawatu Aerial Photo Services RN 17/04/24

Transport Manual of
EN156-5.0MW WTG Components

DPS-0000610_A

10th Jan 2024

Contents

Disclaimer

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1 Purpose and Scope

To ensure the safety of transport of Envision WTG products of nacelle, hub, blade and tower as per Envision Guidelines 156-5.0 MW WTG, including the transport of nacelle, hub, blade and tower.

2 Abbreviations used in this document

Abbreviations

No.	Work description	Explanation
1	PPE	Equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses.
2	Fire Protection	A fire extinguisher: Fire blanket to prevent slag splashing when welding or cutting; Special attention should be paid to the drop of slag to the lower deck during welding or cutting of the upper deck of the ship;
3	Safety Operation at Ports	Boarding and disembarking ship: ladder and safety net. Life vest should be worn within 2 meters from the water side;
4	Lifting Restrictions	It is strictly prohibited to lift nacelle/hub in rain and snow weather; Lifting operation is strictly prohibited in high winds above Beaufort scale 6.
5	Safety Operation near high-voltage power lines	Identify high-voltage lines before transportation and execute them in strict accordance with the traffic requirements of high-voltage lines.
6	EHS	Environment Health Safety
7	WLL	Woking load limits
8	LOTO	Lock out, tag out. A safety procedure used to ensure that dangerous equipment is properly shut off and not able to be started up again prior to the completion of maintenance or repair work.

3 Safety

To ensure the safety of transport of Envision WTG products of nacelle, hub, blade and tower, as per Envision Guidelines.
This document is applied for the EN156-5.0MW WTG, including the transport of nacelle, hub, blade and tower.

3.1 EHS Values

Envision believe that "people are the only mainstay of the enterprise", insist on the principle of safety first when performing work, protect and improve personal safety and health and the community environment.

- Envision and his subcontractors shall abide all the laws and regulations, set stricter standards for ourselves and our suppliers in identifying unacceptable risks.
- Envision and his subcontractors measure and evaluate our performance and remain open and transparent in communication.
- Envision and his subcontractors use EHS knowledge to improve the safety and harmony of the communities involved.

3.2 People, Qualification and Training

Before starting operations, all logistic contractors need to obtain the certificates and licenses which met with local government or other authorities' minimum requirements. All operators should be qualified for their working scope. Envision also conduct safety check during the process of logistic operation to make sure their licenses are valid within the whole time of logistic activities.

Additionally, to make sure everyone can acquire the newest and sufficient EHS knowledge from Envision or our customers, we also provide EHS training to the related the contractors. Trainings are organized regularly and would be held until the project ending.

3.3 Environment Protection

Envision and his subcontractors should strictly follow and comply with local environmental laws and regulations. Resources and energy should be utilized efficiently and appropriately. Envision and subcontractors should manage the waste as minimal as possible and do our best to reduce the impact to the environment during logistic activities. To create a better working and living environments for all, and to keep our business and society continuous developing a clean environment.

3.4 Occupational Health

Envision and his subcontractors should strictly follow and comply with local occupational health laws and regulations, take every possible measure to reduce the concentration or intensity of occupational hazard factors in workplace. Envision and subcontractors should eliminate or control occupational health hazards from the origin and protect workers from any influence of occupational health hazards in their workplace.
Envision should provide appropriate PPE to staffs who could be exposed to any occupational health hazards, as well as logistics subcontractors. Any person who works for or represent for Envision logistic must follow our EHS requirements and wear PPE appropriately. Besides, we also organize pre-employment physical exam and occupational health exam according to the local authority's

requirements. All occupational health documents are well preserved according to the national regulations.

3.5 Safety Management

High-risk operation safety management

The following eight types of operations have been considered as Envision High-risk Activities according to the safety regulations and other best safety practice in the industry, they are: hot work, confined space work, work at height, Blind plate pumping block, lifting, temporary electricity, break ground, break road.

Envision and his subcontractors are required to conduct safety risk assessment before starting any high-risk activity. Safety counter measures must apply with these high-risk operations. And required to check the related procedures, monitor the on-site deployments to make sure all safety actions have been implemented before these operations.

Below are some high-risk activities, workers can be involved during the international logistic projects: lifting WTGs by crane (include Nacelle, Hub, Blade, Tower) Loading at manufactory storage yard, port or vessel operations, working at height during the lifting preparation, hot work when removing sea fastening or transport fixture.

Road Transportation Safety

Any employee who need to drive for business purposes, he or she must pass the Defensive Driving Training Course (including paper test and operation test). For the logistic contractor drivers, they must pass the Envision DDT training course and general safety training course of WTG first, then they can transport products of Envision.

Below are some Envision driving safety requirements for the transportation activities:

- No speeding, overloading, red light running, hazard driving.
- It is forbidden to answer or dial telephone calls, browse electronic equipment and chat with people while driving.
- It's forbidden to bring non-designated passengers when doing operations.
- Transport vehicles shall be equipped with fire-fighting equipment and first aid kit.
- The logistic transporter shall organize special inspection to transport routes before transport vehicles enter the construction site, measurement should be fulfilled strictly according to the transport scheme, and the transport routes should be guaranteed to be safe.
- After entering the site, vehicles shall be parked in designated areas.
- Transport vehicles should have approved certificate of vehicle and annual inspection report should be verified by the supervisor.
- Drivers must carry a valid driver license and have knowledge in transporting oversize cargo.
- GPS or other tracking equipment should be installed, and vehicles have to follow the instructed for speed limitations on construction site.
- The logistic transporter should inspect vehicles periodically, to ensure the vehicles are in good condition. Vehicles who are not in good conditions will not be allowed into the construction site.
- The logistic transporter shall ensure all relevant equipment are available to perform a safe transport (lashing chain – racket strap Etc.

Safety Red Line

- Deliberately delay reporting medical and accidents.
- Unauthorized bypass, modify or disassemble safety protective devices.
- Work at height above 2 meters without fall protection measures.
- Force others to perform duty with safety violations or risks.
- Taking risk to carry on operation without correction on known major dangers.
- Perform high risk duties without written permit.
- Perform special duty, operate special equipment, drive motor vehicle without proper license.
- Enter dangerous zone to perform duty without LOTO.

Logistics Contractor Management

All contractors of Envision should first pass an EHS qualification audit during their introducing period. Some key contractors will be considered an on-site audit if necessary.

Envision will hold regularly EHS inspections with logistic contractors during their daily operation. All findings will be recorded into logistic contractors' KPI. Corrective actions with deadlines are required. The contractor's EHS KPI records will be used for the purpose of review and reassessment in their future service contract.

Emergency Response

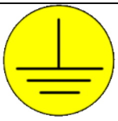
Envision logistic department has established a series of emergency response plans to deal with all kinds of emergency scenarios during international logistic projects. These emergencies will be evaluated on a regular basis. We make sure our emergency plans are practical and all personal are familiar with them. Below are some key scenarios we prepared:

- Human injury during the traffic accident
- Human injury during the lifting, loading, unloading process
- People fall down while working at height
- Fire accident while transportation or storage
- Nature disasters, like storms, flood, earthquake, etc.

3.6 Safety documents

No.	Doc. No.	Doc. Name
1	EM-0002	Envision Energy EHS Management Manual
2	EM-EHS-0032	WTG logistics transportation safety standard
3	EM-EHS-0017-I	Envision Energy External Supplier Health, Safety and Environmental Agreement - Logistics Supplier

3.7 Safety Marks

				
Hazard symbol	Important information	Connect to ground	Charged symbol	Risk for hands
				
Wear anti-noise equipment	Wear goggles	Wear safety belt	Wear safety shoes	Wear safety helmet
				
Risk for environment	Danger Overhead load	Stand clear of Overhead load	No access for unauthorised persons	Safety gloves must be worn
				
Read instructions	Radio communication equipment required			

4 Related Documents

No.	Doc. No.	Doc. Name
1	PRC-0010675	Working Instruction of Transportation Rotating Tool
2	PRC-0007875	Guideline for Stowage, Lashing and Securing of Nacelles and Hubs
3	PRC-0007873	Guideline for Stowage, Lashing and Securing of Blades
4	PRC-0007874	Guideline for Stowage, Lashing and Securing of Tower Sections

5 Transport Specification

5.1 Nacelle specification

Table 5.1 Nacelle Specification

Equipment	Length (mm)	Width (mm)	Height (mm)	Height of COG(mm)	Net Weight (Kgs.)	Weight ±3% (Kgs. Incl. frames)
Nacelle	11792	4448	4274	/	/	107269
Round frame	3600	3600	340	/	1378	/
Square frame	4800	3640	150	/	2922	/
Ventilation hood	2059	2163	605	/	46.4	/

Figure 5.1 Side view of nacelle

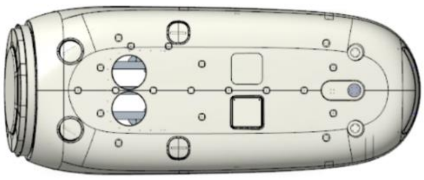


Figure 5.2 Top view of nacelle

Figure 5.3 Left view of nacelle

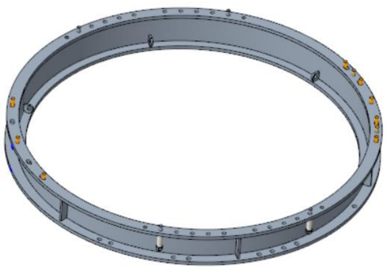


Figure 5.4 Round frame of nacelle

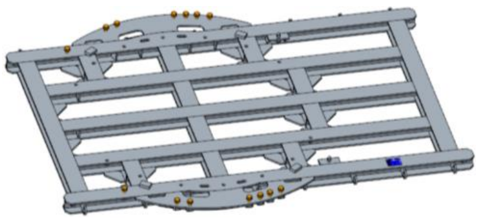


Figure 5.5 Square frame of nacelle

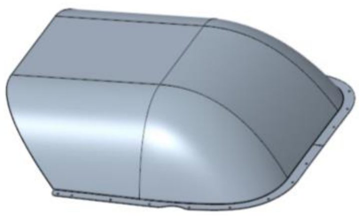


Figure 5.6 Ventilation hood

5.2 Hub specification

Table 5.2 Hub Specification

Equipment	Length (mm)	Width (mm)	Height (mm)	Height of COG(mm)	Net Weight (Kgs.)	Weight±3% (Kgs, incl. frames)
Hub	5059	4500	4109	2176	/	32282
Transport Frame	2650	2650	587	/	2300	/

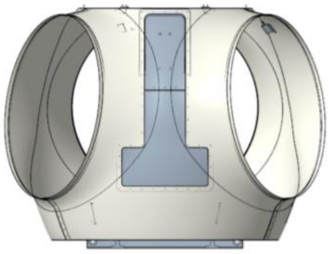


Figure 5.7 Top view of HUB

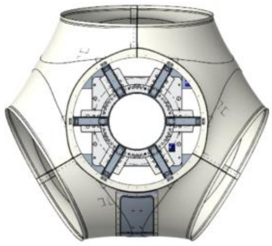


Figure 5.8 Bottom view of HUB

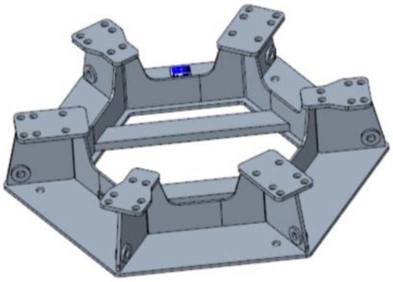


Figure 5.9 Transport frame of hub

Figure 5.10 Spinner nose

5.3 Blade specification

5.3.1 Single Blade

Table 5.3 Single Blade

Equipment	Length (mm)	width (mm)	Height (mm)	Tip-end frame distance (mm)	Net Weight (kgs.)	Weight±3% (Kgs, incl. frames)
156 Blade	76796	4240	3361	42308	22800	27900
156 Blade Root frame	3350	300	3250	156 Blade Root frame	760	/
156 Blade Tip frame	2400	1000	3250	156 Blade Tip frame	2341	/

Figure 5.11 Single blade side view

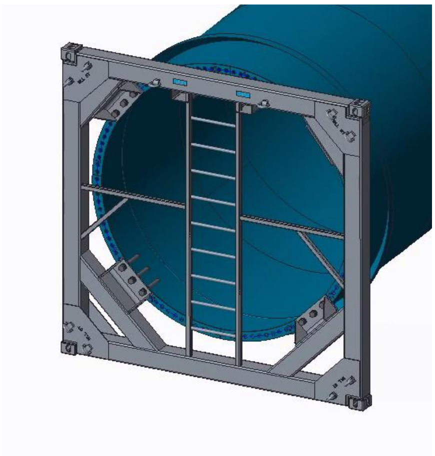


Figure 5.12 Single blade root frame

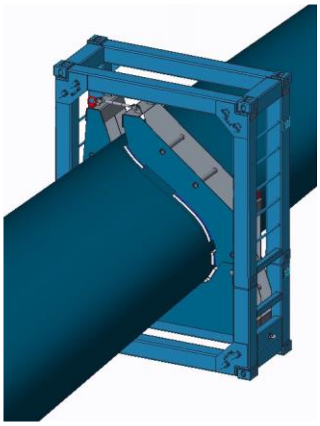


Figure 5.13 Single blade tip frame

5.3.2 Stacked Blade

Blades can be stack at maximum 5 tiers. The sketch of ocean transport can be found in the sketch below.

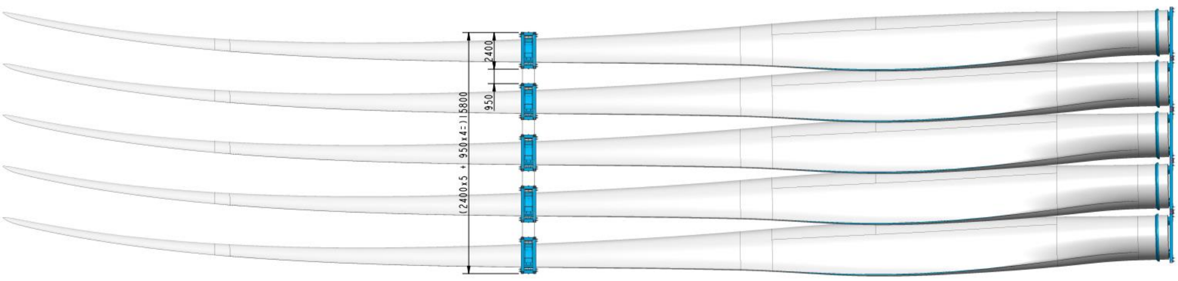


Figure 5.14 Blade stack in 5 tiers top view

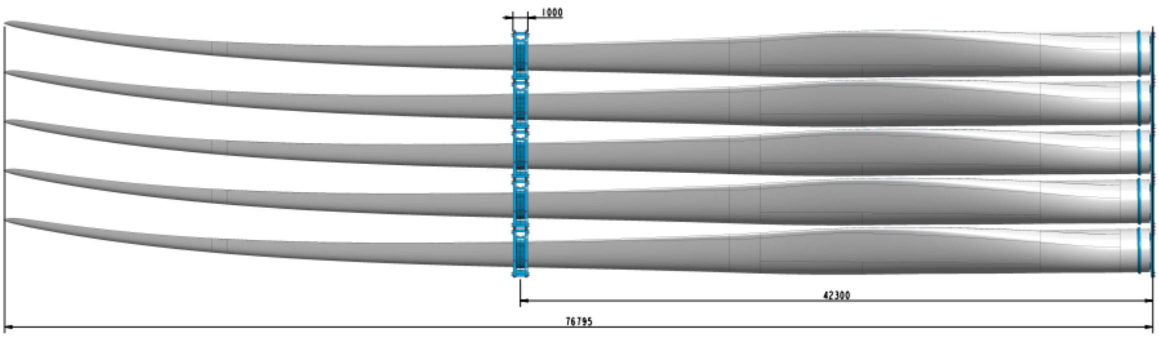


Figure 5.15 Blades stack in 5 tiers side view

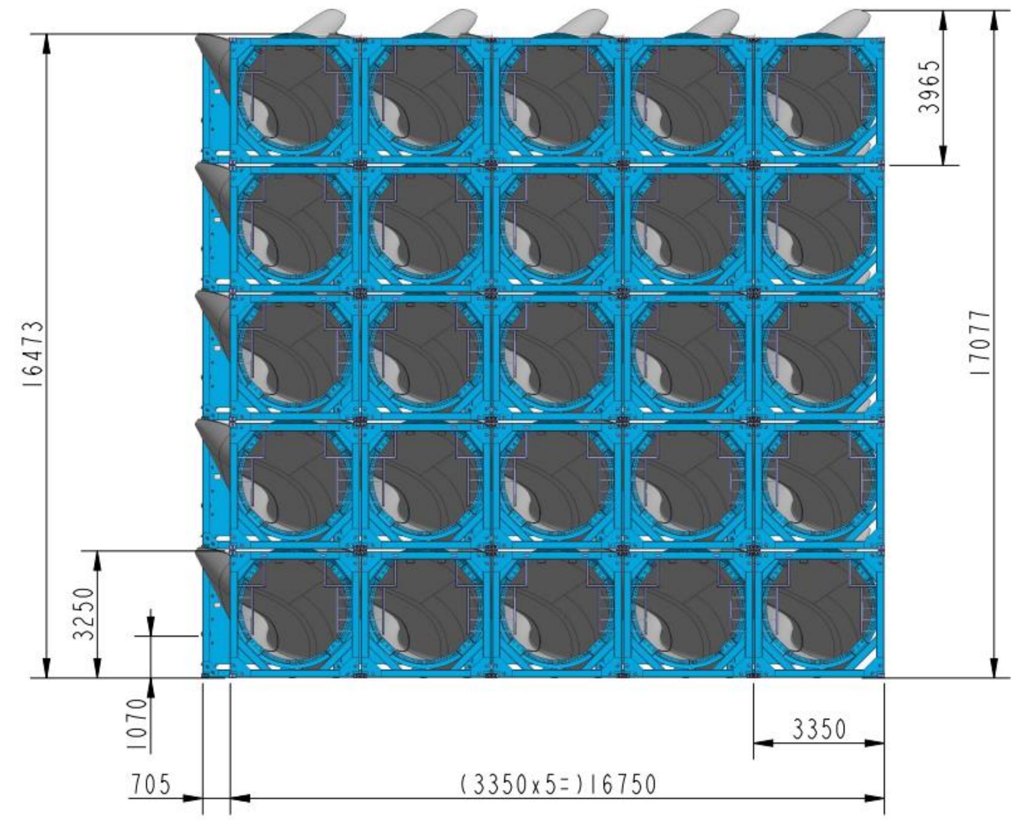


Figure 5.16 Blades stack in 5 tiers front view

5.4 Tower specification

5.4.1 Tower frame and H beam specification

Envision designed the tower transport frame and H beam in accordance with diameter of the tower section and marine double stack stowage requirements.
Tower sections are defined starting with section 1 (the top section of the tower).

Table 5.4 Tower Specification

Component	L(m)	W(m)	H(m)	Weight(kg)	Remark
Section1 Top	22.16	3.68	3.93	41051	Include marine Saddle Frame
Section1	22.86	3.68	4.18	46551	Include marine H beam
Section2	22.54	4.5	4.75	41224	Include marine Saddle Frame
Section2	23.24	4.5	5	46724	Include marine H beam
Section3	22.54	4.5	4.75	56097	Include marine Saddle Frame
Section3	23.24	4.5	5	61597	Include marine H beam
Section4	22.54	4.5	4.75	72450	Include marine Saddle Frame
Section4	23.24	4.5	5	77950	Include marine H beam
Section5 Bottom	20.48	4.8	5.05	102527	Include marine Saddle Frame

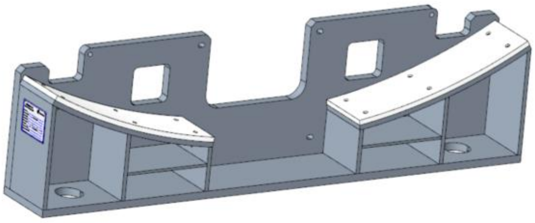


Figure 5.17 Tower transport frame

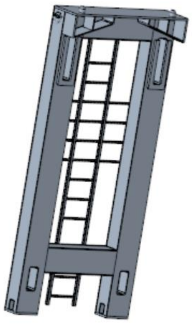


Figure 5.18 H beam

Figure 5.19 Ladder for universal

5.4.2 Tower section sketch

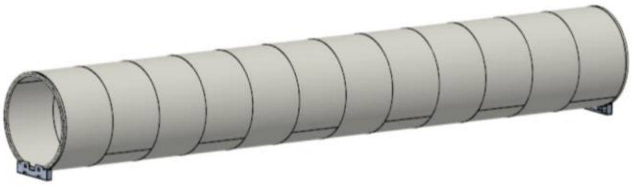


Figure 5.20 Tower Section include marine Saddle view

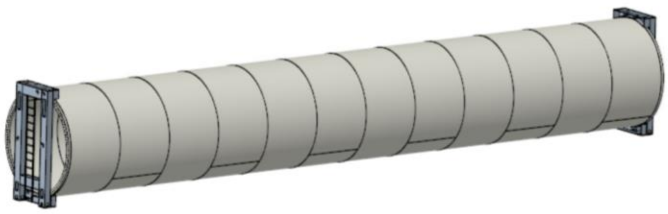


Figure 5.21 Tower Section include H beam view

5.4.3 Stacked Tower sketch for ocean transport

Tower section 1/2 can be stacked at maximum 2 tiers. The stacked sketch for tower section can be found in the sketch below.

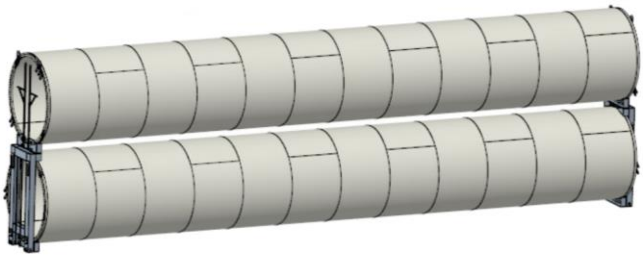


Figure 5.22 Sections should be double stack tower Sections

6 Inland Transport

6.1 Nacelle inland transport

Normally hydraulic trailer not less than 10 axles shall be used to transport nacelle.

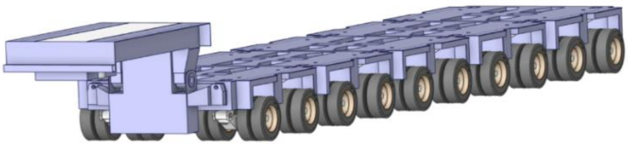


Figure 6.1 Hydraulic trailer

To decrease the overall height of nacelle and trailer components, a hydraulic trailer with drop deck can be used. The disadvantage of this transport mode is much bigger road turning radius required.

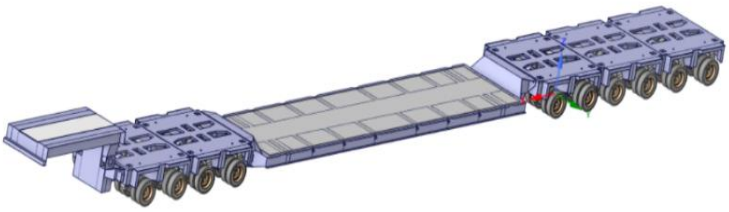


Figure 6.2 Hydraulic trailer with drop deck

Nacelle inland transport trailer arrangement

The principle of making a safe trailer arrangement is trailer strength and overall stability shall be safe enough for local transport circumstance. The trailer strength shall make sure that bending moment, shearing force and deflection of trailer do not exceed their limitations. Dynamic and static transport stability usually should consider the effect from existed external load such as wind speed, road slope, dynamic acceleration, centrifugal force etc.

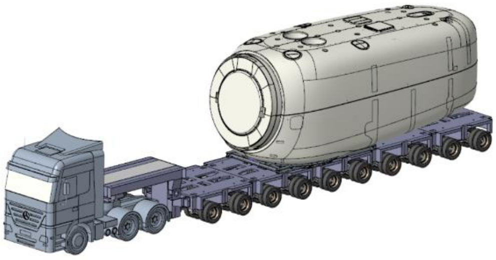


Figure 6.3 Transport trailer for nacelle (hydraulic trailer)

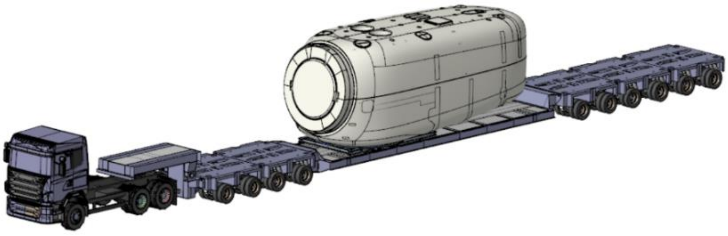


Figure 6.4 Transport trailer for nacelle (drop deck)

Nacelle inland transport lashing

There are 16 lashing points in the nacelle frame, the WLL (working load limit) is 10 tons. It should be connected directly to the trailer lashing points by lashing chain (WLL 10t).

The thickness of 10mm rubber plates or wooden plates should be padded under transport frame to increase friction coefficient. The quantity of rubber plate should not less than 8 and contour dimension should be not smaller than 500*500mm each. Plates should be placed on the main beam of trailer and symmetrically arranged from front to back, left and right, the total area should not less than 2m^2.

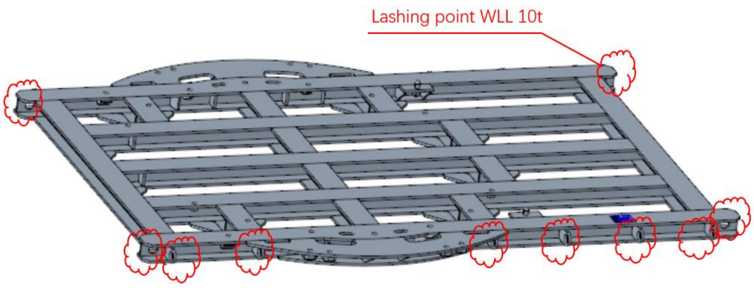


Figure 6.5 Nacelle transport lashing point

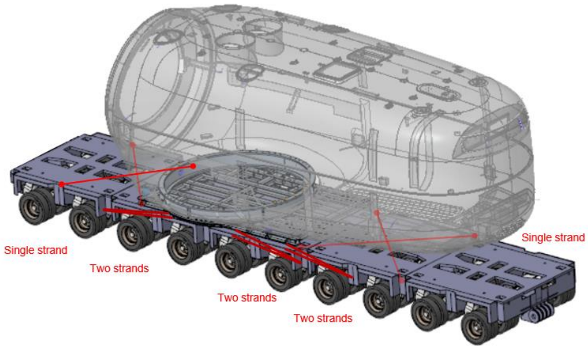


Figure 6.6 Nacelle inland reference transport lashing and dunnage plan

6.2 Hub inland transport

Normally hydraulic trailer 3~4 axles with drop deck should be used to transport hub.

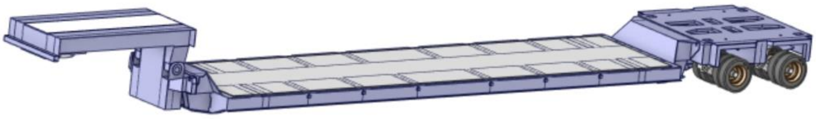


Figure 6.7 Trailer 2 axles with drop deck

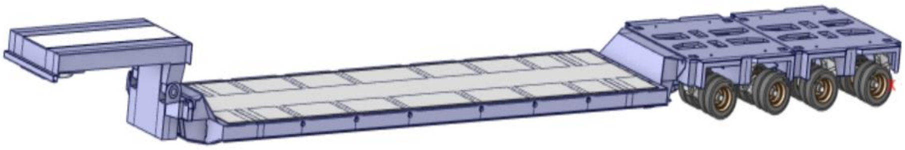


Figure 6.8 Trailer 4 axles with drop deck

Hub inland transport trailer arrangement

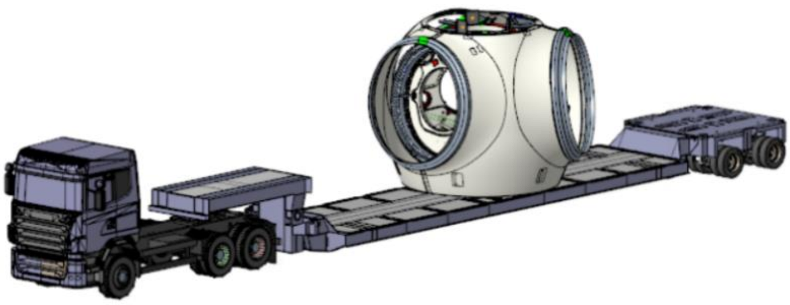


Figure 6.9 Hub trailer arrangement

Hub inland transport lashing

There are 8 lashing points in the hub transport frame, the WLL of each lashing point is 5 tons. The diameter of lashing point hole is Φ70mm. It should be directly connected to the trailer lashing points by lashing chain.

The thickness of 10mm rubber plate should be padded under transport frame to increase friction coefficient. The quantity of rubber plate should not less than 4 and dimension should not smaller than 500*500mm each. Plate should be placed on the main beam of trailer symmetrically from front to back, left and right, the total area should not less than 1m^2.

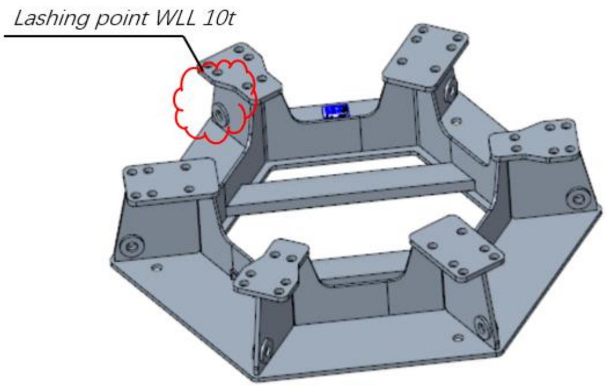


Figure 6.10 Hub lashing frame indication

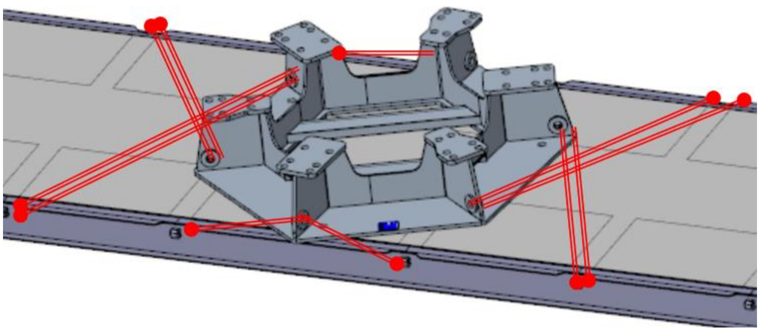


Figure 6.11 Hub inland reference transport lashing and dunnage

6.3 Blade inland transport

Figure 6.12 Blade inland transport trailer

Blade inland transport trailer arrangement

Both the root-end frame and tip-end frame shall be supported by the loading platform of trailer subject to local trailer fleet resource and configuration.

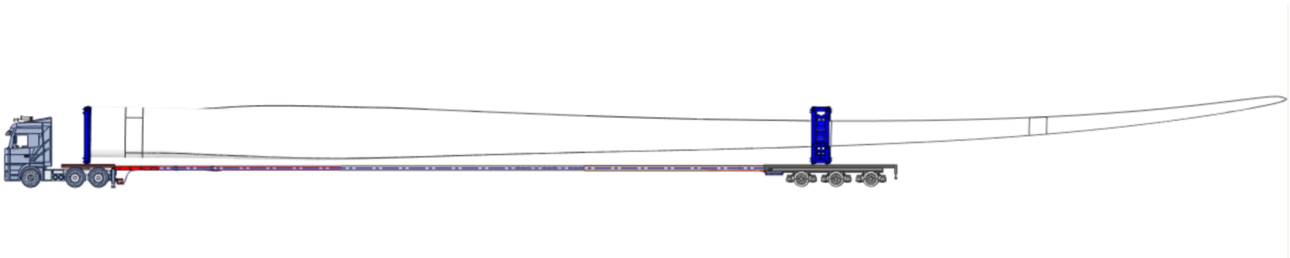


Figure 6.13 Blade inland transport trailer arrangement

Blade inland transport lashing

4 Lashing point for root frame with the twist lock corner, each lashing point WLL is 5 T.

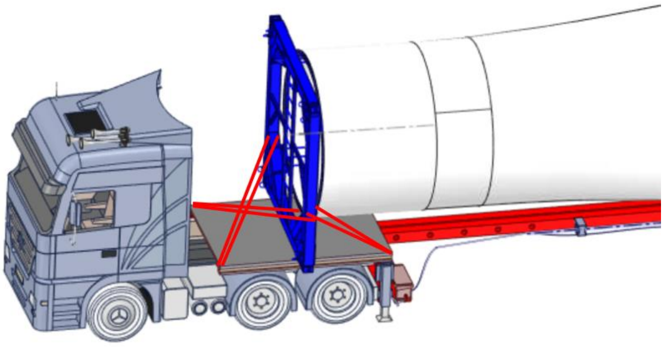


Figure 6.14 Lashing method for root frame

There are 16 marine lashing rings in the lashing blade tip transport frame, each lashing point WLL is 5 tons.

If the height of blade is over the road limits, you can remove the upper and lower frame of the tip frame to adjust the height.

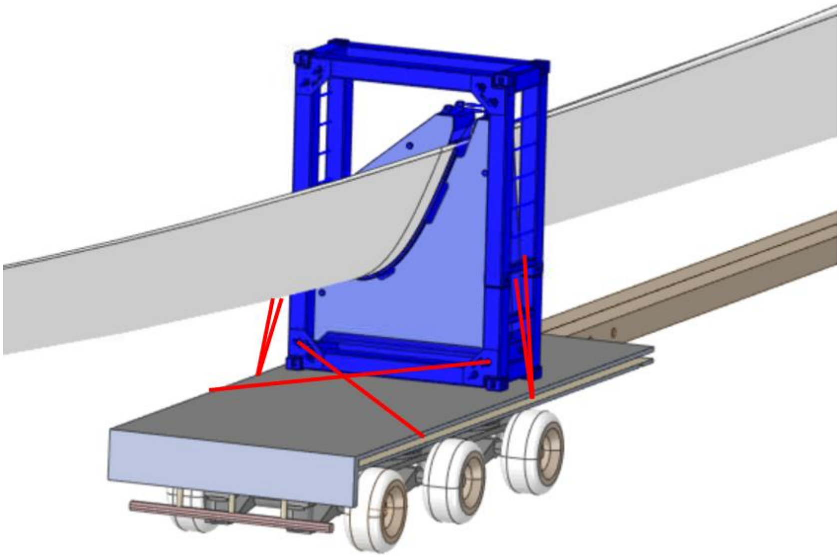


Figure 6.15 Lashing method for tip frame

6.4 Tower inland transport

Tower adapter

The adapter can either be mounted directly on the platform or be used as free-turning device with supporting tip frame and swivel bolster.

Figure 6.16 Tower adapter

Hydraulic trailer with drop deck can be used to transport tower Sections.

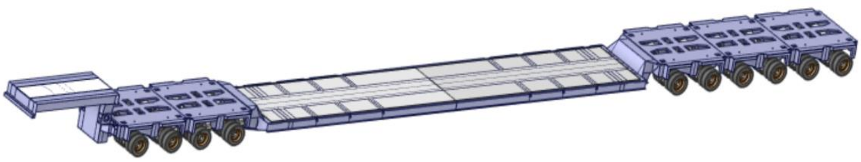


Figure 6.17 Hydraulic trailer with drop deck

Tower inland transport trailer arrangement

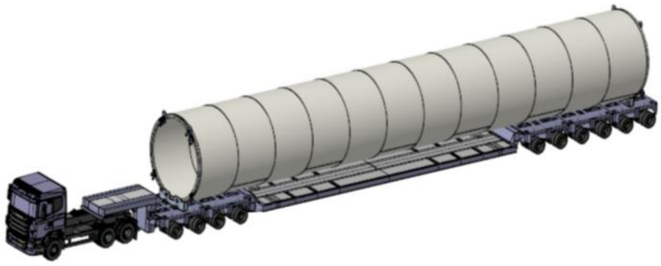


Figure 6.18 Tower transport trailer arrangement

In case of there are over height or road turning radius limitations difficultly go across, the tower adaptor can be used. There are two kinds of tower adaptors which both can reduce the overall height. Additionally, the tower adaptor with free turning device need smaller road turning radius and road width.

Figure 6.19 Tower adapter mounted directly on the platform

Figure 6.20 Tower adapter with free turning device

Tower inland transport lashing

Lashing sketch on trailer for tower are shown on the below sketch. The WLL of each lashing chain should be not less than 10tons.

A rubber plate 3000*300*10mm should be padded between the trailer and frame at both rear and front side.

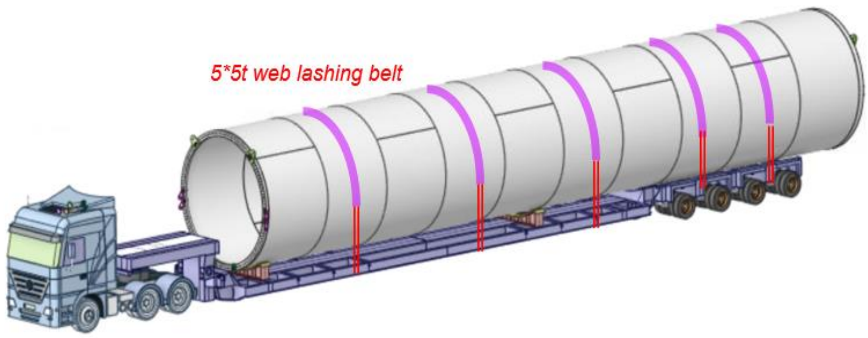


Figure 6.21 Trailer front side lashing method

Figure 6.22 Tower lashing in mountainous wind farm

7 Rotation control of nacelle transport

During the nacelle transportation, the rotation control tool inside the nacelle should be kept rotating. Before transporting, the driver is required to connect the 24V AC power and turn on the switch to the 'I'. (I: on, O: off)

Figure 7.1 Rotation control toolbox

Remove 2 sets of M12 bolts on opposite side of the turning port flange. Use the hexagon bolt just removed with the gasket to fix the motor flange according to the standard torque.

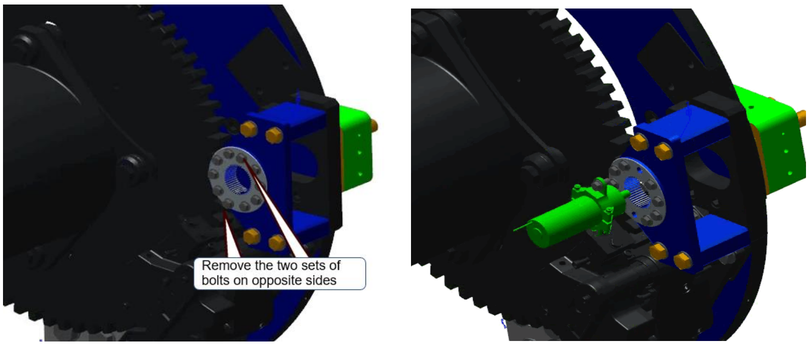


Figure 7.2 Motor assemble sketch

Load the gear from the side, turn and adjust the angle of the brake disc, so that the gear and brake disc mesh into the generator output shaft.

Figure 7.3 Fixed gear wheel assemble sketch

Each nacelle is equipped with Rotation Control Tool. Interface C: to connect with 24V AC power supply.

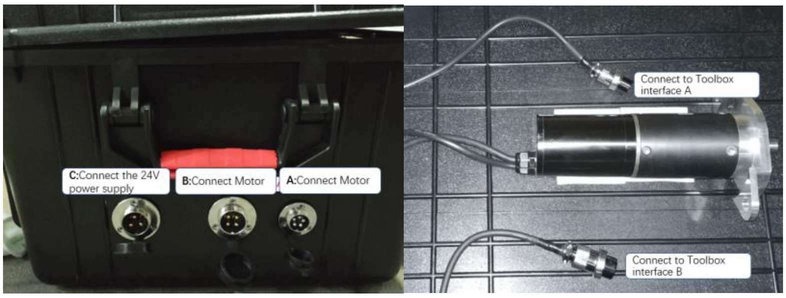
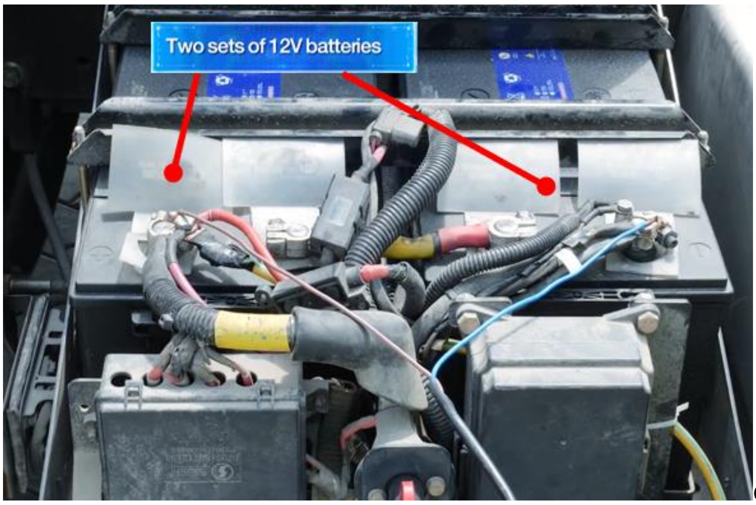


Figure 7.4 Toolbox and motor wiring

Plug the power cord into the interface A above the rotation control cabin as shown in the illustration On the other end of the power cord there are 2 cables. The brown cable is connected to the positive terminal of the truck power supply, and the blue cable is connected to the negative terminal of the truck power supply.



dps

Figure 7.5 The toolbox plugged in to the 24V DC power supply

Turn on the switch of the Rotation Control Tool (as shown in the below figure) when the truck power is switched on which is a mandatory requirement.

If the truck is moving, the Rotation Control Tool should always be working. The driver must check the power cord and the switch every 24 hours and report to Envision personnel in case of any observations.

Figure 7.6 Rotation control tool sketch

Before unloading the nacelle, the site team must check the timer in the Rotation Control Tool, and record the time with the Envision personnel together.

Never press the ‘Reset button’ before record the time and unload the Nacelle.

Figure 7.7 Rotation tool time recorder

During sea transportation, the 380V AC control cabins which needs to be connected to the Ship power.

The Rotation Control Tool Interface C can be connected directly to the control cabins.

One control cabin can power 8-12 Rotation Control Tools.

If the Rotation Control Tool is working, it is indicated by the green light.

The 380V AC control cabins which needs to be connected to the Ship power.

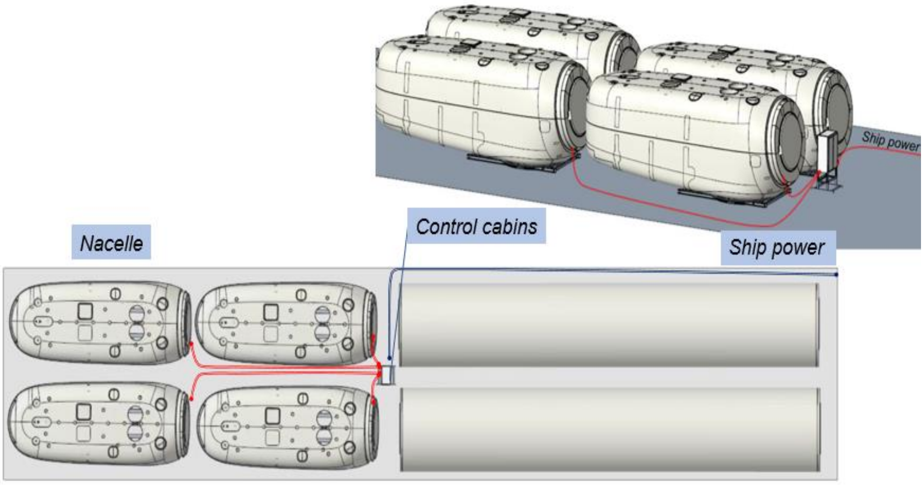


Figure 7.8 Control cabin arrange sketch

8 Lifting method

8.1 Lifting method for Nacelle

The counterweights shall be installed at the corresponding interface on the beam according to the below sketch. Subject to the actual project configuration.

1 Assemble the main frame on site and assemble the lifting end beam to the correct position, as shown in the right image.

① Ring-lifting belt, R01-40×3m, folding in half;
② Ring-lifting belt, R01-20×7.1m folding in half;
③ Ring-lifting belt, R01-20×6m folding in half;
④ Shackle, S-BX55;

If the nacelle lifting is not in the horizontal level, it can choose the beam lifting point 1 and point 4 instead.

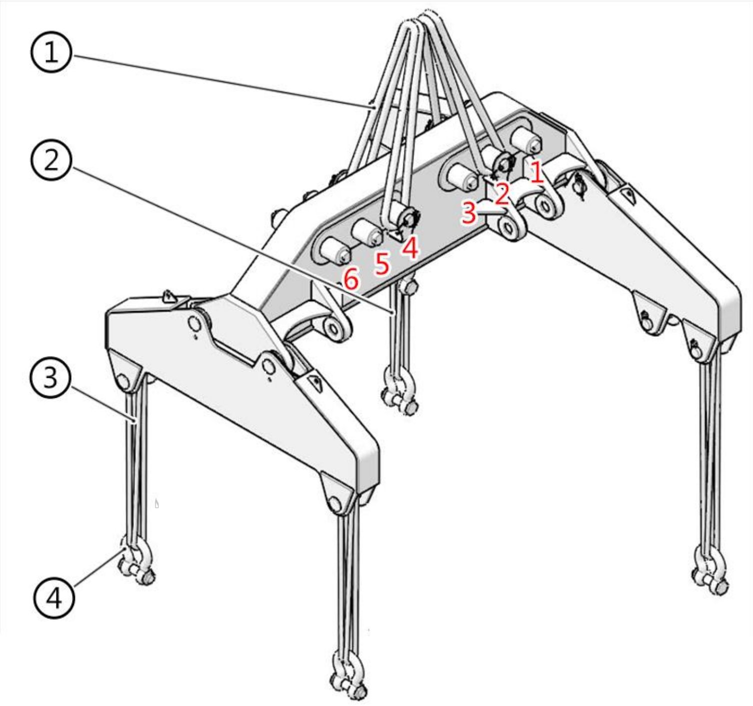


Figure 8.1 Lifting tools assembly sketch

2 Open 4 lifting cap on the top of nacelle

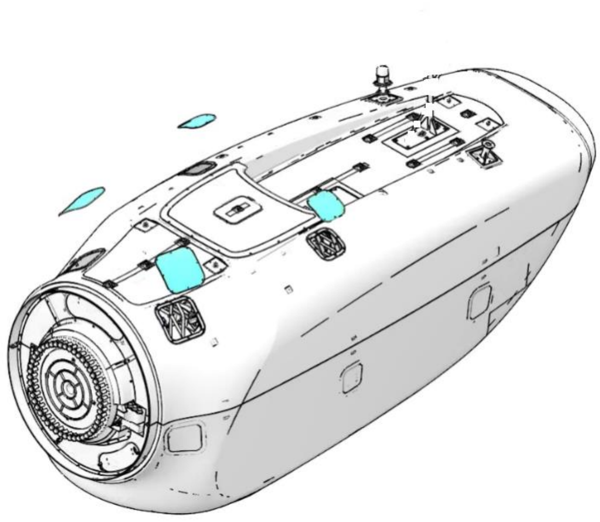


Figure 8.2 Lifting cap sketch

3 Put the lifting belt into the lifting cap slowly, note the forward and backward direction of the lifting beam as the right fig.

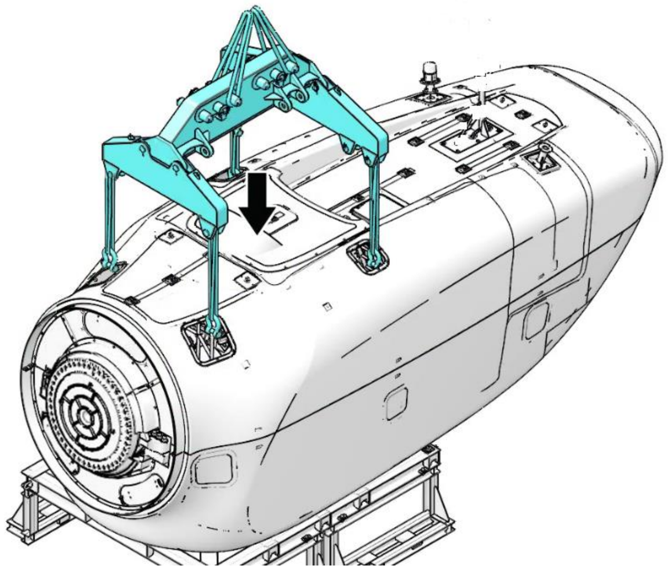


Figure 8.3 Lifting assembling sketch

4 Connect the shackle to the lifting point in the nacelle as the right fig.

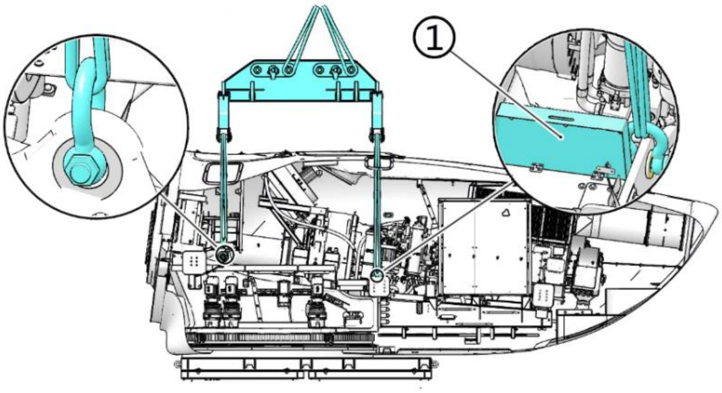


Figure 8.4 Lifting shackles assembling sketch

Hang the upper four slings on the hooks.
Notice:Use claw hooks and adopt a symmetrical hanging method.

Figure 8.5 Hook assembly sketch

Lift the sling and place it above the nacelle, and the rear sling is located in the area of the hoisting hole of the nacelle cover.

Maintenance

Serial number	Precautions
1	Tools must be placed on a special shelf before and after use, stored in a ventilated, dry and clean building, and be kept by a special person;
2	The spreader is not allowed to be stored in acid, alkali, salt, chemical gas and humid environment;
3	Tooling recommended storage temperature: -20~40℃.
4	Regularly clean the rotating parts to prevent jamming.

Scrap standards for tooling and accessories

Serial number	Scrap standard
1	If tools have severe distortion, deformation, or welding cracks that cannot be repaired, it should be scrapped.

Serial number	Scrap standard
2	If the wear of pin shafts, rotating joints and bolts exceeds 10% of the nominal size, they should be scrapped.
3	The tooling parts are seriously corroded and affect the safe use, so they should be discarded.
4	If the tooling is seriously damaged by collision and affects safe use, it should be scrapped.
5	The main parts of the tooling have obvious plastic deformation and should be scrapped.

8.2 Lifting method for Hub

Place the three hooks on the three-legged sling and place on the rotating lifting bolt. Transfer the hub to the reserved location.

① Rotating lifting bolt, VLBG-V-M48-20T;

② Shackle, S-25T;

③ Ring-lifting belt, R01-10T×5m folding in half.

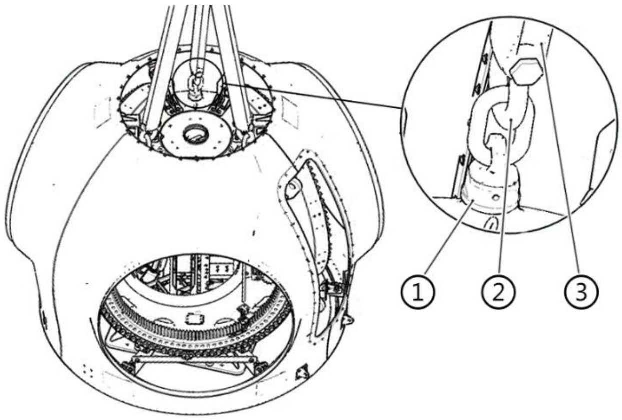


Figure 8.6 Hub lifting sketch

After lifting and removing the sling, restore and secure the top board and secure the top rain proof package.

8.3 Lifting method for Blade

The below lifting facilities should be used at the blade root frame.

- 2 x R01-10TX3M Round slings;
- 2 x S-BX12T-1 1/4 shackles;
- 2 x Eye sling hook 10T.

The below lifting facilities should be used at the blade tip frame.

- 4 x R01-05T*4M Round slings;
- 4 x S-BX12T-1 1/4 shackles;
- 4 x Eye sling hook 10T.

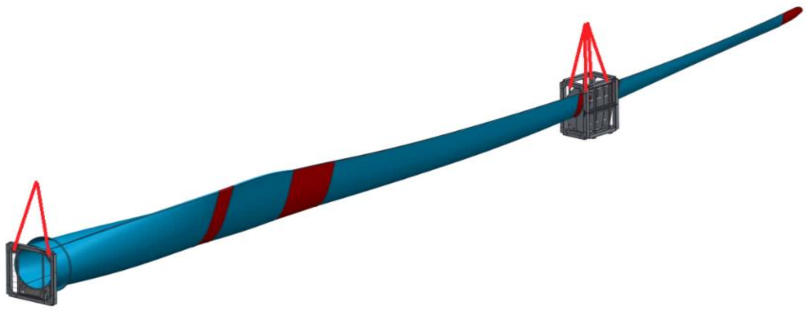


Figure 8.7 Blade lifting overall sketch

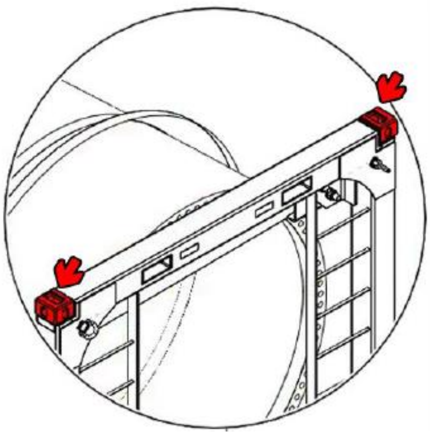


Figure 8.8 Root frame lifting plan

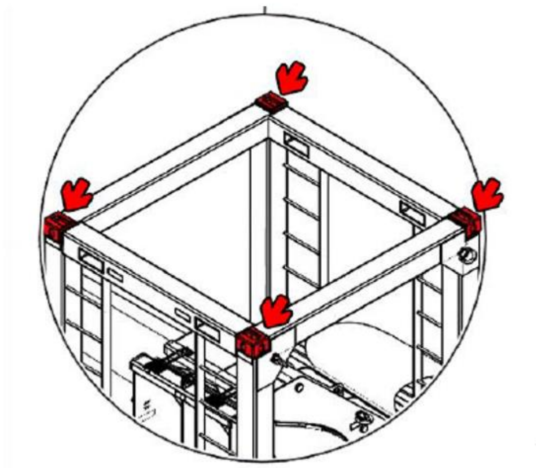


Figure 8.9 Tip frame lifting plan

8.4 Lifting method for Tower

The diameter of lifting hole is 62mm, the below lifting stools are required for tower lifting.

- Shackle: S-BX30T

- Round sling: R01-30T*6m

The right figure shows lifting status of tower.

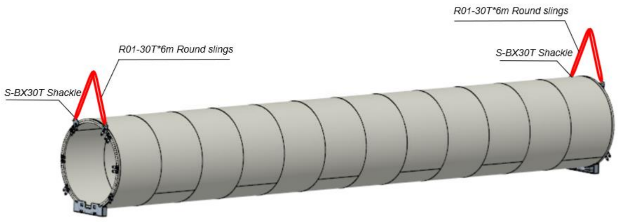


Figure 8.10 Tower lifting plan

When lifting tower as below, the lifting requirement should strictly be followed.

- Flat webbing sling: 30T*20m, the width should not less than 200mm.
- The distance between lifting sling and tower flange sections should be not more than 1/3 of the tower overall length. Two lifting position should be symmetrically arranged by the COG.

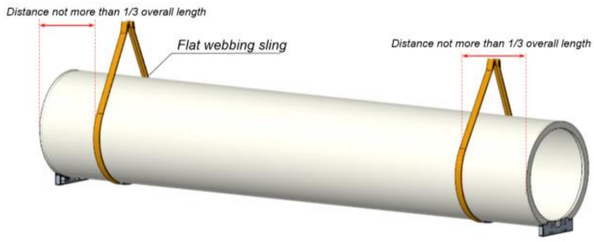
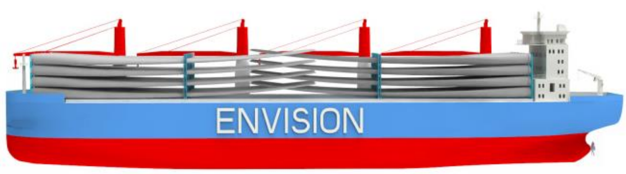


Figure 8.11 Tower belly lifting plan

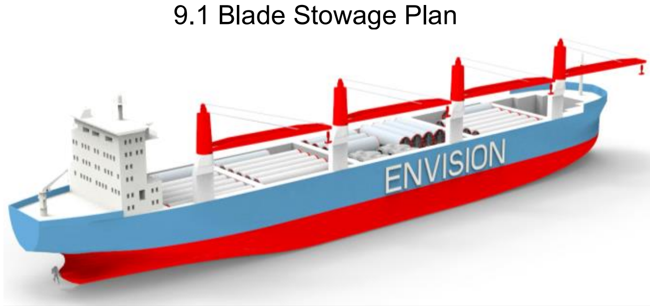
9 Sea Transport

Blade can be stack up to 5 tiers on weather deck. And cross stowage method is also applicable for blade ocean transport.



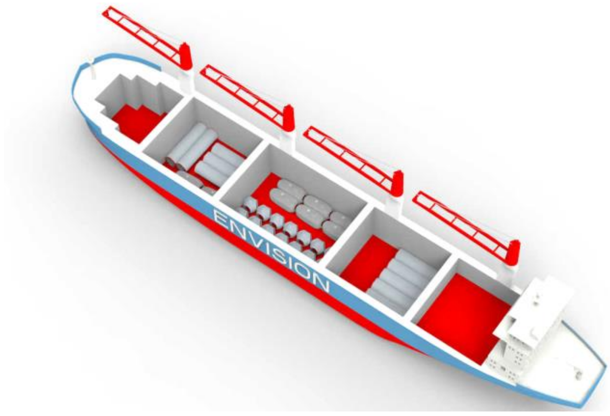
9.1 Blade Stowage Plan

Tower can be stack up to 2 tiers. It can be stowed at hatch cover or tween deck/hold depends on actual stowage requirements.



9.2 Tower Stowage Plan

Nacelle and hub can be stowed at tween deck or lower hold of ocean transport vessel.



9.3 Nacelle and Hub Stowage Plan

10 Requirements of storage

The storage site must be fire-proof. Do not use open flames in the storage site. The storage site shall be equipped with sufficient fire-fighting facilities at the designated location and checked regularly to prevent fire safety hazards.

The strength and slope of all storage area shall meet the requirements of storage, hoisting and transportation. The storage site should be reasonably checked to ensure that cranes and transport vehicles can pass through and carry out loading and unloading operations smoothly.

Never store in areas containing corrosive gases.

The storage site should avoid underground pipes and keep a safe distance (1m and above) from surrounding ground and obstacles in the air. Please comply with relevant regulations in areas with high-voltage lines in the air.

The storage area has clear signs and instructions, and safety protection and care work are taken to prevent the goods from being stolen or damaged.

When the storage area is adjacent to the common access road, isolation facilities and access roads shall be used for isolation and warning.

10.1 Nacelle storage

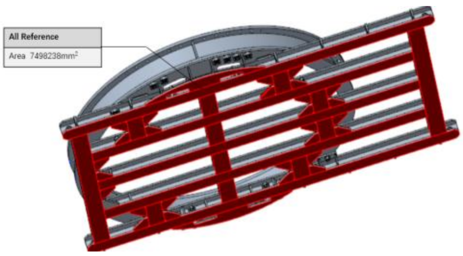


Figure 10.1 Nacelle frame ground contacting area

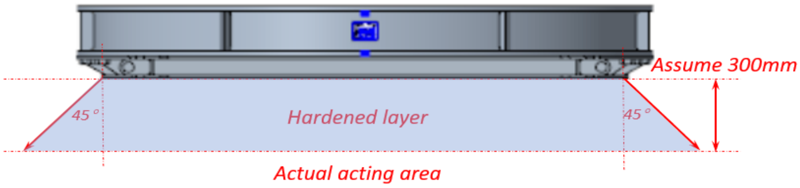


Figure 10.2 Nacelle frame load dispersion sketch

The press on the ground will spread along the 45° direction towards the ground hardening layer. The actual area of action is much larger than the touching area. Considering the safety factor, the ground strength should be at least 20t per square meters.

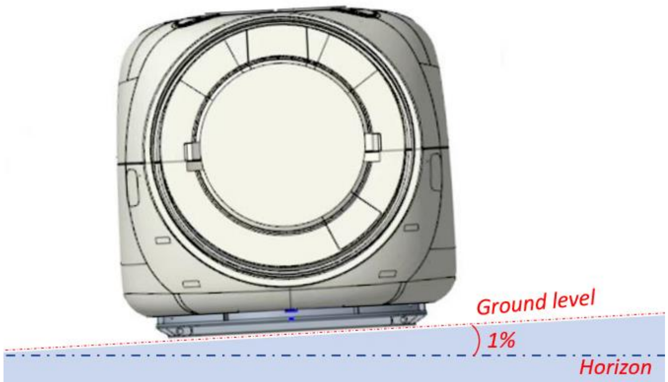


Figure 10.3 Nacelle storage requirement sketch

Ground level degrees from horizon should less than α≤1%.

The drive train needs to be rotated after it has been stored for more than three months.

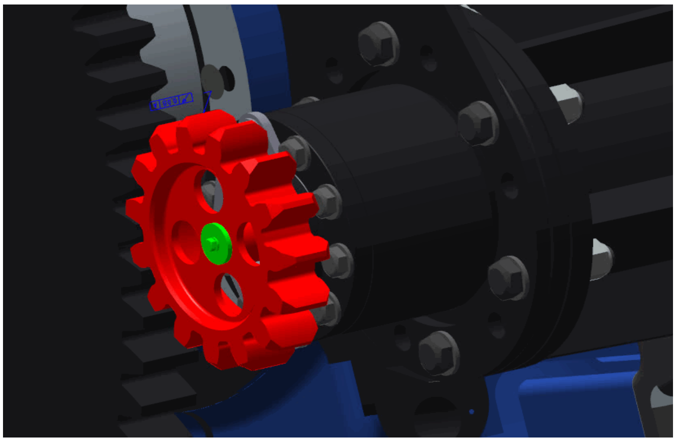


Figure 10.4 Drive train assemble sketch

10.2 Hub storage

The press on the ground will spread along the 45° direction towards the ground hardening layer. The actual area of action is much larger than the touching area. Considering the safety factor, the ground strength should be at least 20t per square meters.

Ground level degrees from horizon should less than α≤1%.

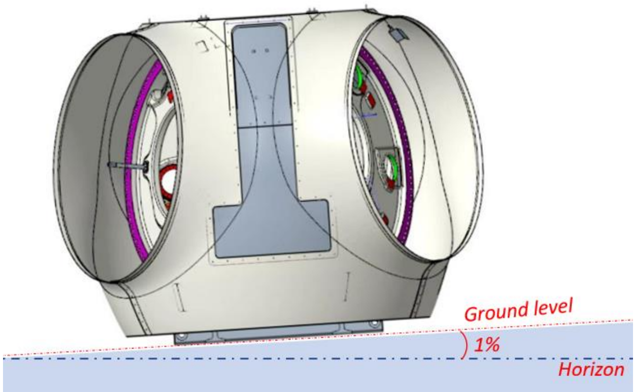


Figure 10.5 Hub storage requirement sketch

10.3 Blade storage

Blade can be stacked at least 2 tiers in port. The ground strength should be at least 15t per square meters.
Lashing and securing as below sketch.

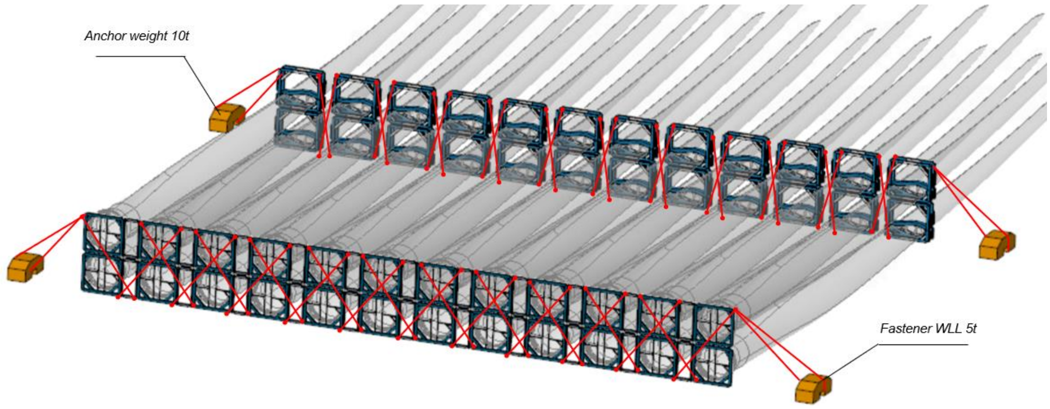


Figure 10.6 Blade storage requirement sketch

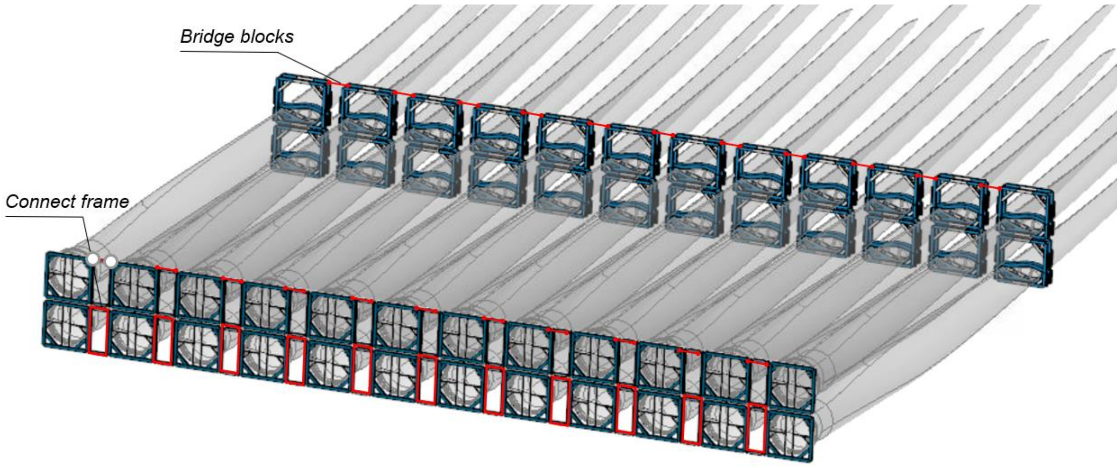


Figure 10.7 Bridge blocks connection sketch

Instructions of blade lashing during storage:

- Blade storage longitudinal direction should be along with wind direction.
- The anchorage block weight should not less than 10t.
- Fastener WLL should not less than 5t.
- The blade root and tip all need to be lashed and the install the bridge blocks shall be installed for connecting the adjacent blades.
- Every column needs to be lashed by more than 2 fasteners for root and tip respectively.

10.4 Tower storage

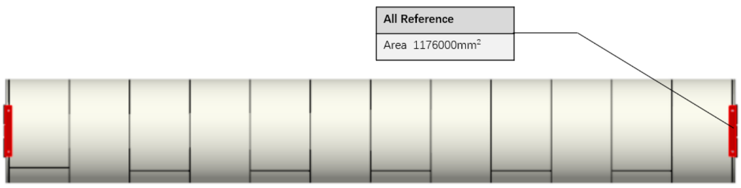


Figure 10.8 Tower frame ground contacting area

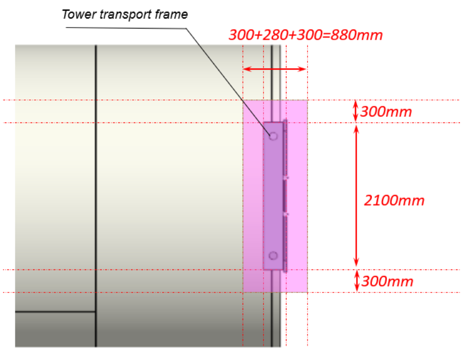


Figure 10.9 Tower frame load dispersion sketch

The press on the ground will spread along the 45° direction towards the ground hardening layer. The actual area of action is much larger than the touching area. Considering the safety factor, the ground strength should be at least 20t per square meters.

Ground level degrees from horizon should be less than α≤1%.

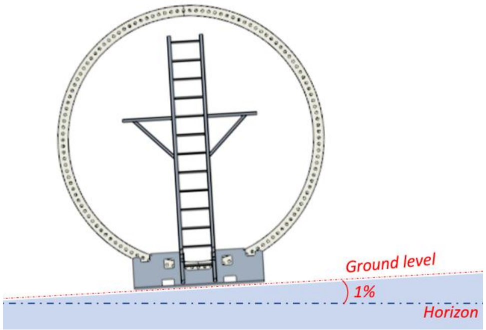


Figure 10.10 Tower storage requirement sketch

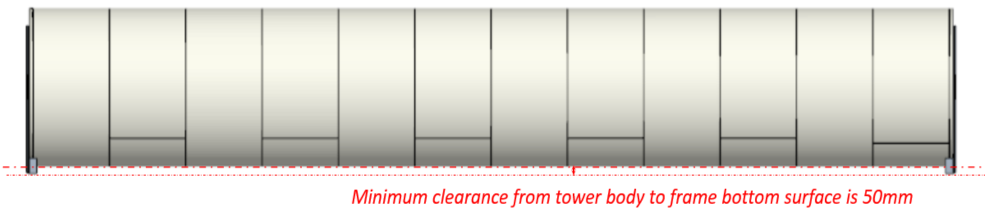


Figure 10.11 Tower storage requirement sketch

Keep the ground in flat condition, make sure there are less than 5cm clearance above the ground.

11 Return of Road Transport frames

11.1 Container loading list

Description	Dimension(cm)	Unit Weight(kg)
Blade tip down frame (Include inner frame)	360*109*149	2024
Tower H frame	500*210*58	2734
Tower H frame	500*210*58	2734
Blade tip upper frame	360*109*218	1140
Tower saddle frame	210*58*65	539
Blade bottom frame	335*45*325	1313
Hub transport frame	265*265*59	2300
Nacelle upper support frame	360*360*34	1378
Nacelle square support flange	480*364*15	2922
Nacelle upper support frame	360*360*34	1378
Nacelle square support flange	480*364*15	2922

11.2 Container loading plan

Nacelle frame and Hub frame loaded by 40FR

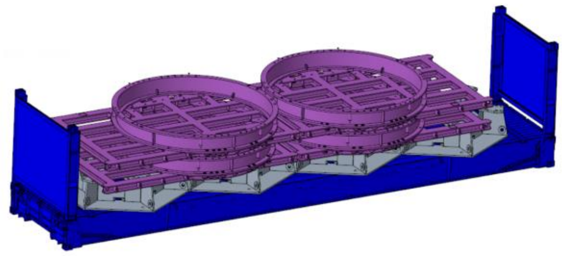


Figure 11.1 Nacelle frame and Hub frame loaded by 40FR

Blade Root frame loaded by 40OT

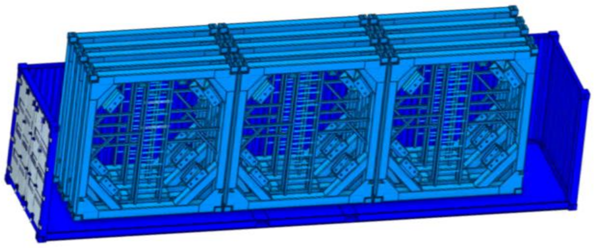


Figure 11.2 Blade root frame loaded by 40OT

Blade Tip frame loaded by 40 OT

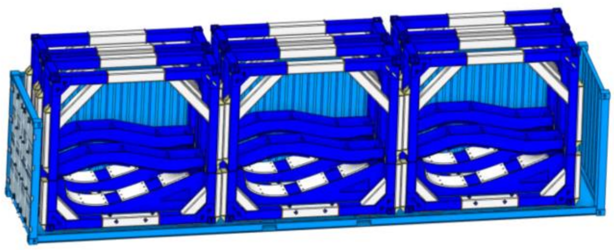


Figure 11.3 Blade tip frame loaded by 40OT

Tower H frame loaded by 40HQ

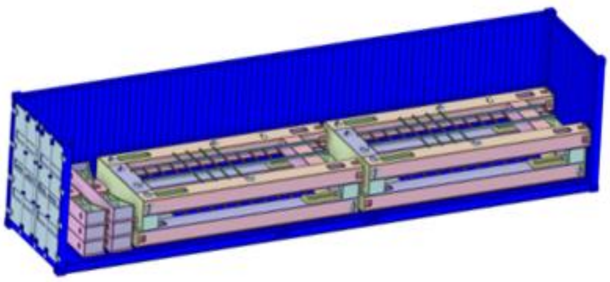


Figure 11.4 Tower H frame loaded by 40HQ

Tower Saddle frame loaded by 40HQ

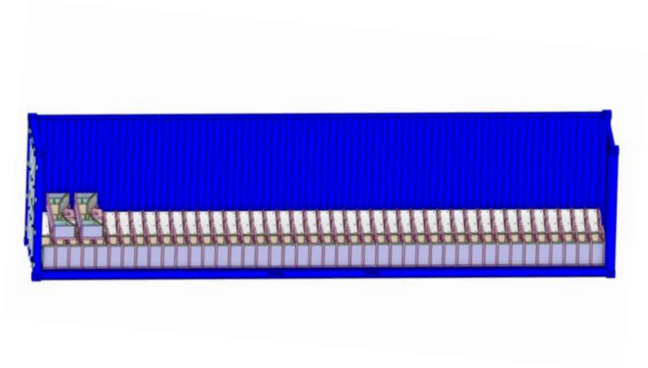


Figure 11.5 Tower H frame loaded by 40HQ