

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of applications to the **WAIKATO DISTRICT COUNCIL** and **WAIKATO REGIONAL COUNCIL** by **WEL NETWORKS LTD** for resource consents to authorise the establishment, operation and maintenance of 28 wind turbines for the generation of electricity and associated activities on the Whararoua Plateau, near Te Uku

STATEMENT OF EVIDENCE OF TONY GLENN KEYTE

1. INTRODUCTION

Qualifications and experience

- 1.1 My name is Tony Glenn Keyte. I am a senior civil and transportation engineer with Bloxam, Burnett & Olliver Limited (BBO), a firm of consulting engineers, planners and surveyors. I have over 18 years experience as a civil and traffic engineer.
- 1.2 My qualifications are Masters of Engineering in Transportation (University of Canterbury, 2007) and a New Zealand Certificate in Civil Engineering (Waikato Polytechnic, 1991).
- 1.3 I am an associate member of the Institute of Professional Engineers New Zealand and a member of the Registered Engineers Association, Member of Contractors Association, Member of NZ Water and Waste Association and have a number of other memberships with NZ and Australian engineering associations.
- 1.4 I have been a civil engineer on a number of large infrastructure projects in the North Island of New Zealand with a strong focus on roading and land development.

Involvement in project

- 1.5 I have acted in my capacity as consulting advisor to WEL Networks on matters relating to civil engineering, traffic and transportation. I have visited the site on a number of occasions and have a good understanding of the site.

- 1.6 My structural engineering colleagues at BBO have assisted me with the assessment on structural foundations. In particular, Mr Pang Chong Heng, whose qualifications are BE (Civil) and MSc (Civil), both from the National University of Singapore and over 18 years experience as a structural engineer, undertook an assessment of the structural elements relating to turbine foundations. I have adopted his analysis in my report and for this evidence.
- 1.7 I have been intimately involved with the development of the site roading, water take, stormwater management and control, earthworks management and structural assessment and quarry management.

Purpose and scope of evidence

- 1.8 The purpose of this evidence is to outline the civil engineering works proposed on the wind park site. In that regard, my evidence will cover the following key elements:
- (a) Matters related to internal roading, including the civil works to be undertaken in, materials required, vehicle movements and construction programme (section 3);
 - (b) Matters relating to the development of the foundations for the turbines, including details of the extent of earthworks (section 4);
 - (c) The scope of earthworks, materials required and the nature of cuts and fills (section 5);
 - (d) Measures proposed to manage earthworks and associated silt, sediment and erosion control (section 6);
 - (e) Construction programme outlining predicted timeframes (section 7);
 - (f) Operation and maintenance (section 8);
 - (g) Concrete batching plant (section 9);
 - (h) Management of stormwater (section 10);
 - (i) Water take (section 11);
 - (j) Environmental management plan (section 12).
 - (k) Submissions in relation to Civil Engineering (section 13); and
 - (l) Summary of potential effects (section 14).

- 1.9 My evidence needs to be read alongside that of Roger Burchett, who outlines the proposal in detail, Mark Mitchell, who addresses geotechnical matters and Mark Apeldoorn, who address traffic and transportation matters.

Expert Witness Code of Conduct

- 1.10 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Note 2006 [2006] NZRMA 357. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

2. EXECUTIVE SUMMARY

- 2.1 The following evidence covers the civil engineering works associated with the construction of access roading to the plateau, access to each turbine location for construction and long term maintenance, turbine platform construction, turbine foundations, hydrology and hydraulics. The proposed civil works are an essential part of the project given that they are the preparatory works that ensure that the Wind Park can be constructed.

Internal access and roading

- 2.2 The scope of the access road extends from the Te Mata Quarry across private farmland to Plateau Road and then crosses and re-crosses the alignment of the paper road to the Plateau. This is known as the primary access and is approximately 7 kilometres long and 6m wide and a significant portion of the access track is already formed. The primary access road will on average have 420 vehicle movements per day once constructed.
- 2.3 The secondary access roads to each turbine total approximately eighteen kilometres and are 10 metres wide to accommodate the 400 tonne crane. The roads will be suitable to convey various forms of vehicles ranging from earthwork equipment to 45m long transporters carrying the turbines from Auckland to the site and a 400 tonne crane. The majority of the road will be unsealed except for steep gradients where additional traction for vehicles may be required.

Turbines

- 2.4 Each turbine will be located on a platform of suitable size to provide working space for the crane, materials and deliveries. Platforms will be approximately 50m x 50m

and generally flat. The turbine concrete foundation is expected to be 18 metres square and 2 meters deep.

Scope and quantity of earthworks

- 2.5 The physical works required to achieve the desired outcomes for the project involve a significant amount of earthworks (approximately 350,000m³), pavement construction (approximately 25km) and concrete foundation construction (approximately 18,000m³). The quantum of earthworks varies around the site ranging from removal of topsoil only to significant cuts and fills in challenging locations. The deepest fill will be approximately 10m across an existing gully head and the deepest cut at the summit of the plateau will be approximately 10m deep. The effects of this work can be mitigated through careful programming and construction management.
- 2.6 The existing soils around the wind park site are suitable for road and turbine construction and exhibit good properties for both civil construction but also to support the turbine loads. It is expected that some soils will be unsuitable for road construction, such as small gullies with organic materials and will require improvements. This is normal practice for roading construction.

Earthworks Management

- 2.7 The management of earthworks relating to the roading, platforms and disposal sites will be undertaken in accordance with EW Erosion and Sediment Control Guidelines for Soil Disturbing Activities. In engineering terms the soils are typically clay like and are not highly erodable.
- 2.8 Controls have been detailed for various types of works around the site including gully fills, large cuts, platforms and roading. Systems will be adopted to mitigate the effect of silt and sediment control ranging from earth bunds, to decanting pond structures.
- 2.9 Erosion will be managed by limiting the amount of exposed surfaces to a manageable level, and the use of silt fences, hydroseeding, topsoil and grass and straw mulch.
- 2.10 Site specific details of controls will form part of the environmental management plan.

Construction Programme

- 2.11 The construction programme anticipates construction of the primary access road in the first earthworks season. The following earthworks season will see the secondary access roads constructed. As turbine platform sites become available (in parallel with the construction of secondary access roads), turbine concrete foundations will be constructed. The erection of turbines will follow with view to complete this in the following winter period.

Operation and Maintenance

- 2.12 At the completion of the physical works, the existing secondary access road will be landscaped back to a 3-6m wide road. The existing width will be topsoiled and grassed.
- 2.13 Construction of a maintenance building and carpark will be located near Turbine 14. This building will be provided with suitable services include water and sanitary sewer.
- 2.14 The operation and maintenance of the wind park (post commissioning) will occur on a daily basis. Materials and staff will utilise the primary and secondary access routes.

Concrete Batching Plant

- 2.15 A portable concrete batching plant will be established at the Te Mata Quarry for the duration of the turbine construction. The plant will source aggregate and water from the quarry. Cement will be trucked into the site.
- 2.16 The plant will manufacture up to 20,000 cubic metres of concrete. Deliveries of concrete to the site will be via conventional concrete trucks. The trucks will use the primary and secondary access roads to access the turbine foundations.

Management of Stormwater

- 2.17 The hydrology of the area and associated catchments are well defined. Preliminary assessment of the area indicates a number of culverts will be required where the road alignment passes over water channels. The required pipe diameter ranges from 300mm diameter to 1050mm diameter. Channel with flowing water will require construction of pipes outside of the natural channel alignment. This is so the construction effects can be minimised. The channels will be diverted through the new pipe at the completion of installation. All stormwater runoff from the road will be captured in side swale drains and then directed to a pond or controlled outlet

point. Attenuation devices will also be utilised to control the velocity of stormwater on steep sections of road.

Water Take

- 2.18 An existing consent for water take from the Pakoka River has been granted. The water take is sufficient to supply both the Te Mata Quarry and the wind park project.
- 2.19 An assessment of the wind park requirements has been undertaken to ascertain that the average demand does not exceed 10% of the 5 year low flow in the Pakoka River.
- 2.20 An average of 11 litres per second will be taken from the Pakoka River and stored in a man made lake adjacent to the Quarry.

Environmental Management Plan

- 2.21 The environmental management plan is the key controlling document for construction of the wind park. Amongst other things it will set out the controls required to maintain compliance with the regional and local council requirements.
- 2.22 The EMP will contain the following plans:
 - (a) Construction Management Plan (including detailed design information);
 - (b) Traffic Management Plan;
 - (c) Stormwater, Silt and Sediment Control Plan;
 - (d) Ecological Management Plan;
 - (e) Landscape Management Plan;
 - (f) Operational and Maintenance Management Plan.

Effects Assessment

- 2.23 The effects of the civil engineering works have been discussed in detail in both my evidence and civil engineering report. I conclude that the effects can be avoided, remedied or mitigated.

Consent Conditions

- 2.24 Resource consent conditions and associated controls coupled with detailed design and control systems in the Environmental Management Plan will ensure that the

effects from the works are controlled and are no more than minor. This can also be achieved by managing materials on-site and limiting the downstream effects. An example of this is making use of rock from the site for pavement construction, therefore eliminating the importation of materials from outside source and therefore limiting cartage from some distance. The resource consent conditions are thorough.

3. **INTERNAL ACCESS AND ROADING**

3.1 In this section I will explain the route to site, length and width of roads, the purpose of the road, the types of vehicles required, and the day to day construction traffic.

3.2 The external access to the site will be discussed in evidence present by Mr Apeldoorn. The demarcation point between the external public roading system and internal roading system is the Te Mata Quarry.

Primary Access Road

3.3 The proposal involves construction of a new access road from the Te Mata Quarry onto the Wharauoa Plateau and to the location of the wind turbines. This road is known as the primary access road and will be constructed to a width of 6m. The length of primary access road is approximately 6.8 kilometres. The road will climb approximately 310m from the quarry to the plateau.

3.4 On part of the site, the primary access road will utilise the existing Plateau Rd i.e. the last 1.7 kilometres of the formed unsealed carriageway. This portion of the existing road will be upgraded to provide 6 metres of width and existing pavement strengthened to withstand construction traffic loads. (See **Appendix 1**)

3.5 This portion of Plateau Rd currently provides access to the Jowsey Farm but is also used by the other local farmers adjacent to the road for occasional farm access. Vehicles using the road are generally farm tractors, ATV's and trucks. There is one residence that requires the use of this portion of Plateau Road being Clint Jowsey who manages the Jowsey farming operation (Clint is the son of the owner).

3.6 It is intended to change the status of the road to a construction zone for the duration of the project thereby allowing the contractor to use unlicensed vehicles on the road and provide suitable traffic management systems.

3.7 The primary access road intersects Plateau Rd at angle and will require roading improvements. This will involve local straightening of Plateau Rd so that it will form a 'T' configuration with the primary access road. A giveaway sign, along with other warning signs, will be erected at this point for the duration of the construction so that Plateau Road traffic yields to construction traffic.

- 3.8 The primary access road will be mainly utilised by vehicles accessing the site such as concrete truck deliveries, turbine components, and delivery of other materials such as cables, steel, culverts and the like. The 6 metre width proposed provides sufficient space for two-way traffic based on a typical road registered vehicle, noting however those off-road vehicles will also be used.
- 3.9 The primary access road will be designed with sufficient pavement to accommodate the predicted number of heavy vehicle movements, loads and type of vehicle. The vehicle type ranges from small utilities to large over dimension trucks. The road's vertical and horizontal alignment is primarily determined by the longer over dimension vehicles that will carry the turbine components. Information supplied by the truck operator indicates that the trial truck and trailer requires a minimum horizontal radius of 25m. Vertical gradients also need to be controlled to cater for traction and manoeuvrability.

Secondary Roads

- 3.10 At the termination of the primary access road, a number of secondary roads extend to each turbine cluster. The roads generally follow ridge lines where possible. The secondary access roads are approximately 18 kilometres in length and will be constructed to a width of up to 10m. The additional width of the secondary access road is to provide for movement of the 400 tonne crane required to erect the turbines. These cranes have a track width of up to 8.7m and will manoeuvre under its own power (walk) between turbine platforms. Gradients for the secondary roads need be limited to 14% to accommodate the crane.

Road Pavement

- 3.11 The road pavement will be approximately 300mm thick. Basalt rock can be a difficult aggregate to bind in road construction (as a basecourse), however the Te Mata Quarry also produces a surfacing material known as high fines AP20. This material is used on many local Waikato unsealed roads and assists with binding the basecourse, but also produces a tight surface to stop erosion, rilling and water ingress.
- 3.12 Sections of the road that require steep gradients may require sealing to assist with both erosion protection and traction for heavy vehicles.

Vehicle Movements

- 3.13 The construction of the civil engineering works will involve a large amount of construction equipment and associated work force. I have analysed the number of

vehicle movements required to undertake the proposal by assessing the requirements of each work activity and the likely materials required (post construction of the road i.e. it does not include the movement of earth). A detailed assessment of this can be found in Section 5 of the Civil Engineering Assessment, however I provide a summary of as follows:

Description	Quantity	Movements	
		Total	Average Per Day
Batched Concrete primarily for turbine footings	18,200 cu.m	3025 trucks	40
Reinforcing Steel	1000 tonnes	50 trucks	1
Plant Establishment		80	2
Pavement materials	150,000 cu.m	11,500 trucks	100
Turbines and Supports	84 blades 28 supports	112	2
Staff (labour)	50-100 staff	12000 vehicles	50
Water (dust suppression and water additive)	Varies		*5
Other materials such as cabling, culverts etc	varies		*10
Total			210

- 3.14 The average per day for these items varies significantly depending on work activity and season. I have estimated a typical number of movements based on my experience, but recognise that the numbers could be significantly higher on some days and lower on others. An example is dust suppression where the need for water will be limited by weather conditions.
- 3.15 Based on the above generic table, the access road will typically carry in excess of 210 vehicles per day in each direction (AADT = 420). The actual number of vehicles per day will vary depending on site activities and time of year. For example, when a turbine foundation is ready for pouring, the number of concrete trucks will peak during that day.
- 3.16 The typical construction equipment will consist of large excavators (30 to 50 tonne), large dumpers (50-60 tonne), bulldozers, motorscrapers, rollers, graders, water carts, mobile crusher, loaders, fuel tanker, road trucks, cranes etc.
- 3.17 In summary, the site soils and topography is suitable to construct access roading to the terminals and roading can be constructed to a suitable standard to facilitate construction of the turbines..

4. TURBINE FOUNDATIONS

- 4.1 In this section I will outline the typical form of turbine foundation, size and scale. I will briefly discuss the founding soils.
- 4.2 Mr Mitchell has already outlined the geology of the site in his evidence and the type of founding soils. Mr Mitchell has also confirmed that a seismic event in this location of New Zealand is very low and typically can be expected every 1500-1600 years. The site consists of varying materials near the surface but is generally consistent at depth.
- 4.3 The alluvium ash soils exhibit good properties to found slab foundations. In many cases the turbine concrete foundations will be founded on the underlying rock, providing for a very competent substrate.
- 4.4 The style of turbine foundation will typically consist of an 18 metre square by 2 metre deep concrete foundation. The concrete will be steel reinforced. Alternative foundations can be adopted such as piled foundations, however soil testing to date indicates that the slab foundation will be suitable. Our analysis to date has been based on the Vestas manufacturing design guide information using the extreme load data.
- 4.5 The exact dimensions and depths of the concrete foundation will be confirmed during the design phase of the project.
- 4.6 At each turbine foundation, a platform of approximately 50 metres square will be earthworked, formed and metalled to provide sufficient space for the 400 tonne crane and a lay down area for materials. At the completion of the project the majority of the platform will be topsoiled and grassed.
- 4.7 The method of turbine erection includes the erection of the tower supports (typically steel and in three or four sections). This is then followed by the placing of the nacelle (weighing approximately 80 tonnes) and rotor hub and finally the erection of each of the three turbine blades.
- 4.8 In summary, the soils on the site are suitable to support the concrete foundations and turbines proposed in the application.

5. SCOPE OF EARTHWORKS

- 5.1 In this section I will discuss the nature and scope of the earthworks, and the significance of the Te Mata Quarry and other rock sources.

Materials required and quantity of earthworks

- 5.2 The proposal to construct turbine platforms, roading, laydown areas and a substation platform will involve earthworks totalling 300,000 cubic metres of cut to fill and approximately 30,000 cubic metres of cut to waste. The earthworks volumes are approximate only and this is as a result of the preliminary nature of the ground survey and limited geotechnical testing. Undercutting of unsuitable material will be required where soils have inadequate strengths. This soil will be either disposed of to a disposal site or used as landscaping fill (if suitable). The quantity is unknown at this stage, but my preliminary estimate is approximately 10,000-20,000 cubic metres.
- 5.3 Approximately 70,000 cubic metres of aggregate is required to construct the road pavement, 21,000 cubic metres for the turbine platforms and 18,000 cubic metres for the concrete foundations (109,000 cubic metres total). The Te Mata Quarry will be the primary source of this material and has been consented separately.
- 5.4 Alternate sources of rock have been identified in a number of locations on the site, including a site near the end of the primary access road. The location has been annotated in the civil engineering drawings. During the design stage, exploratory drilling will be undertaken to prove the rock source. Should the source prove useable, the road alignment will be straightened to remove a series of tight radius curves and to enable winning of the rock. Should the source prove to be useful it is expected that 20-30,000 cubic metres of rock may be excavated.
- 5.5 The proposal includes establishment of a portable crusher near the termination of the primary access road to make use of any suitable rock won from earthworks excavations. This will assist in minimising the length of haul from the Te Mata Quarry to the farthest away turbine approximately 14 kilometres from the source. This would mean a reduction in cartage distance resulting in 1500 fewer truck movements along the primary access road or up to 21,000 fewer kilometres of travel.

Nature of Earthworks – Cut/Fill

- 5.6 The most significant fill on the site is the location where the road passes over an existing gully. The old track has very tight curve radius and would prevent the turbine components reaching the plateau. The existing gully is approximately 10m deep and is relatively incised.
- 5.7 The catchment upstream of the gully fill is very small (<3ha), but during rain events forms a constant low flow of stormwater across the existing track. This “clean

water” will be diverted away from the active earthworks and directed to the gully via a flume or similar downstream of the work. A full methodology on the proposed works can be found in the civil engineering assessment and subsequent further information to Environment Waikato.

- 5.8 The most significant cut is near turbine 15 and is approximately 12m deep. This portion of the site is the highest in altitude and avoids a very arduous route along the existing farm track / paper road. The surplus cut material from this area will be disposed in the head of an existing gully/depression near turbine 28.

6. **MANAGEMENT OF EARTHWORKS**

- 6.1 This section will address earthworks/material management and control of silt, sediment and erosion.
- 6.2 The management of earthworks and silt, sediment and erosion control will be a significant driver during the detailed design stage. Sidling fills will be avoided where possible and cuts will be employed in preference. Slope stability will be actively assessed for differing materials with the view to reducing the cut volume where possible. An example of this is through weathered rock, where more vertical slopes can be utilised. Lower factors of safety can be used as this is a private road, however at all times good engineering practice will be applied.
- 6.3 Strict environmental controls relating to silt, sediment and erosion control will be included in the environmental management plan and this will become the site control document. Controls will be based around the EW Erosion and Sediment Control Guidelines for Soil Disturbing Activities.
- 6.4 A variety of measures will be utilised depending on the situation or location. The site varies in topography from the flattish plateau to ridges and valleys with steep slopes. Systems to control silt, sediment and erosion of earthworks have been shown in some detail in the civil engineering assessment.
- 6.5 Particular attention to the controls will be taken where earthworks are adjacent water courses, drains and the existing streams as the potential effects of earthworks are greater. The controls are also essential to ensure the water needed for the project at the downstream location is clean. The water take from the Pakoka River relies on low turbidity results and hence reliance on clean water.
- 6.6 The typical method of road/platform construction will be to install all silt and sediment control measures first. Then the topsoil will be removed and generally placed along side the road alignment in bunds. This will help control stormwater

runoff, but also assists with future road remedial work and landscaping. Some topsoil will be reserved and carted to the Te Mata Quarry or other sites in need of topsoil for rehabilitation works.

- 6.7 Cut to waste material will be minimised where possible. However, a number of waste locations have been identified around the site. These areas are generally depressions in the ground contour, however there are some larger sites nominated. General methodology when using disposal sites will be to establish the environmental controls and then strip topsoil to stockpile. Disposal material will be placed into the depressions and bladed and compacted where possible with a bulldozer. The disposal sites will be re-contoured, topsoiled and grassed when full.
- 6.8 All road cut and fill batters will be re landscaped as the works progress. A number of methods will be used including topsoil and grass, hydroseeding and hay mulching. Where slopes are at risk from erosion, silt fences will be erected along with cut off drains and systems to reduce scour of the soils.
- 6.9 I now refer you to the staging diagrams (attached at **Appendix 1**) to illustrate the measures, staging and controls that will be employed during construction for the construction of a significant gully fill (refer SK44 and 45).
- 6.10 In summary, earthworks resulting from the road and platforms can be managed such that the effects are avoided, mitigated or minimised.

7. **CONSTRUCTION PROGRAMME**

- 7.1 As with any wind farm, the civil works enable the construction of the wind turbines and this means that completion of the earthworks during the initial earthworks season is a significant milestone on the project. The preliminary construction programme envisages earthworks commencing on 1 October, with the view to establishing regional council controls earlier if practical (the earthworks season is 1 October through to 30 April (see condition 8 of Schedule 1 of the proposed EW conditions).
- 7.2 Earthworks will begin, primarily on three fronts. That is the portion of Primary Access road from Te Mata Quarry to Plateau Rd, the Plateau Rd widening and the portion of the Primary Access Road from the end of the formed Plateau Rd. This will enable the crews to concentrate on establishing the earthworks and pavement on the primary access road as far as the Plateau.
- 7.3 The secondary access roads can then be constructed with multiple crews each working on spurs and platforms without constraint from the primary route. We

anticipate that this may need to extend into the second earthworks season, although every effort will be made to establish as much roading as possible in the first year. The order of works will see the primary access route established in 4 months and the secondary access routes in the 4 months following winter.

7.4 Turbine foundations can be constructed in parallel as road works extend from the first turbine closest to the primary access road (Turbine 14) to the turbine furthest away (Turbine 21). This is consistent with a south to north construction approach.

7.5 In summary, I am satisfied that the wind park can be constructed in the predicted time frames that the assessments have been based on.

8. OPERATION AND MAINTENANCE

8.1 In this section of my evidence, I will outline the procedures proposed at the completion of the implementation phase and the long term maintenance

8.2 At the completion of the implementation phase, the existing secondary roads (10 metres in width) will have the aggregate regarded and compacted back to a 3 to 6 metre width. The topsoil previously placed along side the roads will be bladed back over the old road subgrade and regressed.

8.3 Turbine aggregate laydown platform areas will be topsoiled and grassed to allow ongoing farming.

8.4 The long term maintenance of the site that is not returned to farming will remain the responsibility of WEL. The access roads will be used on a regular basis for maintenance and repairs of the turbines and associated infrastructure.

8.5 All maintenance vehicles will use the constructed primary access route to the site. This will not have an effect on Plateau Road except for the last 1.7 kilometres of the unsealed and upgraded section.

8.6 The portion of Plateau Road upgraded and used by the project will be returned to Council in a suitable condition that is fit for purpose and meets Council's code of practice requirements for a rural unsealed road.

8.7 The route to the plateau will be gated such that the public will not be able to drive to the site. The paper road from the end of the formed unsealed road will remain accessible via foot or bike in accordance with Waikato District Council requirements.

- 8.8 A small operations and maintenance building will be located nearby turbine 14. The building will be provided with a sealed parking and set down area approximately 690 m² (15m x 46m) in size. The parking area will be sufficient to provide loading and staff parking (4 parks).
- 8.9 The building will require such facilities as water supply and wastewater system. This will be similar to a rural residential property with water collected from the roof in rain tanks and effluent discharge to a low impact EW approved dripper system.
- 8.10 In summary, the long term maintenance and operation of the wind park can be successfully achieved through the proposed systems outlined above.

9. **CONCRETE BATCHING PLANT**

- 9.1 In this section I will outline the size and location of the batching plant and the management thereof.
- 9.2 The concrete batching plant will be established at the Te Mata Quarry. The plant is a portable system that can be transported to site in one load. The proposed plant can produce approximately 45 cubic metres of concrete per hour. The plant will be supplied with aggregate and water from the quarry. Both the quarry extraction and water take have already been consented.
- 9.3 The batching plant will manufacture about 20,000 cubic metres of concrete over the duration of the project although the majority of the concrete will be used in a four month period. Cement for the plant will be trucked to site requiring a total of 280 truck deliveries. Deliveries of concrete to each platform will be via conventional road registered concrete mixers unless larger units can be sourced. Each turbine foundation pour will require approximately 108 truck loads of concrete.
- 9.4 The plant will be established in a self contained area, i.e. any possible spillages of concrete or cement will be contained within the site via site bunding.
- 9.5 Part of the Te Mata Quarry consent includes provision for a new culvert crossing of the Pakoka River. This will provide better direct access to the concrete batching plant and the primary access road. It also assists in better internal circulation of traffic around the quarry.
- 9.6 In summary, the establishment of a portable batching plant at the aggregate source is a sustainable method to providing concrete for the site. I am satisfied that adequate aggregate and water resource is available on-site to ensure successful outcomes are achieved.

10. **STORMWATER MANAGEMENT**

- 10.1 In this section of my evidence, I will outline the stormwater management required for the site works in relation to catchments and culvert construction.
- 10.2 An assessment of each channel or stream crossing required for roading and earthworks has been undertaken and presented in the civil engineering assessment. The various catchments range in size with the most significant is the Pakoka River catchment. Each culvert has been sized accordingly.
- 10.3 Construction of culverts will be in accordance with the EW Erosion and Sediment Control Guidelines for Soil Disturbing Activities. Culverts will be constructed off line of the drainage path. All made channels will be rock lined and inlets/outlets protected using rock sourced from the site.
- 10.4 Permanent stormwater solutions for the roads and platforms will be developed at the detailed design stage. Normal design practice will be to camber the road to one side so that stormwater can be managed efficiently. In sidling cuts the road will be sloped to the inside of the cut. Stormwater will be piped to outlet points via culvert and flume solutions. Stormwater socks will be utilised in locations where the outlet is down a steep embankment and where the bank is well vegetated.
- 10.5 Permanent ponds and decant systems will be employed as required whilst vegetation and plantings are established.
- 10.6 In summary, I am satisfied that appropriately designed and constructed stormwater solutions can be employed on the site in order to minimise the impact of the existing systems.

11. **WATER TAKE**

- 11.1 In this section of my evidence, I will outline the location and methodology for the proposed water take. This will also cover in broad terms the construction requirements for water.
- 11.2 The water take consent forms part of the Te Mata Quarry consent application and has been granted separately. The consent has an allowance to take sufficient water to supply the needs of the wind park construction. However in order to demonstrate that adequate water take provisions have been made for the wind park project, I will provide a broad outline.
- 11.3 The wind park project requires water for concrete batching, quarry operations, earthworks and pavement control, dust control and cleaning down and the like.

Anticipated use is assessed as 714 cubic metres per day (714,000 litres per days) during the summer and 420 cubic metres per day (420,000 litres per day) during the winter. When comparing this to the low flow water take, the summer requirement is 8.3 litres per second and is less than the Q5 low flow.

- 11.4 The consented water take allows for pumping of water from the Pakoka River at no more than 10% of the 5 year river low flow. A desktop assessment of the low flow has been undertaken which concluded that flows are approximately 110 litres per second. The proposed water take will therefore be 11 litres per second.
- 11.5 The water will be pumped to the existing upper pond adjacent to the quarry. The pond will act as a large storage device to modulate peak site usage. The pond has the ability to store in excess of 40,000 cubic metres (40,000,000 litres). Much of this already exists in the pond as a result of the natural runoff. The pond is man made but has been in existence for some time.
- 11.6 In summary, a suitable water source has been identified and consent obtained to supply the site during construction. In my opinion sufficient water will be available for the construction activities.

12. **ENVIRONMENTAL MANAGEMENT PLAN**

- 12.1 The key control proposed for the project is the Environmental Management Plan (EMP). The EMP will include management plans that address both regional and district matters. The EMP will form one of the most important post consent documents and will bring together all of the environmental effects identified at the consent stage and identify controls to address each one. The consent assessments will identify elements of the design, construction and operation of the wind park that require mitigation but will not have specified them in detail.
- 12.2 This approach allows the details to be determined as the design progresses (for example, as the siting of turbines and access roads are finalised). The EMP also provides certainty to the Council and affected parties about WEL's commitment to a development that minimises adverse effects on the environment. The EMP will be a condition of the resource consent.
- 12.3 The purpose of the EMP is to provide a tool to ensure that the actual environmental effects of a development are consistent with those evaluated in the assessment of environmental effects. In particular, it provides a means of:
- (a) Establishing environmental goals and strategies for the main environmental issues;

- (b) Recording the relevant legal and other obligations, including details of mitigation measures to be implemented;
- (c) Defining best practice management procedures and allocating responsibilities to ensure that the obligations are met and mitigation measures are effectively implemented; and
- (d) Ensuring that the implementation and outcomes are appropriately monitored.

EMP Content

12.4 The EMP will comprise two parts, being Management of Construction Issues and Management of Operational Issues (see condition 3.2 of the proposed WDC conditions).

12.5 Part 1 of the EMP – Management of Construction Issues - will consist of the following:

- (a) Roles and responsibilities of principal people;
- (b) Preconstruction site meetings;
- (c) Earthworks management plan;
- (d) Erosion and Sediment Control Plan;
- (e) Groundwater management plan;
- (f) Construction Noise Management Plan;
- (g) Ecological Management Plan;
- (h) Pakoka River Tributary Management Plan;
- (i) Spill Prevention and Response Plan;
- (j) Traffic Management Plan;
- (k) Other methods of achieving compliance with the conditions during construction.

12.6 Part 2 of the EMP – Management of Operational Issues – will include:

- (a) Roles and responsibilities of principal people;

- (b) Methods of achieving compliance with the conditions during operation.
- 12.7 Respective experts in each field will prepare each plan within the framework of the EMP. The plans will address all relevant environmental requirements for the construction stage of the project. Part 1 of the EMP will comprise both generic procedural components and issue-specific management components. The EMP would typically be prepared as a report with many of the specific environmental issues recorded in site plan format (annotated with relevant standards) to ensure a user-friendly document.
- 12.8 Generic procedural components would comprise the following:
- (a) Project environmental objectives and strategies;
 - (b) Responsible personnel;
 - (c) Environmental training/site induction;
 - (d) Environmental monitoring and auditing requirements; and
 - (e) Reporting procedures.
- 12.9 Specific environmental issues to be addressed in the construction phase would include the following:
- (a) Working hours;
 - (b) Erosion and sediment control, including the management of dust and protection of watercourses;
 - (c) Ecological management;
 - (d) Temporary and permanent Traffic management including site access requirements;
 - (e) Accidental discovery protocol if a suspected archaeological site is located within the project area;
 - (f) Noise management, including noise arising from quarrying, construction of road and turbine foundations and construction traffic;
 - (g) Fuel and other hazardous substance procedures, including emergency response and spill management;
 - (h) Site reinstatement;

- (i) Visual screening and landscape management;
- (j) Waste management; and
- (k) Community liaison, including updates on project progress and issues, and procedures for handling complaints.

12.10 Prior to the commencement of specific elements of the construction works, the relevant contractor would be required to identify environmental requirements relating to their element of the works, and prepare an EMP relevant to those works and consistent with the EMP.

12.11 An Operational EMP would be prepared to address on-going monitoring requirements of the proposed wind park. Aspects of an Operational EMP of direct relevance to civil engineering matters would include information on:

- (a) The details of, and responsibility for, proposed site maintenance and monitoring programs;
- (b) Reporting requirements;
- (c) Approvals and consents issued under the approval process, including resource consent and
- (d) Established operating procedures, including all relevant New Zealand Standards;
- (e) Site reinstatement in the event that the wind park is decommissioned.

12.12 Plans relating particularly to silt, sediment and erosion control will address the following issues:

- (a) Standards used for controls;
- (b) Site plan;
- (c) Detailed written methodology including project description, estimate of sediment loss, principles to minimise sediment discharge, design of erosion and sediment control devices, timetable and nature of site stabilisation;
- (d) Maintenance, monitoring and report procedures;
- (e) Heavy rainfall response and contingency measures;
- (f) Procedures for review and or amendment;

- (g) Identification of site responsibilities and
- (h) Construction time frames.

12.13 In summary, the EMP is a critical document used before, during and after construction of the wind park to control all facets of the project.

13. **SUBMISSIONS**

13.1 In this section of my evidence I will seek to address a number of the issues identified by submitters through the submission process. The issues specifically relate to the civil engineering aspects of the application.

Vibration

13.2 I have investigated the probability of the concerns raised with regard to low frequency vibration effects of turbines onto the ground and the possible effects on the erosion of soils.

13.3 Research (attached at **Appendix 2**) by British Wind Energy Association, Low Frequency Noise and Wind Turbines Technical Annex indicates that earlier turbine models did have issues with regard to low frequency vibration (typically in turbines erected 15-20years ago). Modern technology and advances in the design and construction of turbines have effectively eliminated this issue (refer DEWEK 2004, German Wind Energy Institute, Research Paper, Vibration Analysis of Rotor Blades and Balancing of Rotors on Wind Turbines) (**see Appendix 2**). The turbines are also fitted with vibration sensors that shut down the turbine if vibrations are sensed resulting from mechanical break down or imbalance.

13.4 During the design stage of the turbine foundation, a number of elements will be considered including seismic risk and the isolation of any minor vibration from the ground. I have sought expert advice from Mr Pang Chong Heng and concur that due to the significant mass of concrete supporting the turbine, the advanced design of the turbine itself and the need to design the support for seismic events, the transmission of vibration energy to the substrate will be eliminated.

Earthworks – Silt and Sediment Control

13.5 Submitters have expressed concern over the quantum of earthworks required on the site and the effects that silt, sediment and erosion may have on the receiving environment. In my evidence I have outlined various proven methodologies that will be utilised around the site. I have limited my evidence to describing these in general, however my Civil Engineering assessment has outlined proposed staging

and works that will be adopted to construction the works. Further the Environmental Management Plan will, at the design stage address each area and situation in further detail to the satisfaction of Environment Waikato. Actual works on the site will be monitored by the contractor, engineer and regional council to ensure compliance.

Diversion of unnamed tributary

- 13.6 Submitters have expressed concern about the diversion of the unnamed tributary. In engineering terms, the upstream catchment is very small (<3.5ha) and the diversion is a straight forward procedure. Detailed information provided to Environment Waikato indicates the way in which this process will be undertaken to Councils satisfaction, all in accordance with Erosion and Sediment Control Guidelines for Soil Disturbing Activities. I have outlined in my evidence the staging events, methodologies, and mitigation activities anticipated to manage the earthworks to Environment Waikato's' satisfaction.

14. ASSESSMENT OF EFFECTS

- 14.1 In the following section I have tabulated a summary of effects that I have identified. I outline the effect and the response required to avoid, remedy or mitigate the effect. I then summarise the outcome of the response and conclude with an assessment of the potential residual effect.

	ISSUE	RESPONSE	OUTCOME	POTENTIAL RESIDUAL EFFECT
	Earthworks			
1.	Silt and Sediment Controls – may result in adverse effects on downstream waterways	Controls designed in accordance with EW Silt, Sediment and Erosion Control Guidelines. Control design and plans submitted as part of the Environment Management Plan.	Silt and Sediment controlled in accordance with EW guidelines. Minimal effects on downstream water channels. Effects mitigated.	No more than minor
2.	Erosion - open excavations exposed to rainfall and erosion	Controls designed to minimise exposed soils at any one time. Construction systems reactive to rainfall. Soils are generally plastic and not so susceptible to erosion. All bare surfaces to be made good during construction with hydroseed, straw grassing or similar	Erosion controlled in accordance with EW guidelines. Effects mitigated.	No more than minor
3.	Stability - earthworks may cause a failure of insitu soils as a result of cut or fill slopes	The detailed investigations and design by a qualified geotechnical engineer will ensure that required stability and controls are in place.	Slopes are constructed to a stable angle. Effects avoided.	No more than minor
4.	Disposal Sites - long term stability of the larger disposal areas.	The detailed investigations and design by a qualified geotechnical engineer will ensure that required stability and controls are in place.	Disposal sites are suitably buttressed and drained. Effects avoided.	No more than minor

	ISSUE	RESPONSE	OUTCOME	POTENTIAL RESIDUAL EFFECT
	Roading			
5.	Pavement material - unsealed road exposed to vehicle loads and stormwater	Material design and specification shall make allowance for the properties of basalt basecourse. Use of WDC plastic running course will mitigate problems and contractor methodology.	Pavement materials resistant to pavement loads and stormwater. Effects remedied.	No more than minor
6.	Upgrade of Plateau Road - affects Public users	The last 1.5km of Plateau Road is generally used by one farmer (Jowsey). However Mr Jowsey is involved with supply of aggregates to the wind park and I believe that he understands the implications.	Effects will be remedied after the upgrade of Plateau Road.	No more than minor.
7.	Steep sections of unsealed internal access roads - traction for vehicles and control of stormwater.	Gradients between 10-17% are suitable so long as they are sealed. Cross fall on steep sections of roads will be increased to 6% to minimise stormwater running longitudinally down the road. Side channels will be protected with rock.	A steep section of Secondary Access Road will be sealed. Effects avoided.	None

	ISSUE	RESPONSE	OUTCOME	POTENTIAL RESIDUAL EFFECT
	Stormwater			
8.	Access roading will pass over a number of natural waterways.	Culverts will be constructed to cope with a 5 year return period and overtopping for a larger rain event. Most of the culverts required are permitted activities under the regional rules. Larger culverts will be subject to an EW storm water consent. A detailed stormwater management plan has been submitted to Council for approval.	EW Consent controls along with careful site management and detailed design will ensure the effects are minimised. Seven key locations have been identified. Effects mitigated.	No more than minor.
	Water take			
9.	Water take from the plateau area may be required additional to that consented for the Quarry.	A further separate EW water take consent may be sought for this following analysis of the possible requirements (i.e. insitu soil water content testing). Q5 low flow calculations will be undertaken to ensure the effects are minimised. The fall back option is to obtain all the of water from the quarry (provided for in the Te Mata Quarry Consent)	EW Consent controls on water take from the plateau water channels. Effects mitigated.	No more than minor.

	ISSUE	RESPONSE	OUTCOME	POTENTIAL RESIDUAL EFFECT
	Concrete Batching Plant			
10.	Makes best use of local aggregate and is located at Te Mata Quarry.	The establishment of a portable concrete batching plant at Te Mata Quarry makes best use of high quality aggregate and minimises the distance to transport the product.	Minimal wear on local roads associated with concrete cartage. Uses local aggregate producing sustainable solution. Effects mitigated.	No more than minor.
	Portable Crushing Plant			
11.	Makes use of on-site rock excavated resulting from the access road construction.	The establishment of a portable crushing plant on the Plateau makes best use of the available on-site rock and therefore limits the cartage from Te Mata Quarry.	Minimises cartage / haul distance and makes best use of the in-situ materials as high quality pavement products. Uses local rock producing sustainable solution. Effects mitigated.	No more than minor.
	Te Mata Quarry			
12.	Makes use of plant and materials adjacent to the site.	The supply of aggregate to the site will primarily be sourced from the Quarry. (consented separately)	Minimal wear on local roads associated with aggregate cartage. Uses local aggregate producing sustainable solution. Effects mitigated.	No more than minor. No net cost to local authority for wear and maintenance public roads as a result of limitations local supply to outside markets.

	ISSUE	RESPONSE	OUTCOME	POTENTIAL RESIDUAL EFFECT
	Wind Turbines			
13.	Long term accessibility and maintenance of equipment	The existing access roads will remain for future site access. The roads will also assist the farmer with management of their farms by providing improved accessibility.	Long term serviceability of the turbines is maintained via essentially private roads.	No more than minor.

15. **PROPOSED CONDITIONS**

15.1 I have considered the conditions recommended by Council's consultant and others are set out in the Council reporting Planner's report. I support the comments made by Mr Mitchell relating to the timing aspects of the various plans required and Mr Burchett's evidence in relation to the application of the conditions.

15.2 My review of the conditions relating to earthworks produced by Environment Waikato is consistent with my expectations and covers:

- (a) Earthworks management and design;
- (b) Silt, sediment and erosion control;
- (c) Earthworks remediation.

15.3 This is consistent with EW's jurisdiction. The conditions proposed by EW are proven, robust and best practice.

15.4 Some earthworks matters are within the jurisdiction of the WDC and WEL wishes to offer a level of comfort to WDC through the conditions, particularly in relation to Building Act matters, earthworks management and design controls.

15.5 However, I have some concerns in relation to the WDC earthworks conditions. In particular, some of those conditions appear to replicate a number of the conditions proposed by EW. I am concerned about the duplication because it may result in confusion, could give rise to processing risk and, in some cases, creates contradictory requirements between the two authorities. It may also lead to on-site management problems in terms of which authority controls different aspects of the works.

15.6 Examples of these issues in relation to jurisdiction and duplication are:

- (a) WDC condition 4.2(d) – Dust Control.

Dust control is a regional issue and under the control of EW. EW have covered this aspect under condition 30 of Schedule 1 of the proposed conditions, but the WDC conditions also address dust control.

- (b) WDC condition 4.1(c) – Stability analysis of slopes.

This is covered more or less by Condition 10 of Schedule 1 of EW's conditions. This condition not only duplicates the EW condition, but reflects a different philosophy to the EW condition. The EW condition simply

requires a geotechnical engineer to assess stability of earthworks and associated drainage operations, whereas the WDC condition requires an earthworks design for review and approval.

(c) WDC condition 4.2(a) – Erosion and Sediment Control

EW conditions 11 – 25 specifically deal with erosion and sediment control. Both the WDC and EW conditions require formal approval from each authority. This could lead to confusion on site as to the appropriate controls.

15.7 In my view, the conditions could be modified in a manner that removes duplication and provides clarity for WEL as to jurisdiction.

16. **CONCLUSION**

16.1 In summary, I am satisfied that the proposal can go ahead and that the effects can be appropriately avoided, remedied or mitigated.

Tony Keyte
November 2007

Appendix 1

Drawings

Appendix 2

Research documents