**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 Wharauroa Plateau near Te Uku

# FURTHER STATEMENT OF EVIDENCE OF BLAIR CHRISTOPHER WALTER

## 1. INTRODUCTION

### Qualifications and experience

1.1 My name is Blair Christopher Walter. My qualifications and experience, involvement in the Te Uku project and commitment to comply with the Expert Witness Code of Conduct are set out in my evidence presented in November 2007. I will not repeat them here.

### Purpose and scope of evidence

1.2 I have previously presented evidence on the wind industry in general and the requirements for a viable wind energy development, considering the merits of the Te Uku site in that context.

1.3 The Committee has requested further information in respect of the wind resource on Wharauroa Plateau. The purpose of this evidence is to further comment on the wind resource of the Te Uku site and, in particular, to respond to submissions in relation to that wind resource presented by Mr Cox.

1.4 Against that background my evidence will address the following:

(a) Relevant due diligence undertaken by Connell Wagner in relation to the Te Uku wind resource (section 3);

(b) An Electricity Commission study on New Zealand's wind resource being undertaken by Connell Wagner (section 4); and

(c) Mr Cox's submission relating to the Te Uku wind resource and other matters (section 5),

1.5 I will also summarise the preliminary findings of a study Connell Wagner is undertaking for the Electricity Commission on quantifying New Zealand's wind energy development potential by region to assist grid investment planning.

1.6 A summary of this further evidence is contained in Section 2.

## 2. SUMMARY OF MY EVIDENCE

2.1 In this section of my evidence, I will briefly summarise the content of my complete evidence.

### Te Uku wind resource assessment

2.2 Connell Wagner's technical due diligence of the Te Uku project verified that the wind monitoring equipment and configuration used were consistent with good industry practice as confirmed in Mr Kerley's evidence. The mast positions selected for wind monitoring and modelling across the site are sensible and provide a good picture of the spatial variation of the wind resource over the site.

2.3 WEL Networks has adopted a rigorous approach to calculating the wind resource of the site by using independent parties to undertake wind analysis. Our technical evaluation of the project found no significant issues with the analysis undertaken and we found Hydro Tasmania Consulting's work to be thorough and to a high standard.

2.4 WEL Networks is taking appropriate steps in investigating and evaluating the most suitable class of turbine for each location and will finalise this decision when the final wind resource assessment for the site is available.

### Electricity Commission Study

2.5 Preliminary results of a Connell Wagner study into the economic wind resource in New Zealand give a very clear signal that the bulk of useable wind resource of the North Island exists in the lower North Island, with the Waikato Region having fairly limited wind development potential compared to the rest of the country. As the best site in the Waikato area, the Te Uku project is therefore an important part of the

Waikato region's contribution to meeting New Zealand's renewable energy targets with a geographically diversified generation base.

**Submission by Sean Cox**

2.6 My understanding from Mr Cox's submission is that he has assessed the wind speed of the Te Uku site by somehow measuring the time that a characteristic gust cell would take to pass the site. In my four years of working in the international wind industry, I have never heard of this technique for measuring wind speed and it is hard for me to imagine that it can provide an accurate assessment of wind resource or compare to continuous readings taken from the site.

2.7 Mr Cox refers to NIWA's data as showing that there is nowhere on the North Island or South Island of New Zealand that have a 9 m/s average wind. I have **attached as Appendix C** to my evidence a letter from Dr Steve Reid of NIWA which confirms that wind speeds of 8 to 9 m/s at the Te Uku site are consistent with NIWA's expectations given the location and exposure of the site and the wind climate of the area.

2.8 In his submission, Mr Cox questions the ability of New Zealand's electricity system to handle significant wind generation, referring to it as "erratic power". I addressed this point in my initial evidence, pointing out that wind energy is variable in the short-term but predictable on longer time frames. Short-term variability in wind energy can be managed with accurate forecasting and a number of initiatives are underway to provide these forecasting services.

2.9 Mr Cox's submission speculates on possible weather effects, caused by "local low pressure zones" in the turbulent wake of each turbine possibly causing condensation, with a particular concern about rainfall in summer easterlies on the Aotea Harbour. Given the lack of evidence of local weather effects caused by wind farms constructed around the world to date and the opinions of leading local meteorologists on the likely effects, I suggest that this is not a material concern for the Te Uku project.

## 3. TE UKU WIND RESOURCE ASSESSMENT

3.1 In this section of my evidence, I will summarise the due diligence analysis completed by Connell Wagner in order to verify the accuracy of the wind resource assessment for the project.

**Connell Wagner due diligence**

3.2 Connell Wagner undertook a technical evaluation of the Te Uku project in the early part of 2007. This evaluation addressed three key technical areas critical to a viable project, namely wind resource assessment, constructability and power offtake. Our review of the wind resource assessment covered the following topics:

a) Information reviewed;

b) Site description;

c) Wind data;

d) Wind resource assessment;

e) Turbine selection;

f) Layout;

g) Energy yield;

h) Losses;

i) Uncertainty;

j) Discussion; and

k) Conclusion.

3.3 The purpose of our technical evaluation was to confirm that the wind resource assessment being undertaken by WEL Networks, using various consultants and turbine suppliers, was of a high standard and consistent with industry best practice.

3.4 Our technical evaluation was based on our own observations from a site visit, review of the raw wind data recorded by the monitoring masts and collated by HTC/PB Power, and review of various documents provided which are commercially sensitive to WEL, including:

a) Wind Monitoring Equipment Installation Report (PB Power);

b) Wind data verification reports April 05 - Jan 07 (PB Power);

c) Long-term resource assessment Wharauroa Plateau (PB Power, May 2006);

d) Various wind resource and energy reports prepared by Hydro Tasmania Consulting between October 2005 and March 2007 (five separate reports); and

e) Production Estimate Report (Suzlon Energy, January 2007).

3.5 The following sections of my evidence address the key aspects of the wind resource assessment process.

**Wind monitoring**

3.6 Our review of the wind monitoring undertaken at the site verified that the monitoring equipment and configuration used were consistent with good industry practice as confirmed in Mr Kerley's evidence.

3.7 At the time of our evaluation (April 2007), only a few months of data were available from the 80 m mast, and the 50m mast was still to be relocated to the north end of the site. When additional data from the 80 m mast is combined with data collected from the 50 m mast in its new location at the north end of the site, this will provide an even more robust assessment of the wind resource of the site. The mast positions selected for wind monitoring and modelling across the site are sensible and provide a good picture of the spatial variation of the wind resource over the site.

3.8 A number of minor equipment issues have affected data collection at the site. However, the technical issues experienced are commonplace and the overall data recovery rate is high by reference to industry standards.

3.9 Appropriate redundancy is incorporated in the mast design through using two anemometers at the top level of each mast and using two wind vanes on each mast to ensure high data recovery rates.

**Wind resource assessment and energy yield prediction**

3.10 WEL Networks has adopted a rigorous approach to calculating the wind resource of the site by using independent parties to undertake wind analysis. PB Power has collected and quality checked the raw wind data, and generated its own estimate of long-term wind speed, using long-term reference sites for correlation. Hydro Tasmania Consulting has independently analysed the wind data and generated its own predictions of long-term wind speed and energy yield for the site, again using long-term reference sites (both physical and modelled) for correlation. Connell Wagner's due diligence of the project confirmed that the data collection and analysis methodologies adopted by both PB Power and Hydro Tasmania Consulting were reasonable. Suzlon Energy, a turbine supplier, has provided its own

assessment of the site which offers further confirmation of the wind resource, although the assessment undertaken by Suzlon Energy was fairly basic.

3.11 Our technical evaluation of the project found no significant issues with the analysis undertaken. We found Hydro Tasmania Consulting's work to be thorough and to a high standard. We have reached similar conclusions regarding Hydro Tasmania Consulting's work on other wind projects that we have reviewed.

3.12 For Te Uku, Hydro Tasmania Consutling's assessment of wind resource and energy yield has not changed materially in the three revisions completed to date (October 2005, July 2006 and March 2007). However, we would expect some minor adjustment of energy estimates as future revisions are completed. The fact that the later predictions, which are based on the longest record of wind data, agree with the earlier preliminary predictions confirms that the analysis methodology is sound.

**Turbine selection**

3.13 The final turbine model for a wind project is usually selected just prior to awarding contracts for the project, when the wind resource assessment has been finalised and the project economics confirmed. Key considerations for turbine selection are classification, suitability for the site, expected performance, manufacturing quality, price and commercial conditions such as guarantees and warranties.

3.14 As discussed in Dr Kerley's evidence, wind turbine models are designed for different classes of wind speed, relating to wind speed, turbulence intensity and gust parameters which define the loading on the turbine components. Considering only mean wind speed, Class I turbines are designed for mean wind speed of 10 m/s and Class II turbine are designed for mean wind speed of 8.5 m/s.

3.15 Wind resource monitoring completed to date at Te Uku suggests a mixture of both Class I and Class II locations within the proposed wind farm layout. WEL Networks is taking appropriate steps in investigating and evaluating the most suitable class of turbine for each location and will finalise this decision when the final wind resource assessment for the site is available.

3.16 The main differences between Class I and Class II turbines are the ratio of rotor to generator size, and the strength of components, with Class I components designed to withstand a more aggressive wind environment. Different classes of turbine sometimes have no visible differences. For example, the Vestas V90 turbine with 90 m rotor diameter is available as a Class I machine with rated output of 3 MW, as a Class II machine with rated output of 2 MW, and as a Class III machine with rated

output of 1.8 MW. Other manufacturers have opted to change the rotor size for different wind classes, for example Repower offers the MM82 and MM92 turbines, both with rated output of 2 MW but with rotor diameters of 82 m and 92 m for Class I and Class II respectively.

## 4. ELECTRICITY COMMISSION STUDY

4.1 In this section of my evidence, I will summarise the preliminary findings of a study being undertaken by Connell Wagner to quantify New Zealand's wind energy development potential. This study was commissioned by the Electricity Commission as part of its *Transmission to Enable Renewables* program. The purpose of the work is to signal to Transpower where new wind development is likely to occur to assist Transpower with its grid investment planning. Regions were derived from a study of constraints on the Transpower network.

4.2 Our draft report is available on the Electricity Commission's website and a copy is **attached in Appendix A**. The study is relevant in considering the potential for wind energy development in the Waikato Region compared to other regions.

4.3 Connell Wagner used advanced mesoscale meteorological modelling techniques through our collaboration with the University of Canterbury's Centre for Atmospheric Research to assess New Zealand's wind resource, mapping wind speeds over the entire country at a model resolution of 3 km. These wind maps provide a very good picture of the variation of wind speed over major terrain features and we have used the wind maps to generate zones of attractive wind speed, for example above 8 m/s in the preliminary results for the North Island.

4.4 These wind zones have then been laid over terrain maps and filtered using advanced GIS tools to calculate theoretically useable land area for wind development, with a conversion to potential installed capacity using a standard installation density. Exclusions applied in the GIS analysis include terrain slope, the sheltering effect of ridgelines, National Parks, waterways and urban areas, and buildings. Finally, a land use factor was applied to represent the willingness of land owners to make their land available for wind development and to consider competing land use such as existing forestry.

4.5 Results were validated against existing wind developments in the Manawatu area and shown to be reasonable. However, further refinement will occur following the receipt of public submissions on the preliminary report.

4.6 The preliminary report gives a very clear signal that the bulk of useable wind resource of the North Island exists in the lower North Island, with approximately

60% of calculated useable land area in the Manawatu and Wellington regions. If Hawkes Bay and Taupo-Wanganui areas are included, this figures increases to approximately 87%.

4.7 The Waikato area was calculated to represent only 3.7% of the land area currently economic for wind development. Of the total potential capacity in the North Island of 6,400 MW calculated by this study, Waikato's share is equivalent to 237 MW.

4.8 While the installed capacity figures may change slightly with further refinement of the results, a strong message remains- that Waikato has fairly limited wind development potential compared to the rest of the country. As the best site in the Waikato area, the Te Uku project is therefore an important part of the Waikato region's contribution to meeting New Zealand's renewable energy targets with a geographically diversified generation base.

## 5. SUBMISSION BY SEAN COX

5.1 In this section of my evidence I will address certain aspects of Mr Cox's submission relating to the wind resource of the site, integration of wind power into New Zealand's electricity network, and the possibility of effects on local weather.

### Wind resource

5.2 Mr Kerley's evidence has provided a detailed consideration of Mr Cox's submission relating to the wind resource of the site, and in particular the methodology used by Mr Cox to assess the wind resource. My understanding from Mr Cox's submission is that he has assessed the wind speed of the site by somehow measuring the time that a characteristic gust cell would take to pass the site. In my four years of working in the international wind industry, I have never heard of this technique for measuring wind speed and it is hard for me to imagine that it can provide an accurate assessment of wind resource or compare to continuous readings taken from the site, at an elevation commensurate with the height of turbines. I have heard of limited use of smoke trails on wind sites, but this is to visually assess the behaviour of turbulence characteristics and is not used for wind speed measurement.

5.3 Mr Cox refers to NIWA's data as showing that there is nowhere on the North Island or South Island of New Zealand that have a 9 m/s average wind. I assume that Mr Cox is referring to the map of wind speeds produced by NIWA and published on the NIWA website, which I have **attached as Appendix B** to my evidence.

5.4 This wind map is based on observed wind speeds from weather monitoring stations that NIWA operates in various locations around the country. Most of these monitoring stations are in low-lying areas to provide information for weather forecasting and other climatic research, with few measurements on elevated ridgelines that are of interest for wind energy development.

5.5 In addition, the wind represents wind speeds at approximately 10 m above ground level, whereas we are interested in wind speeds at heights of around 80 m above ground level. Wind increases significantly with height above ground level as discussed in the evidence of Mr Wright.

5.6 Finally, the model used by NIWA to produce the wind map does not calculate topographical effects such as speed-up over elevated ridgelines. These three factors mean that the NIWA wind map is not a reliable basis for assessment of wind speeds at the Te Uku site.

5.7 To confirm this, I approached Dr Steve Reid of NIWA, who has been involved in wind research and modelling for NIWA. I have **attached as Appendix C** to my evidence a letter from Dr Reid which confirms that wind speeds of 8 to 9 m/s at the Te Uku site are consistent with NIWA's expectations given the location and exposure of the site and the wind climate of the area.

5.8 Mr Cox's reliance on the NIWA wind map to question the measured wind resource of the Te Uku site and his own wind assessment methodology suggests to me that Mr Cox has a flawed understanding of New Zealand's wind climate. Similarly, the economic analysis of the project that Mr Cox presents in his evidence is completely invalid as the key input to this, namely the wind speed, is simply wrong. It is of concern that Mr Cox, as a proclaimed wind expert, presents such a detailed analysis based on unreliable inputs.

**Wind integration**

5.9 In his submission, Mr Cox questions the ability of New Zealand's electricity system to handle significant wind generation, referring to it as "erratic power". I addressed this point in my initial evidence, pointing out that wind energy is variable in the short-term but predictable on longer time frames, with annual variation typically less than half of the annual variation of hydro generation.

5.10 A key finding of the Electricity Commission's Wind Generation Investigation Project (WGIP), which is assessing the impact of various scenarios of wind penetration, was that short-term wind forecasting is critical in enabling high penetration of wind generation, with the most significant impact on system operations being in the pre-

dispatch process. From the Electricity Commission's June 2007 report *Effect of large scale wind generation on the operation of the New Zealand Power System and Electricity Market*, Section 1.3, page 6:

> *"The effect of wind generation forecast errors on the pre-dispatch processes is to reduce the accuracy of the pre-dispatch schedules and make managing power system security more difficult. Inaccuracy in pre-dispatch schedules will also complicate generators' decision making, particularly regarding when to commit slow starting thermal plant. Security issues (e.g. a shortfall of offered generation to meet forecast demand) may not be identified until it is too late for generators to offer more generation."*

5.11 Short-term variability in wind energy can be managed with accurate forecasting and a number of initiatives are underway to provide these forecasting services. The Metservice currently provides wind forecasts to Meridian Energy and TrustPower for their respective wind farms in the Manawatu area. The Foundation for Research, Science and Technology is running a 2007-08 investment round, which includes funding for development of improved wind forecasting as a priority activity. Connell Wagner is developing a wind forecasting capability using our mesoscale modelling skills. Internationally, there are a number of organisations that can provide reliable wind forecasting services.

5.12 Mr Cox's statement in the summary of his submission that operating the Te Uku wind turbines "will cause disruption to electricity supplies and deliver relatively small amounts of power" is simply not true and not supported by any meaningful evidence.

**Local weather effects**

5.13 Mr Cox's submission speculates on possible weather effects, caused by "local low pressure zones" in the turbulent wake of each turbine possibly causing condensation, with a particular concern about rainfall in summer easterlies on the Aotea Harbour.

5.14 In my own experience in the wind sector, I have never come across any evidence or complaints about wind farms affecting local weather. I have made enquiries around the wind industry in New Zealand with no reported experience of local weather effects.

5.15 A literature search revealed a small number of research papers on theoretical effects from very large scale wind farms through modelling exercises but the

findings of this research were not conclusive and further research was recommended.

5.16 Connell Wagner's wind team includes two full-time meteorologists who are based at the Centre for Atmospheric Research at the University of Canterbury and mentored by Professor Andrew Sturman and Dr Peyman Zawar-Reza, two leading figures in meteorological research. This team provides mesoscale meteorological modelling for the purposes of wind resource assessment for wind farm development and has established expertise in the processes of the atmospheric boundary layer. It is the opinion of these experienced meteorologists that while there will be some localised effect on turbulence and airflow downstream of each turbine, the wind farm is unlikely to have any significant effect on what people generally consider to be weather ie cloud, rain and snow etc. The processes that cause rainfall such as heating of land and regional wind flows are on a much larger scale, both in the vertical and horizontal directions, and not significantly influenced by turbulent effects.

5.17 Dr Steve Reid of NIWA also shares the opinion that wind turbines will not have noticeable effects on local weather. He uses the example of a jet aircraft wing sometimes creating condensation in the above-wing area in highly humid, low-pressure conditions. However, the pressure drop over a wind turbine blade is much less than over a jet aircraft wing and in Dr Reid's opinion condensation is very unlikely to occur.

5.18 Given the lack of evidence of local weather effects caused by wind farms constructed around the world to date and the opinions of leading local meteorologists on the likely effects, I suggest that this is not a material concern for the Te Uku project.

**Blair Walter**
**January 2008**

## Appendix A

## Connell Wagner- Draft Economic Wind Resource Study

## Appendix B

## NIWA Wind Speed Map

## Appendix C

## Dr Steve Reid, NIWA letter