

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of a Board of Inquiry appointed under s146 of the Resource Management Act 1991 to consider an application by Mighty River Power Limited for resource consents to construct, operate, and maintain a wind farm at Turitea

STATEMENT OF EVIDENCE OF JASON ROBERT HILLS

1. INTRODUCTION	3
QUALIFICATIONS AND EXPERIENCE	3
PURPOSE AND SCOPE OF EVIDENCE	4
SUMMARY OF EVIDENCE	5
2. MY ROLE IN THE PROJECT	5
3. PROJECT CONTEXT AND METHODOLOGY	6
4. POTENTIAL EFFECTS OF WIND FARMS ON RADIO SERVICES.....	7
5. POTENTIAL RADIO INTERFERENCE EFFECTS FROM THE TURITEA WIND FARM	9
ANALOGUE TELEVISION	9
DIGITAL TERRESTRIAL TELEVISION.....	10
FIXED RADIO LINKING	11
AERONAUTICAL RADAR SERVICES.....	12
OTHER WIDE AREA COVERAGE SERVICES.....	12
6. MITIGATION STRATEGIES	15
7. RESPONSE TO SUBMITTERS	15
8. CONCLUSION	17

1. INTRODUCTION

Qualifications and experience

- 1.1 My name is Jason Robert Hills. I am a Senior Engineering Consultant with Kordia ® Ltd (“Kordia”), working in the radio frequency (“RF”) coverage planning area.
- 1.2 I hold a Bachelors degree with honours majoring in Information Engineering from Massey University which I obtained in 1999.
- 1.3 I have worked in the radio communications industry for nine years, five of these with BBC Research & Development in the United Kingdom and the remainder with Kordia and its predecessor, BCL. During this time I have worked in the RF coverage planning area. Projects of relevance to wind farm developments that I have worked on include:
- Field surveys to measure the high frequency (“HF”) emissions from wind turbines in order to assess the turbines’ effect on the existing environmental RF “noise”;
 - Various RF compatibility studies to assess the potential impact of a wind farm development on existing RF services;
 - Television and radio interference analysis, which required various field survey investigations;
 - A number of research projects studying the aspects of indoor and outdoor television and radio reception. Effects such as ‘ghosting’ caused by large structures (including wind turbines) were also investigated in these studies, along with the effect of impulsive interference on analogue and digital television reception;
 - Designing and implementing a software program to model the reception and interference margins for rebroadcast off-air television links for a 1,150 station analogue and digital television network; and
 - Investigation and specification of new television transmission sites in New Zealand, Australia and the United Kingdom to fill ‘gaps’ in coverage.
- 1.4 I have read and agree to comply with the ‘Code of Conduct for Expert Witnesses’ in the Environment Court Practice Note 2006. Except where I state that I am relying upon the

specified evidence of another person, my evidence in this statement is within my area of expertise. I have endeavoured to be accurate and to cover all relevant matters relating to the topic on which I am giving evidence. I am not aware of any matters which might adversely affect my conclusions which I have not included. The assumptions on which my evidence is based are not, in my view, unlikely or unreasonable assumptions and, therefore, my evidence complies with Section 5.3 of the Environment Court's Code of Conduct for Expert Witnesses.

Purpose and scope of evidence

- 1.5 The purpose of my evidence is to outline the assessment I have undertaken on the potential for interference effects to various radio communications facilities resulting from the proposed Turitea Wind Farm, and how such effects may be appropriately avoided, remedied or mitigated (as necessary).
- 1.6 My evidence will accordingly cover the following matters:
 - (a) My role in the project;
 - (b) Project context and methodology;
 - (c) Potential effects of wind farms on radio services;
 - (d) Analysis of potential radio interference effects from the Turitea Wind Farm on:
 - (i) broadcast television (analogue and digital);
 - (ii) fixed radio links;
 - (iii) aeronautical RADAR; and
 - (iv) other wide area coverage services;
 - (e) Mitigation strategies;
 - (f) Response to submitters; and
 - (g) Conclusions.
- 1.7 A summary of my key points is set out in the following section of my evidence.
- 1.8 This evidence is given in support of Mighty River Power's resource consent applications to construct, operate and maintain the proposed Turitea Wind Farm.

Summary of evidence

- 1.9 I consider that the potential effects on radio communication services from the proposed Turitea Wind Farm will be minor, and for the most part are so low or are unlikely to be detectable as to not require any specific mitigation or other action.
- 1.10 The most significant potential effects on radio based services that may arise from the proposed Turitea Wind Farm are to analogue terrestrial television services. However, any effects are likely to involve only a very small number of dwellings.
- 1.11 In addition, there are relatively straightforward remedies to mitigate typical effects. For example, in the event that ghosting occurs when the wind farm is built (despite the receiving antennas being correctly installed and well maintained), this can easily be mitigated by installing a free-to-air signal (such as Freeview), or providing viewers with a digital satellite receiver.
- 1.12 Any RADAR systems with a line-of-sight view of a wind farm will almost certainly be affected by wind turbines. As discussed in the evidence of Mr Henry, Airways New Zealand (“Airways”) has confirmed to Mighty River Power that the closest RADAR (the “Ballance RADAR”) will not be affected by the project as the turbines fall largely below the RADAR’s “line of sight”. The potential effects of the RADAR were also assessed by the Civil Aviation Authority (“CAA”) as part of Mighty River Power’s “Hazards in Navigable Airspace Determination” application (made in accordance with Part 77 of the Civil Aviation Rules). No aeronautical or RADAR issues were identified during the processing of the CAA determination and the determination was issued to Mighty River Power in November 2008.

2. MY ROLE IN THE PROJECT

- 2.1 I have been involved in the proposed Turitea Wind Farm project since the 9th of April 2008 when Kordia was initially engaged to provide an RF Compatibility report for the Assessment of Environmental Effects (“AEE”). I have been primarily responsible for undertaking this assessment, and preparing the report ‘Turitea Wind Farm – Compatibility with Radio Services’, which outlines the results of this work and was included as Appendix H of the AEE submitted in support of Mighty River Power’s consent applications.

2.2 I note that since preparing that report, the project has been modified through the deletion of nine of the originally proposed turbine zones (being zones 0049, 0050, 0051, 0053, 0079, 0080, 0081, 0093, and 0126). This evidence is therefore based on and reflects that modified proposal.

3. **PROJECT CONTEXT AND METHODOLOGY**

3.1 A detailed description of the project and its respective components has been provided by other witnesses. However, I confirm that the following specifications as to the maximum envelope for the proposed wind farm have been used for the purposes of my evidence:

- (a) up to 122 wind turbines;
- (b) turbine capacity of up to 3 MW;
- (c) up to 80 m hub height;
- (d) maximum blade length of 45 m;
- (e) three blades per turbine; and
- (f) total height of up to 125 m (tower and blade).

3.2 In terms of methodology, my assessment involved:

- (a) Reviewing the current research and case study literature on effects to radio communications from wind farms, and providing summary explanations as to the various mechanisms by which such effects can occur;
- (b) Searching all radio services licensed to operate in the general vicinity of the proposed wind farm;
- (c) Assessing and evaluating the risk that the Turitea Wind Farm will interfere with the range of relevant radio services; and
- (d) Considering possible mitigation measures as necessary.

3.3 Each of these matters is addressed in more detail in the following sections of my evidence.

4. **POTENTIAL EFFECTS OF WIND FARMS ON RADIO SERVICES**

4.1 There are several potential mechanisms by which a wind turbine or wind farm (or other structure) could affect a radio service. These occur when the machines or structures in question:

- (a) Generate and radiate radio frequency energy that causes interference to some types of radio signal (also called electromagnetic interference or “EMI”);
- (b) Are so close to an existing antenna that they adversely affect the correct operation of the antenna (i.e. the obstructing object also acts like an antenna, causing a change in performance of the actual antenna), otherwise called a “near field” effect;
- (c) Cause radio waves to be partially blocked, meaning the radio waves bend slightly around the machine or structure and some signal power is lost, otherwise known as diffraction (or obstruction); or
- (d) Reflect radio waves off their surfaces, also known as reflection (or scattering).

4.2 I have considered each of these mechanisms in my assessment of the possible effects of the Turitea Wind Farm on radio services.

4.3 As part of this assessment, I have considered the topography of the area and the likely signal strengths of potentially affected radio services. I then assessed the risk of possible effects on radio services in the vicinity of the proposed wind farm, taking into account the proposed locations and dimensions of the wind turbines. I also reviewed appropriate literature on the effects of wind farm radio interference and possible mitigation measures that had been identified in respect of other wind farm developments.

4.4 My overall analysis of the possible effects on radio services is summarised in Table 1. This table indicates the range of radio services considered for the assessment, and identifies the likely cause, impact, and risk of interference effects occurring.

Table 1: Summary of Potential Interference Risk to Radio Services Due to Wind Farms.

Type of Service	Cause	Impact	Specific Turitea Wind Farm Risk
<i>Analogue Television</i> <i>(Wide Area Coverage Service)</i>	Reflected or scattered signal	Impairment of TV images by ghosting.	Likely. It is estimated that up to 23 dwellings may have mildly impaired reception, although this will be sporadic in nature and can be readily mitigated.
<i>Digital Terrestrial Television</i> <i>(Wide Area Coverage Service)</i>	Reflected or scattered signal	Impairment of TV picture or sound from uncorrected bit-errors	Not likely. Interference is unlikely to occur.
<i>Fixed Radio Linking</i>	Towers impinge on ray path between transmitter and receiver. Scattering.	Degradation or loss of received signal strength. Degradation in fade margin due to scattering interference.	Not likely. There are fixed radio linking services operating within the general vicinity and that cross the boundary of the proposed wind farm. However, given the separation distances involved in particular, it is unlikely that these links will be subjected to interference from turbines.
<i>RADAR</i>	Towers, nacelle, or blades cause reflection of RADAR signal.	False traces or impairment on RADAR readings.	Not likely. Airways has advised Mighty River Power that the Turitea Wind Farm will not adversely affect the Ballance RADAR. CAA has considered potential effects on any other RADAR systems through the Hazards in Navigable Airspace assessment and has concluded that the wind farm will not impact on any other RADAR system.
<i>Other Wide Area Coverage Services</i> <i>(Broadband Wireless Access – BWA, Mobile communications including cellular and emergency services)</i>	Towers, nacelle, or blades cause degradation of signal.	Degradation to the coverage area or loss of signal received from subscriber.	Not likely. There are other wide area coverage services operating within the general vicinity but all exceed the minimum separation distance to any of the turbines in the proposed wind farm.
<i>AM/FM Broadcast Radio</i>	Reflected signal interferes with signal demodulation, or diffracted signal causes signal loss.	Degradation to the coverage area or loss of signal received from subscriber.	Not likely. Any interference caused is unlikely to be detectable.

4.5 In summary:

- (a) There have been no instances of New Zealand wind farm installations causing EMI to radio services, and it is not expected to be an issue for the Turitea Wind Farm.
- (b) The Turitea Wind Farm is not expected to cause any near-field or diffraction effects having regard to the proposed turbine tower layout for the project, which complies with the recommended separation distances for all existing fixed “base station” and mobile services.
- (c) There are, however, likely to be minor reflection or scattering effects that may affect the analogue television reception of up to 23 dwellings. The nature of these effects, and proposed mitigation measures, are discussed in more detail further in my evidence.

5. **POTENTIAL RADIO INTERFERENCE EFFECTS FROM THE TURITEA WIND FARM**

Analogue Television

- 5.1 Broadcast analogue television is transmitted from the Kordia tower at Wharite, and received via a roof top antenna. TVOne, TV2, TV3, and C4 are broadcast using the VHF band. SkyTV, Maori TV, and Prime are broadcast using the UHF band.
- 5.2 The BCLIPPS (BCL Integrated Propagation Prediction System) radio prediction model was used to assess the likely extent of the areas that could have services affected (primarily through reflection) as a result of the project. In New Zealand, BCLIPPS is an industry standard radio coverage predicting model. The building point data, provided by Critchlow business mapping solutions (2007), used in this assessment contains locations for buildings of all types including sheds, barns, and residential dwellings. An occupancy ratio is also given for each building point. This ratio gives a statistical estimate of the number of building points that are likely to be occupied dwellings. The results of the study found that 52 building points were at high risk of being affected by multi-path interference. From these 52 building points I have used the occupancy ratio to estimate that up to 23 occupied dwellings may be at risk of having their television reception quality impaired by the wind turbines.

- 5.3 However, it is important to note that this figure does not make any allowance for the fact that some of the dwellings will be receiving television via digital satellite services. Specific information on dwellings in the area of assessment that may be receiving television via digital satellite services has not been confirmed. However, assessments in other similar locations suggest that this could reduce the number of affected dwellings by more than 50%.
- 5.4 The exact degree of degradation would be difficult to predict, as this will vary according to viewer location, antenna type and heading, as well as the strengths of the various signals received relative to the level of interference. Should a dwelling be affected the extent and severity of the television interference will therefore not be known until the wind farm is established.
- 5.5 Adverse effects on analogue television reception caused by the wind turbines could be readily identified by an experienced radio engineer. This would be done by visual inspection of the interference and analysis of the ghost pattern. Any such effects can be mitigated and therefore eliminated by providing the affected viewers with an alternative signal source, such as satellite digital TV or Freeview. It is also noted that the final date for analogue television switch-off is to be announced in 2012, or when digital television is available in 75% of New Zealand households – whichever happens first.
- 5.6 The potential effect of the project on analogue television coverage is therefore considered to be minor, as only a small number of dwellings are potentially affected and the effect is easily remedied by providing affected dwellings with the ability to receive an alternative signal source.

Digital Terrestrial Television

- 5.7 Digital terrestrial television reception (known as Freeview) is also broadcast from the Kordia tower at Wharite. Since the reception of digital television is more robust than its analogue counter-part (especially against multi-path interference), the analogue television analysis can be used as a worst case scenario for all television broadcasting. Due to the more robust digital transmissions, the project is not expected to result in any adverse effects with respect to digital television reception.

Fixed Radio Linking

- 5.8 There have been no specific studies undertaken as to the effects of wind turbines on microwave fixed radio linking. This is because it is more effective to ensure that new microwave links do not pass through wind farms, or that wind turbines are not constructed in the direct path of existing links.
- 5.9 However, if any of the proposed wind turbines are incorrectly located (for example, outside a proposed turbine zone and also causing the link's path to be obstructed), fixed radio links could suffer signal strength loss due to path obstruction and interference due to scattering. In some instances the same radio frequency may be re-used by different links in the same geographical area. Depending on the relative location of such links and wind turbines, and the visibility between the associated radio facilities and the turbines, scattering can lead to elevated coupling of signals between the links thereby causing interference. Whilst the impact of the interference would not be apparent for most of the time, the consequential reduction in design margins would increase the frequency, intensity, and duration of such effects, thereby degrading the performance of the relevant link.
- 5.10 Each of the four mechanisms of interference (as outlined earlier in my evidence) have been examined with respect to potential effects on fixed radio links in the vicinity of the project. For this purpose, all links operating within a 150 kilometre radius of the wind farm site were identified, with more detailed assessment being undertaken with respect to those within a 20 kilometre radius and/or that directly pass through the wind farm.
- 5.11 27 fixed link paths were identified in close proximity to the project, although of these, only three cross the boundary of the proposed Turitea Wind Farm. Each of the three fixed link paths that cross the boundary of the proposed Turitea Wind Farm have suitable clearance distances from any of the proposed turbine zone locations. Therefore this will ensure that these three radio links will not be affected.
- 5.12 In summary, the potential effects on fixed link radio communications are as follows:
- (a) For the reasons outlined earlier in my evidence, and given that the wind turbines are proposed to have fully enclosed generators, the fixed link radio services within the vicinity of the project are not considered likely to be affected by EMI.

- (b) Near field effects are not considered to be an issue, as this type of interference mechanism does not generally affect fixed radio linking services, and no antenna will be within 20 metres of any turbine.
- (c) Of the fixed links that cross the project boundary, all three have suitable clearance distances from any of the proposed turbine zone locations to ensure there will be no scattering interference or obstruction effects. The closest proposed turbine zone is located at least two kilometres away from any of the radio links' transmitters/receivers.

Aeronautical RADAR Services

- 5.13 There are six high powered RADAR transmitting services at three locations within 20 kilometres of the project, with the closest being the Ballance RADAR system at two kilometres. RADAR is a specialised technology and equipment used in the RADAR field can vary greatly, meaning there is also a wide range of possible interference implications.
- 5.14 In relation to interference derived from wind farms, if a wind farm falls within the “field of view” of a RADAR system there will almost certainly be an effect on the system. Effects on RADAR systems by wind turbines are generally able to be mitigated.
- 5.15 As outlined by Mr Henry, Airways has advised Mighty River Power that the Turitea Wind Farm is located below the “line of sight” for the Ballance RADAR and the wind farm will not adversely affect the operation of the RADAR. I further understand, as also explained by Mr Henry’s evidence, that CAA has considered any potential effects on the five other RADAR systems in proximity to the wind farm through the CAR Part 77 Determination of Hazards in Navigable Airspace assessment that was undertaken in late 2008. I understand that the CAA assessment was undertaken in consultation with Airways and any other parties using navigable airspace.

Other Wide Area Coverage Services

- 5.16 Other wide area coverage services located in the general vicinity of the proposed wind farm that need to be considered include VHF/UHF mobile radio, cellular services, and broadband wireless access services (“BWA”). If any proposed turbine zones are located

too close to any of these transmissions, the performance of these services may be adversely affected.

5.17 These services can be assessed by estimating a conservative minimum required separation distance (coordination contour) from wind turbines for each service type – locations beyond this distance will have a low likelihood of interference problems. Locations within this distance have a potential to be affected, requiring further investigation.

5.18 The maximum scatter to signal ratios ($\frac{P_{Scatter}}{P_{Signal}}$) required for each service are shown in the following bullet points, and include an additional 6 dB factor to ensure that the scattered signal imposes only a 1 dB reduction in fade margin (this is an appropriate criterion chosen to protect data services, but is conservative for voice services):

(a) VHF and UHF FM land mobile, -26 dB

(b) Cellular services, -18 dB

(c) Cellular (voice only), -12 dB

(d) BWA services, -24 dB

5.19 Scatter to signal ratios are used to determine how sensitive the radio service is to interference caused by scattering. The power of a signal that is scattered from a wind turbine and received at a radio transmitter/receiver is related to the inverse of the distance squared ($\frac{1}{D^2}$) between the turbine and the radio transmitter/receiver. In other words, as the radio transceiver is moved closer to the turbine there will be a point at which the scatter to signal ratio threshold will be breached, giving a minimum separation distance for each service type.

5.20 Using conservative generalised values for the parameters of the turbines, radio equipment, radio service quality expectations, and radio propagation conditions, it is therefore possible to calculate a separation distance beyond which services will not be at risk of suffering degradation.

5.21 The estimated minimum separation distances (in metres) between a radio service and a wind turbine for the maximum typical RADAR cross-section (from multiple hypothetical wind turbines) of 3,162 m², not taking into account any antenna directivity and obstruction loss to wanted or unwanted signals, are given in Table 2.

Table 2: Estimated minimum separation distances.

Service	Separation Distance (m)
VHF land mobile, 160 MHz, -26 dB	600
UHF land mobile, 400 MHz, -26 dB	600
Cellular services, 950 MHz, -18 dB	<100
Cellular (voice only), 950 MHz, -12 dB	<100
BWA, 2100 MHz, -24 dB	400

5.22 In light of the above, wide area coverage services will only have the potential to be at risk of interference if they are operating within the separation distances given in Table 2. Drawing the largest contour (600 metres) around the proposed wind farm would protect all services listed in Table 2. The Ministry of Economic Development’s licence database records one licence as operating within this contour. However, I understand that Horizons Regional Council (who operate the relevant repeater on behalf of Manawatu District Council) has confirmed to Mighty River Power that the repeater is actually located a further 1.7 kilometres north of the recorded co-ordinates (and it is therefore outside the 600 metre contour).

5.23 Further, it is expected that AM or FM modulated audio radio services will not be noticeably affected by reflections from the Turitea Wind Farm. These signal types are considered very tolerant to this type of interference, so no further consideration of such effects on this type of radio signal is required.

5.24 As there are no marine-to-shore type communication sites within the coordination zones, the proposed wind farm will also not be a safety concern to maritime users.

5.25 Based on the above assessment, I consider any interference risk to wide area coverage services will be *de minimis*.

6. MITIGATION STRATEGIES

- 6.1 Once the wind farm is operational, an experienced radio engineer could readily identify any adverse effects on analogue television reception that were being caused by the wind turbines. This would be done by visual inspection of the interference and analysis of the ghosting pattern.
- 6.2 If interference is being caused, the following mitigation strategy is recommended:
- (a) First inspect the existing antenna and address any antenna installation and maintenance issues.
 - (b) If confirmed that adverse effects are caused by the wind turbines either;
 - (i) Upgrade existing analogue receiver system (if appropriate), or
 - (ii) Provide and install Satellite Digital TV or Freeview receivers. It is possible to receive satellite digital television services free-to-air by purchasing a suitable decoder and having a satellite dish installed.

7. RESPONSE TO SUBMITTERS

Symes

- 7.1 The submission by Mr Robert Symes (submission 604) on behalf of his family raises general concerns regarding the Census data used to estimate the number of potentially affected households, and in particular, the use of the occupancy ratio to derive the number of potentially occupied dwellings.
- 7.2 The occupancy ratio is derived using two datasets, the latest Census data from Statistics NZ (2006) and digital map data provided by Critchlow business mapping solutions (2007). The Census data divides the entire country into a set of polygon areas, known as meshblock boundaries, and provides a count of the total occupied dwellings within each meshblock. The Critchlow digital map gives locations of building points, which include barns, sheds, other buildings, together with occupied dwellings. By dividing the total dwellings of a meshblock by the number of building points contained within that meshblock an average occupancy can be derived and assigned to each building point. This is referred to as an occupancy ratio, which varies among meshblocks. This ratio is then used to provide a statistical estimate of the number of occupied dwellings that may

be potentially affected. The important outcome from my analysis is that it is possible to calculate and identify which building points are occupied dwellings and therefore potentially affected. If necessary, a manual field survey can also be conducted to inspect which of the identified building points are actually occupied dwellings.

- 7.3 The area or size of each meshblock is decided by Statistics NZ and varies depending upon the density of dwellings and building points for particular locations. In rural areas, such as Turitea, the meshblock polygon areas are relatively large, containing many building points (barns, sheds, dwellings), with only a few occupied dwellings. This results in small occupancy factors, such as less than 0.5 occupied dwellings per building point. By contrast, in urban areas the meshblock areas are generally smaller and contain fewer building points (some are aggregated as a central building point) with the majority of building points being occupied dwellings. This results in higher occupancy factors, often greater than 10.
- 7.4 Mr. Symes claims that the methodology used in Kordia's report is inaccurate. This claim is based on the assumption that the report uses an occupancy ratio of 0.44 for every building point in the Palmerston North region. As explained in paragraph 7.3, each meshblock contains building points with different occupancy ratios and the appropriate ratio has been used for each meshblock. I accordingly consider that using Census data is a reliable and robust method for estimating the likely number of occupied dwellings that may suffer radio communications effects from the Turitea Wind Farm.
- 7.5 Mr. Symes also claims the maps used in Kordia's report were too old and did not contain new streets built within the Turitea region. This claim does not affect the accuracy of the investigation undertaken because the assessment does not rely on the map image as a data input. The map image is nothing more than a background image used to display the results of the assessment.

Perera

- 7.6 The submission by Jonathan and Debra Perera (submission 450), who live on Oram Drive in Ngahere Park, raises concerns about the close proximity of the wind farm to residential properties. In particular, Mr Perera expresses concern that the proximity of the turbines may lead to TV/Radio interference.
- 7.7 As outlined in Section 5 of my evidence, there is potential for the project to affect analogue television reception. My conservative analysis shows that a few building points situated along Turitea Road have some potential to be affected in this manner. However, building points identified to the west of this road, including those on Oram Drive are unlikely to be affected, as they are located on higher terrain above the Turitea Stream valley. In addition, any interference effects can easily be mitigated using mitigation strategies discussed in Section 6 my evidence.
- 7.8 With respect to the Pereras' concerns regarding AM and FM radio services, I have already noted that as these services are considered very tolerant to reflection interference, such effects can be discounted.

Airways

- 7.9 Mr Henry's evidence responds in detail to Airways' submission, and in particular the consultation undertaken with respect to potential effects on the Ballance RADAR. I have also noted (in paragraph 5.15) that a CAR Part 77 Determination of Hazards in Navigable Airspace has been undertaken in late 2008. In my opinion, Airways' concerns have been sufficiently addressed.

8. **CONCLUSION**

- 8.1 In conclusion, I consider that the potential effects on radio services from the proposed Turitea Wind Farm will be minor, and for the most part are so low or are unlikely to be detectable as to not require any specific actions or mitigation.
- 8.2 The most significant potential effects on radio based services in the area surrounding the proposed Turitea Wind Farm are to analogue television services, and any such effects can be easily mitigated using the strategies I have outlined in Section 6 of my evidence. Airways and CAA have addressed potential effects with respect to RADAR systems

through consultation with Mighty River Power and the CAR Part 77 Determination of Hazards in Navigable Space assessment that has been undertaken.

- 8.3 As a result of my assessment, I therefore consider that provided the recommended mitigation strategies for the potential effects on analogue television are adopted, the overall effects of the Turitea Wind Farm on radio services will be no more than minor.

J R Hills

1 May 2009