APPENDIX 4: Marshall Day Acoustic Noise Evidence

MARSHALL DAY Acoustics

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10 September 2010

FMR c/-Southern Planning Ltd
Level 3 45 Camp St
Queenstown 9300

Attention: Sean Dent

Sean

FROST FAN NOISE-WANAKA

Following the Marshall Day Acoustics (MDA) report to FMR Group dated 29th July 2010, we have carried out modelling of the noise from the Defender Frost Fan in more detail.

Modelling was carried out using the ISO 9613 sound propagation model as implemented in the SoundPLAN software. In summary, SoundPLAN uses a digital topographical terrain map of the area as its base. Each noise source is located in the map and the software then calculates noise generation for multiple directions. This method takes into account shielding by terrain and large structures, and ground absorption due to attenuation over acoustically porous surfaces such as grass and soil. We note that the supplied contour data were in 20m increments instead of the 5m increments requested. However using this provided data has enabled some refining of the results set out in the MDA report of 29th July.

The 40, 45, 50 and 55 dBA contours are shown overlaid on the aerial photograph.

DISTRICT PLAN CRITERIA-GENERAL

Marshall Day Acoustics (MDA) has been involved in the development of District Plan rules in other parts of New Zealand. Although MDA has not been involved with all of the following, there are some aspects common to the following criteria set out in the overview below:

The Western Bay of Plenty District Council has provided Frost Control Fan Guidelines since June 2000. The guidelines state that a performance standard for non-notified consent applications is that the noise level should not exceed 55 dBA L_{10} at a separation distance of 400m. This is equivalent to a noise level of 67 dBA L_{10} at a distance of 100m from the fan. Note that the subject Defender frost fan comfortably complies with this criterion (59 dBA L_{10} at 100m distance).

At this stage both the Hurunui District Council and the Marlborough District Council are addressing the issue of frost fan noise within their District Plans.

In summary, the Marlborough District Council has adopted 55 dBA L_{eq} as a standard that must be achieved within 300m of an operating frost fan. Additionally it applies a 5 dB penalty for special audible characteristics as set out in NZS 6802:2008. The aim is to achieve a noise level of around 30 dBA L_{eq} in bedrooms of houses in potentially affected sites. However, there are no restrictions on the number of times per year the frost fans may operate.

The Hurunui District Council is also considering the adoption of a limit of 55 dBA L_{eq}, but without the application of the 5 dBA penalty for special audible character. However, in place of this penalty, a limit to the operation of the frost fans to no more than 20 nights per year is being considered.

NOISE EFFECTS

Subjective Response

There are few cases regarding community response to frost control fans sufficiently documented so as to provide useful information where complaints about noise can be compared to objective noise measurements. The three cases providing such information are all located in New Zealand, in either olive or grape growing areas.

In summary, the findings of these cases are:

- External frost fan noise level of 60 dBA results in significant complaints;
- External frost fan noise levels of 50-55 dBA are grudgingly accepted;
- External frost fan noise level of 45 dBA still causes some sleep disturbance.

Sleep Disturbance

World Health Organisation guidelines[1] suggest a noise level of 30 dBA L_{eq} is appropriate within bedrooms to protect against sleep disturbance. AS/NZS 2107 supports this limit, suggesting 30 dBA as satisfactory for "houses and apartments near minor roads", and the same limit as being a maximum for "houses in areas with negligible transportation".

Measurements by Marshall Day Acoustics[2] show that existing New Zealand houses reduce aircraft noise by an average of 26 dB with closed windows. More recent measurements[3] (2005) around Wellington airport give essentially the same results. While these results relate specifically to the control of aircraft noise, other overseas studies[4], and Marshall Day calculations, suggest that the results for frost control fans are likely to be similar. A 30 dB indoor criterion, plus an average house performance of 26 dB suggests an outdoor limit around 56 dB.

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[1] Community Noise ed. B. Berglund, T. Lindvall, D H Schwela (prepared for World Health Organisation), 1999
[2] Manukau City Mayoral Mediation Forum, Auckland International Airport Appeals Sound Insulation and Ventilation Study May 2000, prepared for Manukau City Council, Auckland International Airport Ltd Board of Airline Representative s NZ Inc. by Beca Carter Hollings & Ferner Ltd & Marshall Day Acoustics 22 May2000.
[3] Land Use Management and Insulation for Airport Noise Study (LUMINS) report, by Marshall Day Acoustics Ltd, 2005.
4 Waters-Fuller, T & Lurcock, D. NANR116: "Open/Closed Window Research Sound Insulation Through Ventilated Domestic Windows", The Building Performance Centre, School of the Built Environment, Napier University, February 2006

However the aircraft noise studies showed that older houses with timber windows on average only give 24 dB noise reduction. This gives an outdoor limit of 54 dB.

Note, however, that this assumes that bedroom windows will be closed at times when frost control fans are operating.

Subject Frost Fan

District Plans in general have a permitted activity night-time limit of 40 to 45 dBA L_{10}. This night-time criterion applies to activities that could occur for all nights of a year. A frost fan event would occur only occasionally over a year and accordingly it would be appropriate to apply a less stringent criterion. As such, it is our view that 45 dBA L_{10} is a conservative limit for frost fans. Whilst there may be some effects at levels below 45 dBA, we consider these effects to be minor.

As a result, we do not consider notification for those residents within the 40 dBA contour is necessary, but would recommend notification for those residents within the 45 dBA contour.

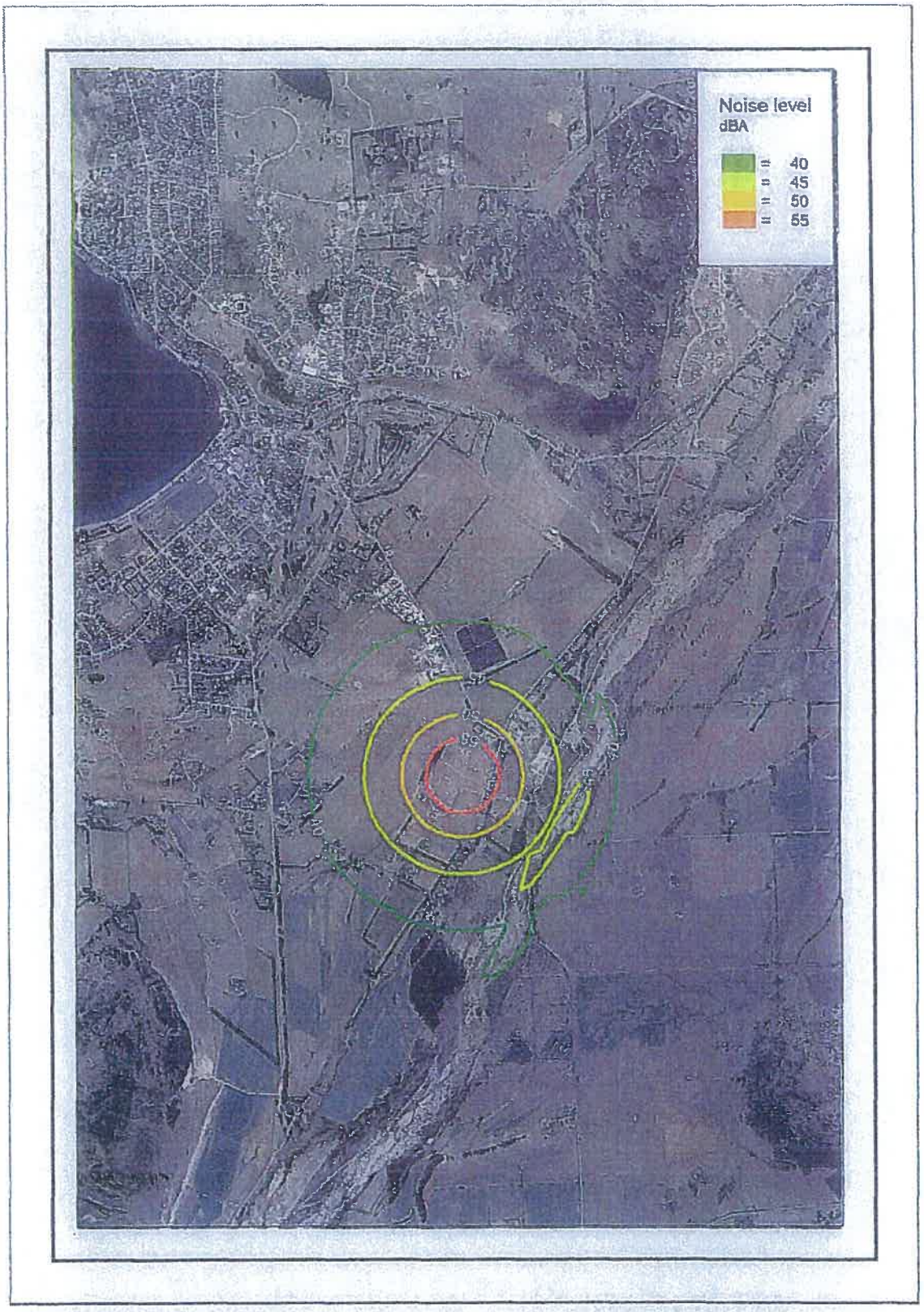
We trust this information is satisfactory. If you have any further questions please do not hesitate to contact us.

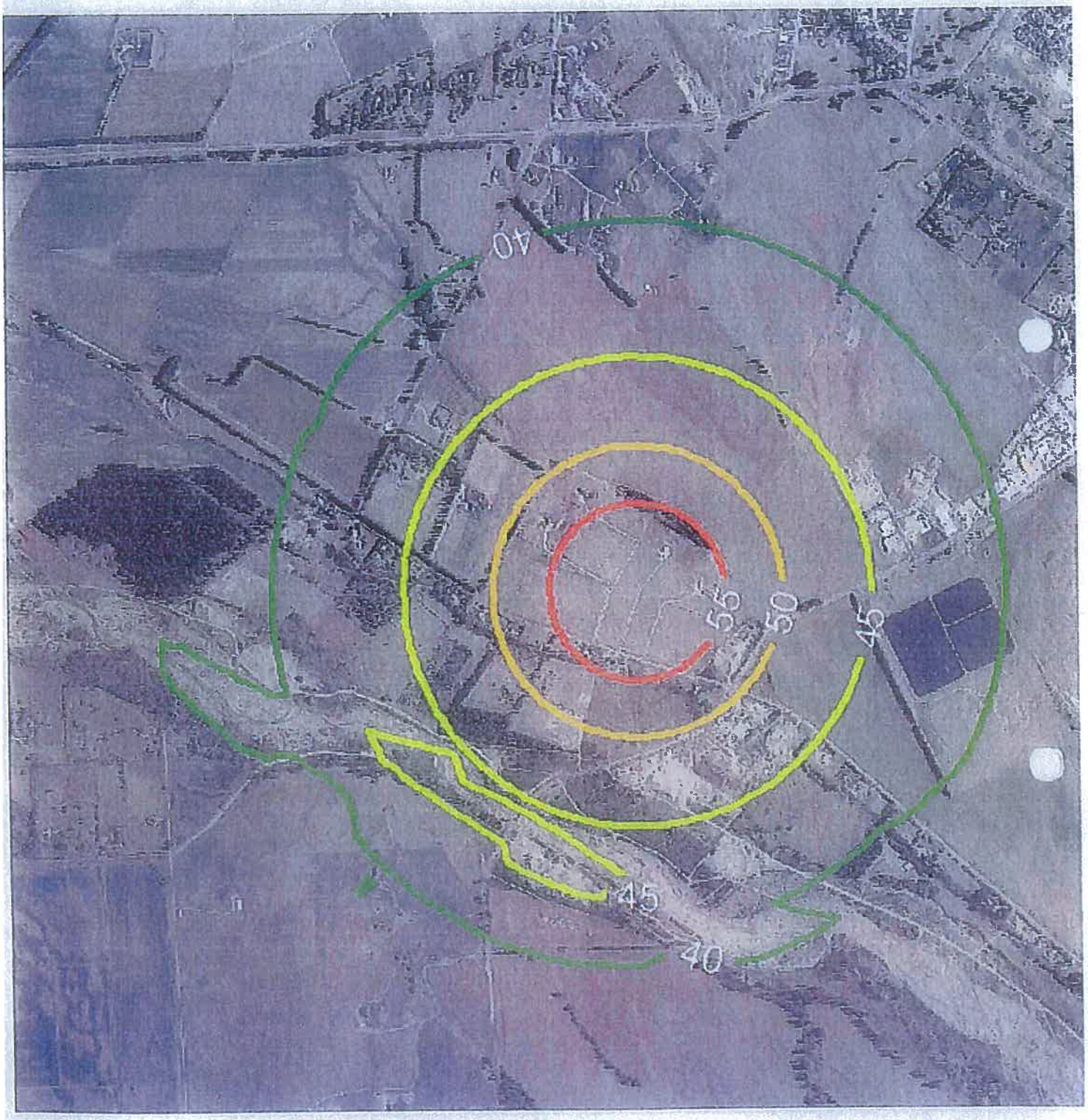
Yours faithfully

MARSHALL DAY ACOUSTICS LTD

Bill Wood

Consultant

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29 July 2010

FMR Group
Blenheim

Attention: Chris Clifford

Dear Chris

WANAKA FROST FAN NOISE COMPLIANCE

I have predicted the radius of noise effect at the Riverbank, Wanaka site, on the basis of a 40 dBA L_{10} (night-time) noise limit.

We have measured the average sound level around a Defender Frost Fan operating at an engine speed of 1850 rpm, at a distance of 300 metres. At this distance the average sound level is 50 dBA L_{10}. The predicted radius at which 40 dBA L_{10} would be created by this fan is 800 metres over soft ground such as is found in vineyard or other rural land.

At this site, this radius partially encompasses the Cardrona River. The effect of the river would be to extend the 40 dBA noise contour to 1400 metres when the receiver is within 40 metres of the riverbank, collapsing to 900 metres when the receiving location is further than 40 metres from the edge of the river.

This 40 dBA L_{10} contour is shown in the figure below, overlaid on the District Plan zone map.

These predictions are made using the ISO9613 Part II sound propagation model, and assume flat ground. It is possible that variations in the ground topography may increase or decrease the radius of the 40 dBA contour. However this flat-ground approximation is sufficiently accurate to assess the general scope of the resource consent application which may need to be lodged.

To accurately predict the noise level within the +/- 2 dB tolerance stated in the ISO9613 standard, we recommend that more detailed modelling be carried out if the ground varies significantly in elevation. This would require an accurate topographic map with resolution of 5 metres or less.

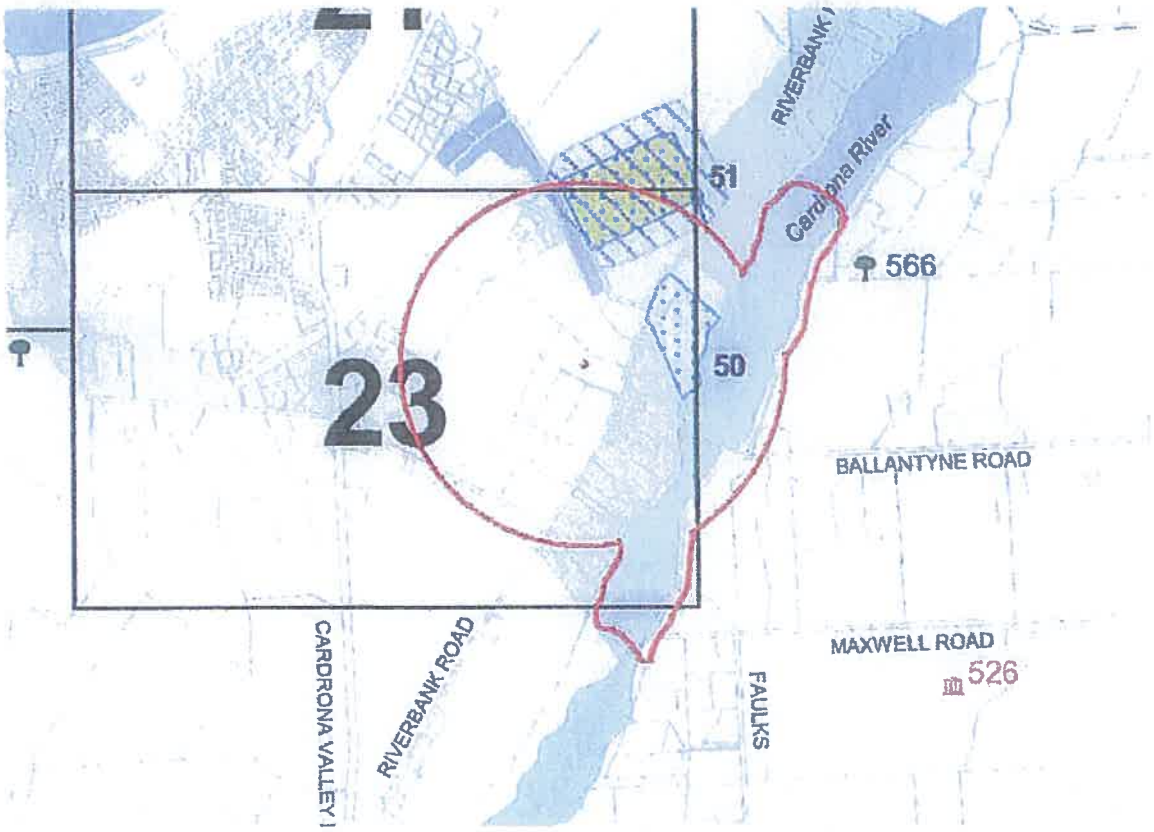

Figure 1 – 40 dBA L_{10} Predicted Noise Contour, Defender Frost Fan @ 1850 rpm engine speed

Please do not hesitate to contact us if we can be of further assistance.

Yours faithfully

MARSHALL DAY ACOUSTICS LTD

M. Miklin Halstead

Associate

BEFORE THE QUEENSTOWN LAKES DISTRICT COUNCIL

IN THE MATTER OF	**The Resource Management Act 1991**
AND	
IN THE MATTER OF	**Of RM100294 – Application for land use consent to construct and operate a frost control fan.**

STATEMENT OF EVIDENCE OF MICHAEL MIKLIN HALSTEAD

1.0 INTRODUCTION

1.1 My name is Michael Miklin Halstead. I am an Associate with Marshall Day Acoustics Limited.

1.2 I have the following qualifications and experience relevant to the evidence I shall give:

1.2.1 I hold a Bachelors degree in Industrial Engineering;

1.2.2 I am a member of the New Zealand Acoustical Society and the Resource Management Law Association;

1.2.3 I have had 24 years experience assessing and advising on the environmental sound effects of various projects, including wind farms, gas production plants, electricity substations and roading projects for industrial and public sector clients;

1.2.4 I served as Chair of the NZS6801-6802 (noise measurement and assessment standards) revision committee.

1.3 I confirm that I have read the 'Code of Conduct for Expert Witnesses' contained in the Environment Court Consolidated Practice Note 2006 and amended 1 March 2011. My evidence has been prepared in compliance with that Code in the same way as I would if giving evidence in the Environment Court. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

2.0 SCOPE OF EVIDENCE

2.1 My evidence will cover the following matters:

2.1.1 Discussion of the modelling methodology used for predicting sound levels from the proposed frost fan;

2.1.2 Discussion of the sound levels which could be considered reasonable, given the proposed circumstances;

2.1.3 Comparison of the sound levels of the proposed frost fan with other alternative means of frost protection;

2.1.4 Response to issues raised by submitters.

3.0 MODELLING METHODOLOGY

3.1 In July 2010, I made extensive measurements of the Defender II Frost Fan, the model which is proposed for this application. These measurements were made in sufficient detail that accurate predictions of the sound level resulting from the fan's operation could be made. In particular, these measurements were taken in freezing temperatures with still or very light wind conditions, which are the conditions in which frost fans are intended to operate.

3.2 These measurements were taken at a range of distances up to 300 metres from the fan. Extrapolation of sound levels to further distances is a common calculation, and is covered in detail by the Standard titled ISO 9613-2, *Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation.*

3.3 This method was used and presented on two occasions by my firm. The first calculation was done as a simple hand calculation of the radius of effect, plus a correction for the propagation over the Cardrona River. This was presented in a letter on 29 July 2010. The radius which related to a sound level of 40 dBA L_{10} was found to be 800 metres (over soft ground).

3.4 The second calculation of sound level from the proposed fan was carried out by my colleague Bill Wood, and involved the use of SoundPlan software which implements the same noise propagation method, but allows the effects of topography to be included. The resulting 40 dBA contour ranged from 800 metres to 960 metres, depending on terrain. This is equivalent to a variation of 0 – 2 dB between the predictions. This result was presented in a letter dated 10 September 2010.

3.5 The second prediction was based on terrain data given in 20 metre vertical increments, which were interpolated within the SoundPlan software. It is unlikely that higher resolution terrain data would have produced a higher predicted sound level. Instead, such data would likely have identified locations where additional screening or ground attenuation could have occurred, producing lower sound levels.

3.6 The sound level contours in both cases presented sound level as measured, and did not include any penalty for special audible characteristics. In my opinion if these levels were directly compared to district plan limits, a 5 decibel penalty would need to be applied.

4.0 REASONABLE SOUND LEVELS

4.1 District Plan permitted activity noise limits provide a good basis for assessing noise which may occur on a continuous or regular basis. However there are numerous examples of noise sources which operate infrequently or for limited duration which are permitted higher noise levels for those times.

4.2 One example is construction noise, which is permitted to make considerably higher noise levels than normally permitted during daytime, and 5 decibels higher (45 dBA) at night time than the permitted activity limit allows. Under the context of the construction noise standard, NZS6803:1999, such events could occur continuously for many months provided the overall duration is limited.

4.3 More relevant to the present application, several District Councils have investigated the noise effects of frost fans and developed criteria for their assessment. International criteria for sleep disturbance provides a useful point of reference, as does direct experience with community response to frost fans.

4.4 The World Health Organization (WHO) recommends an indoor sleeping environment of no more than 30 dBA, which conservatively translates into an outdoor level of 45 dBA with windows open, or 54 - 56 dBA with windows closed, depending on the modernity of the particular building. For an activity which is restricted to cold night-time operation it is my opinion that a "windows closed" assumption is reasonable.

4.5 However the audible character of frost fans such as the Defender II is such that it would attract attention more readily than the noises envisaged by the WHO. If frost fans were a regular occurrence it would be appropriate to consider a more stringent control than the 54 dBA suggested, even with windows closed, and the 5 dB penalty could provide an appropriate correction in this case.

4.6 Direct experience with community response to frost fan noise has been considered in the process of developing the Marlborough District and Hurunui District rules on frost fans. Community response has been studied by our firm by comparing complaint frequency with various sound levels produced by a large vineyard, where 53 two-bladed fans were in operation. These fans exhibited special audible characteristics.

4.7 The sound level the community was exposed to was controlled by varying the number of fans in operation. The pattern that emerged has been related to me by my colleague Stuart Camp who carried out the analysis. He relates that at an outdoor sound level of 60 dBA there was strong protest. When the noise level was limited to 55 dBA, the community agreed that an adequate compromise had been reached, provided the fans only operated when necessary.

4.8 In a separate study, Mr Camp describes similar response to similar levels near an olive grove, but tempers the community's acceptance of 55 dBA with the comment that when this occurred 23 nights in a single month it was considered unacceptable. I note that in the present application, use of frost fans in this manner (for crop drying) is prohibited by the proposed consent conditions and this prolonged operation would not occur.

4.9 Because the above cases consisted of noise with similar characteristics to the frost fan proposed for this application, it is not necessary to make further correction for special audible characteristics to compare my noise predictions with the levels found to be acceptable or unacceptable.

4.10 Against this background I have considered the noise levels which the neighbours will be exposed to. Of the neighbours who have not given written approval (as described in Section 5.0 of the Planners Report), only the Redai / Smith property adjacent to the subject site falls within the 55 dBA noise contour. However no residence appears to fall within the 55 dBA contour at this property.

4.11 Several houses on the opposite side of Riverbank road appear to fall between the 50 and 55 dBA contours. I understand that there is also a residential building platform (with rights to build in the future) at 245 Riverbank Road within this contour.

4.12 At these residences I would expect the noise levels to be similar to those judged to be "acceptable provided it doesn't happen too often" at other sites. Outside of the 50 dBA contour I would expect that residents would be aware that the frost fans are operating, but that by closing windows a satisfactory sleeping environment would be achieved.

4.13 The applicant has stated that the frequency of operation is expected to be on average seven nights per year, for around 1 – 3 hours per night. This is less frequent and of shorter duration than the cases described earlier where community response was gauged. Therefore I am of the opinion that the comparison of this case to those provides a valid, conservative estimate of community response relative to noise level.

5.0 ALTERNATIVE FROST PROTECTION METHODS

5.1 I have considered the noise effects of two alternatives to the proposed Defender frost fan – a helicopter, and another frost fan.

5.2 I understand that a helicopter would need to operate at an elevation of approximately 15 metres to be effective, and this means that the noise from a helicopter can be compared to that of the modeled frost fan simply by comparing the sound power levels of the two sources. The sound power level is the total sound emitted to the environment, prior to any calculation of propagation.

5.3 My firm has measured a number of helicopters commonly in use in New Zealand. The sound power levels they emit range from approximately 15 dB to 25 dB noisier than the Amarillo Defender frost fan, and have similar audible characteristics. In subjective terms, an increase in 10 decibels is considered twice as loud, and 20 decibels is four times as loud. In my opinion the Amarillo Defender is by far a quieter alternative to helicopters for frost protection.

5.4 I have measured a number of other frost fans, including the previous model of Amarillo frost fan, and fans from other manufacturers. The Amarillo Defender frost fan is approximately 5 decibels quieter than the previous Amarillo fan, and 10 decibels quieter than other fans I have measured.

5.5 I am aware that the Amarillo Defender fan was specifically designed to reduce noise emissions, and to my knowledge this fan is the quietest machine available for the wind coverage it provides.

5.6 I do not have expertise in the general area of frost protection, so I cannot comment on the practicality of other methods of frost protection.

6.0 ISSUES RAISED BY SUBMITTERS

6.1 Issues raised by submitters are paraphrased in italics, with my response following in each case.

6.2 *"Noise modeling is insufficient due to only 20 metre contours being used."*

6.2.1 In general, terrain will have little effect on the sound level received unless line of sight between the fan and the receiver is broken. While the land undulates, it does not appear to offer significant shielding to residents, and this is reflected in the current modelling. If such a case were to occur, the result would be a decrease in sound level relative to what is predicted.

6.2.2 In my experience, the noise levels I have presented are sufficiently accurate for this assessment, and any error due to limited terrain resolution would be in the favour of the neighbours, that is an over-prediction of sound level.

6.3 *"The environment is lively and carries sound well."*

6.3.1 This accurately describes most rural environments, and is not unusual for relatively quiet areas, even when punctuated by occasional traffic noise. However this does not change the physics of sound propagation, and thus does not negate the accuracy of my noise predictions.

6.4 *"We sleep with windows open all year round."*

6.4.1 Properties within the 45 dBA noise contour may find it necessary to close their windows on those occasions that the frost fan operates to have an appropriate sleeping environment. I would expect to be less of an imposition on cold nights than on hot nights, although I acknowledge it may be an imposition regardless.

6.5 *"Wind effects have not been considered."*

6.5.1 The ISO 9613 noise model predicts sound levels based on all receivers being downwind from the noise source. This is an inherently conservative assessment when there is wind, as properties upwind from the noise source will actually receive less noise than predicted. Receivers downwind of the source will be accurately predicted, and in the case of calm, temperature inversion conditions (which is when frost fans commonly operate), the prediction is generally accurate in all directions.

6.6 *"Noise would be a continual annoyance and pose a health risk due to sleep deprivation."*

6.6.1 The noise from the proposed fan would be an occasional annoyance, and for most properties would not be sufficient to significantly degrade the sleep environment on those occasions. The effects on residents in close proximity to the fan have been considered, and compared with other communities where similar noise levels have been found to be acceptable.

6.7 *"Surely there is a quieter fan."*

6.7.1 In my experience the Amarillo Defender is the quietest fan available.

6.8 *"We intend to develop land adjacent to the applicant property in the future. A wind fan may not be compatible with residential neighbours".*

6.8.1 I have not considered multiple dwellings on the property in question (directly to the north of the applicant property) as I understand it is not currently zoned for the development as suggested. However if consent were granted for that development, there are measures available to protect future residents and maintain the ability of the vineyard owners to operate the frost fan according to the consent proposed conditions.

6.8.2 The property in question falls outside the predicted 55 dBA contour, and protection to the residents would be afforded by normal residential constructions provided that ventilation requirements could be met with closed windows. A requirement on the developer of new dwellings to include mechanical ventilation and appropriate external façade insulation to achieve 30 dBA inside while the frost fan operates would not significantly impact on the cost of these dwellings, and in my opinion would be an appropriate means of ensuring an adequate sleeping environment.