Wanaka Airport - Updated Noise Contours and Assessment of Effects

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Project: **Wanaka Airport - Updated Noise Contours and Assessment of Effects**

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1.0 INTRODUCTION

Marshall Day Acoustics Ltd (MDA) has been engaged by Queenstown Airport Corporation (QAC) to prepare revised airport noise contours for Wanaka Airport. The airport noise contours provide the basis for the implementation of New Zealand Standard NZS 6805 in the District Plan.

The purpose of this report is to prepare revised noise control boundaries and to assess any noise effects as a result of the contours, that will assist in the Plan Change and Notice of Requirement process.

The noise contours produced in this assessment cover two potential runway configurations, and comprise projected operations for the year 2036 using *either*:

- the existing runway (extended), or;
- a proposed new runway (which would be located parallel to the existing).

The model for each runway configuration includes the effects of some starter extensions for jet aircraft departures and the effects of helicopter hovering along the northern boundary.

The noise contours from each runway configuration have been overlaid to produce one single set of combined contours. As a result, the noise contours presented in this assessment would enable either runway option to be developed in the future.

A glossary of technical terms is provided in Appendix A.

2.0 NOISE PERFORMANCE STANDARDS

The New Zealand Standard NZS 6805:1992 "*Airport Noise Management and Land Use Planning*" provides a recommended approach for territorial authorities dealing with airports and land affected by airport noise. The process aims to manage the adverse effects of airport noise by controlling the use of land around airports, and by ensuring the airport does not exceed the future noise contours used for the planning process.

The Standard recommends two boundaries, the Airnoise Boundary (ANB) defined by the 65 dB L_{dn} contour and the Outer Control Boundary (OCB) defined by the 55 dB L_{dn} contour.

For Wanaka Airport, both the ANB and OCB have previously been implemented in the Queenstown Lakes District Council (QLDC) District Plan. The existing noise contours contained within the District Plan were developed in 1995, with data representing the predicted airport operations for the year 2010. The existing District Plan noise boundaries are shown in Figure 1, Appendix E

In this case, it is proposed to introduce a further noise boundary and the rationale for this approach is discussed further throughout the report.

When establishing the location of noise boundaries, an allowance for the expected growth of the airport is made and NZS 6805 recommends a minimum 10 year projection of future aircraft operations. Some New Zealand Airports have used capacity as the future growth scenario. MDA recommends a minimum 20 year projection be used.

Reference should also be made to the provisions of New Zealand Standard NZS 6807:1994 "*Noise Management and Land Use Planning for Helicopter Landing Areas*" when, as is the case at Wanaka, helicopter operations make up a significant component of activity at the airport. Application of this standard is discussed further in the section on helicopters.

A summary of NZS 6805 is provided in Appendix B.

3.0 INTEGRATED NOISE MODEL

Several computer based models have been developed to predict aircraft noise in the vicinity of an airport. The most widely used of the models (and the model referenced in NZS 6805) is the Integrated Noise Model (INM) developed by the US Federal Aviation Authority. The INM calculation procedures use an energy averaging technique to calculate the noise exposure in terms of L_{dn}.

The INM calculates the noise level at a large number of grid points by summing the 'noise energy' from each aircraft movement during a 'typical' day's operation. The 'noise energy' is calculated using the hourly L_{Aeq} value, night-weighted by +10 dB (if applicable) and then averaged over 24 hours to give the daily L_{dn} value at each grid point. The grid points with equal noise level are then joined graphically to give a plot of L_{dn} noise contours.

The original airport noise contours used to develop the existing airport noise boundaries were generated in 1995 using INM version 4.11. Since this time there have been a number of updates to the INM program which produce slightly different results. The current version used for this updated set of contours is INM v7b.

This software includes revised lateral attenuation algorithms to more accurately predict lateral attenuation of sound for propeller-driven aircraft and helicopters and fully incorporates the Helicopter Noise Model (HNM). It is expected that the effect of this model update will be to increase the area of the noise contours in the direction perpendicular to the flight paths and in close proximity to the airport.

4.0 INM INPUT DATA

4.1 Updated Runways

The updated set of contours includes an extension to the existing runway (11-29) to a length of 1700m. As well as the extension to the main runway, the updated model includes a parallel 'Future' runway (11L-29R) on the north side of the existing runway.

4.2 Updated Flight Tracks

The flight tracks in the Wanaka noise model have been updated to provide a more accurate representation of actual and likely future movements. Wanaka Airport Company has provided the flight track details. These include extra flight tracks from most directions, plus the removal of those touch and go tracks not used in practice. Updated helicopter flight tracks have also been included in the model.

The flight tracks on which the noise model is based are shown in Figures 2-4, Appendix E.

4.3 Projected Aircraft Activity

The updated set of noise contours for Wanaka Airport is based on projected aircraft activity provided by Airbiz in the Wanaka Airport Masterplan for the year 2036. The adoption of the 2036 planning horizon takes into account such issues as;

- The forecast intentions of airport based operators
- Visitor arrivals for the Wanaka area
- Population statistics for Wanaka
- Population and Regional Tourism Forecasts from Department of Statistics and Tourism Research Council respectively
- Local business activities and growth
- A comparative assessment of actual and forecast growth at Queenstown Airport
- QLDC planning studies relating to regional growth and future population estimates
- Airline planning and marketing initiatives
- Airport planning and development proposals
- Airline and other operator's choice of aircraft type, size, frequency and schedules
- Assessment of alternative transport choices (car, bus etc. versus air).

Therefore the subsequent noise contours represent a reasonable worst case scenario, in terms of noise and provides robust protection of the Airport's ability to operate.

Movement data has been provided for each different aircraft type for different periods of the day. This movement data has also been assigned to the differing flight tracks as a percentage of the overall movements. Further, a seasonal loading has been applied to the movement figures to account for the potential busiest three month period within a year, as recommended by NZS 6805.

NZS 6805 states that projections should be based on an average day calculated from all operations during the busiest three months of the year. Therefore, operations that are atypical, such as airshow flights, have not been included in the projections

For each aircraft movement, including departures, arrivals and training circuits, the following information was provided for input in the model:

- Aircraft type
- Time of day (day 0700-2200 or night 2200-0700)
- Runway usage
- Departure, arrival or training circuit tracks
- Stage length at take-off

The table in Appendix C presents a summary of the projected aircraft movement data for the year 2036 used in the model.

It is noted that the Wanaka Airport Designation currently has restrictions in terms of a night-time curfew that limits aircraft operations during the hours of darkness. The Designation rule states:

> *"Operations During Hours of Darkness*
>
> *The airport shall not be used for scheduled passenger services during the hours of darkness unless a suitable lighting plan is produced and the 65 and 55 L_{dn} contours and associated Air Noise Boundary and Outer Control Boundary are reassessed."*

For the purposes of calculating noise contours, NZS 6805 defines night-time as being between 10pm and 7am, which has no relation to the hours of darkness.

It is proposed to allow for scheduled passenger services between 10pm and 7am in the future operating scenario at Wanaka Airport, therefore some night-time movements are included in the updated noise contours. It is recommended that the Operations During Hours of Darkness rule (above) should be reviewed and/or removed from the rules relating to Wanaka Airport. A discussion of night-time noise effects is presented later in this report.

4.4 Terrain

Since the existing noise contours were implemented in the District Plan, the INM noise model has been updated several times. The latest version of the INM has the ability to include terrain effects in the noise contour calculation procedure. This is particularly helpful for airports such as Wanaka where there are significant topographical features in close proximity. The adjustment made for terrain in the model accounts for the change in distance between aircraft in-flight and receivers on the ground.

Terrain data for Wanaka has been derived from NASA topographical data.

4.5 Aircraft Taxi-ing

The INM does not specifically include calculations for aircraft taxi operations. However, there is provision to estimate noise from taxi-ing in the model. In situations where airport noise contours are located close to an airport, aircraft taxi-ing may contribute to the overall noise exposure level.

Therefore in these cases it is considered appropriate to include taxi-ing operations when calculating the airport noise contours. It has previously been shown that the situation at Wanaka Airport warrants the inclusion of taxi-ing in the noise contours. Only the noise from scheduled aircraft taxi-ing to and from the airport apron has been included in this assessment.

4.6 Standard INM Aircraft Data

Based on previous studies comparing the INM prediction methodology with measured noise levels, the adjustments presented below have been utilised for the B737-800 in the noise contour calculations to more accurately predict the noise levels.

Arrival profile

- B737-800 – increase in Reverse Thrust components (as percentage of static thrust of 60%) on touchdown.

5.0 CALCULATED NOISE LEVELS

5.1 NZS 6805 Combined Fixed Wing and Rotary Aircraft

The predicted future 55 dB L_{dn} and 65 dB L_{dn} contours and the 95 dB SEL contour are shown in Figure 6 Appendix E. These contours are referred to throughout this report as the L_{dn} 55 contour, the L_{dn} 65 contour and the SEL 95 contour respectively. Figure 6 also shows the existing District Plan Outer Control Boundary (OCB) and Air Noise Boundary (ANB).

It can be seen that the revised L_{dn} 55 contour is generally similar in area to the OCB, with some variation for areas perpendicular to the flight tracks in close proximity to the airport, specifically to the north. The south-eastern extent is generally smaller, primarily because of the drop-off in terrain in this location.

It can be seen that the revised L_{dn} 65 contour covers a similar area to the present ANB, but again is wider to the north, and more extensive to the north-west (on extended runway centreline).

The SEL 95 contour has been included to indicate the potential for sleep disturbance effects from night-time aircraft movements (refer Section 7.2). As can be seen, the majority of the SEL 95 contour lies outside the L_{dn} 65 contour except for a small area opposite the airport buildings where on-airport helicopter hovering pushes the L_{dn} 65 contour beyond the SEL 95 contour.

5.2 NZS 6807 Helicopters

The updated contours include 43 helicopter movements per day (35% of the total movements). Due to the distinctive character of helicopter noise, and the nature of helicopter operations, New Zealand Standard NZS 6807:1994 *"Noise Management and Land Use Planning for Helicopter Landing Areas"* has been developed specifically to deal with noise from helicopter landing areas.

NZS 6807 is similar to NZS 6805 in that it recommends controlling noise and the use of land around helicopter landing areas by establishing a 'helinoise boundary', defining an area of land within which, no new incompatible land uses are recommended unless adverse effects are mitigated.

The helinoise boundary is generally defined at 50 dB L_{dn} which is 5dB more stringent than the L_{dn} 55 contour used for the OCB, recommended in NZS 6805. A night-time 70 dB L_{AFmax} limit is also defined in NZS 6807 for the management of sleep disturbance effects in residential and rural areas.

The land use planning measures recommended inside the helinoise boundary are similar to those recommended in NZS 6805 for areas within the OCB, ie. new noise sensitive activities are prohibited unless a District Plan permits such uses subject to appropriate sound insulation.

NZS 6807 recommends that where an area is subject to planning measures in accordance with NZS 6805 as well as in accordance with NZS 6807, the position of the OCB should take into account the position of the helinoise boundary. Due to the complexities of applying two separate standards to mixed use airports, MDA typically recommends assessing fixed wing and rotary aircraft together in accordance with NZS 6805. However where helicopter movements are a significant part of airport activities, a separate assessment of helicopter noise effects is recommended.

In the case of Wanaka Airport the future helicopter activity accounts for 35% of the total movements. For completeness, helicopter noise contours have been calculated in accordance with NZS 6807. The L_{dn} 50 contour and L_{max} 70 contour for future helicopter movements are shown in Figure 7, Appendix E. For comparison purposes the L_{dn} 55 contour from combined fixed wing and helicopter activity is included in the figure. It can be seen that the 'helicopter only' contours lie inside the overall L_{dn} 55 contour, with the exception of an area to the north east. This is discussed further in Section 6.1.

6.0 RECOMMENDED NOISE BOUNDARIES

The recommended noise control boundaries are presented in Figure 8, Appendix E. In summary, these are:

- The Outer Control Boundary (OCB)
- The Airnoise Boundary (ANB)
- The Night-time Noise Boundary (NNB)

The Outer Control Boundary and Airnoise Boundary are similar in concept to those already contained in the District Plan and are effectively direct replacements. The Night-time noise boundary is proposed to manage sleep disturbance effects from aircraft movements at night.

It is anticipated that the land use planning controls associated with the noise control boundaries would be revised as part of the plan change application. Recommended land use planning and airport noise controls associated with the proposed boundaries are detailed in Section 8.

6.1 Outer Control Boundary

In order to strictly ensure consistency between the application of NZS 6805 and NZS 6807, the OCB would ideally encompass the largest area defined by the fixed wing aircraft L_{dn} 55 contour and the helicopter L_{dn} 50 and L_{max} 70 contours. This approach is feasible when setting a land use control boundary, however it does present practical difficulties for management and implementation.

In the case of Wanaka Airport it has been shown that the helicopter L_{dn} 50 and L_{max} 70 contours are generally smaller than the total fixed wing *and* helicopter movements L_{dn} 55 contour (refer Figure 7, Appendix E), with the exception of two small areas to the north east of the apron and south of the airport by State Highway 6. Therefore the total fixed wing *and* helicopter movements L_{dn} 55 contour represents a practical boundary location for indicating (and mitigating) effects as well as simplifying the management process. As such, MDA recommends that the L_{dn} 55 contour from fixed wing and helicopter operations (Figure 6) be used as the basis for the proposed OCB, as shown on Figure 8, Appendix E.

Notwithstanding this, as there is an appreciable contribution from helicopters to the overall noise levels, it is also recommended that all helicopter operators be made aware of the Helicopter Association International's "Fly Neighbourly" program and should avoid, where possible flying over or close to residential areas.

6.2 Air Noise Boundary

NZS 6805 recommends the L_{dn} 65 contour be used for the ANB. This approach has been adopted for the existing District Plan noise boundaries and is also proposed for this revision of the boundaries. The proposed ANB is shown on Figure 8, Appendix E.

6.3 Night-time Noise Boundary

The current airport planning provisions in the District Plan make no allowance for night-time aircraft operations as there has historically been no expectation or capability for night-time flights at Wanaka. It is understood that a potential future demand for a small number of night-time aircraft movements may eventuate.

NZS 6805 requires that night time operations be considered when establishing the ANB. The standard recognises that individual aircraft noise events at night may result in sleep disturbance effects that are not adequately managed using the night weighted sound exposure metric L_{dn}. However the standard falls short of specifying a suitable metric or limit of acceptability.

At other airports in New Zealand the 95 dB SEL contour has been adopted as the limit which defines the onset of significant sleep disturbance and in some cases specific land use controls apply inside an airport's 95 dB SEL contour.

Figure 6, Appendix E shows the worst case 95 dB SEL contour for Wanaka Airport, calculated based on the noise emissions from a B737-800 on a domestic stage length. It is recommended that this contour provide the basis for a Night-time Noise Boundary (NNB), as shown in Figure 8, Appendix E for the purposes of managing sleep disturbance effects.

7.0 ASSESSMENT OF NOISE EFFECTS

The effects of the proposed revised noise boundaries on the surrounding community have been assessed by considering the change in noise level, annoyance effects and sleep disturbance effects.

There are four dwellings located inside the current OCB and none inside the current ANB. Under the revised noise boundaries only two dwellings would be located inside the OCB, as well as two consented building platforms. No dwellings or consented building platforms would be located inside the proposed ANB.

7.1 Change in Noise Level

The proposed revised airport noise boundaries would represent a change in aircraft noise levels compared with the current noise exposure and the District Plan noise boundaries. The effect of this change on the surrounding areas has been assessed.

The three airport operating scenarios which have been examined are:

- The level of activity in 2009, i.e. the current level of noise
- The level of airport activity anticipated by the operative District Plan
- The proposed updated future noise boundaries (Figure 8, Appendix E)

The combination of the runway extension and future growth of air traffic would both result in a change in average noise exposure as described by the L_{dn} noise metric. The change in noise level varies depending on the location around the airport, so all four existing dwellings inside the OCB have been used as assessment positions. The location of these dwellings is shown in Figure 1, Appendix E.

The change in L_{dn} noise level has been predicted using the INM at the four assessment locations surrounding the airport for each of the three operational scenarios listed above. The results are listed in Table 7-1 below.

Table 7-1: Predicted Change in Noise Level at Assessment Positions

Assessment Location	Permitted District Plan Level* (L_{dn} dB)	2009 Noise Level (L_{dn} dB)	2036 Noise Level (L_{dn} dB)	Change (2036 – 2009)
1	56*	49	54	+5
2	58*	51	58	+7
3	56*	46	53	+7
4	55*	46	53	+7

* Estimated from District Plan Maps

The subjective response to a change in noise level is widely variable from individual to individual and is also different for a change that occurs immediately, compared with a change that occurs slowly over many years – as will be the case for Wanaka Airport.

However, to give an indication of the meaning of the changes in noise level tabled above, the following general response to an immediate change in noise is typical;

- An increase in noise level of 10 dB sounds subjectively about 'twice as loud';
- A change in noise level of 5 to 8 dB is regarded as noticeable;
- A change in noise level of 3 to 4 dB is just detectable;
- A change in noise level of 1 to 2 dB is not discernible.

The predicted change in noise level of five to seven decibels from 2009 to 2036 would be noticeable for the four dwellings if it occurred overnight. However as this increase is predicted to occur slowly over 30 years, it is likely to be less noticeable.

It is important to note that the proposed future noise exposure at three of the four dwellings would be 2 – 3 dB less than that which is currently permitted. The noise level at dwelling 2 would be unchanged.

The runway extension would enable domestic jet aircraft to operate and this would result in a change in noise from individual aircraft events. This is because the runway extension would not only bring the runway closer to some properties, it would enable larger aircraft to operate from the airport.

To quantify the effect of the proposed runway extension, the highest sound exposure level (SEL) from individual aircraft events, before and after the extension, has been calculated at the four assessment locations, as shown in Table 7-2.

Table 7-2: Change in Aircraft Event Noise Levels Due to Runway Extension

	Loudest Predicted Noise Level from a Single Event (dB SEL)		
Assessment Location	**Current Configuration (Beech 1900D)**	**Proposed Configuration[1] (B737-800)**	**Difference (Proposed-Current)**
1	77	93	+16
2	80	93	+13
3	79	94	+15
4	79	94	+15

[1]The predicted noise levels for the Proposed Configuration are the highest noise level from either runway configuration (being the existing extended or the future parallel runway)

The current loudest movement, which only occurs during the day, is 77 – 80 dB SEL at the assessment locations. These levels are considered to be reasonably low, and would be the same or less than noise levels from a truck on the State Highway 40m distant.

For either proposed runway configuration the dwellings could experience up to 94 dB SEL from the loudest aircraft movement. This change in noise level would be a significant increase for residents and would be perceived as being more than twice as loud. However, as there are only a small number of jet movements in the future forecasts, these high noise events would occur infrequently.

Noise Levels of 90 – 100 dB SEL are not uncommon for dwellings surrounding airports. Nevertheless, MDA considers that although this single event noise level would be reasonable during the day, during night-time hours however, levels in excess of 95 dB SEL are not. This matter is addressed further in the following section.

It is important to note that despite this increase, the average noise exposure (L_{dn}) is not altered significantly, as already discussed above

7.2 Sleep Disturbance Effects

The Wanaka Airport Master Plan anticipates night flights (10pm – 7am) taking place in the future at Wanaka Airport. For airports dominated by a few movements of large aircraft, the 65 dB L_{dn} contour (and thus the ANB) could be located very close to the airport due to the small number of movements per day. If residential development is allowed to establish just outside the ANB, then residents may be exposed to relatively high levels of noise from individual aircraft events. During the day this may not create annoyance, however night time flights may result in sleep disturbance effects for residents.

There have been many studies of the effects of noise on sleep carried out both in the laboratory and in the field. The term sleep disturbance itself has various connotations and can include a range of aspects from awakening to affecting the depth of sleep in various stages and creating difficulty with falling asleep.

Many of the studies acknowledge that continuous noise and intermittent noise events have differing effects on sleep. The effects from intermittent noise events are the most relevant to aircraft noise.

The findings of relevant studies relate sleep disturbance effects to either the SEL or L_{AFmax} noise level in the bedroom. L_{AFmax} is the maximum noise level occurring during the aircraft noise event. The Sound Exposure Level, SEL, is the noise level of one second duration that has the same total sound energy as the aircraft noise event.

Generally for multi-use airports, MDA uses the SEL metric and recommends an upper limit of acceptability of 95 dB SEL for night time events in residential areas.

The sleep disturbance effects at this recommended threshold level are likely to vary depending on the number of night time events and the timing of the events. However the effects can be quantified in general terms by applying a dose-response relationship. A relationship developed in 1997 by FICAN[1] (shown in Figure 7.1) predicts the maximum percentage of an exposed population[2] expected to be behaviourally awakened for a given indoor SEL.

This relationship predicts a maximum of six percent of the population being awakened by events of 70 dB SEL and ten percent awakened by events of 80 dB SEL received in the bedroom. With windows ajar for ventilation 80 dB SEL indoors is approximately equivalent to 95 dB SEL outdoors.

1 Federal Inter-agency Committee on Aviation Noise (1997). *"Effects of Aviation Noise on Awakenings from Sleep"*.
2 The study recommends that this relationship applies to adults residing in aircraft noise affected areas.

As discussed in Section 6.3, it is recommended that a NNB defined by the SEL 95 contour be implemented at Wanaka Airport for the purposes of managing sleep disturbance effects.

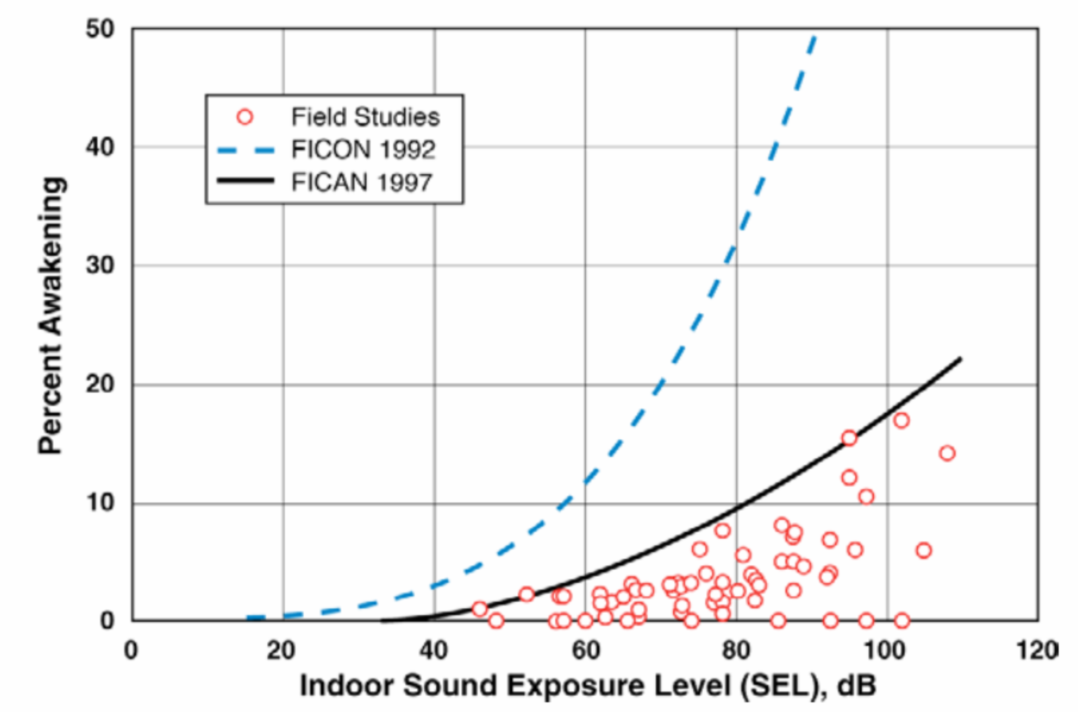

Figure 7.1: FICAN Sleep Disturbance Dose-Response Relationship

There are no existing noise sensitive activities located inside the proposed NNB therefore it is considered that potential sleep disturbance effects on the existing population would not be significant.

To mitigate sleep disturbance effects for future residents it is strongly recommended that new noise sensitive activities be discouraged or prohibited from developing inside the NNB. Controls to prevent this taking place are discussed in Section 8.3.

It is noted that the night-time control for helicopters (ie the 70 dB L_{AFmax} control), seen in Figure 7, Appendix E, is less extensive than the SEL 95 contour and hence the effects of helicopters on sleep disturbance are adequately controlled through the sole use of the SEL 95 contour as the NNB.

Further, all night-time helicopter operations should adhere to a requirement to depart or arrive on the extended runway centreline, until an altitude of 1000 feet is attained.

7.3 Annoyance Effects

Individual responses to a certain level of aircraft noise vary greatly. A large number of studies have been carried out overseas in an attempt to determine the overall relationship of response to noise of a residential community as a whole. Much of this was taken into account when NZS 6805 was developed.

In 1978 Shultz[3] combined the results of eleven different studies to produce a 'curve' of the % of people highly annoyed (%HA) versus external noise level (L_{dn}). The studies involved a number of different transportation noise sources including trains, road traffic and aircraft.

Since this time dose response relationships specific to aircraft noise have been developed by Miedema and Oudshoorn[4], as shown in Figure 7.2 below. This relationship is similar to other relationships by Bradley[5] and Miedema and Vos[6] and provides similar results.

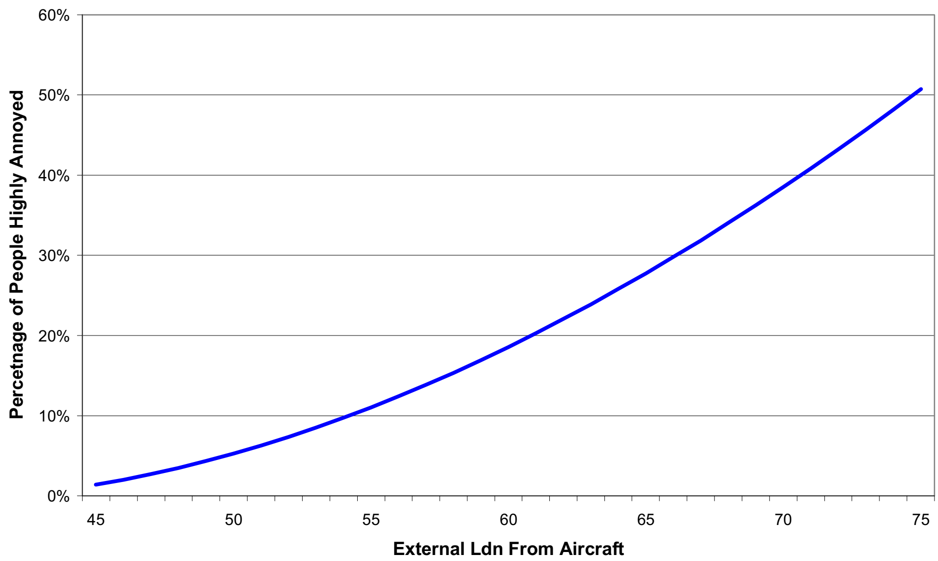

Figure 7.2 Miedema & Ouldshoorn Dose-Response Relationship

The dose response relationship indicates that for aircraft noise environments of 65 dB L_{dn} 28% of the population are likely to be highly annoyed. This is one of the reasons that NZS 6805 recommends prohibition of noise sensitive activity inside the ANB). For aircraft noise environments of 55 dB L_{dn} 11% of the population are likely to be highly annoyed by the noise.

It is noted that annoyance effects are not confined to noise levels in excess of 55 dB L_{dn}. Although the L_{dn} 55 contour forms the basis of the OCB, and the outer extent to which land use planning and airport noise controls are proposed, there may

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3 Schultz T J (1978) *"Synthesis of social surveys on noise annoyance"* J.Acoust. Soc. Am. 64, 2, 337-405.
4 Miedema, H M E and Oudshoorn, G M (2001) *"Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals."* Environmental Health Perspectives 109 (4) 409 – 416.
5 Bradley, J S (1996). *"Determining acceptable limits for aviation noise".* Proceedings of Internoise 1996.
6 Miedema, H M E and Vos, H (1998). *"Exposure-response relationships for transportation noise"*. J. Acoust. Soc. Am. 104 (6) 3432 – 3445.

be some annoyance effects for a small percentage of people in areas outside the OCB. This is because aircraft movements outside of the OCB would still be audible.

The proposed revised noise boundaries represent a minor increase in the number of people likely to be highly annoyed compared with the current situation, but a minor decrease in number of people likely to be highly annoyed compared with the existing District Plan boundaries.

On this basis, and considering the very few existing dwellings inside the OCB, and the small change in noise exposure between that proposed and that currently permitted, it is considered that overall annoyance effects would not alter significantly.

8.0 LAND USE PLANNING RECOMMENDATIONS

8.1 Inside the OCB

In keeping with the provisions of NZS 6805 MDA recommends that new 'Activities Sensitive to Aircraft Noise' (ASANs) inside the OCB be prohibited where practicable to do so. Where this does not occur, new ASANs should be subject to sound insulation measures to ensure an acceptable internal noise environment. These sound insulation provisions should also apply to alterations or additions to existing ASANs in these zones.

Historically in most cases sound insulation standards for noise sensitive uses around airports have been specified as an internal noise criterion. Buildings must be built to achieve the target internal noise level based on the future external noise exposure defined by the airport noise contours. If this approach is preferred, then the following criteria would be recommended:

- Internal noise level of 40 dB L_{dn} in all habitable rooms;
- Internal noise level of 65 dB SEL in all bedrooms.

An alternative approach is to specify a sound insulation performance criterion for the building which describes the sound insulating properties of the building construction instead of the target internal noise environment. This approach has the benefit of simplifying the design process. However it does mean that some houses may be slightly over designed.

In most situations, the required sound insulation standard can only be achieved in buildings when doors and windows are closed. As almost all houses in New Zealand rely on open windows to provide ventilation, alternative methods such as mechanical systems are necessary to achieve minimum ventilation standards. Alternative ventilation can typically be achieved using moderately inexpensive ducted fan systems in ceiling spaces, which bring air from the outside into habitable rooms.

It is recommended that alternative ventilation is a specified requirement for noise sensitive activities inside the OCB. Such a ventilation system should also be designed to comply with an acceptable noise limit inside the dwelling. Typical limits are 35 dB L_{Aeq} in bedrooms, and 40 dBA L_{Aeq} inside other habitable rooms.

As discussed above, MDA recommends that new ASANs be prohibited inside the OCB. Where they already exist, or in the event that prohibition is not implemented, MDA recommends that a standard noise reduction criterion be applied. Further, MDA recommends that Table 1 in Appendix D form the basis of the District Plan Sound Insulation rule, applicable to ASANs in the OCB. This table of acceptable constructions would ensure that if allowed to establish, appropriate sound insulation would be provided for all new or altered dwellings inside the OCB. It is recommended that the table should only be applicable to habitable rooms.

Where ventilation systems are required, they should meet the performance standards of Table 2 and Table 3, Appendix D. It is noted that MDA are not experts in ventilation system requirements, but we understand that these standards have been developed by Beca for Queenstown Airport and would also be suitable for Wanaka Airport.

8.2 Inside the ANB

Noise environments greater than 65 dB L_{dn} are not suitable for residential activity. Sound insulation measures can improve internal noise environments but do not fully mitigate the effects for residential activity, particularly in outdoor living areas or where residents wish to open windows and doors.

As such, NZS 6805 recommends that land use controls to prohibit new noise sensitive activities should be imposed within the ANB. This approach has been adopted for the existing District Plan and is also recommended for this revision of the boundaries.

8.3 Inside the NNB

It is recommended that land use controls to prohibit new noise sensitive activities (similar to those within the ANB) should be imposed within the NNB to protect the potential for night-time operations at the airport and to protect future residents against sleep disturbance effects.

Due to the high sound exposure levels in some locations, it may be extremely expensive or impracticable to effectively insulate buildings. In addition, sound insulation alone is considered to be the mitigation option of last resort and reverse sensitivity issues may still arise. It is therefore recommended that new noise sensitive activities be prohibited within the NNB.

In the situation at Wanaka Airport there are two consented residential building platforms inside the proposed NNB which need consideration. It is recommended that these buildings be required to be constructed in accordance with the sound insulation performance standards in Table 1, Appendix D.

Any alterations or additions to these buildings in the future should also be subject to the same sound insulation performance standards.

Where ventilation systems are required, they should meet the performance standards of Table 2 and 3, Appendix D.

In addition, assuming the implementation of the above for the existing consented ASANs, and considering the potential for sleep disturbance effects (refer section 7.2), it is considered that the most appropriate method of mitigating sleep disturbance and reverse sensitivity effects is to prohibit *new* ASANs inside the NNB.

8.4 Summary of Recommendations

MDA recommends that:

- *New* Activities Sensitive to Aircraft Noise (ASAN) located within the Outer Control Boundary (OCB), Air Noise Boundary (ANB) or Night Noise Boundary (NNB) should be prohibited where practicable to do so.
- Alterations and additions to existing ASAN's located within the Outer Control Boundary (OCB) and Night-time Noise Boundary (NNB) should be fitted with appropriate sound insulation (refer Section 8.1, 8.3)
- Where sound insulation is required a ventilation system (or systems) should be provided (refer Section 8.1, 8.3)
- Where a ventilation system (or systems) is required, noise from such a system should be at a reasonable level (refer Section 8.1, 8.3)

9.0 AIRPORT NOISE CONTROL RECOMMENDATIONS

9.1 Airport Noise Management

MDA recommends that:

- The Airport should be managed so that the noise from aircraft operations does not exceed a Day/Night Level of 65 dB L_{dn} outside the proposed Air Noise Boundary (ANB) and 55 dB L_{dn} outside the proposed Outer Control Boundary (OCB).
- To ensure compliance with the above, calculation of Aircraft Noise Contours using the Integrated Noise Model (INM) program and records of actual aircraft activity at the Airport is recommended, initially within 6 months of the Plan Change becoming adopted, and thereafter every 2 years.
- Noise monitoring should be undertaken to check the compliance contours are not exceeding the requirements set out above. It is recommended that once the calculated noise level exceeds 64 dB at any point on the ANB, then the

following level of monitoring is required; a minimum of one month summer and one month winter at each of two measurement locations. This should be undertaken on the predicted 65 dB L_{dn} contour shown in Figure 6, Appendix E.

- All aircraft that undertake operations between 10.00 pm and 07.00 am shall be certified in advance to have an SEL 95 dB noise contour that does not exceed the Night Noise Boundary (NNB).

Any airshow activities should be explicitly excluded from compliance calculations or infield monitoring. However it is recommended that prior to any airshow, a Noise Management Plan be formulated to detail, as far as is practicable, the manner in which airshow noise would be managed to ensure reasonable compliance with the objectives of the District Plan.

9.2 Engine Testing

The aviation industry has strict requirements regarding the need to run an engine after maintenance before it can be used for passengers. Routine or unscheduled work on an engine will often require a period of idling or a short full power run of the engine.

Routine engine maintenance on passenger aircraft is not proposed at Wanaka Airport. However, in the event of unexpected equipment failure, unscheduled work may be carried out requiring engines to be run up before returning the aircraft to service.

Therefore, the testing of aircraft engines is another noise generating activity that is vital to the operational viability of a commercial airport with scheduled flights. It is noted that at present there is no specific provisions for engine testing in the District Plan. Just as aircraft noise can not be pragmatically controlled by the standard District Plan noise rules for land based activities, so too engine testing often requires its own specific noise rule.

The recommended method of control for unscheduled engine testing is to allow a limited number of events within a 12 month period with a maximum duration and noise limit.

A recommended Engine Testing Rule for Wanaka is presented below:

"Noise levels from Aircraft Engine Testing shall comply with the following:

i. *Between the hours of 7am and 10pm, noise generated by aircraft engine testing and measured at or within the boundary of any site in the General Rural zone or Rural Visitor zone outside the Airport Designation shall not exceed 55 dB $L_{Aeq(15\ hours)}$; and*

ii. *All aircraft engine testing shall be scheduled to take place between 7am and 10pm and only essential unscheduled engine testing shall take place outside those hours.*

iii. *In some situations it may be necessary to conduct essential unscheduled engine testing between 10pm and 7 am. Essential unscheduled engine testing shall take place on no more than 18 occasions per year and noise from such engine testing shall not exceed the following noise levels at the notional boundary of any site in the General Rural zone or Rural Visitor zone outside the Airport Designation :*

Time Period	*Noise Level*
All days 10.00 pm to 7.00 am	*55 dB $L_{Aeq(9\ hours)}$*
All days 10.00 pm to 7.00 am	*80 dB L_{AFmax}*

iv. *On each of these occasions the date, time, noise level reached, duration and reason for the tests shall be reported within 10 days to the Queenstown Lakes District Council.*

v. *For the purpose of this control aircraft engine testing shall be measured in accordance with New Zealand Standard NZS 6801:2008 "Acoustics – Measurement of environmental sound" "*

APPENDIX A – GLOSSARY OF TERMINOLOGY

dB	Decibel – A measurement of sound level expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 μPa i.e. dB = 20 x log(P/Pr)
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear. All noise levels are quoted relative to a sound pressure of $2x10^{-5}$Pa
$L_{Aeq\ (t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates
L_{dn}	The day night noise level which is calculated from the 24 hour L_{Aeq} with a 10 dB penalty applied to the night-time (2200-0700 hours) L_{Aeq}.
SEL	The sound level of one second duration which has the same amount of energy as the actual noise event measured.
NZS 6805:1992	New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"*
NZS 6807:1994	New Zealand Standard NZS 6807:1994 *"Noise Management and Land Use Planning for Helicopter Landing Areas"*

APPENDIX B – SUMMARY OF NZS 6805:1992

In 1991 the Standards Association of New Zealand published New Zealand Standards NZS 6805:1992 *"Airport Noise Management and Land Use Planning"* with a view to providing a consistent approach to noise planning around New Zealand Airports. The Standard has two majors aims:

(i) to establish compatible land use planning around an airport and

(ii) to set noise limits for the management of aircraft noise at airports.

B1 - Noise Boundaries

The Standard recommends two noise boundaries to achieve its aims. This involves fixing an Outer Control Boundary (OCB) and a smaller, much closer Airnoise Boundary (ANB) around the airport.

The Standard recommends that inside the ANB, new noise sensitive uses (including residential) should be prohibited. Between the ANB and the OCB new noise sensitive uses should also be prohibited unless provided with sound insulation. The ANB is also nominated as the location for future noise monitoring of compliance with an 65 dB L_{dn} limit.

The Standard is based on the Day/Night Sound Level (L_{dn}) which uses the cumulative 'noise energy' that is produced by all flights during a typical day with a 10 dB penalty applied to night flights (see Appendix A for an explanation of terminology). L_{dn} is used extensively overseas for airport noise assessment and it has been found to correlate well with community response to aircraft noise.

When establishing the location of the Noise Boundaries, an allowance for the expected growth of the airport can be made and NZS 6805 recommends a minimum 10 year projection should be made of future aircraft operations. The L_{dn} contours for the airport can be calculated using a computer programme called the Integrated Noise Model (INM).

The location of the ANB is then based upon the projected 65 dB L_{dn} contour and the OCB on the projected 55 dB L_{dn}. NZS 6805 also recommends that, where appropriate, night time single event noise levels should be considered in the location of the ANB.

B2 - Land Use Planning

Land Use Planning can be an effective way to minimise population exposure to noise around airports. Aircraft technology and flight management, although an important component in abating noise, will not be sufficient alone to eliminate or adequately control aircraft noise. Uncontrolled development of noise sensitive uses around an airport can unnecessarily expose additional people to high levels of noise and can constrict, by public pressure as a response to noise, the operation of the airport.

NZS 6805 lays out recommended criteria for Land Use Planning around airports. In summary, Tables 1 and 2 of the Standard recommend the following :

Inside the ANB

(i) New noise sensitive uses (including residential) should be prohibited;

(ii) Existing residential buildings and subsequent alterations should have appropriate sound insulation.

Between ANB and OCB

(i) New noise sensitive uses (including residential) should be prohibited unless a District Plan permits such use subject to appropriate sound insulation.

(ii) Alterations or additions to existing noise sensitive uses (including residential) should include appropriate sound insulation.

B3 - Airport Noise Management

In addition to land use controls, noise controls can be used to manage the level of noise impact around airports. These controls can take the form of preferential runway usage, noise abatement flight tracks, curfews, noise emission limits and others. NZS 6805 proposes maximum noise emission limits for the airport. This procedure is consistent with the general approach to noise control in New Zealand, in that it is left to the operator to best decide how to manage its activities to comply with an agreed level of noise.

The Standard proposes that the Day/Night Sound Level (L_{dn}) produced by the Airport should not exceed 65 dB L_{dn} at or outside the ANB (or L_{dn} 65 dB contour). A measurement would involving monitoring the hourly noise levels over a period of typically 3 months and obtaining the L_{dn} by averaging the daytime and weighted night-time noise levels.

The location of the 65 and 55 dB L_{dn} contours determines the extent of the noise emission from the airport and thus the extent to which the airports future operations are constrained. Therefore when calculating the contours and locating the ANB and OCB it is vital that the future expansion of the airport be taken into account.

APPENDIX C: SUMMARY OF PROJECTED AIRCRAFT MOVEMENTS

Airbiz 2010 Aircraft Movements Forecast[1]

Category	2016	2026	2036
Scheduled Domestic			
High	1,420	2,370	2,990
Median	**1,250**	**1,830**	**2,090**
Low	1,100	1,390	1,310
Non-Scheduled Charter			
High	177	262	388
Median	**113**	**151**	**203**
Low	54	65	80
Flight seeing			
High	2,940	4,410	5,730
Median	**2,750**	**3,940**	**4,880**
Low	2,570	3,510	4,150
Other GA			
High	12,300	16,600	20,300
Median	**11,800**	**15,000**	**17,100**
Low	11,200	13,500	14,500
Helicopters[2]			
High	7,460	11,600	15,590
Median	**6,980**	**10,330**	**13,220**
Low	6,520	9,190	11,210
TOTAL			
High	**24,300**	**35,200**	**45,000**
Median	**22,900**	**31,300**	**37,500**
Low	**21,400**	**27,700**	**31,200**

[1]For the purposes of the noise modelling, the 'High' movement numbers were used.

[2]Helicopter movements also include hover-training activity to the north of the runway.

APPENDIX D: RECOMMENDED SOUND INSULATION CONTROLS

Table 1: Sound Insulation Requirements – Acceptable Constructions.

Building Element	Minimum Construction	
External Walls	**Exterior Lining:**	Brick or concrete block or concrete, or 20mm timber or 6mm fibre cement
	Insulation:	Not required for acoustical purposes
	Frame:	One layer of 9mm gypsum or plasterboard (or an equivalent combination of exterior and interior wall mass)
Windows/ Glazed Doors	4mm glazing with effective compression seals or for double glazing 6mm-6mm airgap-6mm	
Pitched Roof	**Cladding:**	0.5mm profiled steel or masonry tiles or 6mm corrugated fibre cement
	Insulation:	100mm thermal insulation blanket/batts
	Ceiling:	1 layer 9mm gypsum or plaster board
Skillion Roof	**Cladding:**	0.5mm profiled steel or 6mm fibre cement
	Sarking:	None Required
	Insulation:	100mm thermal insulation blanket/batts
	Ceiling:	1 layer 9mm gypsum or plasterboard
External Door	Solid core door (min 24kg/m^2) with weather seals	

Note: The specified constructions in this table are the minimum required to meet the acoustic standards. Alternatives with greater mass or larger thicknesses of insulation will be acceptable. Any additional construction requirements to meet other applicable standards not covered by this rule (eg fire, Building Code etc) would also need to be implemented.

Table 2: Ventilation Requirements

Room Type	Outdoor Air Ventilation Rate (Air Changes per Hour)	
	Low Setting *	High Setting *
Principle living areas	1-2 ac/hr	Min. 15 ac/hr
Other habitable areas	1 2 ac/hr	Min. 5 ac/hr

** Each system must be able to be individually switched on and off and when on, be controlled across the range of ventilation rates by the occupant with a minimum of 3 stages.*

Each system providing the low setting flow rates is to be provided with a heating system which, at any time required by the occupant, is able to provide the incoming air with an 18 degC heat rise when the airflow is set to the low setting. Each heating system is to have a minimum of 3 equal heating stages.

If air conditioning is provided to any space then the high setting ventilation requirement for that space is not required.

Table 3 – Ventilation System Noise Limits

Room Type	Noise Level Measured at Least 1m from the Diffuser (Leq dB))	
	Low Setting	High Setting
Principal living areas	35	40
Other habitable areas	30	35

APPENDIX E – FIGURES