Before an Independent Hearings Panel
appointed by the Waimakariri District Council

under: the Resource Management Act 1991

in the matter of: Submissions and further submissions in relation to the proposed Waimakariri District Plan, Variation 1 and Variation 2

and: Hearing Stream 7: Residential, Large Lot Residential, Ecosystems and Indigenous Biodiversity, Variation 1 and Variation 2

and: **Christchurch International Airport Limited**
Submitter 254

Statement of evidence of Laurel Smith (Acoustics)

Dated: 30 August 2024

REFERENCE: JM Appleyard (jo.appleyard@chapmantripp.com)
ME Davidson (meg.davidson@chapmantripp.com)

chapmantripp.com
T +64 3 353 4130
F +64 3 365 4587

PO Box 2510
Christchurch 8140
New Zealand

Auckland
Wellington
Christchurch

chapman tripp

STATEMENT OF EVIDENCE OF LAUREL SMITH

INTRODUCTION

1 My full name is Laurel Jean Smith.

2 I am a consultant in the acoustical consulting practice of Marshall Day Acoustics Limited (*Marshall Day*). I hold the degree of Bachelor of Engineering from Auckland University. For the past 20 years I have worked in the field of acoustics, noise measurement and control in New Zealand. My work has included noise control engineering work for various industries in New Zealand.

3 I have undertaken noise prediction and provided consulting advice on over eight airports in New Zealand. My work has involved noise calculations, computer modelling, noise boundary development, assessment of noise effects, recommending airport noise rules, development of sound insulation packages and noise monitoring.

4 Marshall Day has been engaged by Christchurch International Airport Limited (*CIAL*) since 1992 to advise on various noise issues including:

4.1 preparation of the original noise contours to form the basis of the airport noise provisions in the Canterbury Regional Policy Statement (*CRPS*) and the Canterbury, Waimakariri and Selwyn District Plans;

4.2 preparation of the 2023 remodelled noise contours which involved participation in the peer review process and remodelling the agreed revisions; and

4.3 on a number of specific land use consent applications and plan changes.

CODE OF CONDUCT

5 Although this is not an Environment Court hearing, I note that in preparing my evidence I have reviewed the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023. I have complied with it in preparing my evidence on technical matters. I confirm that the technical matters on which I gave evidence are within my area of expertise, except where relying on the opinion or evidence of other witnesses. I have not omitted to consider material facts known to me that might alter or detract from my opinions expressed.

SCOPE OF EVIDENCE

6 I have been asked to comment on the relief sought by CIAL in relation to the proposed Waimakariri District Plan (*Proposed Plan*) relevant to Hearing Stream 7. The relief sought relevant to this hearing stream is outlined in Mr Kyle's Hearing Stream 10A evidence.

7 My evidence will address:

7.1 airport noise management – the international and local approach;

7.2 adverse effects from aircraft noise on residents;

7.3 operational restrictions on airports (reverse sensitivity)

7.4 achieving a balance and minimising effects in practice; and

7.5 CIAL relief sought including the Updated Noise Contours and land use controls.

8 Some of my evidence repeats what I have presented at Hearing Stream 10A. I include this in the written form of my evidence as necessary to provide context. However, I do not intend to speak to this at hearing and will provide a summary statement to addresses the key issues relevant to this hearing stream.

AIRPORT NOISE MANAGEMENT

9 In this section I provide an overview of the internationally recognised and applied approach to airport noise management. Then I reference my Hearing Stream 10A evidence to describe the New Zealand approach, being New Zealand Standard 6805 "Airport Noise Management and Land Use Planning" (NZS 6805:1992) (the *Standard*), and how the Standard is applied in Canterbury.

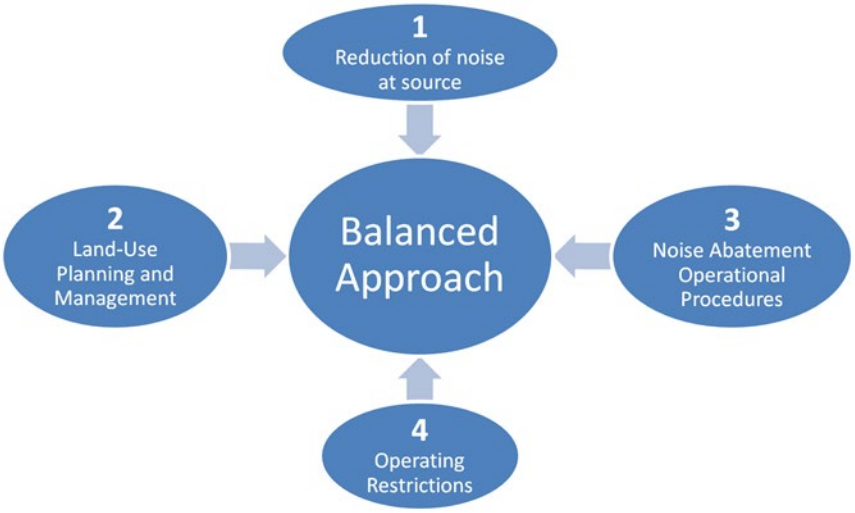
International Overview

10 It is widely accepted that reducing the impacts of aircraft noise requires a combined effort such that incremental improvements from many contributing factors can result in a meaningful reduction. It is important to differentiate between noise exposure, and the resulting noise nuisance which is an outcome relating to the size of the population affected. If aviation services are important to a region, then the solution needs to be multi-dimensional rather than simply reducing aircraft noise by restricting operations. Responsible land use planning plays a significant role in reducing the impacts of aircraft noise.

The ICAO Balanced Approach framework

11 The International Civil Aviation Organisation (*ICAO*) Balanced Approach framework sets out four fundamental principles for managing noise pollution around airports (refer **Figure 1**). The ICAO Balanced Approach reinforces the NZS 6805 approach to managing the effects of aircraft noise.

Figure 1 ICAO Balanced Approach Four Principles



12 Although operational restrictions is one of the principles, the Balanced Approach framework recommends that noise exposure be reduced through the other three principles ahead of applying operating constraints.

13 Noise exposure reductions due to principles 1 and 3 are evident with quieter engine technology and improved airspace management technology. The aviation industry will likely continue to improve in these areas although the magnitude of achievable improvement has diminished over time. With respect to principle 2, land use planning is commonplace around New Zealand airports to varying degrees, however, in order to manage future noise exposure, it is important these measures are at least upheld or improved rather than relaxed.

ICAO Airport Planning Manual

14 The International Civil Aviation Organization (*ICAO*) Airport Planning Manual (selected pages attached as **Appendix 1**)[1] provides further support for land use planning within aircraft noise affected areas being an internationally applied method for minimising noise effects

[1] International Civil Aviation Organization *Airport Planning Manual: Part II - Land Use and Environmental Management.*

and potential airport restrictions. I have not addressed this report in my previous evidence.

15 The Airport Planning Manual has been prepared with the benefit of the collective experiences, and knowledge from airports worldwide. It demonstrates that internationally airports, and governments are grappling with the same issues and that in practice, the planning responses vary on a wide spectrum.

16 In particular, the manual identifies that governments are responsible for upholding the land use planning pillar in the Balanced Approach. This involves implementing appropriate land use planning with the goal of minimising the number of people affected by aircraft noise which in turn minimises the risk of airport operational restrictions and avoids nullifying the noise reductions achieved by the aviation industry.

17 The New Zealand approach to airport noise management is in step with the manual in concept. However, I note the application of land use controls in New Zealand is at the discretion of local authorities and in practice have been applied fairly lightly throughout most of the country.

New Zealand Approach (NZS 6805:1992)

18 I discussed NZS 6805:1992 and the implementation of the standard at New Zealand airports and in Canterbury at length during Hearing Stream 10A.[2]

19 In summary, the approach to airport noise management that the Standard provides for is to "*implement practical land use planning controls and airport management techniques to protect and conserve the health of people living near airports without unduly restricting the operation of airports*." The principles of the Standard align with the ICAO balanced approach.

Airport Noise Management Summary

20 In general, the two main objectives of noise management frameworks are:

20.1 Minimise noise effects on people

20.2 Minimise operational restrictions on airports

21 It is widely understood that the two outcomes are inherently connected. Objective 1 can be achieved through operational restrictions, but this fails to meet objective 2. Achieving objective 1 through other means also benefits objective 2.

[2] Refer to paragraphs 16-46 of my evidence for Hearing Stream 10A.

22 Airport noise management frameworks are predicated on the understanding that allowing incompatible land use in airport noise affected areas increases noise effects on people which in turn increases the likelihood of operational restrictions.

23 In the next sections of my evidence, I discuss the adverse effects of aircraft noise on people and the risk of reverse sensitivity leading to airport operational restrictions.

ADVERSE EFFECTS FROM AIRCRAFT NOISE

24 My work in airport noise management over the last 20 years includes the quantification and assessment of aircraft noise effects. For this, I rely on available research and evidence-based guidelines. Over time the quality and volume of available research has increased.

25 Since I provided my evidence for Hearing Stream 10A, CIAL engaged **Professor Charlotte Clark** to prepare a report on the evidence base for the effects of avaiation noise on health. Her evidence sets out the current knowledge regarding the health effects of aircraft noise exposure and comments on the application of the evidence-base in the Christchurch context.

26 I also rely on the 2018 WHO guidelines[3] which identifies the following health effects associated with aircraft noise:

26.1 Annoyance

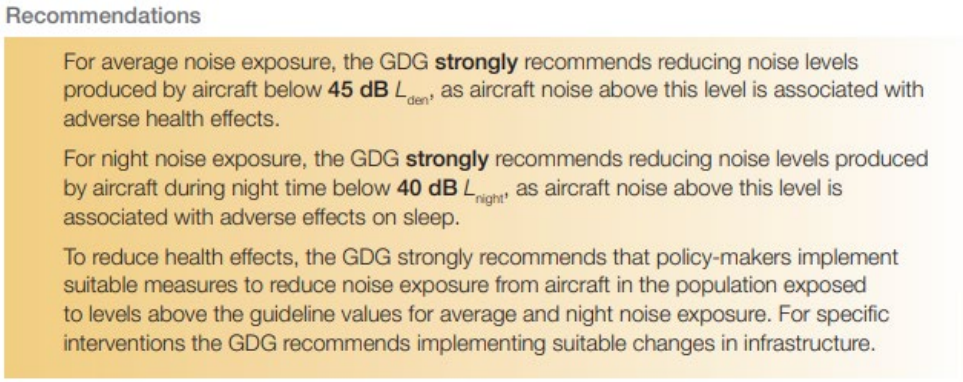
26.2 Sleep disturbance

26.3 Cognitive impairment (children's reading and oral comprehension)

26.4 Cardiovascular disease (low quality evidence)

27 The 2018 WHO guidelines provide the most comprehensive, evidence-based recommendations on aircraft noise effects at this point in time. The guideline recommendations are:

[3] World Health Organisation European Region (2018) "Environmental noise guidelines for the European Region".



28 There may be a misconception among laypeople that high annoyance is just an amenity effect for residents. The WHO identifies high annoyance as a health effect. I discuss high annoyance and sleep disturbance further in the following sections of evidence.

Annoyance Effects from Aircraft Noise

29 Research relating adverse effects to aircraft noise exposure dates back to the 1970's. In 1978 T J Schultz produced a dose response curve relating transportation noise exposure (L_{dn}) to residents being highly annoyed (refer **Figure 2**).

30 To this day, community annoyance continues to be a key measure of transportation noise effects. Annoyance is easily measurable meaning there is a large amount of data available. The survey method is based on respondent's self-reported annoyance to the noise of interest and can be applied to large samples of residents cost effectively. To laypeople, annoyance might be seen as an amenity effect only, however epidemiologists believe there is a correlation between annoyance, the human nervous system and health impacts. The evidence of **Professor Charlotte Clark** describes this further.[4]

Aircraft noise is more annoying than other transportation noise

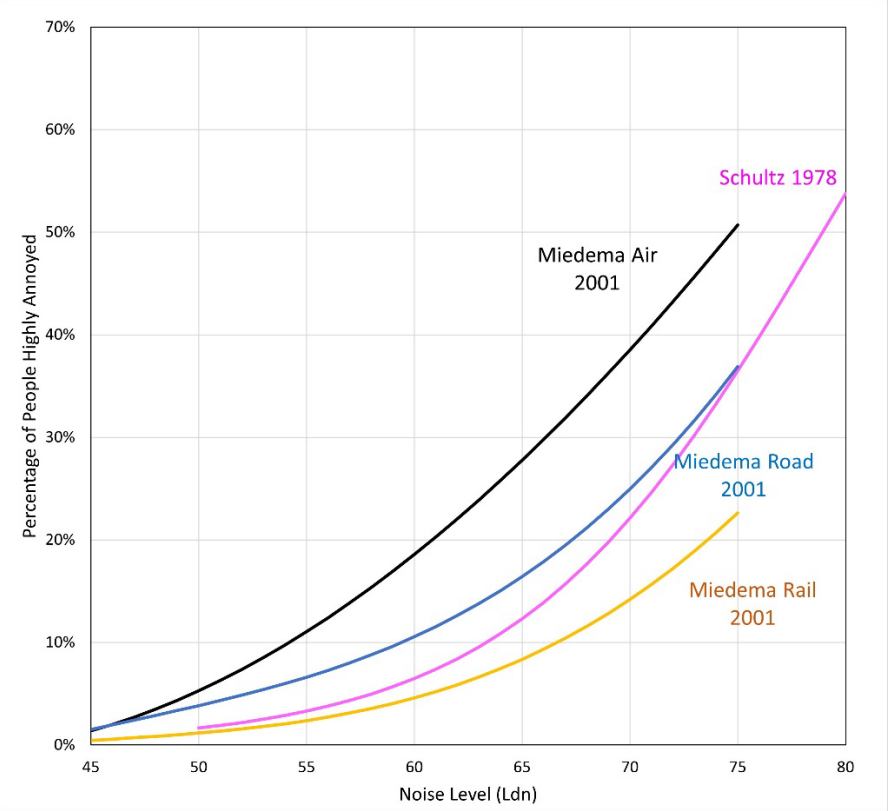
31 Since 1978, many other highly annoyed dose response curves have been developed. In 2001 Miedema and Oudshoorn[5] developed separate annoyance curves for aircraft, road and rail traffic. This study identified that aircraft noise was appreciably more annoying than road and rail noise (refer **Figure 2**). This study also found the annoyance response to aircraft noise was greater than the Schultz relationship predicted. For many years this 2001 annoyance curve

[4] Statement of evidence of Professor Charlotte Clark dated 30 August 2024.

[5] Henk Miedema and Catherine Oudshoorn "Annoyance from Transportation Noise. Relationships with Exposure Metrics DNL and DENL and Their Confidence Intervals" (2001) 109(4) Environmental Health Perspectives 409

was used in New Zealand and internationally to quantify annoyance effects.

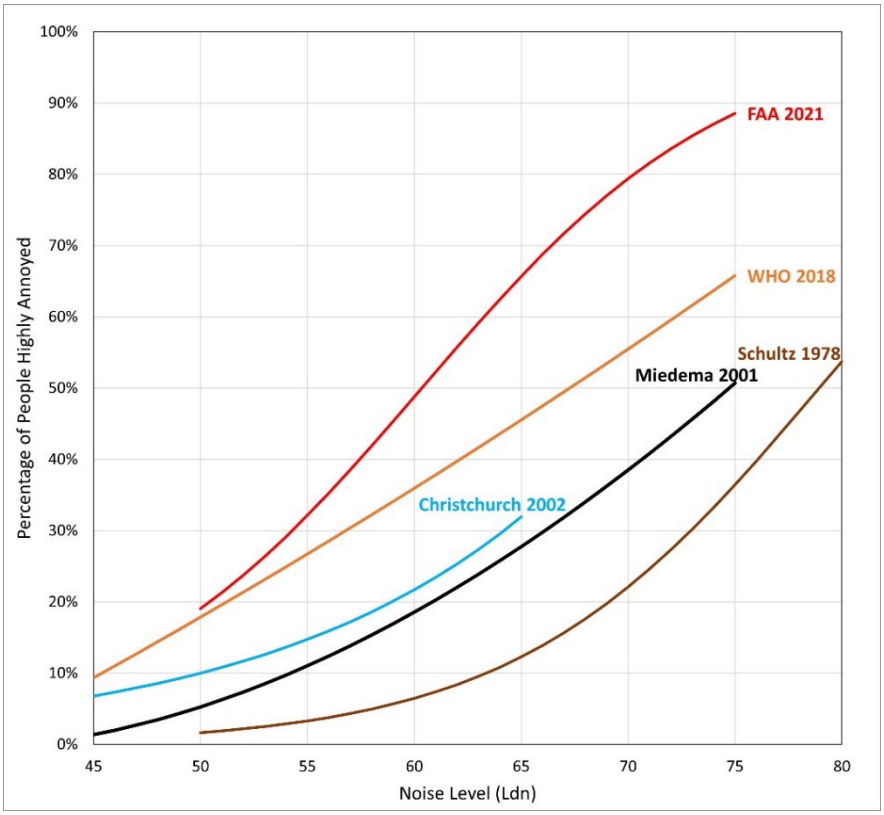
Figure 2 Early dose response curves for transportation noise



Annoyance in Canterbury

32 In 2002 Taylor Baines & Associates and Marshall Day Acoustics undertook a noise annoyance survey in Canterbury to investigate how the local community responded to aircraft noise. The results are included in **Figure 3** and show a slightly higher annoyance response in Canterbury than the 2001 Miedema curve.

Figure 3 A sample of dose response curves for aircraft noise



33 Since 2002 there have been many more studies internationally correlating community annoyance with aircraft noise. Marshall Day recently undertook a review of available literature on community response to aircraft noise. This report is appended to my Hearing Stream 10A evidence. Recent literature suggests that annoyance levels have increased markedly compared with earlier research 20 years ago. Two recent studies that demonstrate this are shown in **Figure 3** (the study referenced by the 2018 WHO guidelines and a study undertaken by the United States Federal Aviation Administration (FAA) in 2021[6]).

34 I note that some researchers contest the conclusion that annoyance is increasing, preferring that surveying methods and sample biases are the cause of the increased annoyance results. Despite ongoing re-analysis of available data by researchers, the various results still indicate higher annoyance responses than the 2001 study widely used previously.

35 The 2018 WHO guidelines recommend a limit for aircraft noise of 45 dB L_{den} as the research indicates almost 10% of the population

[6] US Department of Transportation, Federal Aviation Administration *Analysis of the Neighbourhood Environmental Survey* (National Technical Information Service, February 2021).

are highly annoyed at this level. This is 10 dB lower than NZS 6805:1992 which recommends prohibiting noise sensitive development within 55 dB L_{dn}. I note that NZS 6805 was developed in 1992 and was informed by the Schultz research at the time.

36 **Table 1** below is taken from the 2018 WHO guidelines and shows the predicted annoyance (% people highly annoyed) relative to aircraft noise exposure.

Table 1: 2018 WHO Guidelines Annoyance Response for Aircraft Noise

L_{den} (dB)	%HA
40	1.2
45	9.4
50	17.9
55	26.7
60	36.0
65	45.5
70	55.5

37 Applying this relationship to the Christchurch Airport noise contours, it could be expected that 18 - 27% of people exposed to 50 – 55 dB L_{dn} would be highly annoyed by aircraft noise. This increases to 27 - 46% between 55 and 65 dB L_{dn}.

Sleep Disturbance Effects from Aircraft Noise

38 The literature Marshall Day reviewed found there have been many sleep disturbance studies and dose response relationships developed over the last 30 years using a range of different metrics both indoors and outdoors. However, there is currently not a single accepted approach in the literature to accurately assess the effects of aircraft noise on sleep disturbance. There are generally two types of approach using either energy equivalent metrics (i.e. average noise levels at night) or single event metrics.

39 The energy equivalent metric L_{night} is used in Europe to map night noise impacts from transportation sources including airports. The 2009 WHO Night Noise Guidelines set 40 dB L_{night} as an ideal target to avoid adverse sleep disturbance effects from aircraft and 55 dB L_{night} as a pragmatic interim target to avoid serious health effects from night-time noise where the lower target was not feasible in the short term. The 2018 WHO guidelines only recommends a limit of 40 dB L_{night} to avoid adverse sleep disturbance effects from aircraft based on a predicted 11% of people being highly sleep disturbed at this level.

40 **Table 2**, taken from the 2018 WHO guidelines, shows the predicted percentage of people highly sleep disturbed (%HSD) at various L_{night} levels.

Table 2: 2018 WHO Guidelines Sleep Disturbance for Aircraft Noise

L_{night}	%HSD	95% CI
40	11.3	4.72–17.81
45	15.0	6.95–23.08
50	19.7	9.87–29.60
55	25.5	13.57–37.41
60	32.3	18.15–46.36
65	40.0	23.65–56.05

41 In Australia, Number Above contours using single event level of 60 dB L_{Amax} are used to understand night noise effects around airports. This is an example of the single event noise approach to assessing sleep disturbance.

Application of Research to Noise Management Frameworks

42 Airport noise management frameworks apply objective measures and thresholds based on research to manage noise effects. It is generally not practicable to control for zero effects therefore thresholds are selected to minimise effects as far as reasonably practicable.

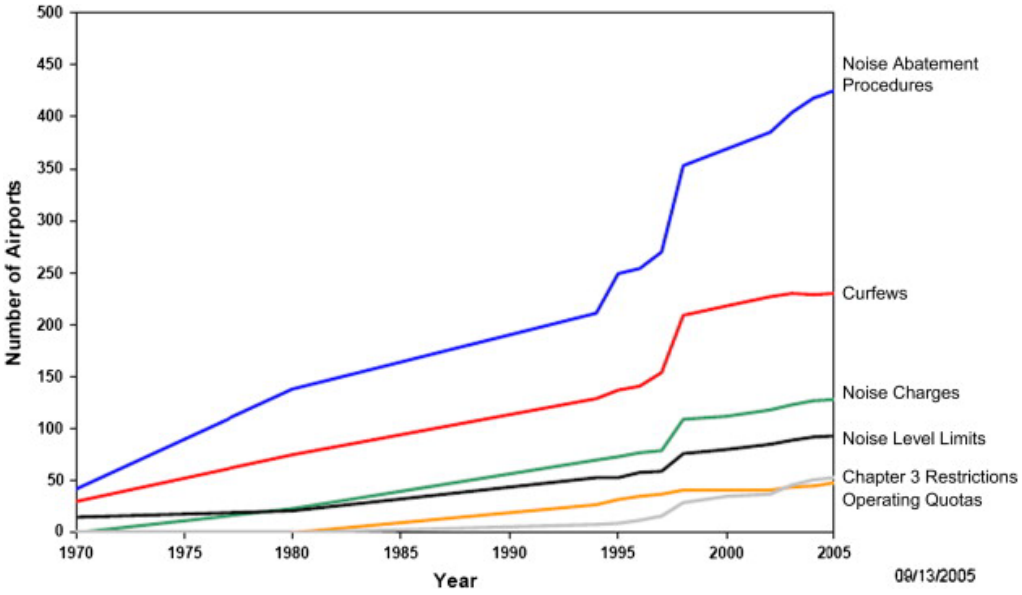
43 There is a wide range of approaches taken internationally with most countries implementing bespoke frameworks that are often based on local research. Different countries have different views of reasonably practicable thresholds, that are related to the local context.

44 Over time the international research has evolved and often the findings change, as we have seen with the annoyance curves. Although the collective knowledge has improved, it is not easy to alter existing airport noise management frameworks. Therefore, a survey of existing frameworks provides an interesting benchmark, but we must recognise that these do not necessarily reflect current knowledge of aircraft noise effects.

REVERSE SENSITIVITY AND AIRPORT OPERATIONAL RESTRICTIONS

45 In contrast to Christchurch's foresighted planning that has resulted in relatively few people inside the noise contours, overseas, there has been less success in keeping people away from airport noise affected areas. As a result, many airports world-wide have had operational restrictions due to noise effects forced upon them. **Figure 4** below shows the significant growth in airport noise restrictions over time.

Figure 4: Growth in Airport Noise Restrictions (Boeing)



46 I understand that some submitters, in other planning processes in Canterbury and around New Zealand, have suggested that reverse sensitivity effects due to aircraft noise are not a real effect and do not need to be considered at New Zealand airports. Some have submitted that operational restrictions on airports do not necessarily correlate with the number of people exposed to aircraft noise and therefore residential density restrictions to mitigate potential reverse sensitivity is unnecessary. These views are contrary to the widely accepted concept that is the foundation for the multitude of noise management frameworks seeking to minimise incompatible land use to jointly reduce noise effects and avoid airport restrictions.

47 From my review of this topic, operational restrictions generally come about either through strong public reaction to a change or through planning processes where airports experience continuous pressure to reduce noise by implementing additional restrictions, and removal of legacy restrictions is very unlikely. I will explain further with examples where airports have experienced these impacts.

Restrictions Through Public Reaction

48 My evidence for Hearing Stream 10A provided some real-world examples of reverse sensitivity effects including the severe public reaction to the new flight paths and/or runways which triggered senate inquiries and operations restrictions at three airports in Australia and the operational constraints that have been placed on Queenstown Airport as a result of planning decisions.

49 In addition to those examples, I wish to bring the Panel's attention to Wellington Airport which is currently experiencing reverse

sensitivity effects related to its lawfully established activities. A residents group exposed to noise in the order of 45 – 50 dB L_{dn} has objected to a flight path change which was introduced for the purpose of improving safety and efficiency of airport operations. Noise from airport operations remains fully compliant with the noise rules. Despite this, the Airport Company was pressured to undertake additional infield monitoring and is currently undertaking a review of the flight path with the potential options resulting in either greater track miles or diminished safety and efficiency.

50 The residents group has also sought a judicial review of the flight path change. In addition to the cost of the monitoring, flight path review study and legal proceedings, the reverse sensitivity effects could result in ongoing flight path restrictions impacting efficiency.

51 Auckland Airport experienced a similar situation in 2013 relating to flight path changes that were within the airport's lawfully established activities. The most oppositional residents were exposed to noise in the order of 45 – 50 dB L_{dn}. Over several years the airport company received an overwhelming number of complaints, undertook additional infield noise monitoring and noise studies and eventually implemented additional alternative flight paths.

52 The Auckland and Wellington experiences demonstrate that even at lower noise exposure levels, residents who are highly annoyed can impact an airport's lawfully established operations.

Restrictions Through Planning Processes

53 The other avenue for operational restrictions being imposed is the constant pressure that airports face through regular planning processes.

54 For these processes, objective measures of the noise effects are used for decision making. When the impact of aircraft noise on a population is assessed, the scale of effects is quantified by the number of people affected.

55 As knowledge and data grows, the commercial cost of operational restrictions will be weighed against the public health cost. It follows that the greater the number of people affected, the greater the health cost in this equation. Therefore, the potential for future operational restrictions is heavily influenced by the number of residential properties permitted in aircraft noise affected areas. Enabling residential intensification inside the airport noise contours not only increases the scale of effects but also adds weight to a case for operational restrictions on an airport.

56 The United Kingdom Department for Transport applies an appraisal method for airport policy interventions that monetises health effects

due to aircraft noise along with other costs and benefits.[7] Monetising all effects of a proposed change (positive and negative) allows a range of factors to be weighed up and provides a standardised comparison of different options.

57 The number of people affected is also used as a measure for noise reduction targets. Schiphol Airport is an example where, until a recent court decision, the airport was required to implement operational restrictions (which involved caps on movements and curfews) to meet targets based on number of houses inside contours and number of people highly annoyed and highly sleep disturbed. The cost of the operational restrictions required to achieve a 19% reduction of houses affected by 48 dB L_{night} or more, was estimated at an average of €710,000 per house[8]. The November 2023 court decision has halted that process for now.

58 In my view it is relevant for this hearing stream, that the costly operational constraints at Schiphol were to be implemented to reduce the number of houses inside the noise contours. In Canterbury there is the opportunity to avoid the Schiphol predicament by maintaining the low number of people affected by aircraft noise, by continuing to avoid additional houses being built inside the noise contours.

Noise Complaints Are Not a Reliable Metric

59 As discussed in my evidence for Hearing Stream 10A, noise complaints are not a reliable metric for annoyance in the community. There are many reasons why people do not complain when annoyance is being experienced. For example, a major reason for people not complaining about noise is when they perceive nothing can be done about the noise source. People are also more likely to complain when an airport changes operation (flight paths or runway length).

60 It is also important to understand that current aircraft noise levels are appreciably lower than the future noise environment that the Updated Noise Contours provide for. As such, the lack of complaints historically does not support intensification of noise sensitive development inside the Updated Noise Contours.

ACHIEVING A BALANCE AND MINIMISING EFFECTS

61 Decision makers must balance the benefits of residential intensification against the consequential noise effects and potential reverse sensitivity effects on airport operations. In my experience,

---

[7] UK Department for Transport "*Transport Analysis Guideline (TAG) Unit A5.2 Aviation Appraisal"* https://www.gov.uk/transport-analysis-guidance-tag

[8] Statement of Evidence of Laurel Smith for Hearing Stream 10A Appendix F of Assessment of Noise Effects Report in Appendix 1.

it is probably unrealistic to plan for zero effects but minimising the scale of effects by minimising the number of people affected is a worthwhile and achievable goal. Many international airport noise management frameworks have objectives such as this. Some seek to avoid exposing more people to aircraft noise effects and the more ambitious seek to reduce the number of people affected.

62 The effects of aircraft noise are not binary across a certain level of exposure. The prevalence of adverse effects is on a sliding scale, increasing as noise exposure increases. The research also shows that an individual's response can vary widely either side of the average community response. Considering these points, it seems appropriate that the land use planning response to manage aircraft noise effects is also not binary. Just as noise effects are on a sliding scale, the extent of mitigation through land use planning can also be progressive in the pursuit of minimising effects.

63 This is the approach taken by the Standard and by many international frameworks, starting with prohibition at the highest exposures and progressively applying other mitigation measures at moderate noise exposure levels such as density controls and acoustic insulation. In my opinion, density controls at lower noise exposures are an effective method of minimising effects and achieving a balance. Acoustic insulation is not a complete solution as I discuss next.

Limitations of Acoustic Insulation

64 Some advocates for residential development in areas affected by aircraft noise suggest that sound insulation fitted to new dwellings is sufficient on its own to avoid the adverse effects of noise and to protect the efficient operation of an airport. I agree that sound insulation can mitigate some of the effects of aircraft noise however I do not agree that sound insulation alone is sufficient to prevent annoyance, health effects and reverse sensitivity effects.

65 There is a lack of evidence to quantify the benefit of acoustically mitigated dwellings. A separate study referenced in the 2018 WHO guidelines showed a reduction in annoyance associated with acoustic mitigation however the evidence was rated low quality.

66 Annoyance relates to indoor and outdoor noise, and acoustic insulation does not mitigate noise effects in outdoor living environments.

67 Indoor environments are only insulated when windows and doors are closed which then requires mechanical ventilation and thermal control. In the New Zealand context, acoustic insulation, ventilation and air-conditioning is a compromise that comes with disbenefits such as operating costs, disconnection from the outdoors, undesirability of living/sleeping in air-conditioned spaces.

68 Research indicates annoyance effects occur at aircraft noise levels of 50 – 55 dB L_{dn} (18 – 27% highly annoyed) where indoor noise levels with windows open would meet typical indoor design criteria (40 dB L_{dn}). This shows that achieving 40 dB L_{dn} indoors does not mitigate all the effects. Research also shows sleep disturbance effects occurring where internal noise levels would meet typical criteria with windows open.[9] This further supports my view that acoustic insulation does not mitigate all effects.

69 In the situation at Schiphol Airport, the recently proposed measures to reduce noise impacts on residents, were not acoustic insulation. Instead, the measures involved reducing and restricting aircraft operations to reduce the number of houses within the noise contours. This is further evidence that acoustic insulation is not a complete solution.

70 In addition to the evidence I presented at Hearing Stream 10A, I wish to highlight that:

70.1 The 1999 WHO noise guidelines[10] includes target values for environmental noise in residential outdoor living areas and balconies as follows:

> "*To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55 dB LAeq on balconies, terraces and in outdoor living areas. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level should not exceed 50 dB LAeq. Where it is practical and feasible, the lower outdoor sound level should be considered the maximum desirable sound level for new development.*"

70.2 The same document also recommends the following for schools and pre-schools and I note the Ministry of Education (MoE) requires this performance standard when certifying new pre-schools in New Zealand:

> "*For outdoor playgrounds the sound level of the noise from external sources should not exceed 55 dB LAeq.*"

Therefore, according to WHO and the MoE, outdoor noise environments do matter for residential and educational

---

[9] Assuming a 15dB outdoor to indoor reduction with open windows, indoor criterion of 30 dB L_{Aeq} is achieved at a level 45 dB L_{night} which correlates with 15% highly sleep disturbed.

[10] World Health Organisation *Guidelines for Community Noise* 1999.

activities, and structures generally cannot mitigate aircraft noise in these environments.

70.3 The ICAO Airport Planning Manual also recognises that "*the major drawback to noise insulation is that it does nothing to mitigate noise outdoors*".[11] Aircraft noise received in residential outdoor living areas is problematic because:[12]

> "*In single-family dwellings in temperate and warm climates, families live outside during many of the daylight hours, especially in the summer months […] It is this outdoor activity that creates the real noise compatibility problem for residential property in the vicinity of the airport."*

70.4 NZS 6805 recommends that new residential development in areas exposed to 55 – 65 dB L_{dn} are prohibited as a preference but provides a fall-back option of requiring acoustic insulation. In my view this approach recognises that insulation does not mitigate all the effects but sometimes a compromise may need to be made depending on the local situation.

71 In summary, I consider that a noise mitigation by insulation approach results in an inferior outcome for residents. It would not mitigate all the effects and it introduces compromised living conditions. An unsatisfactory external noise environment is a potential source of residential complaint with demands to reduce noise, affecting airport operations. In my opinion, sound insulation is a less desirable option to avoiding the effects of airport noise through appropriate land use controls.

CIAL RELIEF SOUGHT

Updated Noise Contours

72 This material is included in my Hearing Stream 10A evidence (paragraphs 99 – 117).

Assessment of Noise Effects in Waimakariri

73 I have prepared an Assessment of Noise Effects (*ANE*) for the Outer Envelope Updated Contours which is appended to my Hearing Stream 10A evidence at Appendix 1.

---

[11] International Civil Aviation Organization *Airport Planning Manual: Part II - Land Use and Environmental Management* (2018, fourth edition) at [7.2.3.4].

[12] International Civil Aviation Organization *Airport Planning Manual: Part II - Land Use and Environmental Management* (2018, fourth edition) at [3.5.8].

74 The ANE considers the impact of changes to the two factors influencing the scale of future aircraft noise effects on the surrounding population:

a) Change in aircraft noise planning environment (Updated Contour);

b) Change in the receiving environment (i.e. growth in residential activity enabled by operative land use controls).

75 Most relevant to this hearing stream is the change in the receiving environment as decisions relating to residential intensification have a direct effect on the scale of future aircraft noise effects in the Waimakariri population. In paragraphs 125 to 131 of my Hearing Stream 10A evidence I provided Waimakariri specific statistics which I summarise below.

76 I considered the impacts resulting from a change in the receiving environment (i.e. increased residential activity). For this, I calculated the number of people affected using a hypothetical future housing stock which represents the theoretical residential capacity within the air noise contours based on the operative density controls.

77 This analysis indicates the currently permitted growth in residential activity in Waimakariri allows a 46% increase in the number of houses inside the noise contours and a 68% increase in the number of people highly annoyed (based on the runway 20 bias scenario).

78 **Figure 5** below shows the predicted number of people highly annoyed in Waimakariri for the existing housing stock compared with the future housing stock. The increase in affected population due to the change in receiving environment is appreciably greater than the increase due to the Updated Contours.

Figure 5: Number of People Highly Annoyed Waimakariri Summary

79 This demonstrates the scale of noise impacts is heavily influenced by population density. It also shows the current planning framework allows an appreciable increase in affected population. This analysis emphasises that land use planning is a major contributor to the future scale of aircraft noise impacts.

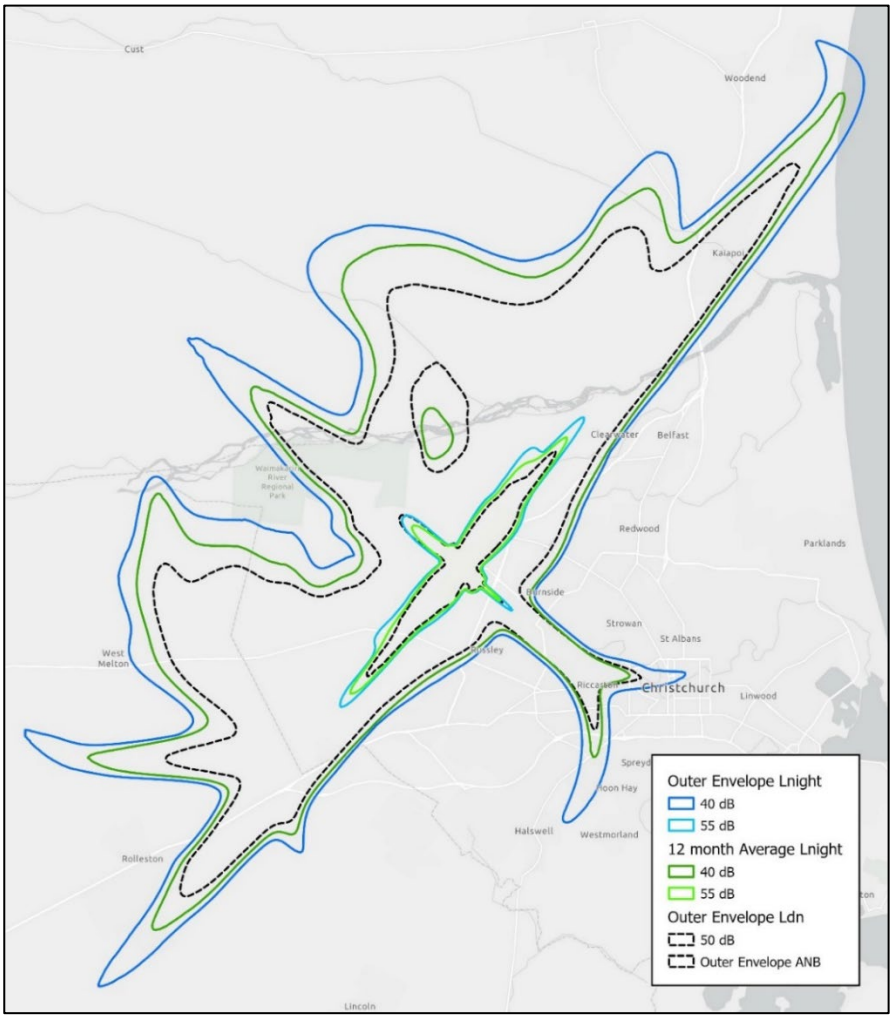
80 If greater residential intensification is enabled inside the airport noise contours, the scale of airport noise effects on the surrounding population could increase even more significantly.

81 In the ANE report I have mapped the L_{night} contours for reference against the WHO guidelines for sleep disturbance effects. This is shown in **Figure 6** below.

82 The 2009 WHO Night Noise Guidelines set 40 dB L_{night} as an ideal target to avoid adverse sleep disturbance effects from aircraft and 55 dB L_{night} as a pragmatic interim target. The 2018 WHO guidelines rely on research that suggests 11% of the population are highly sleep disturbed (HSD) by aircraft noise at 40 dB L_{night}. The same relationship predicts 26% HSD at 55 dB L_{night}.

83 The guidelines refer to L_{night} as the 12-month average which I expect is due to the availability of 12-month average data through the European Environmental Noise Directive (END). Given the seasonal variability of operations at CIA, I have also mapped the Outer Envelope 3-month L_{night} for information.

Figure 6: Night Noise Contours and Remodelled Contour



84 The figure shows that both the 12-month and 3-month 40 dB L_{night} contours extend beyond the Updated Contours. The 40 dB L_{night} target defined by WHO is generally considered to be aspirational. I agree that in most situations it is not practicable to achieve this target. However, when considering whether green fields development and residential intensification in areas affected by aircraft noise is appropriate, consideration of the L_{night} contours in this context is prudent.

85 Decision makers must balance the benefits of residential intensification against the consequential noise effects and an understanding of aspirational targets is appropriate. From a noise effects basis, the L_{night} contours support the case for avoiding new noise sensitive development inside the Updated Contours.

Proposed Land Use Planning

86 The relief sought by CIAL is set out in the evidence of **Mr Kyle** (Hearing Stream 10A and 7). Based on my experience in airport

noise management and my evidence set out above, from a noise effects and airport safeguarding perspective, I support land use controls that minimise the number of residents inside the Updated Noise Contours.

Dated: 30 August 2024

Laurel Smith

APPENDIX 1 PAGES FROM ICAO AIRPORT PLANNING MANUAL

ICAO

Doc 9184

Airport Planning Manual
Part II — Land Use and Environmental Management

Fourth Edition, 2018

Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION

FOREWORD

The purpose of this part of the manual is to provide guidance material on land-use planning in the vicinity of airports and on environmental management regarding airport development and operations. It was originally based on conclusions of the Special Meeting on Aircraft Noise in the Vicinity of Aerodromes held in 1969 and on the current practices of several States. It incorporates guidance material on airport environmental aspects as recommended by the Eighth Air Navigation Conference held in 1974.

"Land-use Planning" and "Environmental Management" are terms of relevance used by airport planners for planning the airport and its environs with a view to ensuring the safety of aircraft operations. Since these issues have evolved considerably in recent years, it was necessary to update the information included in previous editions of the manual and to reflect in the title the evolution of the environmental activities at and around airports.

This publication reflects updates from the Committee on Aviation Environmental Protection (CAEP) that were first presented to CAEP/4 in 1998. Further updates have since been added and this final version of the manual was approved at the CAEP/10 meeting in February 2016.

It is intended that the manual be kept up to date. Future editions will be improved based on the results of the work of ICAO and of comments and suggestions received from the users of this manual. Readers are therefore invited to give their views, comments and suggestions on this edition. These should be directed to the Secretary General of ICAO.

The Secretary General
International Civil Aviation Organization
999 Robert-Bourassa Boulevard
Montréal, Quebec H3C 5H7
Canada

[...]

Chapter 2

ENVIRONMENTAL IMPACTS ASSOCIATED WITH AVIATION ACTIVITIES

2.1 GENERAL

This chapter deals with environmental issues related to airport and aircraft operations. It identifies most of the major environmental issues that may be directly associated with air transport and civil aviation in particular. However, this does not necessarily mean that all of the subjects are suitable for consideration in this manual. Excluded are issues concerning the conditions for passengers and crew (such as the effects of smoking, ozone, high altitude radiation, or noise and vibration within the cabin) and issues concerning the working conditions of airline or airport employees. These are defined as occupational health and safety issues. For each environmental issue presented, a brief description is provided, including a summary of past and present ICAO activities aimed at mitigating the issue, as well as comments on the relevant activities of other organizations, whenever pertinent.

2.2 AIRCRAFT NOISE

2.2.1 Since the introduction of jet aircraft, noise has been considered to be perhaps the most important local environmental impact associated with civil aviation. Noise levels in the vicinity of airports are affected by two opposing trends: the replacement of noisy aircraft by quieter ones and the increasing number of aircraft movements. As a result, the level of impact from aircraft noise may decline at some airports but increase at others. In some cases, the level of impact from noise related to aviation activities has prevented the expansion of airport capacity, thereby limiting airport growth and contributing to airport congestion. Because of this and other environmental concerns, some States limit aircraft operations at airports based on environmental considerations, rather than on airport capacity. In other words, the standard "operational airport capacity" has been replaced by capacity restrictions based on environmental parameters such as noise exposure.

2.2.2 Other noise sources that occur on and around airports may include (but not be limited to) aircraft engine testing, auxiliary power units (APUs) used during ground operations, other equipment such as ground power units (GPUs) and ground support vehicles and equipment (GSE).

2.2.4 Annex 16 — *Environmental Protection*, Volume I — *Aircraft Noise* sets the International Standards and provides Recommended Practices for noise certification of subsonic jet and large propeller-driven aircraft, small propeller-driven aircraft, helicopters and tilt-rotor aircraft. The ICAO Committee on Aviation Environmental Protection (CAEP) maintains and reviews Annex 16, Volume I, and develops new noise Standards and Recommended Practices as technology advances. Annex 16, Volume I, also includes guidelines for noise certification of auxiliary power unit (APU) installations and associated systems, as well as recommendations for noise monitoring and assessment around airports.

2.2.5 A worldwide policy has been developed, at ICAO, to define and implement operating restrictions on aircraft that are either non-noise-certificated or only meet the requirements of Annex 16, Volume I, Chapter 2. These were adopted in 1990 with Resolution A28-3[1] and nearly all States now prohibit the operation of these aircraft in their territories.

1. Superseded by Resolution A33-7.

2.2.6 In 2001, the ICAO Assembly unanimously endorsed the concept of the balanced approach to aircraft noise management and in 2007, the 36th ICAO Assembly reaffirmed the balanced approach principle in Resolution A36-22: "Consolidated statement of continuing ICAO policies and practices related to environmental protection". The balanced approach to noise management developed by ICAO consists of identifying the noise problem at an airport and then analysing the various measures available to reduce noise through the exploration of principal elements, namely reduction at source, land-use planning and management, noise abatement operational procedures and operating restrictions, with the goal of addressing the noise problem in the most cost-effective manner. The recommended practices to assist States in implementing the balanced approach are included in the *Guidance on the Balanced Approach to Aircraft Noise Management* (Doc 9829).

2.3 AIR QUALITY IN THE VICINITY OF AIRPORTS

2.3.1 Air quality in the vicinity of airports can vary greatly depending on local climatic conditions and can be impacted by sources such as road traffic, aircraft engine emissions, emissions from airport motor vehicles and emissions from other sources (e.g. heating/power plants incinerators and construction).

2.3.2 Air pollution refers to a condition of the air quality marked by the presence therein of one or more air contaminants that can:

— degrade the air quality from its normal state;

— endanger the health, safety or welfare of persons;

— interfere with normal enjoyment of life or property;

— endanger the health of animal life; or

— cause damage to plant life or to property.

2.3.3 Air pollution is an environmental problem in many countries, especially in urban areas, and is generally recognized to contain:

— **Carbon dioxide (CO_2)** which is produced by the combustion of hydrocarbon fuels;

— **Carbon monoxide (CO)** is a product originating from the incomplete combustion of hydrocarbon fuels;

— **Oxides of nitrogen (NOx)** result from high-temperature oxidation of atmospheric nitrogen and is composed of a mixture of NO and NO_2. This takes place in the high temperatures and pressures of aircraft engines, road vehicles and other internal combustion sources, and to a lesser extent in other combustion and natural sources (such as lightning);

— **Volatile organic compounds (VOC)** are low boiling point organic chemicals which can be both man-made and naturally occurring. Fugitive emissions and odours from aircraft fuel tanks, oil tanks and other fuel storage facilities can release VOCs into the local area with some recognized as carcinogens. Chronic exposure to some VOCs can cause health problems;

[...]

of identifying the noise problem at an airport and then analysing the various measures available to reduce noise through the exploration of four principal elements, namely reduction at source (quieter aircraft), land-use planning and management, noise abatement operational procedures and operating restrictions.

3.5.2 To reduce noise at source (quieter aircraft), States, manufacturers and research institutions have undertaken research which has led to considerable aircraft engine and airframe performance improvements and reduction of aircraft engine source noise. As a result, modern aircraft are significantly quieter than earlier generations of aircraft. With this in mind, before an aircraft is permitted to operate, it must receive noise certification to required standards granted by the State of Registry. Aircraft noise certification provisions are detailed in Annex 16 — *Environmental Protection*, Volume I — *Aircraft Noise* and the *Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft* (Doc 9501, Volume I), which provides practical guidance to certificating authorities on the implementation of the technical procedures of Annex 16.

3.5.3 Land-use planning and management is an effective means to ensure that the activities nearby airports are compatible with aviation. Its main goal is to minimize the population affected by aircraft noise by introducing land-use zoning around airports. Compatible land-use planning and management is also a vital instrument in ensuring that the gains achieved by reduced noise of the latest generation of quiet aircraft are not offset by encroachment and further residential development closer to the airports. In addition, with a view to promoting a uniform method of assessing noise around airports, ICAO recommends the use of the methodology contained in *Recommended Method for Computing Noise Contours around Airports* (Circular 205). This is discussed in more detail in Chapters 5 to 7 of this manual.

3.5.4 Noise abatement procedures, to further reduce the population adversely affected by aircraft noise, have been employed to reduce noise levels around airports. Noise abatement procedures enable reduction of perceived noise during aircraft operations and can be achieved at comparatively low cost. There are several methods, including preferential runways and routes, as well as noise abatement procedures for take-off, approach and landing. The appropriateness of any of these measures depends on the physical layout of the airport and its surroundings, but in all cases, the procedure must give priority to safety considerations. ICAO's noise abatement procedures are contained in the *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168), Volume I — *Light Procedures,* Part V. In addition to noise abatement procedures, operating restrictions are discussed in 3.2.9.

3.5.5 Acoustical barriers can only provide a benefit in a fairly limited number of situations. A wall or berm between residences and an airport will only be effective against ground-based noise sources such as aircraft taxiing and apron vehicles, and will generally not shield residences from the noise during aircraft take-off, landing and flyover. Furthermore, a wall needs to be placed very close to the residences (within about 20 m) and needs to be built sufficiently high to block the line-of-sight between the noise source and receiver.

3.5.6 If the airport has a large buffer area between it and areas affected by ground-based noise, a forested area can provide better noise mitigation than bare land. The forest buffer would need to be at least 100 m deep and care would need to be taken not to create a wildlife hazard for aviation.

3.5.7 The use of a noise barrier or enclosure to reduce the noise from aircraft engine run-ups is discussed in 4.6.2 of this manual.

3.5.8 Sound insulation can be used to improve the aircraft noise intrusion levels within buildings affected by aircraft noise. Whether retrofitted to existing buildings or required a part of a building code for new constructions, sound insulation clearly can only improve the internal noise levels of a residence, hospital or school. Furthermore, as the benefits of sound insulation are negated if a building occupant opens external windows or doors, in many climates, sound insulation will need to be accompanied by the provision of alternative ventilation for habitable spaces. Further discussion on sound insulation can be found in the land-use planning sections of this manual in Chapter 7.

[...]

Chapter 5

LAND USE

5.1 GENERAL

Land use around airports can impact the operational safety and efficiency of the airport, the safety of surrounding communities, and community exposure to the environmental effects of airport operations. Hence, activities around an airport that can affect the safe and efficient operation of aircraft and/or community exposure should be taken into consideration when planning land uses in the vicinity of airports. Similarly, land-use compatibility planning can also be utilized to minimize impacts such as aircraft noise on surrounding communities and local third'-party risk. As guidance on proper airport and land-use compatibility planning, this chapter describes a variety of possible land uses with a broad appreciation of their relative sensitivity to aircraft and airport operations, local third-party risk and aircraft noise exposure and describes their compatibility or incompatibility to aircraft noise and to airport operations.

5.2 NATURAL LAND USE

5.2.1 Every airport is different, as are the areas surrounding them. Natural areas, such as forests, open land, rivers, swamps, and bays are found in varying degrees in the vicinity of airports. In many cases, the presence of natural areas influences the selection of the airport site. In other cases, the selection is based on different factors, but the existence of natural areas can provide additional benefits.

5.2.2 The presence of natural features in aircraft approach and climb-out areas has done much to prevent aircraft noise problems. An example is a new airport which has been situated in the bend of a river to take advantage of the close-in water approaches under both ends of the runway. Runways located on filled land on the edge of bays also afford unobstructed approaches over water. New airports have even been located on artificial islands created specifically for the airport. Bird control measures should be used and proper reporting of bird strike problems followed in such cases.

5.2.3 Natural features have been, and can be, used to advantage not only in reducing noise impacts but also in adding natural elements and interest to the airport. Nevertheless, where rivers, lakes, bays or swamps are found in the airport area, bird hazard problems may exist. At some airports, this problem has been so serious as to cause accidents.

5.3 AGRICULTURAL LAND USE

Many airports provide an opportunity to establish agriculture in order to increase revenues. The agricultural use of land contributes several important factors to an airport programme, such as:

a) producing income from what might otherwise be waste or idle land;

b) providing crop cover and prevents soil erosion; and

c) eliminating the expense to the airport of mowing or taking care of the land.

5.8.2 The location of industrial sites at the airport has generally been found to be compatible with aircraft noise because of the relatively higher ambient noise level, both internal and external, associated with industrial activity. This factor, combined with the ever growing need for industrial land around airports, has contributed to the development of industrial parks in and around commercial and general aviation airports. Business has learned to take advantage of the unique benefits that air transportation can offer, and many major commercial enterprises are also located at airports.

5.8.3 Prospective sites for industrial development should still satisfy the following basic requirements:

a) desirable geographical location, considering the community in question;

b) availability of land of sufficient size to accommodate the planned industrial development;

c) access to commercial transportation facilities, in addition to air transportation, if necessary;

d) present and/or future availability of needed utilities;

e) access to nearby residential areas for the industrial employees, with reasonable commuting time; and

f) compatibility of proposed industrial development with other area land uses.

5.9 RESIDENTIAL AND INSTITUTIONAL LAND USE

5.9.1 In this publication, residential housing refers to single-family dwellings, multi-family dwellings, and estates. Institutional housing refers to community facilities such as schools, hospitals and churches. All these facilities should be planned and situated with thorough consideration of airport activities and the potential arrival and departure corridors with the goal to reduce the number of properties affected by aircraft noise and other environmental impacts.

5.9.2 In single-family dwellings in temperate and warm climates, families live outside during many of the daylight hours, especially in the summer months. This is also true of estates and, to a lesser extent, of multi-family dwellings, particularly where a community swimming pool exists. It is this outdoor activity that creates the real noise compatibility problem for residential property in the vicinity of the airport.

5.9.3 Institutional dwellings may require a greater degree of sound insulation than do residential structures because a lower sound level is necessary for indoor use. The requirements of patients in hospitals and of the speech level in schools and churches demand special evaluation if these facilities are located in the vicinity of the airport.

[...]

Chapter 6

LAND-USE PLANNING

6.1 GENERAL

6.1.1 The *Guidance on the Balanced Approach to Aircraft Noise Management* (Doc 9829) provides guidance on alleviating the problem of noise in the vicinity of airports. This "Balanced Approach" recommends consideration of four noise management pillars, one of which is land-use planning.

6.1.2 Land-use planning can be an effective means to ensure that the activities nearby airports are compatible with both current and future aviation activities. Its main goal is to minimize the population affected by aircraft noise by introducing land-use planning measures, such as land-use zoning around airports. In addition, land-use planning also can have safety benefits for those people living in the vicinity of an airport.

6.1.3 There are substantial benefits to be gained from the correct application of land-use planning techniques in the development of airports. Land-use planning benefits may take time to be fully realized and should be implemented as soon as noise problems are foreseen. Efforts to correct situations detrimental to proper land-use around airports should however not be ignored simply because of the lead time for such measures to be effective. This is particularly true in the application of land-use planning to existing airports where it is recognized that the ability to make immediate land-use changes is limited, but where it is also important to prevent further expansion of incompatible land uses.

6.1.4 Compatible land-use planning and management based on appropriate "planning" noise contours, rather than "current" noise contours, can prevent encroachment of residential development at airports where future aircraft noise levels are projected to increase. Using "current" noise contours for land-use planning can allow residential encroachment, thereby nullifying the benefits the reduced noise of the latest generation of quiet aircraft.

6.2 ASSESSING NOISE FOR LAND-USE PLANNING

6.2.1 The intrusiveness of aircraft noise in airport communities is dependent upon many factors including the following:

- sound pressure level;
- broadband frequency distribution;
- tonal content;
- noise duration;
- flight path, including take-off and landing profiles;
- number, frequency and time of day of operations;
- operating procedures (such as engine power settings, cutback altitude);

[...]

6.2.5 In general, land-use planning should be based on a "planning" noise contour for a projected future operational scenario or based on traffic forecasts and airport capacity, taking into account future runway and infrastructure development. Three time horizons are usually studied: short-term (around five years), medium-term (around ten years) and long-term (around fifteen years).

6.3 NOISE ZONES AND ASSOCIATED MAXIMUM NOISE INDICES

6.3.1 In general, the planning noise contours can be used to define noise zones around the airport. The structure of noise zones should be inherently related to the particular situation where they are applied. In many jurisdictions, two zones (e.g. medium and high noise zones) are used, but in some cases more zones, either with a finer gradation or a greater noise range (e.g. medium to very high) may be used.

6.3.2 Land-use rules are then adopted and enforced based on the noise level in each zone. Some examples are provided below and in Appendix 3.

— In a high-noise zone, new noise-sensitive developments, such as residences, hospitals and schools might be prohibited. Those which already exist might be subject to sound insulation and ventilation retrofits.

— In a medium-noise zone, new developments might be allowed but subject to maximum density limits or specific sound insulation and ventilation requirements.

These zones or land-use rules may be subdivided into various noise exposure levels for appropriate land-use planning and other measures by the national or local authorities. Such measures should be strictly enforced to prevent any noise-sensitive development. Outside these noise zones, the level of aircraft noise is deemed to be compatible with residential activity and land-use restrictions are generally not required.

6.3.3 The values of the noise exposure indices, corresponding to the noise zones adopted for land-use planning, should form a logical progression. States use different noise descriptors and noise-exposure calculation methods to determine the noise levels for different land uses. An approximate comparison can be made between the values of the different methods used by States (for a description of these methods, see the *Recommended Method for Computing Noise Contours around Airports* (Doc 9911)). France, applying the European Directive 2002/49EC at the national level, uses the L_{den} noise metric for noise contours around French aerodromes. For each noise exposure map, three and sometimes four noise zones are defined (PEB: Plan d'Exposition au Bruit) (see Table 6-1). The legal limit values in L_{den} for these noise zones may vary depending on the type of traffic and on local situations.

6.3.4 Land-use restrictions for new constructions vary with noise zones. For example, only housing and facilities necessary for aeronautical activities, as well as public facilities which are vital to the existing population are allowed within Zone A, whereas no land-use restrictions for new constructions but obligation to insulate new housing and to inform inhabitants within Zone D.

[...]

Wherever possible, and particularly when planning the construction of new airports, the location of the airport should be considered as a part of the total planning environment, so that long-term community needs and the consequences of the airport's operation in terms of noise exposure are not in conflict (see Table 6-4).

Table 6-4. Some typical examples of compatible land uses around airports

	Zones		
	A	B	C
Examples of compatible land uses or development	Most land uses and development are not permitted	Some restriction on land uses and developments	Unrestricted land uses and developments
Agricultural: Crop farming	unrestricted	unrestricted	unrestricted
Industrial: Machine shop	unrestricted	unrestricted	unrestricted
Commercial: Warehouse and shipping	unrestricted	unrestricted	unrestricted
Offices and banking	restricted	restricted	unrestricted
Residential: Low-density housing	restricted	restricted	unrestricted
High-density housing	prohibited	restricted	unrestricted
Public facilities: Schools and hospitals	restricted	restricted	unrestricted

Note 1.— With respect to certain uses (e.g. housing and commercial), a development might be allowed in a zone of a higher restriction when other planning considerations indicate a need, and where suitable building techniques, sound insulation, etc., can reduce the aircraft noise exposure to an acceptable level.

Note 2.— In special cases where activities depend on speech communication (e.g. schools) or require more stringent standards (e.g. certain hospital activities), additional restrictions may be required to take into account absolute noise levels as well as total noise exposure, unless noise reduction can be ensured in the building construction.

Note 3.— The zones will have to be defined against a noise exposure scale (e.g. noise contour mapping) and will have to take into account local and national needs when the zones are drawn up.

Chapter 7

LAND-USE ADMINISTRATION

7.1 GENERAL

7.1.1 Noise exposure is not the only factor to be taken into account for the purpose of land-use management in the vicinity of airports. It is recognized that economic factors are involved in land-use choices. Ideally, land-use decisions around airports would try to find a compatible balance between the interests in the land and the aeronautical use of the airport. For this reason, the authorities, local or central, have an important part to play in ensuring that aircraft noise exposure is taken into account when planning land use in the vicinity of airports and that the ensuing plans are implemented.

7.1.2 There are many techniques for regulating development or bringing about conversion or modification of existing land uses to achieve greater compatibility between the airport and its environs. Some of these may be controls, such as zoning or building and housing codes; other methods influence development through acquisition or taxation. Experience has shown that any attempt to control land use through easements and purchases is extremely expensive and cannot be considered as a solution to the entire aircraft noise problem. A more practical approach is the adoption of proper land-use planning and zoning. Zoning, however, is limited in its ability to effect changes around existing airports located in developed areas. Land use can be managed more effectively when zoning is applied to new airports and existing airports in still undeveloped areas.

7.1.3 Unfortunately, local land development decisions are often made based on considerations which may ignore both the need to minimize the impact of aviation noise on the community and the importance of protecting the airport from encroachment by incompatible development. The most common issues are the return that the owners or developers want from their commercial properties, the local government's interest in increasing the tax base, and the interest of the owners and residents in maintaining or improving the value of their homes. For the airport environs, the cumulative total of such local decisions can seriously degrade a balanced, comprehensive planning approach and development policy. The desired goal is for effective land-use planning based on objective criteria, to minimize the amount of noise-sensitive development close to airports, while allowing for other productive uses of the land.

7.2 LAND-USE MANAGEMENT

7.2.1 Introduction

Various measures are available for managing the use of land around airports. The effectiveness of these measures for both existing and new airports should be considered on a case-by-case basis. Based on a survey of land-use measures and policies in the countries reviewed, it can be stated that no single strategy prevails over other strategies in dealing with this issue. While land-use management and noise-insulation measures are generally transferable from one place to another, the selection of a particular measure and the precise manner in which any measure is formulated, applied and financed depend to a great extent on specific national and local circumstances. Overall, land-use management measures can be categorized as:

a) planning instruments, including comprehensive planning, noise zoning, subdivision regulations, transfer of development rights, and easement acquisition;

b) mitigating instruments, including building codes, noise insulation programmes, land acquisition and relocation, transaction assistance, real estate disclosure, and noise barriers; and

c) financial instruments, including capital improvements, tax incentives and noise-related airport charges.

7.2.2 Planning instruments

Comprehensive planning

7.2.2.1 Comprehensive planning takes into account existing development and ensures that future development is compatible with various community goals. In most countries, the land-use planning and control authority rests with local governmental bodies, which may be obliged or advised to take into account aviation noise measures.

7.2.2.2 A well worked-out comprehensive plan that is used effectively to guide local land-use decisions and development (e.g. zoning, capital improvements planning, subdivision regulations, and environmental review) is among the most powerful and affordable of all compatibility strategies. This is particularly true in developing areas, but it can also be highly effective in guiding urban renewal or redevelopment. The success of such comprehensive planning depends upon its implementation through various developmental decisions and controls.

7.2.2.3 As a land-use control system in relation to airports, comprehensive planning is applied in varying degrees in all the countries surveyed. This strategy appears to be a valuable instrument that is transferable to other countries.

Noise zoning

7.2.2.4 Noise zoning for land use serves a two-fold purpose: the protection of the airport and the protection of the residents. It can be applied to existing airports as well as to future airport development. Zoning should take into account anticipated future airport development so that when airport development takes place, it has minimal impact. In some countries, such as France, there are noise maps that define land-use restrictions for new constructions (so-called PEB – Plan d'Exposition au Bruit) and noise insulation maps (so-called PGS – Plan de Gêne Sonore) that define those inhabitants who may benefit, under specific conditions, from home soundproofing grants.

7.2.2.5 Noise zoning enables a national or local government to define the uses for each parcel of land, depending on the level of noise exposure. It generally consists of a zoning ordinance which specifies land development and use constraints, based on certain noise exposure levels. The noise contours extending outward from the airport delineate areas affected by different ranges of noise exposure. No uses other than those specified for a particular area should be permitted.

7.2.2.6 In an ideal scenario, noise zoning regulations are established and known by all relevant authorities and stakeholders. The noise contours produced by the airport authority should be based upon on maximum airport capacity and the worst possible noise case scenarios, and provided to a single high-level government authority to administer and oversee. The government authority would then ensure that any application of noise-sensitive developments are appropriately considered to ensure that developments only occur within acceptable noise zones, as prescribed by the relevant noise zoning regulations.

7.2.2.7 In many instances where there are multiple local government authorities responsible for development approvals, these local jurisdictions with zoning power (cities, towns or larger administrative units) may often have differing or conflicting policies that have little continuity between authorities. They may also not be aligned to the noise zoning regulations and the maximum theoretical noise contours that have been produced. Having a single authority to enforce the continuity of noise zoning regulations across several local government areas within the airport noise contours can alleviate the problem of multi-jurisdictional interests.

7.2.2.8 Another issue is that the interests of the noise-affected communities near airports are not always consistent with the needs and interests of the airport operator nor with those of each other. Within local government authorities and various communities there is usually a desire for greater population growth, and rising land values. It is these drivers that are often in conflict with the need to preserve surrounding airport areas so as not to compromise the noise reduction benefits achieved from new generation aircraft, with the ultimate goal being to further reduce the total number of people affected by airport related noise.

7.2.2.9 Noise zoning can and should be used constructively to increase the value and productivity of the affected land. One of the primary advantages of zoning is that it may be used to promote land-use compatibility, while still leaving land in private ownership, on the tax rolls, and as economically productive as possible.

7.2.2.10 Zoning is not necessarily permanent and may be changed, although this may be difficult in some countries because of the local legal system. Zoning is usually not retroactive. Changing zoning primarily for the purpose of prohibiting a use which is already in effect is generally not possible. Where such zoning is allowed, an existing use may be allowed to remain as "nonconforming" until a later date when it is changed voluntarily to a conforming use. For this reason, zoning is most effective at airports that have not yet felt the impact of buildings. Furthermore, the proposed use of vacant land must be related to the market demand for the proposed activities, such as commerce or industry.

7.2.2.11 Noise zoning around airports is applied in nearly all surveyed countries as a planning measure to prevent new noise-sensitive developments near the airport. However, it is sometimes only applied to the larger or national airport(s). Ideally, noise zoning should be established for all airports.

Subdivision regulation

7.2.2.12 Noise zoning ordinances may include subdivision regulations. These regulations may serve as a guide to development in noise-impacted areas by reducing building exposure through orientation and density transfer and by providing open-space requirements.

7.2.2.13 Subdivision regulations on their own can be useful in minimizing noise impacts on new development. They would not affect existing development. By means of restrictive covenants, the owner is legally notified that the property is subject to noise from aircraft operations. Additionally, a covenant could require buildings to be designed and constructed in such a way as to minimize interior sound derived from exterior noise sources to the acceptable level.

Transfer of development rights

7.2.2.14 Under this concept, some of the development rights of a property are transferred to another property that is far from the airport where the rights may be used to intensify the level of allowable development. Land-owners could be compensated for the transferred rights by the sale of these rights at new locations or the purchase of the rights by the airport. Depending upon the market conditions and/or legal requirements, the airport could either hold or resell the rights.

7.2.2.15 The transfer of development rights must be fully coordinated with a community's planning and zoning. It may be necessary for zoning ordinances to be amended in order to permit the transfer of development rights. Such transfers are usually effected within a single jurisdiction.

Easement acquisition

7.2.2.16 An easement confers the right to use a land-owner's property for a limited purpose, normally in exchange for some value. In the context of airport noise-compatibility planning, two general types of easements are available:

a) those which permit airport noise over land (including right of flight); and

b) those which prevent the establishment or continuation of noise-sensitive uses on the subject property.

7.2.2.17 For maximum effectiveness, easements should restrict the use of land to that which is compatible with aircraft noise levels. Easements should also ensure the right of flight over the property, the right to create noise and the right to prohibit future height obstructions into airspace. Restrictions that may be addressed by such easements include types of buildings, types of agricultural activity that may attract birds, electromagnetic interference, and light emissions.

7.2.2.18 The first type of easement described in 7.2.2.16 a), which simply buys the right to make noise over the land, has fewer advantages. It does nothing to change the noise-sensitive character of the land or to reduce noise for people on the property. However, it does legally protect the airport operator from noise litigation, financially compensates property owners for noise, and warns potential buyers that a property is subject to aircraft noise.

7.2.2.19 The second type of easement described in 7.2.2.16 b) can be a highly effective strategy for ensuring compatible development around airports in situations where land is being developed for the first time or is being redeveloped in connection with a land acquisition and relocation strategy or general urban redevelopment programme. The easement has the advantage of being permanent. It is less costly than outright purchase of land (if the land has not otherwise been purchased) and it allows the land to remain in private ownership, in productive use, and on local tax rolls. This latter type of easement is used most frequently in combination with noise insulation. Such easements are often required by airport owners in exchange for noise insulation. Again, the use of certain easements is dependent on the legal system.

7.2.3 Mitigating instruments

Building codes

7.2.3.1 Construction techniques and material standards often determine the interior noise levels of residential or commercial structures in noise-impacted areas. Building codes are essentially a legal means of requiring the incorporation of adequate sound insulation in new construction. Any noise-insulation strategy depends upon a closed-in structure for maximum effectiveness, and this in turn usually raises the issues of adequate ventilation and air conditioning in warm weather.

Noise insulation programmes

7.2.3.2 Noise insulation can lower interior noise levels for structures that cannot reasonably be removed from noise-exposed areas (e.g. residential buildings). Noise insulation is particularly effective for commercial buildings, including offices and hotels. However, it is much more desirable to control insulation requirements for such buildings from the outset, if they must indeed be constructed in noise-exposed areas. While there may be difficulties in getting sound insulation requirements incorporated in building codes for new construction, these are slight compared with the problems of effective soundproofing for existing buildings, particularly housing. Even if houses in high-noise areas were made of stonework, insulation and air conditioning may cost more than the value of the additional rent or sales' prices. The degree of insulation requirements varies from country to country. In some countries, the acceptable level of interior

noise is prescribed by legislation. As an example, French legislation defines indoor–outdoor noise reduction levels for each noise zone of a noise exposure map (PEB). These requirements are applied for new constructions and depend on the type and the allocation of the buildings.

7.2.3.3 A noise-insulation programme should be preceded by a structural and acoustical survey of all homes and other buildings earmarked for noise insulation. The cost of noise insulation depends upon several variables, such as the degree of insulation required (from insulating the attic only to insulating all exterior walls and ceilings and upgrading doors and windows), size and condition of the building, and location within the noise exposure area.

7.2.3.4 For effective noise insulation, it is necessary to have a closed-window condition, which may not be desirable to homeowners in all seasons and which imposes additional ongoing costs to home-owners for climate-control systems. The major drawback to noise insulation is that it does nothing to mitigate noise outdoors. This drawback however does not apply as much to schools, hotels, commercial structures, or even large apartment buildings, because they are frequently constructed with a closed-window condition and their activities usually take place indoors.

7.2.3.5 Other insulation programmes could include sound conditioning or air conditioning. This can contribute much towards making all types of dwellings acceptable during the hours when the interior of the building is in use; this is particularly important during the night-time hours. Hence, the amount of sound reduction must be balanced against the external sound level in order to achieve an acceptable noise level for the occupants of the dwelling. Installation of sound conditioning can be relatively simple if incorporated initially in new construction but becomes more complex if incorporated as a modification of old construction.

Land acquisition and relocation

7.2.3.6 This strategy involves the acquisition of land through purchase by the airport operator (or planning authority in case of new developments) and the relocation from the acquired land of residences and businesses that are not compatible with airport-generated noise levels. This strategy is within the direct control of the airport operator (or planning authority) and does not require additional action by another political entity.

7.2.3.7 Land acquisition and relocation assure an airport of long-term land-use compatibility. Acquired land can be cleared, sold with easements (to control future development), and redeveloped for compatible land uses. However, this strategy is not a practical solution to the total noise problem because it is costly and socially disruptive to buy all significantly noise-impacted land.

7.2.3.8 Land acquisition and relocation have been widely used in the United States by airport operators as the ultimate solution to land-use compatibility in certain areas with significant noise exposure.

Transaction assistance

7.2.3.9 Transaction assistance involves some level of financial and technical assistance to a homeowner who is trying to sell a noise-impacted property. It may involve paying realtors' fees. An airport operator may even buy the property which has been on the market for an extended period of time and then resell it. In order to become compatible with noise levels, the properties are noise-insulated prior to resale and usually resold with an easement. This strategy can be useful in areas where it has been decided that existing residential neighbourhoods will be maintained. It can also be less expensive than other acquisition strategies. Homeowners are sometimes given a choice of noise insulation/easement or transaction assistance. These choices enable those people most annoyed by noise to leave the area and prevent the airport authorities or developers from having to buy out everyone.