Appendix F

Background to the Western Sydney International Airport noise insulation and property acquisition policy

Overview of research to inform the noise insulation and property acquisition policy for Western Sydney International (Nancy-Bird Walton) Airport

F1 Introduction

Under Condition 16(7) of the Western Sydney Airport Plan, DITRDCA is required to develop a noise insulation and property acquisition (NIPA) policy in relation to aircraft overflight noise for buildings outside the Airport Site, having regard for the 24-hour nature of operations at WSI. This condition was included as part of the Government's approval for Stage 1 of WSI for single runway operations and 10 million annual passengers.

Land use planning and development restrictions have been in place for some time in proximity to WSI, including through a range of State Environmental Planning Policies. Outside of these planning restrictions, the primary mechanism to manage aircraft noise within communities is the application *of Australian Standard 2021: Acoustics – Aircraft Noise Intrusion – Building Siting and Construction:2015* (AS2021). The purpose of AS2021 is to inform land use planning of new developments near existing airports (e.g., within ANEF contours) and building requirements associated with noise affected areas. Further information is outlined in Technical paper 6: Land use and planning.

There will still remain residual noise impacts that may not be fully addressed by the flight operations design at existing sensitive buildings and land-uses. DITRDCA recognises this, and the need to preserve living amenity for those most significantly affected residents and communities.

The NIPA policy outlines criteria for those properties that are significantly impacted by aircraft overflight noise who, subject to final government approval, will be eligible for either voluntary acquisition or noise insultation treatment.

In order to inform the development of this policy DITRDCA undertook a review of:

- literature associated with aircraft noise impacts and perceptions of noise
- existing standards and guidelines commonly adopted to reduce aircraft noise impacts
- similar noise insulation and acquisition policies and associated programs that have been implemented in Australia and internationally.

The section below summarises this process and the key findings.

F2 Aircraft noise treatment

Aircraft noise, a by-product of a growing economy, is considered the most significant cause of adverse community reaction to aviation operations. Given the spread of sound, potentially affected parties include all residents and other noise sensitive land-uses in the areas surrounding airports and under flight paths. For those relatively close to these flight paths, aircraft noise can be well above the background noise. Additionally, aircraft noise events can be infrequent and occur at some of the most sensitive times of the day, including night-time hours.

While it is not possible to guarantee any suburb, group, or individual exemption from aircraft noise exposure, aircraft noise management needs to consider the effects of noise on everyday activities.

Noise, being airborne sound, enters a residential dwelling or building in broadly the same ways that air enters – through openings (windows and doors) and cracks and gaps (window frames, open eaves etc.). The pathways and mechanism for aircraft noise to penetrate a building, via the building envelope elements, is provided in Figure F.1. This figure highlights the common weak points where noise intrusion is greatest, which tends to be the elements that have a low density or a large area.

The main building elements that contribute to noise intrusion within an existing dwelling include:

- cracks and gaps in building envelope at joints (e.g., window/door frames, roof-façade junction, etc.)
- open windows or natural ventilation vents
- closed windows or solar tube lights
- entry doors (e.g., glazed sliding doors or solid core entry doors)
- combined roof and ceiling construction (e.g., steel roof or rooftiles)
- air conditioning ducts or kitchen exhaust fans
- solid façade elements (e.g., masonry, weatherboard, etc.).

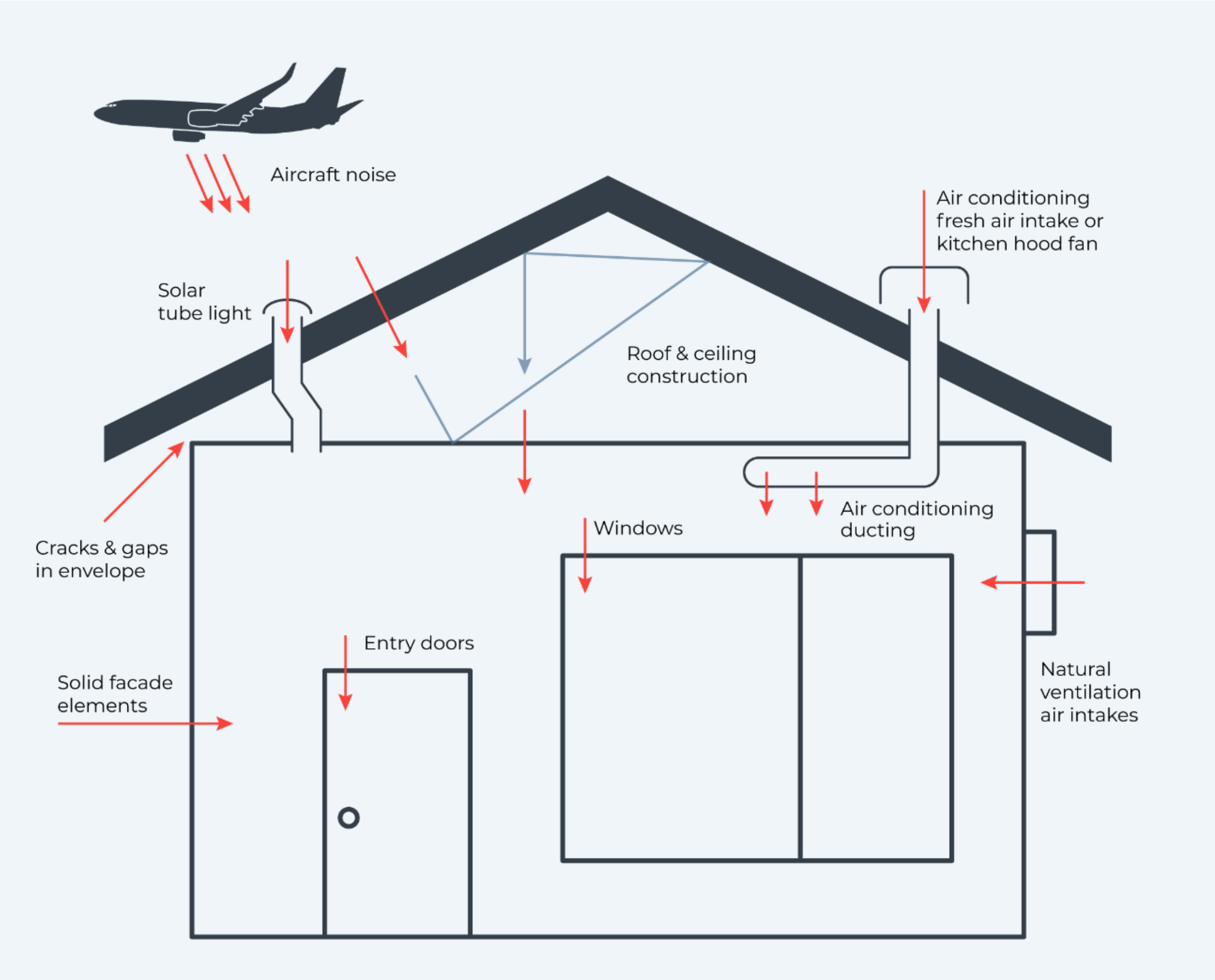

Figure F.1 How sound can permeate into a building

The overall level of external noise entering a dwelling is the combined effect of all the pathways for sound. Measures to restrict and limit the intrusion of noise within a dwelling therefore need to target the primary (dominant) pathways for sound to achieve an overall reduction to the noise intrusion.

As aircraft fly overhead, the roof area is the largest element of a home exposed to aircraft noise. Aircraft noise usually impacts the facades of a dwelling fairly equally, unlike noise from road traffic where one or two facades of a dwelling tend to experience the majority of the noise. Options to help reduce the amount of aircraft noise within a dwelling may have to consider treatments to all major elements of the building, including the roof and ceilings.

An aircraft noise event comprises sounds across a wide range of frequencies. At its source aircraft noise contains high, mid, and low frequency noise. Due to the distances people are located from runways and flight paths, it is often the residual low frequency aircraft noise that can cause annoyance.

Low frequency sound can penetrate buildings, and in some cases induce perceptible vibration of elements such as glazing and light weight walls. The standard sound insulation of a dwelling does not always sufficiently reduce low frequency noise, and to achieve an overall improvement to the internal noise environment the intrusion of the low frequency noise needs to be controlled.

Due to its acoustic characteristics, low frequency noise can be difficult to attenuate. To improve the low frequency sound insulation performance of building elements, the following two principles apply:

- Increasing the weight or density of the element. (e.g., adopting concrete or masonry wall constructions, increasing the glazing thickness of windows, and adding additional layers of plasterboard)
- increasing the width of the cavity between two construction elements. (e.g., implementing timber stud constructions and double glazing). The sound energy dissipates across the air gap introduced by the cavity.

Good acoustic design for properties and buildings should incorporate one or both of these principles. It is good practice to first mitigate noise intrusion via the weakest elements to achieve a suitable reduction in noise and provide a cost-effective solution. For example, upgrading window glazing would result in a more noticeable improvement compared to upgrading a solid masonry wall.

In most cases the effectiveness of noise reduction measures to a home or dwelling requires the external windows and doors to be kept closed. Any open windows or doors can substantially limit the level of aircraft noise reduction that could be achieved. Requirements to close windows and doors are usually accompanied by complementary measures to ensure adequate air flow and ventilation within a dwelling.

Referencing *Reducing Aircraft Noise in Existing Homes* provided by Perth Airport, a summary of the conventional options available to reduce the intrusion of aircraft noise to existing homes is provided in Table F.1.

Table F.1 Practical ways to reduce noise levels in a home[1]

Option	Example treatment	Potential noise reductions
Sealing gaps around doors and windows	• Caulking gaps around window frames with a mastic sealant. • Sealing larges gaps (>15 mm) with expandable foam. • Installing compressible seals to window and door frames. • Installing seals to door thresholds.	• Reductions up to 10 dB (possibly higher) can be achieved.
External doors	• Replace or upgrade hollow doors. • Install perimeter seals to door frames.	• Hollow doors can reduce noise by approximately 18 dB(A). • Solid core doors with acoustic seals can improve noise reduction to up to 30 dB(A).
Closing vents in walls and ceilings	• Grouting up wall vents or covering over with fibre cement sheeting. • Removing vents in walls that are not currently in use and sealing over the openings.	• Reductions up to 10 dB (possibly higher) can be achieved.
Ventilation	• Closing windows. • Install small fans in the roof with acoustic seals and ductwork. • Install an acoustic baffle over ceiling exhaust fans. • Avoid through-wall air conditioning systems.	• Reductions up to 10 dB (possibly higher) can be achieved.

Option	Example treatment	Potential noise reductions
Roofs and ceilings	• Add thermal insulation above the ceiling. • Use surface mounted or drop lights. • Lay plasterboard over joists and add insulation above the plasterboard. • Install loaded vinyl noise blanket over insulation and joists.	• Reductions greater than 10 dB can be achieved.
Windows	• Increasing the thickness of single glazing. • Install double glazing (two panes of glass with an air gap). • Consider awning windows rather than sliding windows.	• Improvements to single glazing can reduce noise by up to 8 dB. • Upgrading to double glazing is more effective and can reduce noise by 10 dB or more.
Other elements	• Remove skylights. • Close open eaves. • Insulate the cavity of weatherboard walls.	• Reductions up to 10 dB (possibly higher) can be achieved.

1. Perth Airport (2016). Reducing Aircraft Noise in Existing Homes

One of the main challenges of a noise insulation program is the range of application, both in terms of volume and breadth of property typologies. Without considering the particularities of WSI's location and surroundings, it is expected that any program would have to deliver noise treatments to suit a broad range of properties and dwellings – such as single-dwellings, high-density residential, retail and commercial properties. In addition to these building typologies, the building elements presented in Table F.2 may impact individual treatments and therefore cost of noise treatments.

Table F.2 Summary of noise insulation cost considerations

Cost consideration	Description
Pre-1980's construction	Dwellings constructed prior to 1980 are highly likely to contain hazardous materials (e.g., asbestos) and will require removal and remediation. In some overseas programs (e.g., Sea-Tac) the airport required residents to remove/treat hazardous materials, at their own cost, before amelioration. Managing a program this way for WSI may reduce cost and risk but may raise issues of equity for local residents.
Heritage listed buildings	Heritage listed buildings are likely to require bespoke amelioration treatment.
Non-code compliant buildings	Non-code compliant structures may require additional work to be made compliant prior to amelioration work (if deemed eligible).
Respite costs	Some properties (both residential and non-residential) may require temporary relocation while amelioration works are underway.
Rectification costs	If the scheme is to include monitoring post completion of the amelioration program, some properties may require rectification works to meet program objectives and/or internal noise targets (if targets are established).
Unique property features	Properties with unique property features such as oversized windows and bifold external doors can significantly increase the cost of amelioration treatment.

The construction industry is currently experiencing unforeseen increases in construction costs due to a range of factors including increased demand, constrained supply chains, devaluation of the Australian currency, high escalation, rising cost of raw materials, and labour shortages. This creates additional uncertainty and risk regarding the delivery of an amelioration program. Other socio-economic issues such as international conflict and the ongoing impact of COVID-19 further exacerbate this risk.

F3 Aircraft noise guidelines and standards

There are two main areas to consider when discussing and evaluating noise and noise impacts from aircraft operations; the level and characteristics of the noise, and how the noise is perceived and experienced. The international aviation industry does not have a consistent approach to address these aspects. There are a range of noise levels and noise metrics applied to assess aircraft noise and provide a benchmark for noise reduction and the amelioration of impacts.

However, the overarching principles are generally the same across industry and regulatory bodies – the management of aircraft noise needs to address both the highest levels of noise and the long-term exposure to noise to understand aspects such as annoyance, sleep disturbance, and the effect of noise on health and well-being.

In Australia, the primary mechanism to manage aircraft noise is the application of Australian Standard 2021: *Acoustics – Aircraft Noise Intrusion – Building Siting and Construction:2015* (AS2021). The primary purpose of AS2021 is to inform land use planning for new developments near existing airports. In lieu of a standard to address aircraft noise impacts for existing properties, AS2021 has been used as a guide and benchmark for airport expansions at Sydney's Kingsford Smith Airport and Adelaide Airport. The standard provides an indoor noise level target for new buildings that can also be used as a benchmark to support recommendations for the treatment of existing buildings.

Other planning policies and guidelines that describe the application of AS2021 for the management of aircraft noise intrusion for new developments near airports include:

- *National Airports Safeguarding Framework* (NASF); Guideline A
- *State Environmental Planning Policy (Western Sydney Aerotropolis) 2021*
- other local council development control plans.

Internationally, a range of regulations and guidelines have also been developed. The most recent example is the *Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations* developed in the United States of America by the FAA and released in June 2022. This guideline provides a phased approach to the development of a noise amelioration program including prescribed eligibility criteria and internal noise targets.

The European Union's (EU) *Environmental Noise Directive* is the main EU instrument to identify noise pollution levels and to trigger the necessary action both at Member State and EU level. However, the directive does not prescribe eligibility criteria or internal noise targets, nor does it prescribe the measures to be included in action plans, thus leaving those issues at the discretion of the competent authorities of each Member State.

Research findings suggests that the appropriate noise threshold ranges for night-time sleep disturbance is between 32 dB and 55 dB, and the noise threshold range for general annoyance is between 42 dB and 50 dB. Guideline levels proposed by WHO establish a high standard for managing noise related health effects yet it may not always be possible to achieve these levels with reasonable and practicable measures for aircraft noise management. A desired internal noise target of 50 dB(A) aligns with recommended indoor noise level under AS 2021 for new properties constructed adjacent to an airport.

F4 Reference years for assessment of aircraft noise exposure

Noise exposure calculations for WSI air traffic are based on projected aircraft movements in the projected demand schedules. For the purpose of the EIS, 3 operating years have been modelled (see also Technical paper 1 – Aircraft noise).

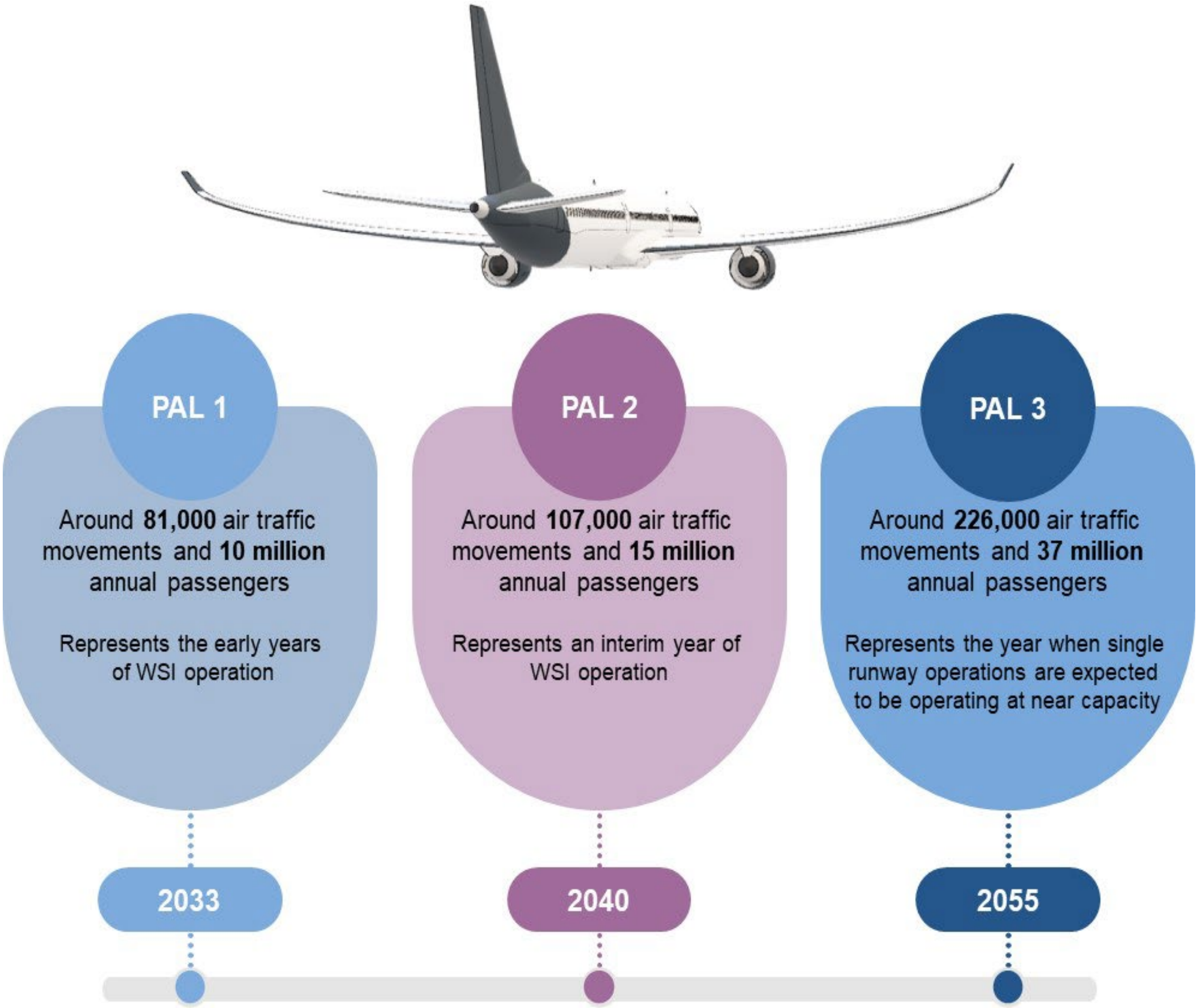

Figure F.2 Reference years for assessment of aircraft noise exposure

F5 Review of existing noise insulation and acquisition programs

In addition to the review of literature associated with aircraft noise and existing standards and guidelines, a review of similar noise insulation and acquisition policies and associated programs that have been implemented in Australia and internationally was undertaken. This review considered the following aspects:

- a review of WSI's operations, layout, geographical context and surrounding developments
- the eligibility criteria, amelioration treatments implemented, and any unique features associated with the program's delivery
- how the program was rolled out including timeframes, governance and delivery mechanisms (e.g., Government owned and delivered, engagement of a managing contractor to act on behalf of the government or one-off payments provided directed to property owners)
- outcomes of the program including effectiveness, community response and costs
- lessons learnt for the development of a similar program for WSI.

Sydney (Kingsford Smith) Airport (KSA) Third Runway and Adelaide Airport (ADL) extension of Runway 05/23 are the most relevant Australian examples for WSI.

The following section summarises the policy and associated program for Sydney (Kingsford Smith) Airport's third runway as well as a summary of lessons learnt from reviewing a number of different Australian and international examples.

F5.1 Sydney (Kingsford Smith) Airport (KSA) Third Runway

The KSA program was facilitated by the Federal Airports Corporation, which at the time was a Commonwealth Government business enterprise. Full privatisation of the airport occurred in 2002, therefore the airport was owned by the Government when the amelioration program commenced. Eligibility for the SYD noise amelioration program was determined using Australian Noise Exposure Forecast (ANEF) contours – which uses a historic record of the previous 12 months of aircraft movements to generate 'current' noise exposure levels and geographical areas affected by airport operating procedures including flight paths, operating schedules, aircraft, and engine types.

Eligibility criteria included:

- voluntary acquisition for residential properties, churches, and child-care centres in the Australian Noise Exposure Forecast (ANEF) 40 contour zone
- insulation for schools and colleges, hospitals and healthcare centres and churches within the ANEF 25 contour zone (some with conditions)
- financial and technical assistance for insulation of residential properties within the ANEF 30 contour zone[1].

The program was developed for existing dwellings, therefore new developments were not eligible for the program.

Eighty-five (85) public buildings were inside the ANEF 25 contour, and the aim was to insulate the noise sensitive areas within the buildings. Given the heritage, design, functional and architectural features of these buildings were quite disparate an acoustic consultant was engaged to assess and recommend a cost effective solution to achieve the noise reduction. Eligibility for the residential insulation program included approximately 4,200 properties and a menu of treatment options was provided for a package approach. This was to provide a cost-effective solution while allowing choice by the homeowner[2]. Approximately 160 properties were eligible for voluntary acquisition.

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1 Department of Transport and Regional Development (1997), *Sydney Airport Noise Amelioration Program*
2 Burgess, M, et. al (2000), *Residential Insulation Scheme Around Sydney Airport*

F5.2 Adelaide Airport (ADL)

The extension of Runway 05/23, completed at the end of 1999, could be seen as the trigger of the ADL noise insulation program. In 2000, the Government introduced a $63.7 million, four-year Noise Insulation Program for ADL3. The program was established in areas of high aircraft noise exposure around ADL.

Under ADL's noise amelioration program residential properties in the Australian Noise Exposure Concept (ANEC) 30 and 35 contour and public buildings (non-residential) in the ANEC 25 contour were eligible for noise amelioration. Public buildings included schools, places of worship, day care centres and hospitals.

Approximately 600 residential dwellings and five public buildings were identified within these contours. Majority of the eligible residential properties were single dwellings built between 1920 and 1970.

Amelioration treatments included, but was not limited to:

- up-rated single glazing or double glazing
- up-rated external doors
- up-rated roof/ceiling insulation.

Based on a property assessment, a noise amelioration package was tailored to the individual property requirements.

By 2010, all eligible residential properties had been ameliorated. Amelioration treatments works on some public buildings continued until 2012 when the Government closed the program.

A comparison of the key eligibility criteria for these two treatment programs is provided in Table F.3.

Table F.3 Key eligibility criteria, KSA and ADL

Eligibility	Sydney Kingsford Smith Airport Third Runway	Adelaide Airport
Acquisition	ANEF 40	–
Amelioration (residential)	ANEF 30	ANEF 30
Amelioration (non-residential)	ANEF 25	ANEF 25

F5.3 Other programs

A review of several Australian and international amelioration programs found that airports tend to approach the amelioration of aircraft noise for impacted properties differently. These differences range from the way eligibility is determined, through to how the programs are delivered. In addition, each jurisdiction around the world uses different noise impact metrics, therefore it is challenging to directly compare eligibility criteria.

Some of the key lessons learnt for consideration for an amelioration program for WSI include:

- In Australia, the ANEF/ANEI contours are the 'standard' approach to identify eligibility based on noise. Over time this has been criticised as not addressing the full range of issues caused by aircraft noise. Airservices Australia has now increased requirements for assessing the impact of noise on populations from flight path changes (in conjunction with *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) requirements). This provides the potential opportunity to supplement eligibility with additional noise levels and metrics.
- Most programs used an annual average or annual average maximum noise metric to determine eligibility. Some airports adopted additional 'peak event' type noise metrics to address properties impacted by night-time noise.
- Most amelioration programs are centrally managed by either private providers, the airport, or government departments. This often includes technical assessment of properties and engaging prequalified contractors to complete treatment works.

- A new policy and associated noise amelioration program will likely need to be a dynamic program to respond to airport operational changes, post commissioning noise impacts compared to modelled impacts, community feedback, and lessons learnt as the program is delivered. The amelioration programs studied have all been altered or amended over time, often in response to community feedback, changing operational conditions, or changes to noise metrics, measures, or standards.
- Programs with rigorous eligibility assessments, pre-treatment requirements, and multistep centrally managed design processes can result in lengthy timeframes between a property owner applying for the program through to implementation of amelioration treatment. However, this level of rigour and more bespoke approach to amelioration may result in greater community acceptance.
- Periodic auditing is a useful tool to assess the success and up take of the program. Most programs reviewed changed over time in response to community feedback and changing airport conditions.
- Careful consideration should be given to how communications and engagement with the community is undertaken for the program. This is especially relevant for newly established airports without an existing background of aircraft noise.