Appendix A

Aircraft overflight noise (Marshall Day Acoustics)

MARSHALL DAY Acoustics

WESTERN SYDNEY SECOND AIRPORT DRAFT EIS
OVERFLIGHT NOISE PEER REVIEW

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6 Gipps Street
Collingwood VIC 3066
Australia
T: +613 9416 1855
ABN: 53 470 077 191
www.marshallday.com

Project: **WESTERN SYDNEY SECOND AIRPORT DRAFT EIS PEER REVIEW**

Prepared for: **WSP / Parsons Brinckerhoff Australia Pty Ltd**
Level 27, Ernst & Young Centre 680 George Street
Sydney NSW 2000
AUSTRALIA

Attention: **Mr Paul Greenhalgh**

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EXECUTIVE SUMMARY

Introduction

Marshall Day Acoustics Pty Ltd (MDA) has carried out a peer review of the aircraft overflight noise assessment presented in the draft Environmental Impact Statement (draft EIS) for the proposed Western Sydney Airport (the proposed airport).

The peer review specifically relates to the draft EIS noise assessment of airborne aircraft operations associated with the proposed airport, and the associated ground movements for takeoff and landing. A separate report by WSP Parsons Brinckerhoff documents a peer review of noise impacts associated with construction and aircraft ground operations (including taxiing and engine run-up testing) for the proposed airport.

The objective of this peer review was to assess the reliability and technical accuracy of the aircraft overflight noise assessment.

The peer review considers the following proposed stages of development:

- Stage 1 development comprising a single 3,700 m runway with 63,000 aircraft movements per year which are projected to occur by 2030;
- Longer term development of the single runway to facilitate 164,000 aircraft movements per year which are projected to occur by 2050; and
- Longer term development with an additional parallel runway to enable additional capacity increases to 370,000 aircraft movements per year which are projected to occur by 2063.

Approach

The peer review has been primarily based on information presented in the noise chapters for the Stage 1 proposal and long term developments, in conjunction with the technical noise report presented in Appendix E1 of the draft EIS.

Consideration has also been given to other related sections of the draft EIS to review the broader assessment of noise impacts. The review of these additional sections has been concerned solely with matters related to the aircraft noise assessment. Reference should be made to the separate peer reviews commissioned by WSP Parsons Brinckerhoff for the review of specialist matters directly concerning aviation, fauna, health, planning and social issues.

This peer review addresses the following key elements of the aircraft noise assessment:

- The noise prediction methodology and the associated inputs and assumptions;
- The type of noise level information that has been produced;
- The operational scenarios that have been considered in the noise predictions;
- The noise sensitive receptors that have been identified and considered in the assessment;
- The methods used to assess the impact of the predicted noise levels;
- The proposed noise mitigation and management measures; and
- The level of uncertainty concerning the predicted noise impacts and environmental risks.

In reviewing these aspects of the draft EIS, consideration has been given to the document *Guidelines for the content of a draft Environmental Impact Statement – Western Sydney Airport* (Reference: EPBC 2014/7391 and subsequently referred to as the *EIS guidelines*).

Tasks not conducted as part of this peer review include:

- Consultations with any members of the project team involved in preparing the draft EIS;
- Site studies;
- Review of noise modelling files; or
- Noise modelling for the purpose of validating any of the results presented in the draft EIS

Review Findings – Stage 1 Development

The noise modelling is considered to generally provide a reasonable representation of the extent of noise impacts for the specific flight tracks and operating scenarios that have been proposed. Specifically, predicted noise levels have been determined for a range of operating scenarios. Aircraft noise information has also been produced in a range of formats that are generally consistent with current federal government guidelines for identifying areas potentially affected by aircraft noise.

All noise predictions have been determined using the latest version of the US Federal Aviation Authority's Integrated Noise Model (INM). This software is used widely in Australia and internationally for aircraft noise predictions and is the appropriate choice for this application. However, the use of this software to calculate short term noise levels, which is the main form of noise data used in the draft EIS to identify the extent of affected areas, requires careful consideration. Specifically, the INM supporting documentation notes:

> *INM is not designed for single-event noise prediction, but rather for estimating long-term average noise levels using average input data. Comparisons between measured data and INM calculations must be considered in this context.*

Accordingly, while the use of the INM is reasonable, information has not been provided as part the draft EIS to verify the reliability of the short term noise level data (presented as maximum noise levels and Number Above ratings). This is particularly important for this proposed airport, because of the increased uncertainty associated with the predictions at the lower noise thresholds used in the draft EIS for the assessment of night-time operations and impacts in quiet areas such as the Greater Blue Mountains World Heritage Area.

Notwithstanding the general suitability of the noise modelling data, there are however a number of limitations to the assessment. These relate to the uncertainty surrounding the airspace management design, and the limited assessment of the noise modelling outcomes. These matters are summarised as follows.

Low Stage 1 movement numbers

The total aircraft movement numbers for the Stage 1 development are relatively low when compared to other international airports in Australia. The low movement numbers cast doubt over the suitability of the 5 year time horizon as the primary assessment scenario for the purpose of obtaining approval for a major international airport. In this context, it is unclear how the incremental and periodic approvals that would need to occur as part of the ongoing expansion of the airport provide a sufficient basis for considering the initial 5 years of operation as the primary period for the assessment of noise impacts.

These comments are provided primarily in relation to the plausibility of the movement numbers represented in the noise modelling, based on comparisons with movement numbers documented in the noise modelling for other Australian international airports and similar time horizons. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers provided for the noise assessment are considered in further detail in a separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

Airspace management strategy uncertainties

The draft EIS states that the airspace management strategy used as the basis for noise modelling is a proof-of concept design, and that further work is required to determine the actual flight paths which would be flown in practice. Information about the extent of potential flight path changes is limited. The uncertainty surrounding the final airspace management design that would be implemented represents a significant source of uncertainty in the noise assessment. The potential significance of this source of uncertainty has not been quantified and, with exception of alternative merge points for Stage 1, there has not been any sensitivity analysis carried out to assess the implications of potential flight path changes.

Assessment of community annoyance

The draft EIS includes exposed population statistics which provide a useful indication of the number of people who may be affected by aircraft noise to varying degrees. However, in isolation, this data does not provide an indication of the scale or significance of potential community reaction to aircraft noise levels as a result of annoyance. The Health Risk Assessment in the draft EIS provides the most discussion of community annoyance, including references to research concerning the relationship between noise exposure and community annoyance. However, the Health Risk Assessment ultimately states that no quantitative assessment of annoyance was conducted as part of the study.

Dose-response relationships of the types referenced in the Health Risk Assessment can be used with noise levels and population data to provide a quantitative measure of the potential reaction. The use of these established relationships to represent the reaction of a separate community exposed to aircraft noise must be used with caution. In particular, due consideration must be given to the increased reaction that may be expected from a newly exposed community. However, this type of analysis provides an objective basis for comparing the impacts of alternative operating strategies and, more broadly, establishing the risk of community noise impacts relative to other established international airports in Australia.

While the assessment of the risk of community annoyance is complex, the scale of the proposed airport, and the number of people potentially affected, are sufficiently large to warrant further evaluation of the subject. The introduction of a new 24-hour international airport at a greenfield development site introduces a risk of widespread and prolonged community annoyance. A quantitative analysis of this potential risk would be prudent to inform the environmental impact assessment process and the extent to which operational noise mitigation should be prioritised relative to other non-safety related airspace management considerations. Updated social surveys of the type originally carried out as part of the development of the Australian Noise Exposure metric used in Australia also warrant some consideration, given the significant nature of the proposed development and the availability of detailed aircraft noise information for other existing Australian airports.

Land use impacts

The draft EIS includes calculated Australian Noise Exposure Concept (ANEC) contours for the Stage 1 operating scenarios. ANECs are often presented as an indication of the extent of a potential future Australian Noise Exposure Forecast (ANEF) contour which would be used to guide land use planning for noise-sensitive developments in the vicinity of airports.

However, as acknowledged in the draft EIS, the ANEC contours presented for the Stage 1 proposal provide limited guidance for the purpose of land use planning. The reason for this is that the ANEF is normally derived from ANECs calculated for long term operations or ultimate capacity scenarios, rather than short term ANECs related to an initial phase of operation. Evaluation of land use planning impacts must therefore be primarily based on the ANEC contours presented for the long term development of the airport, rather than initial Stage 1 development contours.

Greater Blue Mountains World Heritage Area

The draft EIS presents information to evaluate the potential impacts of aircraft operations on the acoustic amenity of the Greater Blue Mountains World Heritage Area (GBMWHA). The assessment indicates the potential for a large number of audible aircraft events within the GBMWHA.

The preservation of quiet areas and tranquil landscapes has been a topical subject of research and policy consideration in Europe and the US. For example, the US Transportation Research Board publication on the effects of aircraft noise (Mestre, 2008) includes a chapter which discusses research and US legislation (National Parks Overflight Act of 1987) concerning the effects of aviation noise on parks, open space and wilderness areas. These publications do not provide definitive guidance on assessment techniques, but highlight the complexity and importance of assessing aircraft overflight noise in sensitive wilderness areas.

While the noise levels in the draft EIS are predicted to be relatively low (below 50 – 55 dB L_{Amax}), aircraft over flights would be expected to be audible and represent a significant and widespread impact for a World Heritage Area where natural soundscapes are likely to be a valued feature of the areas amenity. The complexities and sensitivities of this area warrant further consideration in the draft EIS. Specifically, the assertion within the draft EIS chapter concerning the GBMWHA that noise levels below 50 and 55 dB L_{Amax} are 'not significant' is not considered to have been sufficiently justified, and the assessment may therefore not adequately reflect the potential impact to the values of tranquillity within the World Heritage Area.

Mitigation measures and residual noise impacts

The draft EIS noise modelling is based on an indicative proof-of concept air traffic management design which does not present a comprehensive airspace and final air route design. Given the uncertainties concerning the final form of the airspace design, the final form of noise mitigation measures to be implemented is not yet known. Accordingly, the mitigation measures that have been referred to in the aircraft noise assessment are generic in nature.

This is a particularly important point for an airport development as, unlike other forms of infrastructure development, the policies used to manage aircraft overflight noise do not generally stipulate noise limits that airport operations must adhere to at surrounding noise-sensitive locations.

Accordingly, without a defined airspace design, a defined noise mitigation strategy or defined noise criteria to adhere to in practice, the residual impacts and the location of these impacts is subject to considerable uncertainty. Further, without defined noise criteria, it is unclear how noise considerations would be prioritised among other non-safety related airspace management and operational considerations associated with the proposed airport site. These uncertainties may therefore warrant consideration of performance criteria as part of the approval process for the proposed airport.

In addition to the generic operational measures for the mitigation of noise, the draft EIS also refers to mitigation related to dwelling acquisition or dwelling insulation upgrades. There is however no detail provided in terms of the circumstances in which these measures would be implemented, other than a general reference to the guidance of AS 2021. It is unclear if this is intended to infer that such measures would only be considered within certain Australian Noise Exposure areas, or if such measures would be considered at all locations where internal levels may be expected to exceed AS 2021 internal design criteria as a result of the proposed aircraft operations.

Review Findings – Long Term Development

A number of the considerations identified from the peer review of the Stage 1 development are directly relevant to the assessment of the long term development scenarios. For example, matters related to the noise prediction methodology are identical for the Stage 1 and long term development scenarios.

In terms of assumptions about operational capacity, the movement numbers for the 2050 single runway scenario and 2063 dual runway scenario are comparable to the range of movement numbers documented for other similar Australian international airports. On this basis, the values appear to be plausible for noise assessment purposes. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers provided for the noise assessment are considered in further detail in separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

The following limitations are however noted for the long term assessment scenarios.

Land Use Impacts

The draft EIS presents ANECs for a range of operating scenarios in 2050 and 2063 as part of the discussion of potential land use impacts which may result from a future ANEF for the proposed airport.

However, the latest Australian Standard (AS 2021) which defines how Australian Noise Exposure data should be used to inform land use planning includes guidance on how ANECs for multiple operating scenarios may be combined to define an overall area where planning controls should apply. The draft EIS does not refer to this guidance and it is therefore unclear how the various ANECs should be interpreted when assessing land use impacts.

Further, while the draft EIS provides population counts for the various ANEC bands, no assessment is provided of the extent to which land use controls may change as a result of a future ANEF prepared as part of the detailed airspace design for the project. Specifically, the draft EIS does not quantify the potential extent of changes to land use controls relative to the measures which have been in place since the original EIS was undertaken in 1985.

Furthermore, the discussion of land use planning impacts in the draft EIS notes that the National Airports Safeguarding Framework would '*be instrumental in managing potential future operational noise impacts for future land use planning and development around the airport*'. The Framework could potentially translate to the creation of land use planning controls which extend over significantly greater areas than either the current land use planning controls (based on the 1985 EIS) or the 2063 ANEC contours provided in the draft EIS. This has however not been discussed or assessed in the draft EIS.

Cumulative Impacts

The draft EIS notes that the parallel runway scenario (2063) would introduce a number of issues which would need to be addressed in the final airspace design. In particular, the chapter concerning airspace architecture notes the following issues that would need to be addressed:

- Changes to Sydney Airport flight paths ;
- Changes to flight paths serving Bankstown Airport; and
- Resolution of a potential constraint associated with the restricted airspace over Defence Establishment Orchard Hills.

The EIS guidelines establish a requirement to '*identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities'.*

The above issues concerning the airspace architecture are considered to represent potential cumulative impacts which have not been quantified in the draft EIS. Further information concerning this issue is therefore considered necessary to address the requirements of the EIS guidelines.

Key Impacts and Opportunities

The findings of the peer review indicate that noise level information of the form required by the EIS guidelines has generally been provided in the draft EIS. However, the peer review has also identified a number of limitations concerning the content of the draft EIS, and therefore further information and assessments are considered necessary to address the general and noise-specific requirements of the EIS guidelines.

Based on the review of the draft EIS, the key noise impacts associated with the proposed airport are:

- Community annoyance, and related impacts such as speech interference and changes to the way individuals use outdoor spaces;
- Sleep disturbance associated with night-time operations, and related impacts such as the potential need for some residents to sleep with windows closed to achieve a suitable internal amenity; and
- Degradation of the acoustic amenity of the World Heritage Area within the Greater Blue Mountains area

In terms of land use impacts, the existing planning instruments that have been used to control development around the proposed airport site would generally be expected to limit the extent of the potential impacts. However, the draft EIS reference to the National Airports Safeguarding Framework as an instrumental tool for guiding future land planning around the proposed airport site introduces the potential for significantly enlarged development controls. This could translate to land use impacts also being a key impact associated with the proposed development.

Other noise related impacts cornering matters such as health, property values and social impacts are addressed in separate peer reviews commissioned by WSP Parsons Brinckerhoff.

Aircraft noise impacts are an unavoidable consequence of aircraft operations in urban environments. The creation of a new international airport therefore requires a balance to be achieved between the protection of amenity for neighbouring sensitive land uses and the development of infrastructure to respond to the growing demands of a major city.

Determining whether this balance has been achieved is ultimately a matter for regulatory authorities. While this peer review has identified a number of limitations to the present assessment, this is not intended to infer that the proposed development and development site are unsuitable. Rather, in light of the residual uncertainties in the assessment, further information and assessments are considered necessary before stakeholders can reach an informed view on the potential scale and significance of aircraft overflight noise impacts associated with the proposed airport site.

Conducting these further assessments as part of the environmental impact assessment process represents an opportunity to:

- Provide clarity to affected communities and stakeholders about the nature of the noise impacts;
- Provide clarity to regulators about the form of noise controls which will be needed in the project approval to ensure that noise is appropriately managed; and
- Reduce the potential for unforeseen impacts and the associated risk of reactionary noise management procedures which could subsequently jeopardise the operational flexibility of the proposed airport.

TABLE OF CONTENTS

1.0 INTRODUCTION

This document presents the findings of Marshall Day Acoustics' peer review of the aircraft overflight noise assessment presented in the draft Environmental Impact Statement (*draft EIS*) for the proposed Western Sydney Airport (the *proposed airport*), released on 19 October 2015.

The peer review specifically relates to the draft EIS noise assessment of airborne aircraft operations associated with the proposed airport, and the associated ground movements for takeoff and landing (subsequently referred to as the *aircraft noise assessment* within this document). A separate report by WSP Parsons Brinckerhoff documents a peer review of noise impacts associated with construction and aircraft ground operations (including taxiing and engine run-up testing) for the proposed airport.

The peer review considers the following proposed stages of development:

- Stage 1: development of a single 3,700 m runway at the northern end of the candidate site referred to as Badgerys Creek, with 63,000 aircraft movements per year projected to occur by 2030;
- Longer term development of single runway capacity: incremental development of aviation infrastructure and support services to facilitate 164,000 aircraft movements per year which are projected to occur by 2050; and
- Longer term development with an additional parallel runway to the south: an additional runway is proposed for long term operations, enabling additional capacity increases to 370,000 aircraft movements per year which are projected to occur by 2063.

The peer review was commissioned by WSP Parsons Brinckerhoff on behalf of the following organisations:

- Western Sydney Regional Organisation of Councils (WSROC); and
- Macarthur Regional Organisation of Councils (MACROC).

The above organisations are collectively referred to as the Councils within this document.

The objective of the peer review was to assess the reliability and technical accuracy of the aircraft noise assessment in the draft EIS, in turn assisting the Councils to reach an informed view on potential aircraft noise impacts within their respective shires.

The scope of the peer review was defined by the following requested tasks:

- Evaluate whether the noise and vibration study meet the requirements of the EIS Guidelines and relevant other guidelines and methodologies with respect to aircraft noise;
- Evaluate whether the underlying assumptions used to inform the assessment (including any construction or operational assumptions, and modelling assumptions where appropriate) are plausible;
- Evaluate whether the conclusions reached in the studies are valid i.e. an independent evaluation of whether the predicted impacts are in accordance with published standards and guidelines, and whether the conclusions of the assessment are a realistic reflection of the actual impacts;
- Review the mitigation and management measures proposed and advise on their adequacy in mitigating impacts;
- Evaluate the level of uncertainty over impacts and the environmental risks that will arise as a result; and
- Provide a summary of the key impacts and opportunities associated with the project in relation to aircraft noise as part of the noise and vibration study.

The primary documents that have been reviewed in detail are set out in Table 1.

Table 1: Primary draft EIS sections considered in peer reviewing the aircraft noise assessment

Draft EIS Section	Title
Volume 2 – Stage 1 Development	Chapter 10 – Noise (aircraft) referred to herein as the *Stage 1 noise chapter*
Volume 3 – Long Term Development	Chapter 31 – Noise (aircraft) referred to herein as the *long term development noise chapter*
Volume 4 – EIS Technical Reports	Appendix E1 – Aircraft overflight noise referred to herein as the *technical noise report*

The peer review has also considered additional sections of the draft EIS for contextual information, and to provide informative commentary of the broader assessment of noise impacts which has been presented in other related sections of the draft EIS. The review of these additional sections has been concerned solely with matters related to the aircraft noise assessment. In particular, the review of specialist sections such as airspace architecture, human health and social impacts was limited to technical matters concerning noise modelling scenarios, noise level information and noise mitigation measures. Reference should be made to the separate peer reviews commissioned by WSP Parsons Brinckerhoff for the review of specialist matters directly concerning aviation, fauna, health, planning and social issues. All instances in which the commentary within this peer review relates to a section of the draft EIS other than the primary reference documents listed in Table 1 are identified by a reference to the section of the draft EIS in question.

This peer review has been conducted solely on the basis of the published documentation in the draft EIS. Tasks not conducted as part of this peer review include:

- Consultations with any members of the project team involved in preparing the draft EIS;
- Review of noise modelling files; or
- Noise modelling for the purpose of validating any of the results presented in the draft EIS.

A glossary of terminology used in this report is provided in Appendix A.

2.0 REVIEW FINDINGS – STAGE 1 DEVELOPMENT

This section presents a review of the aircraft noise assessment for the Stage 1 Development, having regard to:

- The noise prediction methodology and the associated inputs and assumptions;
- The type of noise level information that has been produced;
- The operational scenarios that have been considered in the noise predictions;
- The noise sensitive receptors that have been identified and considered in the assessment;
- The methods used to assess the impact of the predicted noise levels;
- The proposed noise mitigation and management measures; and
- The level of uncertainty concerning the predicted noise impacts and environmental risks.

2.1 EPBC Act and EIS Guidelines

In conducting this peer review, reference has been made to the document *Guidelines for the content of a draft Environmental Impact Statement – Western Sydney Airport* (Reference: EPBC 2014/7391 and subsequently referred to as the *EIS guidelines*).

The EIS guidelines establish general content requirements relating to matters including:

- Detailed descriptions of the proposed actions;
- Description of baseline conditions;
- Description of mitigation measures; and
- Description of residual impacts following the implementation of mitigation measures.

In addition, the EIS guidelines note the following requirements directly related to noise:

> *Impacts to the environment (as defined in section 528) should include but not be limited to the following:*
>
> *…*
>
> - *aircraft noise and vibration impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment). Discussion and quantification/modelling of aircraft noise impacts should include consideration of all potential flight paths, height of flights, noise exposure patterns, noise contours, the range of frequencies of the noise, cumulative exposure, peak noise, frequency of overflights and temporal variability of this (including long term trends), varying aircraft types, varying aircraft operating procedures, and variations in noise patterns due to seasonal and meteorological factors*

The subsequent sections of this document review the draft EIS against the general and noise-specific requirements of the EIS guidelines.

The findings of the peer review indicate that information of the form required by the EIS guidelines has generally been provided in the draft EIS. However, the peer review has also identified a number of limitations concerning the content of the draft EIS, and therefore further information and assessments are considered necessary to address the general and noise-specific requirements of the EIS guidelines.

In particular, these matters relate to:

- The uncertainty surrounding the airspace management design for the proposed airport, and the corresponding uncertainty this introduces into the noise modelling;
- As a result of the further work required to develop the airspace management design, the proposed mitigation measures have not been developed in detail. As a result, the residual impacts of the proposed airport are not defined; and
- The absence of assessments to evaluate the significance of the predicted noise impacts in terms of community annoyance and land use impacts.

Further discussion of each of these points is provided in the following sections.

2.2 Noise Prediction Methodology

This section provides a review of the input data, assumptions, calculation procedures and calculation settings associated with the noise predictions.

2.2.1 Runway

The technical noise report documents a runway position and configuration which appears to be consistent with the description provided in Volume 1 Chapter 1 *Introduction*. However, the following specific observations are noted:

- The project description in the Stage 1 noise chapter, the technical noise report and Volume 1 Chapter 7 *Airspace architecture and operation* do not define specific location details in terms of an aerodrome reference point, runway end coordinates or elevation details.
- The runway orientation adopted in the noise assessment is consistent with the general description of the Stage 1 proposal and assumes a single southwest / northeast runway designated as runway 23 and 05 respectively. However, the precise orientation of the runway does not appear to have been defined in the project description in the technical noise report or the discussion of airspace architecture presented in Volume 1 Chapter 7, nor is it clear whether the proposed orientation of the runway has been finalised. It is noted that the discussion in Volume 1 Chapter 7 documents the review work conducted by the Australian Bureau of Meteorology to verify the proposed runways 05 and 23. However, the convention of defining runway directions in 10 degree increments means that runways 05 and 23 may relate to direction ranges of 45 to 54 degrees and 225 to 234 degrees respectively. If the runway orientation has not been finalised, this could translate to a significant source of uncertainty in the final location of noise contours.

2.2.2 Terrain Data

The technical noise report specifies the use of terrain data in 10 m height intervals.

The origin of this data has not been specified, however the stated resolution of the terrain data that has been used is considered appropriate for noise modelling purposes.

2.2.3 Flight Paths

The technical noise report specifies that the noise modelling has been prepared on the basis of indicative flight paths prepared by Airservices Australia, noting the following:

Airservices Australia has assessed the airspace implications and air traffic management approaches for Sydney basin airspace arising from the potential introduction of operations at the proposed Western Sydney Airport. The principal objective was to establish whether safe and efficient operations could be introduced at the airport by developing indicative proof-of concept air traffic management designs. Importantly, this work does not present a comprehensive airspace and air route design, nor does it consider all of the essential components that would be necessary to implement an air traffic management plan for the Sydney basin.

Section 7.6 also notes

The conceptual airspace design presented in this draft EIS has not been developed to a level of detail necessary for implementation…

The indicative flight paths therefore do not represent the final flight paths which would be flown if the project proceeds; this is to be expected given the current stage of the proposal. However, the description of airspace architecture in Volume 1 Chapter 7 does not provide any indication of the manner or extent to which the final airspace design may vary from the proof-of concept design, nor is this matter addressed in the technical noise report. This represents a significant source of uncertainty in the predicted noise levels.

The following additional items are noted:

- The flight tracks depicted in Figure A1 of Appendix A of the technical noise report indicate that all departures from runway 05 turn left approximately 3 km from the runway end and head due north for 25 km before branching out in a number of directions. This route still passes over populated areas but avoids direct overflight of the relatively densely populated areas to the northeast, such as Blacktown, thus potentially offering benefits in relation to noise. However, while the discussion in Section 7.6.1 of Volume 1 Chapter 7 (airspace architecture) outlines the considerations (including noise) that were factored into the indicative arrival procedures, there is no specific mention of the basis for this departure route. Given that subsequent sections of the technical noise report identify movements on runway 05 result in the greatest total population numbers within the forecast noise contours, it would be prudent to establish the role of noise considerations in the development of this departure track, and the potential extent to which this track may vary in the development of a final airspace management plan.
- The proposed airspace configuration includes a single nominated merge point system applicable for arrivals on each runway. From the description provided in Volume 1 Chapter 7 (airspace architecture), it is understood this system is not presently in use in Australia, and is noted to have been selected for a range of operational reasons. One of these reasons is noted to be noise benefits, presumably on the basis of the reduced noise of continuous descent arrival procedures. However, the noise assessment subsequently identifies that the merge point introduces a number of noise considerations related to the areas beneath the merge point and beneath the arrival paths from the merge point. Accordingly, further discussion of the reasons and justification for proposing a merge point system, with reference to the noise impacts of alternative arrival management options, would be prudent.

- The discussions of airspace architecture in Volume 1 Chapter 7 and in the technical noise report note that the arrival flight paths do not include any dispersion, other than the inclusion of visual approach paths to the merge point which introduce a form of dispersion. The reason is noted to be the tight control available with instrument/satellite assisted arrival procedures. The absence of dispersion has the effect of concentrating noise levels under the flight path, while conversely limiting the spread of noise into other surrounding areas. This is quite an important consideration for the areas located beneath the arrival paths. Further information to support that arrival movements in practice would not significantly deviate from the designated flight paths would be helpful.

2.2.4 Flight Profiles

Arrivals

The technical noise report notes at Section 2.6.1 that the noise modelling assumes that all arrival profiles will be flown using a procedure known as continuous descent approach (CDA).

CDA involves the aircraft approaching the airport at a nominated location (referred to as the merge point), before descending at a constant angle prior to landing. In contrast, standard arrival procedures involve the aircraft stepping down and flying at constant altitude prior to the final descent and landing. As such, the CDA offers potential benefits for reducing ground noise levels as well as allowing aircraft to save significant fuel amounts and hence reduce other emissions, such as carbon dioxide.

It is however noted that around busy airports, or locations where airspace is congested, as is anticipated to be the case with the proposed airport and the existing Sydney Airport and other smaller airports, that CDA can be difficult to achieve for all arrival operations(Airservices Australia, 2012). Airspace management and other factors, including bad weather, could prohibit the use of CDA for all arrival operations. Furthermore, information provided in Volume 1 Chapter 7 *Airspace architecture* notes the following in Section 7.6:

> *If the point merge system is adopted for the proposed airport, the location of the merge point would be a key component of this further development.*

As the assessment assumes 100 % of arrivals adopt CDA, hence reducing the extent of predicted noise contours, it would be prudent for the assessment consider a percentage of arrival operations that would adopt a standard approach flight profile. Conversely, consideration of a conservative situation whereby standard approach flight profiles are assumed to account for expected variation in airspace management requirements for a new airport, with progressively increased CDA usage when feasible.

Departures

The technical noise report notes at Section 2.9 that the noise modelling assumes standard aircraft departure profiles for all aircraft operations. However, the International Civil Aviation Organization (ICAO) defines noise abatement departure procedures (NADP) which can be used by civilian jet operations to reduce noise levels at varying distances from an airport. Data for NADP movements is contained in the Integrated Noise Model (INM) software and can be used to calculate the potential effectiveness of NADP operations for a given airport.

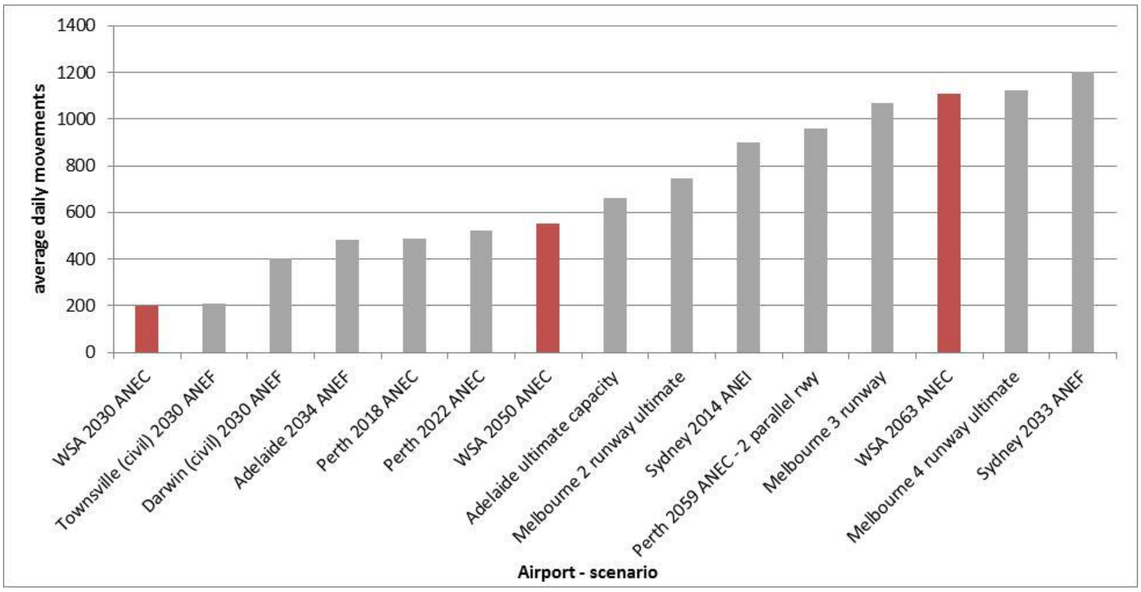
The technical report notes that final design of airspace management arrangements for the airport, including flight paths and procedures, would need to be optimised for noise management purposes as part of the work that Airservices Australia would undertake before the proposed airport becomes operational.

However, in contrast to arrival procedures, there is no mention of the potential use of NADP in the Stage 1 noise chapter or technical noise report. It is unclear if these types of procedures would be considered as part of the final design of airspace management arrangements, and if so, under what circumstances they would be proposed.

2.2.5 Movement Numbers

A general review of the movement numbers associated with Stage 1 development has been carried out by comparing the values with current and future movements at other Australian international airports. Figure 1 shows the proposed daily movement numbers for the Stage 1 development appear relatively low compared with other Australian international airports. This may be reasonable given the relatively short time period of 5 years between the commencement of operations and the assessment year. However, this directly translates to a relatively low numbers of aircraft events exceeding relevant noise thresholds when compared to the longer term development plans for the site. Given the objective of the proposal is to develop a major international airport, the relatively low movement numbers raises the question of the suitability of the 5 year time horizon as the appropriate primary assessment scenario for the purpose of obtaining approval for the development, irrespective of the incremental and periodic approvals (under the Airports Act) that would need to occur as part of the ongoing expansion of the airport.

Figure 1: Comparison of average daily airport movement numbers with other existing Australian International airports



It is noted that the draft EIS refers to ongoing development of airside infrastructure to facilitate the continued growth of the airport. However, it is unclear whether the initial primary infrastructure is to be developed to accommodate a greater number of movements than is projected to occur in Stage 1. Further, it is unclear whether an approval for Stage 1 would specifically restrict the movements to the forecast values presented in the draft EIS. Given these considerations, further information concerning the implications of greater than expected demand under Stage 1 would assist in understanding whether the movement numbers, and therefore the predicted noise levels, could be higher than the forecasts presented in the draft EIS.

These comments are provided primarily in relation to the plausibility of the movement numbers represented in the noise modelling, based on comparisons with the movement numbers documented in the noise modelling for other Australian international airports and similar time horizons. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers adopted for the stage 1 noise assessment are considered in further detail in a separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

2.2.6 Aircraft Fleet Mix

The aircraft noise modelling has been based on a range of different aircraft types to represent the overall mix of aircraft that is expected to operate from the proposed Stage 1 development.

The selected aircraft types that have been included in the modelling are considered appropriate. Further, the noise modelling has opted for a conservative approach by assuming that all future aircraft operations are characterised by the noise emissions of existing aircraft. Given that aircraft are generally expected to produce lower noise emissions in future, this choice is considered to be reasonable and conservative.

Further, the choice for particular aircraft types and single event noise contours is considered conservative. For example, the freight Boeing 747-400 which is being phased out and replaced by the newer Boeing 747-800.

These comments are provided solely on the basis of the mix of INM aircraft assignments that have been adopted to represent the proposed fleet mix. Forecast aircraft fleet mix are outside of our area of expertise and are considered in further detail in the separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

2.2.7 Calculation Procedure

The Integrated Noise Model (INM) version 7.0d developed by the United States Federal Aviation Authority (FAA) has been used to calculate noise levels associated with the proposed airport operations.

The technical noise report acknowledges that INM has been superseded by the Aviation Environmental Design Tool (AEDT) Version 2b, released in May 2015. The technical report then goes on to note that the core procedures for calculating of noise levels are equivalent between the INM and AEDT programs. This is reasonable and it is not expected that the calculation outputs of the two programs would differ significantly. The use of the latest version of INM is therefore considered appropriate. However, its use for the calculation of a range of different noise exposure metrics warrants further consideration.

The INM was primarily designed for the calculation of long term energy-based exposure metrics such as the Australian Noise Exposure (ANE), equivalent noise level (L_{Aeq}), and day night noise level (L_{dn}). In this respect, the user guide for the software notes:

> *INM is designed to estimate long-term average effects using average annual input conditions. Because INM is not a detailed acoustics model, differences between predicted and measured values can and do sometimes occur because important local acoustical variables are not averaged, or because complicated physical phenomena are not explicitly modelled.*

The program also enables the calculation of short term event levels such as the maximum level, and it is widely used for this purpose. However, in relation to the use of INM for short term maximum noise levels, the user guide notes:

> *INM is not designed for single-event noise prediction, but rather for estimating long-term average noise levels using average input data. Comparisons between measured data and INM calculations must be considered in this context.*

This is an important point as the Number Above contours which are used in the draft EIS to demonstrate the potential extent of noise impacts associated with the proposed airport are based on maximum noise levels calculated using the INM. Accordingly, while the use of the INM for calculating the maximum (L_{Amax}) noise levels is considered reasonable, consideration should be given to factors that can affect the INM's calculation of maximum noise levels. This is discussed in the next section and the subsequent discussion of overall prediction uncertainties.

2.2.8 Meteorological Conditions

The meteorological conditions used in the assessment were sourced from the Bureau of Meteorology (BoM) website, based on the previous 5 years. The data has been used largely for determining the airport operational modes and the number of aircraft movements on each runway and flight path.

In addition to the above, local atmospheric conditions can also affect the calculated noise levels in two ways:

- by varying the aircraft position (altitude influenced by air density); and
- by varying the rate of absorption as sound propagates through the atmosphere.

Of these two, the change in the rate of atmospheric absorption generally has the largest effect on the noise levels, particularly when considering the calculation of short term noise metrics such as maximum noise levels. In this respect, it is important to note that seemingly minor changes in calculated noise levels can translate to relatively large changes in the size of noise contours, owing to the distances associated with aircraft noise contours.

The INM enables atmospheric absorption to be factored in one of the two following ways:

- adopting default atmospheric absorption values: these default values do not correspond to any specific temperature or humidity. Instead, the default values are an average of varied absorption conditions relating to noise certification testing throughout Europe and the US; or
- adopting user defined atmospheric values: a single set of average temperature and humidity values are entered by the user for each modelled scenario and INM applies the corresponding atmospheric absorption values.

The noise modelling description in the technical noise report does not explicitly comment on whether default or user defined atmospheric conditions have been accounted for in this aspect of the calculation. However, the stated meteorological conditions do not reference the humidity values that are needed to set user defined atmospheric absorption values. Accordingly, it appears that the default INM atmospheric absorption values have been used which result in lower predicted noise levels.

Previous discussions with Airservices Australia have suggested it is appropriate to adopt user defined atmospheric values where the appropriate environmental parameters are available. They did however note that this was as a conservative approach, which they considered appropriate. Furthermore, the FAA note that the user defined atmospheric values should be used to account for study specific weather conditions, especially when considering specific time periods as opposed to the annual average day.

Accordingly, to account for the variability of short term noise events, and the fact INM is not specifically intended for predicting short term noise events, the adoption of user defined site-specific atmospheric absorption values is generally preferable to default conditions.

2.2.9 Uncertainties

The combined uncertainty of the noise modelling data relates to the net effect of the various calculation settings and choices adopted for the study. Specific values of calculated uncertainty are not provided in the technical noise report. Instead, uncertainty has been addressed through the selection of conservative model input choices in most instances. This is considered a reasonable approach.

However, the following points are noted:

- Information should be provided to support the reliability of the overall prediction methodology and choices for predicting maximum noise levels. This should ideally include details of measurement and prediction comparisons that have been used to validate the INM for predicting maximum noise levels. For example, comparison of available noise information from the Sydney Airport Noise Flight Path and Monitoring System or bespoke surveys. Further detail should also be provided concerning the manner in which atmospheric conditions have been accounted for in the noise predictions.
- The largest source of uncertainty is the indicative flight paths which do not represent the final flight paths which would be flown if the project proceeds. A more detailed analysis on the extent of uncertainty in predicted noise levels due to flight path variation should be provided, either by way of a sensitivity analysis or predicted noise levels for a selection of key flight paths that could change as part of the detailed airspace design.

2.3 Noise Prediction Data

2.3.1 Airport operating modes

Noise prediction information for the Stage 1 development has been provided for a number of operating modes, primarily driven by the prevailing wind direction at the time.

Matters relating to the suitability of the operating modes are considered in a separate peer review of the airport operations described in Volume 1 Chapter 7 airspace architecture.

The operating strategies that have been modelled are generally considered appropriate. However, the following observations are noted:

- Each of the preferred operating strategies includes the use of both runway modes i.e. mode 05 and mode 23. It is expected that the component of movements associated with each mode has been determined on the basis of a statistical analysis of 5 year Bureau of Meteorology data that is referred to in the technical noise report. However, the technical noise report does not specify the component of movements associated with mode of each preferred operating strategy, nor does the report specify how the components were derived.
- The technical report does not present information about how frequently each of the operating strategies would be used, nor is there any information presented to demonstrate whether or not certain times of day would be more or less likely to favour particular operating strategies.
- The modelling assumes the use of a head to head operating strategy comprising arrivals on runway 05 and departures on runway 23 would be viable. However, Volume 1 Chapter 7 *Airspace architecture* indicates the viability of head to head operations is yet to be confirmed, noting the following at Section 7.5:

  > *A third operating mode, 'head to head' may be feasible following further detailed assessment prior to the commencement of operations. This would involve all landings and take off movements occurring in opposing directions, either to or from the south west; or to or from the north east.*

2.3.2 Calculation Metrics and Scenarios

The Stage 1 noise chapter and technical noise report present aircraft noise information in a range of alternative formats, consistent with established government guidance.

The choice of metrics and scenarios are generally appropriate for defining the extent of areas which would potentially be affected by the noise of the assumed Stage 1 operating scenario. In all cases, noise contours do not represent the absolute extent of audible noise which an individual may find unsatisfactory, however this is not a practical objective for a noise assessment.

The following provides a discussion of the key forms of information that have been provided in the technical noise report for the assessment of noise impacts. Further information on the applicability of these metrics is provided in Section 2.4.1 of this review.

Number Above (NA) Ratings

NA ratings represent the number of times that aircraft events are predicted to exceed specified noise levels in a specified time period. The specified noise levels used in the technical noise report are 70 dB L_{Amax} and 60 dB L_{Amax}, resulting in calculated N70 and N60 values for different time periods on a typical busy day.

These values are generally appropriate. The draft EIS also usefully introduces the 90th percentile Number Above ratings as a way of representing the upper N60s and N70s that would be expected to occur in practice.

However, the following observations are noted:

- The 60 dB L_{Amax} lower threshold is generally suitable for assessing noise in urban areas. However, for the assessment of amenity impacts in quiet locations where natural soundscapes are valued, such as the Blue Mountains, lower predicted noise levels would be informative. It is acknowledged that the uncertainties associated with the prediction method increase with distance, meaning the lower values of predicted noise levels are subject to a greater degree of uncertainty. However, the alternative form of information relating to track density plots is not without compromises and is potentially more difficult to properly interpret – particularly given that the noise contours at the low levels extend considerably further than the width of the flight paths used to portray flight density tracks.
- The information concerning the number of events exceeding key thresholds of 60 dB L_{Amax} and 70 dB L_{Amax} is generally only provided as 24-hour average or night-time values, with additional periods selected for assessing recreation areas. While this information is useful, further data to address the number of events expected to occur during specific time periods could provide a useful indication of impacts during sensitive times.

Single event combined maximum noise level contours

Single event maximum noise levels are provided for the loudest and most common aircraft, being the Boeing 747-400 and Airbus A320 aircraft, respectively.

It is noted that the 'combined' contour refers to the worst case scenario of a single noise event occurring on each of the tracks used by the aircraft i.e. where a departure track splits into 2, the maximum noise level considers noise on both tracks, thus providing an overestimate of the maximum level from a true single event. This generally provides a conservative representation of the extent of areas that could experience maximum noise levels of a given value, however the approach also introduces artefacts into the contours which are evident as a 'comb' effect on the contour lobes, artificially suggesting lower noise levels at some positions at the extent of the contours.

Australian Noise Exposure Concept (ANEC)

An ANEC is provided for each operating mode. The ANE metric is an exposure based noise metric, used solely for land use planning in Australia. The ANEC contours presented for Stage 1 provide limited information in regards to land use planning, as these would typically consider longer term, ultimate capacity scenarios. However, the ANEC can be useful in understanding noise exposure around an airport. A number of studies, including the study upon which the ANE was based, have determined a relationship between noise exposure around an airport and community annoyance. This type of information is not provided in the technical noise report, and further discussion is provided in Section 2.4.3 of this review.

Summer/winter variations

The potential changes in noise contour extents between summer and winter are considered in the appendices of the technical noise report. The analysis generally shows minor change in predicted noise levels. However, as per the discussion in Section 2.2.8, it is unclear if the predictions include an account of varied atmospheric conditions for different times of year.

2.4 Impact Assessment Methodology

Environmental noise may result in a number of different direct and indirect impacts. The draft EIS addresses the range of impacts as follows:

- Assessment of the extent of the potential aircraft noise impacts within the Stage 1 noise chapter and technical noise report on the basis of a range of modelling scenarios and metrics used to present aircraft noise information; and
- Assessment of the effect and significance of these impacts in other sections of the draft EIS related to:
  - Health
  - Land use
  - Social
  - Property values

The separation of assessments in this way is not an uncommon approach, particularly given the assessment of the effect and significance of noise impacts often requires specialist knowledge beyond the areas of expertise of acoustic consultants. However, a complete appreciation of noise related impacts therefore requires reference to a range of distributed sections throughout the draft EIS.

Accordingly, while the noise chapters (Stage 1 and long term development) and technical noise report provide the primary basis for the comments in this section of the peer review, additional comment is provided in the following sections in relation to technical noise matters as they are presented in the assessment of noise effects in other chapters and specialist reports.

2.4.1 Methodology Overview

The Stage 1 noise chapter and technical report present predicted noise levels in the form of noise contours and population counts to demonstrate the potential extent of areas that may be affected around the proposed airport. The noise contours are supplemented by additional information such as flight track density maps which illustrate the patterns of overflights beyond the extent of the predicted noise contours.

The predicted noise level information presented in the draft EIS is consistent with the types of aircraft noise information recommended in a number of Federal government publications. Further, the contours generally extend down to relatively low noise levels and event numbers to demonstrate the extent of potential effects well beyond ANEC contours. This approach is considered appropriate.

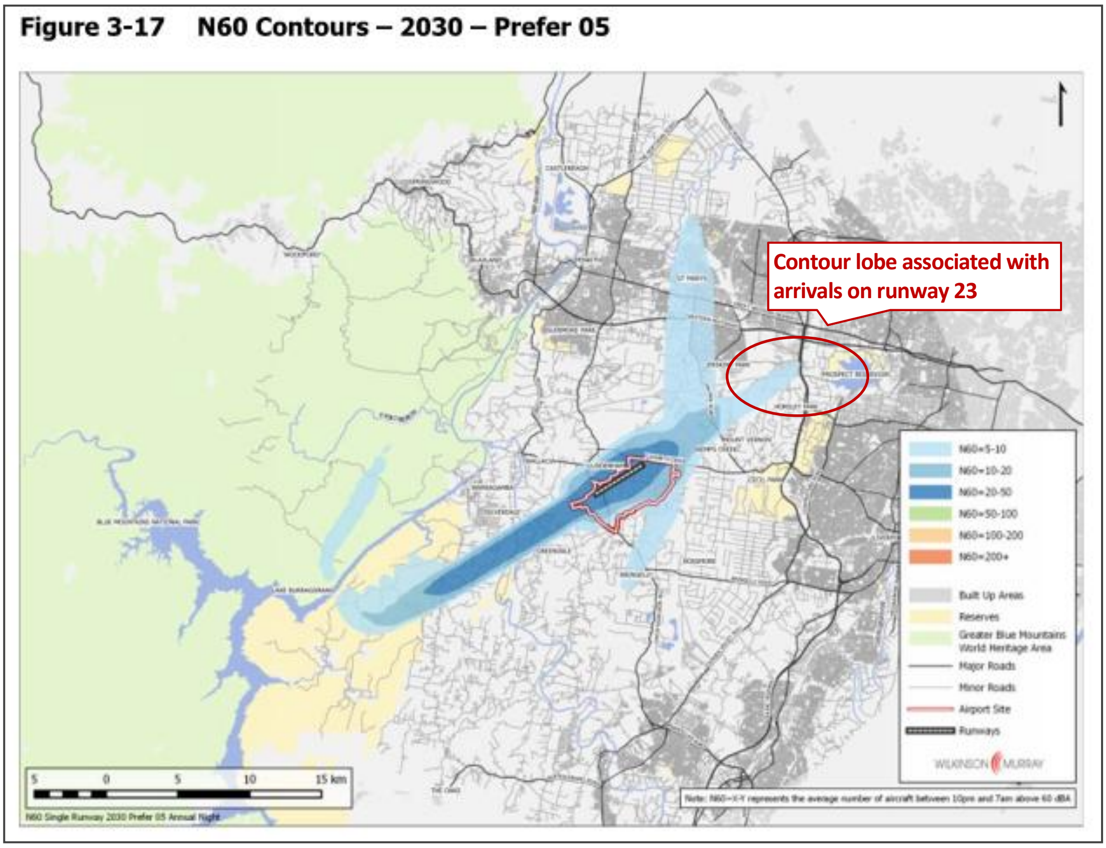
However, the following key observations are noted:

- The illustrated extent of the noise contours is generally considered to be an accurate representation for the assumed Stage 1 operations. However, the uncertainties relating to these assumed Stage 1 operations appear to be significant. The extent to which the Stage 1 airspace design may change is not prescriptively defined in the draft EIS; accordingly, the potential change to the extent of the predicted noise contours has not been defined. An indication of the potential changes to the extent of the contours is partly evident from the various operating modes that have been included in the prediction scenarios. It is however unclear if these represent the maximum extent of the noise contours which could be expected for the final airspace design. The example noted earlier in Section 2.2.3 regarding the departure track from runway 05 illustrates how the final airspace design may significantly alter the areas affected.
- The aircraft movement numbers in the assumed Stage 1 operating conditions are linked to a specific point in time related to the definition of the initial stage of development. The duration of this initial stage of development is linked to one of the incremental milestones in the longer term periodic approval and management framework for the proposed airport. In this respect, the movement numbers do not relate to a specific point in time at which movement numbers are stable or do not change significantly. Accordingly, the contours represent a snapshot of the extent of affected areas at that particular point in time, while the actual extent of areas affected will continually change and expand over time.
- The predicted N60 and N70 noise data are important metrics used to demonstrate a broader extent of impact than exposure metrics such as the ANEC. These values are specifically referenced for:
  - Indoor noise assessment: quantifying the number of external events which would give rise to internal noise levels inside a home with partially open windows which could potentially interfere with conversation or exceed thresholds commonly used for the assessment of sleep disturbance; and
  - Outdoor noise assessment: quantifying the number of events which could interfere with conversational voice levels or require a raised voice for conversation to be understood. This is however specifically only noted in relation to recreation areas (see section 3.7 of the technical noise report), rather than as a general consideration for the external amenity of residential settings.

  The above considerations mean that the extent of impacts illustrated by the N60 and N70 contours is primarily focussed on matters of indoor amenity or external speech interference. As per the discussion of the Greater Blue Mountains area in Section 7 of the technical noise report, noise impacts in quiet outdoor areas where natural soundscapes are valued (whether these are public or private outdoor areas) will occur at levels below 60 dB L_{Amax}. The impacts to these types of locations therefore extend beyond the N60 and N70 contours and reference must be made to alternative forms of supplementary information such as the track density maps presented for the Greater Blue Mountains.

- Noise contour information is presented in terms of ANEC data and NA values for alternative operating configurations including preferred operating strategies such as Prefer 05 (runway strategy favouring movements directed from the southwest and toward the northeast) and Prefer 23 (runway strategy favouring movements directed from the northeast and toward the southwest). It is evident from the noise contours that the Prefer 05 and Prefer 23 scenarios include movements occurring in both directions. For example, this is most evident on figures for scenario Prefer 05. These figures illustrate contour lobes extending to the northeast along the runway centre line, beyond the extent of the departure track, thus indicating the influence of an arrival movement on runway 23 (see example extract in Figure 2 below). Technically this is consistent with the definitions provided for Prefer 05 and Prefer 23. However, these contours may be prone to misinterpretation as single mode contours which illustrate the noise associated with movements occurring in single directions (and would extend further than the illustrated Prefer 05 and Prefer 23 strategy noise contours).

Figure 2: Extract from section 3 of the technical report illustrating the influence of mode 23 movements in the Prefer 05 operating scenario



2.4.2 Sensitive Receivers and Noise Exposure Data

Section 2.10 of the technical noise report notes that the noise sensitive receptors around the proposed airport site include residences, education facilities and health facilities.

The technical noise report subsequently provides noise data and assessments relating to residential receptors, in addition to data concerning sensitive uses in recreation areas and the Greater Blue Mountains World Heritage Area.

However, education facilities and health facilities are not directly referenced or assessed in the Stage 1 noise chapter or technical noise report. Instead, reference is made to alternative noise metrics which were calculated and subsequently assessed in the health report contained in the draft EIS. The predicted noise levels for these locations should be available in the Stage 1 noise chapter and technical noise report, in the same way that they have been provided for other types of noise-sensitive receiver locations such as recreational areas (i.e. including the predicted N60 and N70 values).

Section 2.10 of the technical noise report also describes information sources and methodologies which were used to calculate the number of residential receiver locations experiencing a given level of noise exposure. The data sources and methods used to develop these population statistics are considered appropriate for the application, and include an appropriate account of projected population increases in the areas surrounding the proposed airport. As noted previously however, these are based on a snapshot at the particular assessment point in time, while the actual extent of impacts and people affected will continually change and expand over time.

2.4.3 Community Annoyance Assessment

The Stage 1 noise chapter and technical noise report primarily quantify the extent of areas which may be affected by aircraft noise. The subject of potential community annoyance is separately discussed in the draft EIS chapters and technical reports concerning potential social impacts and health risk assessments.

The population statistics discussed in the preceding section provide a useful indication of the number of people who may be affected by aircraft noise to varying degrees. However, in isolation, this data does not provide an indication of the likelihood or significance of potential community reaction to aircraft noise levels as a result of annoyance.

The Health Risk Assessment presented in Volume 4 Appendix G provides the most discussion of potential annoyance, noting that annoyance is most prevalent community response in a population exposed to environmental noise. The Health Risk Assessment includes a discussion of a range of research studies concerning dose-response relationships between total noise exposure levels and the percentage of a community likely to be annoyed or highly annoyed. However, the Health Risk Assessment concludes the discussion of annoyance by stating that no quantitative assessment of annoyance was conducted as part of the study.

The assessment of potential community annoyance is ultimately a complex task for a development of this scale. Dose-response relationships of the types referenced in the Health Risk Assessment can be used with noise levels and population data to provide a quantitative measure of the potential reaction. The use of these established relationships to represent the reaction of a separate community exposed to aircraft noise must be used with caution. In particular, consideration must be given to the uncertainties associated with using community reactions observed at other airports to predict the reaction of a separate community, exposed to a new source of aircraft noise. This type of analysis does however provides an objective basis for comparing the impacts of alternative operating strategies and, more broadly, establishing the risk of community noise annoyance relative to other established international airports in Australia.

Accordingly, while the assessment of the risk of community annoyance is complex, the scale of the proposed airport, and the number of people potentially affected, are considered sufficiently large to warrant further evaluation of the subject. In particular, the introduction of a new 24-hour international airport at a greenfield development site ultimately represents a significant risk of wide spread and prolonged community annoyance.

A quantitative analysis of community annoyance is therefore considered appropriate to assess the significance of the impact. This analysis would also assist with determining the extent to which operational noise mitigation should be prioritised relative to other non-safety related airspace management considerations. Further consideration should therefore be given to quantitative analysis based on established response relationships. The scale of the project may also warrant consideration of further social surveys which could be used to establish a new dose response relationship which may be more relevant to the long term impacts on potentially affected communities around the proposed airport site. Other types of quantitative analysis could comprise population statistics and complaint trends for existing Australian airports which could provide contextual information about the sensitivity, or otherwise, of the proposed airport site relative to other established international airports in Australia.

Importantly, without a meaningful appraisal of the risks of significant community disturbance, there is the potential for unforeseen impacts and the associated risk of a requirement for reactionary noise management procedures. As well as the impacts to neighbouring communities, this could subsequently jeopardise the operational flexibility of the proposed airport.

2.4.4 Sleep Disturbance Assessment

The technical noise report provides information concerning sleep disturbance in terms of the number of events exceeding 60 dB L_{Amax} for each operating mode during the night-time period 10 pm to 7 am. A level of 60 dB L_{Amax} is cited as the external level which would approximately correspond to an internal level of 50 dB L_{Amax}; an internal level that is commonly used as a design criterion for protection against sleep disturbance.

The selected assessment thresholds in the technical noise report are consistent with common industry practice for assessing sleep disturbance. In particular, the values are generally consistent with the advice contained in the World Health Organisation guidelines (Bergland et al, 2009) which also refers to an external level of 60 dB L_{Amax} for the avoidance of sleep disturbance. The values are also similar to values referenced in NSW policies concerning road traffic. While the technical report does not specifically state the number of events exceeding 60 dB L_{Amax} which are sufficient to represent an increased risk of sleep disturbance, the information is provided for a relatively low number of events (i.e. down to 5 – 10 events). For context, the WHO guidelines suggest that external noise levels exceeding these values should ideally not occur more than 10 to 15 times per night when assessing dwellings with partially open windows.

The technical noise report provides future population counts for this data indicating that between approximately 4,000 and 48,000 people could experience more than 5 events per night exceeding 60 dB L_{Amax}, depending on operating strategy. In terms of areas experiencing a greater number of events, the technical noise report identifies between approximately 600 to 1,200 people experiencing 20 to 15 events per night above 60 dB L_{Amax}, depending on operating strategy.

The key points from these figures are that:

- A large number of people are predicted to experience external maximum noise levels which are sufficient to result in internal noise levels corresponding to sleep disturbance thresholds. In turn, this indicates a large number of people may need to sleep with windows closed to maintain an acceptable internal amenity. The extent of this potential impact would depend on the prevalence of existing ambient noise sources which could prompt an individual to sleep with closed windows, irrespective of the proposed airport.

- As referred to in the technical noise report, the Prefer 05 strategy results in the greatest number of people experiencing more than 5 events per night over 60 dB LAmax , but the least number of people experiencing more than 20 events per night over . In the absence of established guidelines, or proposals in the draft EIS, to indicate whether priority should be given to reducing the number of people to a small number of events or reducing the number of people exposed to the highest number of events, it is unclear how these findings would inform the selection of noise mitigation measures or a preferred operating strategy.
- The information is primarily directed at understanding noise impacts experienced by people in dwellings with partially open windows. The information does not indicate if there are dwellings which would experience night-time events that are sufficiently high in level to result in noise levels above the 50 dB L_{Amax} internal criterion, even if the windows are closed. This type of information would provide an indication of the number of dwelling locations which could potentially require upgraded insulation to maintain an acceptable internal amenity.

In addition to the technical noise report, it is noted that Section 6.3.1 of Volume 4 Appendix G *Community Health* provides an assessment of sleep disturbance. The peer review of this document is being separately carried out be specialists in the field of health assessment and is therefore not reviewed in detail in this peer review document. It is however noted that while the Community Health report makes reference to the maximum noise level data contained in the technical noise report, the Community Health report primarily assesses impact on the basis of equivalent noise levels. Given that the 2030 assessment year involves a relatively low number of movements from the proposed airport (refer to earlier discussion of movement numbers in Section 2.2.5), some discussion of the rationale for focussing on equivalent noise levels instead of maximum noise levels would be prudent; particularly given that the Health Report acknowledges that the dose-response curves have been derived from European studies and may underestimate the impact in the area surrounding the Western Sydney airport site.

2.4.5 Land Use Impacts

The technical noise report presents Australian Noise Exposure Concept (ANEC) contours in section 3.6 titled *Land Use Planning Impacts*.

ANEC contours are not used for land use planning, but are normally presented as an indication of the potential extent of Australian Noise Exposure Forecast (ANEF) contours which are used for land use planning; the ANEF being an endorsed ANEC or combination of ANECs.

However, as acknowledged in the draft EIS, the ANEC contours presented for the Stage 1 proposal provides limited guidance in this instance, as the ANEF is normally derived from ANECs calculated for long term operations or ultimate capacity scenarios, rather than short term ANECs related to the initial phase of operation. Evaluation of land use planning impacts must therefore be based on the long term ANEC contours presented in subsequent sections of the technical noise report. These long term ANEC contours are discussed subsequently in Section 3.1.3 and Section 3.2.5 of this peer review report.

2.4.6 Dwelling Insulation

The Stage 1 noise chapter and technical noise report do not refer to requirements for, or proposals for, insulation of dwellings for the protection of internal amenity.

The potential for dwelling insulation is however mentioned in Volume 2 Chapter 28 *Environmental Framework* which notes the following:

> *the possible insulation or acquisition of buildings exposed to the highest noise levels having regard to Australian Standard 2021, including mechanisms for funding potential noise amelioration works and property acquisitions;*

There is however no detail provided in the draft EIS in terms of quantifying the extent to which such measures would be implemented, or how the process of insulating or acquiring dwellings would occur 'with regard to Australian Standard 2021'. The reference to AS 2021 for this application requires further clarification to understand the extent of areas that may be insulated or acquired. For example, it is unclear if dwelling insulation would only be considered within certain Australian Noise Exposure areas, or if such measures would be considered at all locations where internal levels may be expected to exceed AS 2021 internal design criteria as a result of the proposed airport operations.

2.4.7 General Recreation Areas

Section 3.7 of the technical noise report provides information relating to recreation areas. Separate information concerning the Blue Mountains is provided in section 7 of the technical noise report.

The assessment for these locations is primarily based on the number of events predicted to exceed 60 dB L_{Amax} and 70 dB L_{Amax}. The information and assessment procedures for these locations is considered appropriate, subject to the points noted in the technical noise report concerning the impact on acoustic amenity. Specifically, that the noise would be noticeable in areas used for passive recreation and the noise could be considered intrusive on the acoustic amenity.

2.4.8 Greater Blue Mountains World Heritage Area

The technical noise report provides an assessment of noise levels in the Greater Blue Mountains World Heritage Area (GBMWHA).

To provide a basis for assessing impacts to the GBMWHA, the technical noise report presents information in the form of track density plots. While this form of data provides a useful and established form of information, the reason for reverting to overflight numbers in lieu of predicted noise levels is not stated. As per the discussion in Section 2.3.2 of this peer review, this may be related to increased uncertainty in the predictions when considering low predicted noise levels. However, flight track density plots in isolation do not illustrate the full extent of potentially intrusive noise levels at locations to the side of the flight track.

The report notes that aircraft are typically at an altitude of approximately 5000 ft, which corresponds to a noise level on the ground of approximately 55 dB L_{Amax}, consistent with INM predictions for the Airbus A320 or Boeing 737-800. Measurements at other airports have however demonstrated that aircraft at that altitude are generally higher than those predicted using the INM, and accordingly noise levels in practise could be higher.

As per the technical noise report, levels below 55 dB L_{Amax} could be considered intrusive by recreational visitors and other users, as the natural soundscape is an important attribute of high value wilderness areas. While levels below 55 dB L_{Amax} are likely to be comparable to typical levels associated with ambient noise sources in the GBMWHA, it is generally not considered appropriate to assess aircraft noise intrusion by comparing sound pressure levels; the characteristics of aircraft noise and natural sounds and very different, and are interpreted in very different ways.

The preservation of quiet areas and tranquil landscapes has been a topical subject of research and policy consideration in Europe and the US. For example, the US Transportation Research Board publication on the effects of aircraft noise (Mestre, 2008) includes a chapter which discusses research and US legislation (National Parks Overflight Act of 1987) concerning the effects of aviation noise on parks, open space and wilderness areas. These publications do not provide definitive guidance on assessment techniques, but highlight the complexity and importance of assessing aircraft overflight noise in sensitive wilderness areas.

The potential for a large number of audible events below 50 – 55 dB L_{Amax} is therefore considered to represent a potentially significant and widespread impact within the GBMWHA. On this point, we note that the separate assessment of impacts to the GBMWHA presented in Volume 2 of the draft EIS indicates noise levels below 50 and 55 dB L_{Amax} are 'not significant'. Given the above, the assertion within draft EIS GBMWHA chapter that noise levels below 50 and 55 dB L_{Amax} are 'not significant' is not considered to have been sufficiently justified, and the assessment may therefore not adequately reflect the potential impact to the values of tranquillity within the World Heritage Area.

Given the status of the Blue Mountains as a World Heritage Area, and the potential for intrusive impacts, further assessment of this sensitive receiver location is considered to be warranted. In particular, further information should be provided to demonstrate the relative merits of alternative aircraft arrival management procedures which do not involve a concentration of aircraft movements over the GBMWHA. This should include a discussion of the tradeoffs between protection of amenity in residential areas and the protection of the GBMWHA. Consideration should also be given to different areas within the GBMWHA noting any areas of increased recreational use or areas where tranquillity and natural soundscapes may be more valuable.

2.5 Alternatives

The EIS guidelines establish a requirement to investigate feasible alternatives for the proposal, including:

a) If relevant, the alternative of taking no action;

b) A comparative description of the impacts of each alternative on the matters of national environmental significance and other matters protected by controlling provisions of Part 3 of the EPBC Act for the action; and

c) Sufficient detail to make clear why any alternative is preferred to another.

The technical noise report considers the number of people potentially affected for alternative merge points in general terms. For the two alternative merge points considered, the technical noise reports notes that the flight densities over Blaxland are reduced, and the people affected are aligned to less populated rural residential areas outside the GBMWHA. Track densities and number of aircraft overflights over Blue Mountains' communities are still predicted to be high, while impacts on some areas within the GBMWHA are increased for the two alternative merge points.

It is therefore unclear why preference has been given to the merge point that affects a greater population, i.e. over Blaxland, in lieu of reducing the number of potential affected residences. This is perhaps due to conservation of the world heritage area, however this should be confirmed.

Further, while the merge point system appears to offer some noise benefits related to the use of constant descent approaches, the merge point conversely results in concentrated impacts directly beneath the merge point. The considerations warrant an assessment of the noise of additional alternatives, in terms of alterative merge point configurations (e.g. multiple merge points as per the 2063 airpsace design in lieu of a single merge point), and in terms of alternatives arrival management procedures to the merge point system.

In broader terms, with the exception of the merge points noted above, no assessment of alternative flight tracks or noise mitigation procedures has been presented in the noise chapter or technical noise report. This is presumably related to the limited extent to which the airspace management design has been progressed, however this source of uncertainty is a key reason to consider the impacts of potential alternative procedures.

2.6 Proposed Mitigation Measures

The noise modelling presented in the Stage 1 noise chapter and technical noise report provides information concerning the following mitigation measures:

- The use of continuous descent approaches for all arrival procedures; and
- Relocation of the merge point associated with the Stage 1 proof of concept airspace design.

As discussed in Section 2.2.3 of this peer review report, the noise modelling is based on an indicative proof-of concept air traffic management design which does not present a comprehensive airspace and air route design, nor does it consider all of the essential components that would be necessary to implement an air traffic management plan for the Sydney basin.

Given the uncertainties concerning the final form of the airspace design, the final form of noise mitigation measures to be implemented is not yet known. Accordingly, the mitigation measures that have been referred to in the aircraft noise assessment are generic in nature. The residual noise impacts associated with the proposed airport's operations following the implementation of such mitigation measures is therefore presently unknown.

To provide context, feasibility noise assessments and generic mitigation measures are not uncommon for other forms of infrastructure project for which there are well defined policies that limit the allowable noise that may occur in practice. In contrast, aircraft noise policies and regulations in Australia do not specify limits which apply to aircraft over overflight noise at surrounding sensitive receptor locations. Accordingly, without a defined airspace design or defined noise criteria to adhere to in practice, a defined noise mitigation strategy and the residual impacts and the location of these impacts is subject to considerable uncertainty. Further, without a defined noise limit, it is unclear how noise considerations would be prioritised among other non-safety related airspace management and operational considerations associated with the proposed airport site.

Based on the above considerations, further information about the likely airspace management plan, mitigation strategies or proposed control mechanisms (with reference to performance criteria) is considered essential. The discussion of mitigation measures should include:

- Clarification of preferred operating strategies to manage environmental noise impacts, including reference to mitigation priorities and the manner in which alternative mitigation measures would be evaluated, e.g. is priority given to limiting the number of people experiencing the greatest noise effects or limiting the total number of people within the overall extent of the contours, and how will considerations related to residential and non-residential noise-sensitive receiver locations be balanced;
- Clarification of how the flight paths and hence predicted noise levels may vary during the detailed design of the airspace management procedures;
- Clarification of whether Noise Abatement Departure Procedures (NADP) as defined by ICAO would be considered in the noise management plan, and if so, under what circumstances or operating scenario. For example, would NADP be considered for all operations, operations on a given runway, or operations occurring at night;
- Clarification of the proposal to implement a merge point arrival system;
- Clarification of the proposal to implement head to head operations during night-time hours;

- Clarification of the extent to which dwelling insulation or property acquisition measures would be implemented, or how the process of insulating or acquiring dwellings would occur 'with regard to Australian Standard 2021'. For example, would such measures be limited to locations within the ANEC/ANEF 20 contour, or would dwelling insulation potentially extend to locations outside of the ANEC/ANEF contours to address internal noise levels at locations where noise levels above the design criteria in AS 2021 are not expected to be achieved. Consideration should be given to circumstances where a resident must close windows to protect internal amenity, or in instances where the noise levels are above the design criteria even with windows closed; and
- Consideration of the potential merits of mitigation strategies tailored to the initial phase of operations when communities may be particularly sensitive to the presence of a new major noise source in the area. For example, this could include deliberate and staged incremental movement number increases to avoid 'sudden' noise exposure which has led to significant community reaction at some new airports, particularly in terms of night operations.

3.0 REVIEW FINDINGS – LONG TERM DEVELOPMENT

The following section discusses the noise impacts associated with the longer term development of the proposed airport, accounting for:

- Longer term development of single runway capacity: incremental development of aviation infrastructure and support services to facilitate 164,000 aircraft movements per year which are projected to occur by 2050; and
- Longer term development with an additional parallel runway to the south: an additional runway is proposed for long term operations, enabling additional capacity increases to 370,000 aircraft movements per year which are projected to occur by 2063.

A number of the considerations identified from the peer review of the Stage 1 development are directly relevant to the assessment of the long term development scenarios. For example, matters related to the noise prediction methodology are identical for the Stage 1 and long term development scenarios. Accordingly, this section details any variation to those assessed in the long term development scenarios.

3.1 2050 – Additional capacity single runway

3.1.1 Flight paths

The flight paths are as per the stage 1 development and accordingly the same findings apply. Specifically, they do not represent the final flight paths which would be flown if the project proceeds and the reports do not provide any indication of the manner or extent to which the final airspace design may vary from the proof-of concept design. This represents a significant source of uncertainty in the predicted noise levels.

The 2050 scenario also includes Boeing 747-400 stage 9 departures (i.e. a higher takeoff weight due to longer trip length). However, the proposed runway length of 3,700 m is noted to be less than the required runway length specified in Volume 1 Chapter 5 Airside Precinct (see Table 5-4) for a maximum weight Boeing 747-400 take off. This may be plausible if weight restrictions are applied to Boeing 747-400 departure operations. Irrespective, from a noise perspective, this suggests that the Boeing 747-400's inclusion in the noise modelling may be conservative.

3.1.2 Movement numbers

The movement numbers for the 2050 scenario are consistent with forecasts for similar single runway Australian International airports (Perth, Adelaide), refer Figure 1. Accordingly, the predicted noise levels for this scenario would appear more suitable as the appropriate primary assessment scenario for the purpose of obtaining approval for the development.

These comments are provided primarily in relation to the plausibility of the movement numbers represented in the noise modelling, based on comparisons with the movement numbers documented in the noise modelling for other Australian international airports and similar time horizons. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers adopted for the 2050 noise assessment are considered in further detail in a separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

3.1.3 Land use impacts

We note a difference in the population counts within ANEC bands for the 2050 scenario between the technical noise report and the long term development noise chapter. The source of this discrepancy is unclear. For reference, a sample of the differing values is presented in Table 2.

Table 2: Estimated population within ANEC contours (2050) for Prefer 23 with head-to-head

ANEC	Data from Table 31-2 of Volume 3	Data from Table 4-3 of the technical noise report
20-25	1,293	1,672
25-30	302	379
30-35	72	77
>35	4	4
Total	1,672	2,132

3.2 2063 – Parallel runway

3.2.1 Runway position

The proposed second parallel runway would be located to the south of the proposed stage 1 development runway, with a separation distance of approximately 1,900 m according to Volume 2 (Section 30.2).

The specific location is not defined with reference to an aerodrome reference point, runway end coordinates or elevation details. The parallel runway orientation is assumed to be consistent with the Stage 1 proposal runway, i.e. a single southwest / northeast runway designated as runway 05R and 23L respectively. However, as per the discussion earlier in this peer review report in Section 2.2.1, it is unclear if the exact orientation of the runway has been finalised.

3.2.2 Departure tracks

The flight tracks depicted in Figure B1 of Appendix B of the technical noise report show that departures on runway 05R (parallel) turn left approximately 3 km from the runway end and head due north for 25 km before branching out to a number of directions. This flight path is similar to the track depicted for the initial runway of the Stage 1 development.

However, an additional departure track to the northeast is included in this scenario, and involves direct overflight of the relatively densely populated areas to the northeast, such as Blacktown. Further discussion of noise mitigation measures relating to this flight path would be prudent.

3.2.3 Cumulative impacts

Airspace architecture chapter of Volume 1 (Section 7.4.1) notes that under a parallel runway scenario at the proposed airport, a number of issues would need to be addressed as part of the future airspace design process, including:

- *changes to Sydney Airport flight paths to maintain independent operations at the proposed airport and Sydney Airport and to achieve expected demand capacity;*
- *changes to flight paths serving Bankstown Airport, in particular for instrument flight rule operations, in order to maintain independent operations at the proposed airport and Bankstown Airport and achieve the expected demand capacity; and*
- *resolution of a potential constraint associated with the restricted airspace over Defence Establishment Orchard Hills.*

Section 5B of the EIS Guidelines requires the EIS to:

> *identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity)*

The draft EIS has not considered implications on flight paths at other airports and the associated noise impacts on other communities closer to Sydney, Bankstown and Defence establishments having regard to the potential variation in the final flight paths. The issues concerning the airspace architecture are considered to represent potential cumulative impacts which have not been quantified in the draft EIS.

Further information concerning this issue is therefore considered necessary to address the requirements of the EIS guidelines.

3.2.4 Operating modes

The assessment considers two operating modes only, 'prefer 05' and 'prefer 23'. The technical noise report notes that the use of alternative night time operating modes, such as 'head to head' as per the Stage 1 development could likely reduce night time impacts. This is not quantified and conclusions on the potential reduction in noise levels can therefore not be established.

Further, the discussions presented in Volume 1 Chapter 7 *Airspace architecture* indicate that the feasibility of head to head operations is yet to be confirmed.

3.2.5 Land use impacts and dwelling insulation

As per the assessment of the stage 1 development, the land use planning impacts in the technical noise report considers only the number of potential people within each ANEC band for each of the operating modes.

The ANECs prepared in the technical noise report for the long term development may be considered indicative of the extent of an ANEF for the proposed airport. The technical noise report does however note that an ANEF chart based on further formal flight path design would need to be produced and endorsed by Airservices Australia prior to the commencement of airport operations and to inform land use planning around the proposed airport.

The 1985 EIS prepared an indicative ANEC for the Western Sydney Airport. It is understood this ANEC formed the basis for zoning land uses around a future airport, as detailed in local environmental plans having regard to future aircraft noise. As such, there are current planning mechanisms in place to ensure future dwellings incorporate appropriate treatment in anticipation of the proposed airport.

The draft EIS has not fully undertaken an assessment of land use impacts. Specifically, an assessment of the location of current dwellings within 'zones affected by aircraft noise' documented in the local environmental plans (based on 1985 EIS ANEC contours) and their relative location based on the ANECs prepared as part of this EIS. Details on the change in the ANEC rating for individual dwellings would ideally be undertaken to determine the extent of further mitigation measures. Such measures may include potential dwelling insulation to dwellings where a significant change in ANEC has occurred.

Noting the ANECs prepared for this EIS are not final, consideration should still be given to the potential extent of a single ANEF to be adopted for future land use planning. Australian Standard *AS2021:2015 Acoustics - Aircraft Noise Intrusion – Building Siting and Construction*, details procedures for the preparation of an ANEF. Specifically, where future runways are proposed, a composite chart of a number of ANECs should be produced to cover areas the single runway at ultimate capacity ANEC are not covered by adopting the ANEC incorporating the 2 runways.

A complete assessment should therefore be undertaken with the above considerations, to enable a complete understanding of the potential land use impacts associated with the airport operations.

In addition to the above, the technical noise report does not discuss the potential land use planning impacts related to the National Airports Safeguarding Framework (the *Framework*) which was developed by the National Airports Safeguarding Advisory Group in 2012. This Framework is however noted in the noise chapter, which subsequently refers readers to Chapter 21 *Planning and land use* for further information.

The Framework provides guidance on planning requirements for development that affects aviation operations. As part of the guidance, the Framework proposes the use of new noise metrics for land use planning, subject to the outcomes of a review of Australian Standard AS 2021. The review of AS 2021 was completed and the revised version of AS 2021 published in May 2015. While the revised standard did not include the additional land use buffers that were requested by the National Airports Safeguarding Advisory Group (i.e. the updated version of AS 2021 continues to refer to solely to the ANEF parameter rather than Number Above metrics), it is noted that an amendment to Victorian Planning Provisions (see VC128) was scheduled by the Victorian government on 8 October 2015 to include the National Airports Safeguarding Framework as a policy guideline. This policy only applies in Victoria and it is unclear how this new guidance will affect land use planning around Victorian airports. However, the introduction of the Framework into a state policy provides a precedent for the potential use of noise contours extending well beyond ANEC contours to inform land use planning.

Further, while the Framework is not directly referenced in the noise chapter or technical noise report, the Framework is introduced in Volume 2 Chapter 21 *Planning and land use*. The peer review of this document is being separately carried out by specialists in land use planning and is therefore not reviewed in detail in this peer review document. It is however noted that 21.7.2.2 focuses on the implications of a future ANEF for land use planning, but concludes with the following statement:

> *The implementation of Guideline A: Measures for Managing Impacts of Aircraft Noise under the NASF would be instrumental in managing potential future operational noise impacts for future land use planning and development around the airport.*

This would appear to imply the potential for land use planning instruments extending well outside of the future ANEF contours, despite land use impacts outside of the ANEC/ANEF contours not being specifically cited in the discussion. This is reinforced by content in Volume 2 Chapter 27 *Cumulative Impact Assessment* which states:

> *The draft EIS provides ANEC contours and identified other potential noise impact areas which can be used to guide appropriate future land use planning and compatible development.*

The imposition of the Framework for land use planning around the proposed airport could therefore result in land use impacts extending well beyond the existing land use controls or a future ANEF developed during the detailed design phase of the airport. The potential for these extended impacts should be clarified and clearly disclosed.

4.0 SUMMARY

A peer review of the aircraft overflight noise assessment contained within the draft Environmental Impact Statement (draft EIS) for the proposed Western Sydney Airport has been carried out.

The noise modelling is considered to generally provide an accurate representation of the extent of noise impacts for the development description and operating scenarios that have been proposed. However, the peer review has identified a number of limitations which relate to both the extent to which the airspace management's design has been progressed, and the assessment of the noise modelling outcomes. These matters are summarised as follows:

Low Stage 1 movement numbers

The total aircraft movement numbers for the Stage 1 development are relatively low when compared to other international airports in Australia. Given the objective of the proposal is to develop a major international airport, the low movement numbers raises the question of the suitability of the 5 year time horizon as the appropriate primary assessment scenario for the purpose of obtaining approval for the development. Further, it is unclear how the incremental and periodic approvals that would need to occur as part of the ongoing expansion of the airport provides a sufficient basis for considering the initial 5 years of operation as the primary period for the assessment of noise impacts.

These comments are provided primarily in relation to the plausibility of the movement numbers represented in the noise modelling, based on comparisons with movement numbers documented in the noise modelling for other Australian international airports and similar time horizons. Aircraft traffic forecasts are however outside of our area of expertise and therefore the suitability of the specific movement numbers provided for the noise assessment are considered in further detail in separate aviation peer review commissioned by WSP Parsons Brinckerhoff.

Airspace management strategy uncertainties

the draft EIS clearly indicates that the airspace management strategy used as the basis for noise modelling is a proof-of concept design, and further work is required to determine the actual flight paths which would be flown in practice. Information about the extent of potential changes is limited. The uncertainty surrounding the final airspace management design that would be implemented represents a potentially significant source of uncertainty in the noise assessment. The potential significance of this source of uncertainty has not been quantified and, with exception of alternative merge point points for Stage 1, there has not been any sensitivity analysis carried out to assess the implications of potential flight path changes.

Assessment of community annoyance

The draft EIS includes exposed population statistics which provide a useful indication of the number of people who may be affected by aircraft noise to varying degrees. However, in isolation, this data does not provide an indication of the scale or severity of potential community reaction to aircraft noise levels as a result of annoyance.

The Health Risk Assessment provides the most discussion of community annoyance, including references to research concerning the relationship between noise exposure and community annoyance, but ultimately states that no quantitative assessment of annoyance was conducted as part of the study.

Dose-response relationships of the types referenced in the Health Risk Assessment can be used with noise levels and population data to provide a quantitative measure of the potential reaction. The use of these established relationships to represent the reaction of a separate community exposed to aircraft noise must be used with caution. In particular, consideration must be given to the uncertainties associated with using community reactions observed at other airports to predict the reaction of a separate community to a new source of aircraft noise. However, this type of analysis provides an objective basis for comparing the impacts of alternative operating strategies and, more broadly, establishing the risk of community noise impacts relative to other established international airports in Australia.

Accordingly, while the assessment of the risk of community annoyance is complex, the scale of the proposed airport, and the number of people potentially affected, are considered sufficiently large to warrant further evaluation of the subject. In particular, the introduction of a new 24-hour international airport at a greenfield development site ultimately represents a significant risk of wide spread and prolonged community annoyance.

A quantitative analysis of community annoyance is therefore considered appropriate to assess the significance of the impact. This analysis would also assist with determining the extent to which operational noise mitigation should be prioritised relative to other non-safety related airspace management considerations. Further consideration should therefore be given to quantitative analysis based on established response relationships. The scale of the project may also warrant consideration of further social surveys which could be used to establish a new dose response relationship and may be more relevant to the long term impacts to potentially affected communities around the proposed airport site.

Land use impacts

The draft EIS includes calculated Australian Noise Exposure Concept (ANEC) contours for the Stage 1 and long term development operating scenarios. ANECs are often presented as an indication of the extent of a potential future Australian Noise Exposure Forecast (ANEF) contour which would be used to guide land use planning for noise-sensitive developments in the vicinity of airports.

However, while the draft EIS provides population counts for the various ANEC bands, no assessment is provided of the extent to which land use controls may change as a result of a future ANEF prepared as part of the detailed airspace design for the project. Specifically, the draft EIS does not quantify the potential extent of changes to land use controls relative to the measures which have been in place since the original EIS was undertaken in 1985.

Furthermore, the discussion of land use planning impacts in the draft EIS notes that the National Airports Safeguarding Framework (the Framework) would *'be instrumental in managing potential future operational noise impacts for future land use planning and development around the airport'*. The Framework could potentially translate to the creation of land use planning controls which extend over significantly greater areas than either the current land use planning controls (based on the 1985 EIS) or the 2063 ANEC contours provided in the draft EIS. This has however has not been discussed or assessed in the draft EIS.

Greater Blue Mountains World Heritage Area (GBMWHA)

The draft EIS presents information to evaluate the potential impacts of aircraft operations on the acoustic amenity of the GBMWHA. The assessment indicates the potential for a large number of audible aircraft events within the GMWHA. While the levels are predicted to be relatively low (below 50 – 55 dB L_{Amax}), aircraft over flights would be expected to be audible and represent a significant and widespread impact for a World Heritage Area where natural soundscapes are a likely to be a valued feature of the areas amenity. Accordingly, the assertion within draft EIS chapter that noise levels below 50 and 55 dB L_{Amax} are 'not significant' is not considered to have been sufficiently justified, and the assessment may therefore not adequately reflect the potential impact to the values of tranquillity within the World Heritage Area.

Mitigation measures and residual noise impacts

The draft EIS noise modelling is based on an indicative proof-of concept air traffic management design which does not present a comprehensive airspace and air route design. Given the uncertainties concerning the final form of the airspace design, the final form of noise mitigation measures to be implemented is not yet known. Accordingly, the mitigation measures that have been referred to in the aircraft noise assessment are generic in nature. This is a particularly important point for an airport development as, unlike other forms of infrastructure development, the policies used to manage aircraft overflight noise do not generally stipulate noise limits that airport operations must adhere to at surrounding noise-sensitive locations. Accordingly, without a defined airspace design, a defined noise mitigation strategy or defined noise criteria to adhere to in practice, the residual impacts and the location of these impacts is subject to considerable uncertainty. Further, it is unclear how noise considerations would be prioritised among other non-safety related airspace management and operational considerations associated with the proposed airport site.

Based on the above considerations, further information and assessment are considered necessary before stakeholders can reach an informed view on the potential scale and significance of aircraft overflight noise impacts associated with the proposed airport site.

Conclusion

Aircraft noise impacts are an unavoidable consequence of aircraft operations in urban environments. The creation of a new international airport therefore requires a balance to be achieved between the protection of amenity for neighbouring sensitive land uses and the development of infrastructure to respond to the growing demands of a major city.

Determining whether this balance has been achieved is ultimately a matter for regulatory authorities. While this peer review has identified a number of limitations to the present assessment, this is not intended to infer that the proposed development and development site are unsuitable. Rather, in light of the residual uncertainties in the assessment, further information and assessments are considered necessary before stakeholders can reach an informed view on the potential scale and significance of aircraft overflight noise impacts associated with the proposed airport site.

Conducting these further assessments as part of the environmental impact assessment process represents an opportunity to:

- Provide clarity to affected communities and stakeholders about the nature of the noise impacts;
- Provide clarity to regulators about the form of noise controls which will be needed in the project approval to ensure that noise is appropriately managed; and
- Reduce the potential for unforeseen impacts and the associated risk of reactionary noise management procedures which could subsequently jeopardise the operational flexibility of the proposed airport.

5.0 MDA PEER REVIEW PERSONNEL

The following personnel from Marshall Day Acoustics have conducted this peer review on behalf of WSP Parsons Brinckerhoff.

Engineer and role	Qualifications and key relevant experience
Justin Adcock,	*Bachelor of Engineering (Mech), University of Adelaide, South Australia*
Lead Peer Reviewer	Department of Defence, New Air Combat Capability: Contract and technical manager for the environmental noise modelling and impact assessment of Joint Strike Fighter operations - lead author of the noise impact assessment.
	Dubai International Airport and Jebel Ali International airport: Noise modelling, model validation works and impact assessment– lead report
Alex Morabito,	*Bachelor of Engineering (Mech), University of Adelaide, South Australia*
Peer Reviewer	*Bachelor of Finance, University of Adelaide, South Australia*
	Department of Defence, New Air Combat Capability: environmental noise modelling and impact assessment of Joint Strike Fighter operations
	Adelaide Airport Noise Insulation Program: Compliance testing to verify acoustic design of churches eligible for program
Steve Peakall	*Bachelor of Science (Environmental Engineering), University of the West of England, Bristol, UK*
Peer Reviewer	Institute of Acoustics, Diploma in Acoustics and Noise Control
	Sydney Airport, Peer review of the INM inputs for ANEF contours presented in the 2009 and 2013 Sydney Airport Master Plans.

In addition to the above main peer review personnel, review of key issues has also been provided by the following Marshall Day Acoustics.

Engineer and role	Qualifications and key relevant experience
Christopher Day	*Bachelor of Engineering (Mech), Monash University, Melbourne*
	Christchurch International Airport: Ongoing involvement since 1992 including, initial modelling and update of noise contours, presentation of expert evidence, member of the International Expert Panel, review of noise monitoring strategy and engine testing noise assessments.
	Auckland International Airport: Extensive involvement for more than 23 years involving the preparation of noise contours, assessment of aircraft noise effects, noise management and land use planning and development of a sound insulation programme.

APPENDIX A GLOSSARY OF TERMINOLOGY

Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
ANEC	A contour map showing forecast of aircraft noise exposure around an aerodrome for a future year. It is based on a forecast of aircraft movement numbers, operating times, types, destinations and flight paths
ANEF	A reviewed and endorsed ANEC by Airservices Australia or Department of Defence. It is the only contour map with status in land use planning decisions for aircraft noise exposure
ANEI	A contour map based on historical data from a previous year, where the numbers and types of aircraft which used the aerodrome are known. The map provides the average daily aircraft noise exposure around the aerodrome for that year. ANEI are typically used as benchmarks or an indicator of change in aircraft noise exposure
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
dB	Decibel. The unit of sound level.
Feet (ft)	Unit length 0.3048 m
Frequency	The number of pressure fluctuation cycles per second of a sound wave. Measured in units of Hertz (Hz).
Integrated Noise Model (INM)	A computer program used to model the impact of aircraft noise developed by the US Federal Aviation Administration
L_{Aeq}	The A-weighted equivalent continuous sound level. This is commonly referred to as the average noise level and is measured in dB.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.

APPENDIX B REFERENCES

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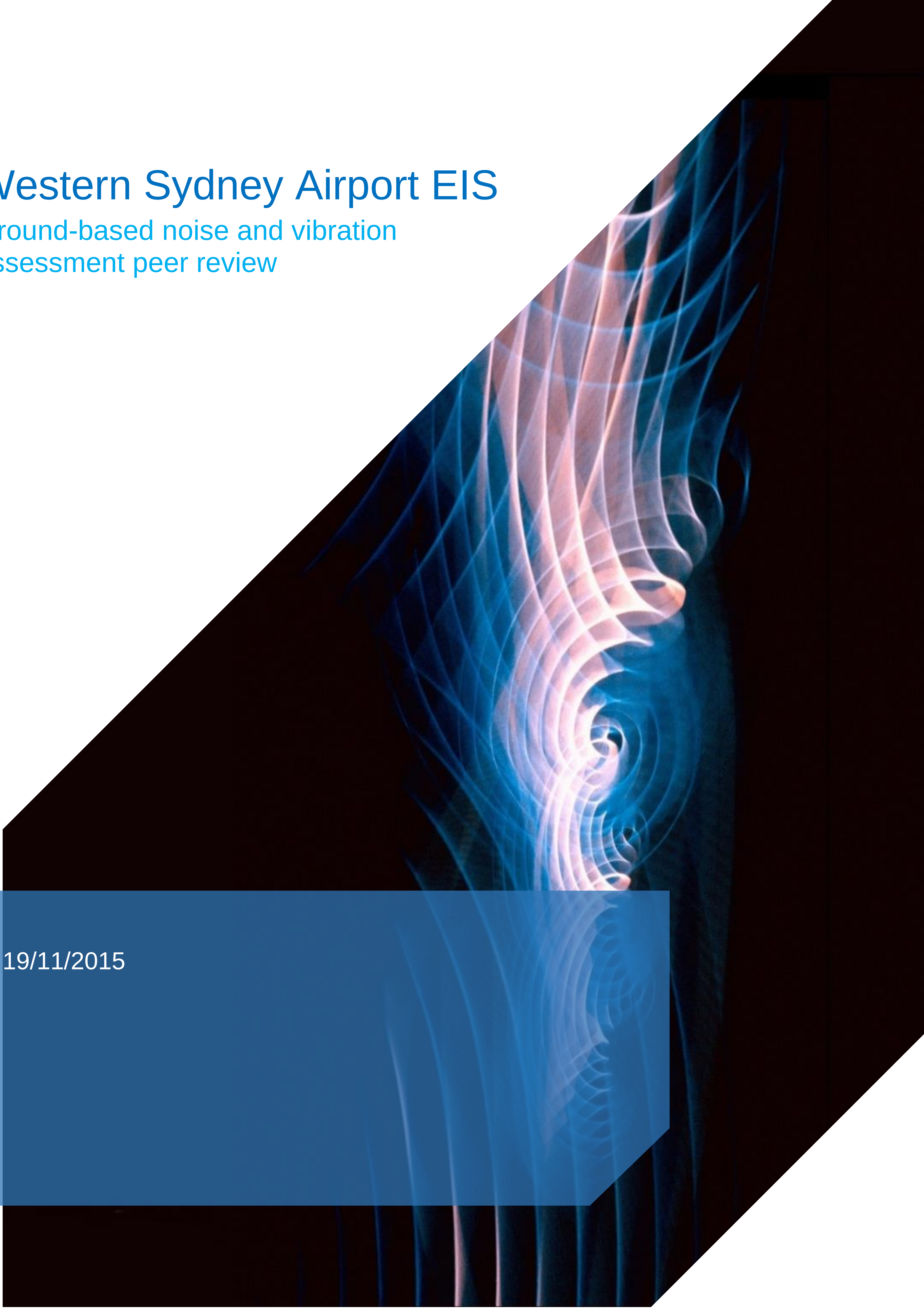
Appendix B

Ground-based noise and vibration (WSP | Parsons Brinckerhoff)

Western Sydney Airport EIS

Ground-based noise and vibration assessment peer review



19/11/2015

Western Sydney Airport EIS

Ground-based noise and vibration assessment peer review

Project no: ACG1517900
Date: 19/11/2015

Prepared for: WSROC

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WSP | Parsons Brinckerhoff
Level 1, 41 McLaren Street
North Sydney
New South Wales 2060
Australia

Tel: +61 (02) 8907 0900
Fax: +61 (02) 9957 4127

acoustics@WSPgroup.com

WSP | Parsons Brinckerhoff Contacts:
Alex Campbell
Mike Barrett

Quality Management

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Table of Contents

Executive summary

Introduction

The Western Sydney Airport draft Environmental Impact Statement (EIS) was prepared to provide an assessment of environmental impacts associated with the development of a new international airport near Badgerys Creek in Western Sydney, NSW. The draft EIS contains an assessment of noise impacts in two components; noise impacts from air-based activities such as aircraft in flight, landing and take-off; and from ground-based activities such as aircraft taxiing and ground based engine run-up. This review is concerned with ground-based activities only.

Scope of review

This scope of this report is to provide an unbiased peer review of all work presented as part of the Western Sydney Airport draft EIS in relation to ground-based noise.

Approach

This review identified uncertainties and unknowns within the ground noise the assessment, provided in the EIS and identified what further assessment would be required to provide an indication of impacts. The limitations of this review are as follows:

- Noise modelling or review of noise modelling files has not been completed as part of this review. Therefore it was not possible to verify the noise contour plots from ground-based activities presented in the EIS. However, comment has been included based on a visual inspection of the plots.
- The review relies on the source noise data that has been included in the ground noise assessment. The review is a desktop exercise and therefore independent source noise measurements have not been conducted to confirm the noise levels used for taxiing and engine ground running as presented in the EIS.

The components of the review are follows:

- The review comments on the EIS chapters relevant to ground noise in addition to *Appendix E2 – Airport ground-based noise and vibration.* This appendix is the technical basis for all other ground noise related documents, including the relevant EIS chapters.
- A document review is contained within Appendix A of this report, and provides references and comment on specific sections of the EIS. The documents reviewed are identified in Section 1.3 of this report.

1st stage airport review findings

A summary of the findings for the 1st stage airport is as follows:

- The assessment does not fulfil the requirements of the Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport 2015 (EIS Guidelines). These guidelines state that the type and magnitude of impact, both pre-mitigation and post-mitigation should be presented. The ground noise assessment should be updated to include this assessment.
- There is insufficient detail to satisfy the EIS Guidelines on the source of the noise data and assumptions used in noise predictions. As these assumptions form the basis for the noise assessment, changes to the source noise data could potentially lead to a significantly different outcome.
- The assessment does not provide sufficient justification to support the assessment being performed based on the year 2030 (five years after opening) and not 2050 when the airport is expected to be approaching capacity for the single runway configuration with potentially increased noise impacts.
- The report does not provide sufficient detail in the assessment of the ground-based power supply to aircraft when they are parked. The assessment excludes the use of Auxiliary Power Units (APU), however it does not provide sufficient detail of alternative ground-based power supplies. As an alternative power supply method is not presented, there is potential for additional noise sources being introduced that have not been considered.
- Background noise monitoring was conducted at 10 locations in the region, however a single background level has been assumed for all receptors, rather than several location-specific values. This generalisation

has underestimated the assessment noise criteria and therefore the magnitude of noise impacts at receptors close to the airport that are currently exposed to low levels of environmental noise.

- The nearest noise sensitive receptors in Luddenham were not included in the background noise monitoring and therefore there it is uncertain if noise impacts have been adequately assessed at this location.
- No consideration has been given to the cumulative noise impact from all ground noise sources at the nearest noise sensitive receptors both with and without mitigation measures as required by the EIS Guidelines. Additional assessment should also be undertaken for other ground noise sources, such as the compass calibration pad.
- It is recommended that the mitigation measures identified in the assessment, including the restriction of APUs and the limitation of engine ground run-ups during the night, are formalised as part of the project approval.
- The assessment does not provide sufficient evidence that all reasonable and feasible mitigation measures have been considered to reduce noise impacts from taxiing and ground run-ups.
- Semi-enclosed pens and bunded areas to reduce noise impacts from engine ground run-up noise are considered in the assessment. It is recommended that these measures are considered further as part of the approvals and subsequent design stages.
- No comment has been made on the potential cumulative noise impact from the new M12 motorway and realignment of The Northern Road that are being developed to accommodate the airport.
- The EIS contains misleading statements relating to operational road traffic noise which do not acknowledge the limitations of the assessment. The development of the M12 motorway and realignment of The Northern Road have been excluded from the assessment and statements regarding operational road traffic noise should include these limitations.

Long term development review findings

- The assessment is considered to contain an appropriate level of detail for the long term development as the potential noise impacts are predicted for a considerable time in the future (into 2063). It is acknowledged that the noise environment may change over time.
- The comments raised in this review for the 1st stage airport assessment should be addressed and applied to the long term development assessment. Where this occurs, the current framework for further assessment of the long term development is considered appropriate.
- The EIS does not include ground-based noise in the summary or conclusion for the long term development. It is recommended that the outcomes of the revised long-term development ground-based noise assessment are included in these sections so that all impacts are clearly presented.

Key impacts and opportunities

It is considered that the ground-based noise assessment does not provide an appropriate level of detail on a number of key aspects including:

- The derivation and allocation of assessment criteria
- Noise impacts at the nearest sensitive receptors in Luddenham
- Noise source levels and modelling assumptions
- The type and magnitude of impacts with and without mitigation
- Evidence that all reasonable and feasible mitigation has been considered
- Cumulative noise impacts from operational activities and road traffic projects.

As a result, without further clarification or justification, it is uncertain that the draft EIS has adequately presented and addressed the noise impacts associated with the proposed development.

It is recommended that these items are addressed to reduce the level of uncertainty, increase the accuracy of the assessment and to satisfy the requirements of the EIS Guidelines.

1 Scope

1.1 Summary of approach

This scope of this report is to provide an unbiased peer review of all work presented as part of the draft Western Sydney Airport Environmental Impact Statement (EIS) in relation to ground-based noise.

The draft Western Sydney Airport EIS was prepared to provide an assessment of environmental impacts associated with the development of an international airport near Badgerys Creek in Western Sydney, NSW. The EIS contains an assessment of noise impacts in two components; noise impacts from air-based activities such as aircraft in flight, landing and take-off; and from ground-based activities such as aircraft taxiing and ground based engine run-up. This review is concerned with ground-based activities only.

The Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport (EIS Guidelines) (Commonwealth Government, 2015) were released to provide a framework for the preparation of the EIS.

The current status of the approvals process for the airport is presented in Figure 1-1. It is recommended that the findings of this review are considered and incorporated into the final EIS prepared in the next phase of the approvals process.

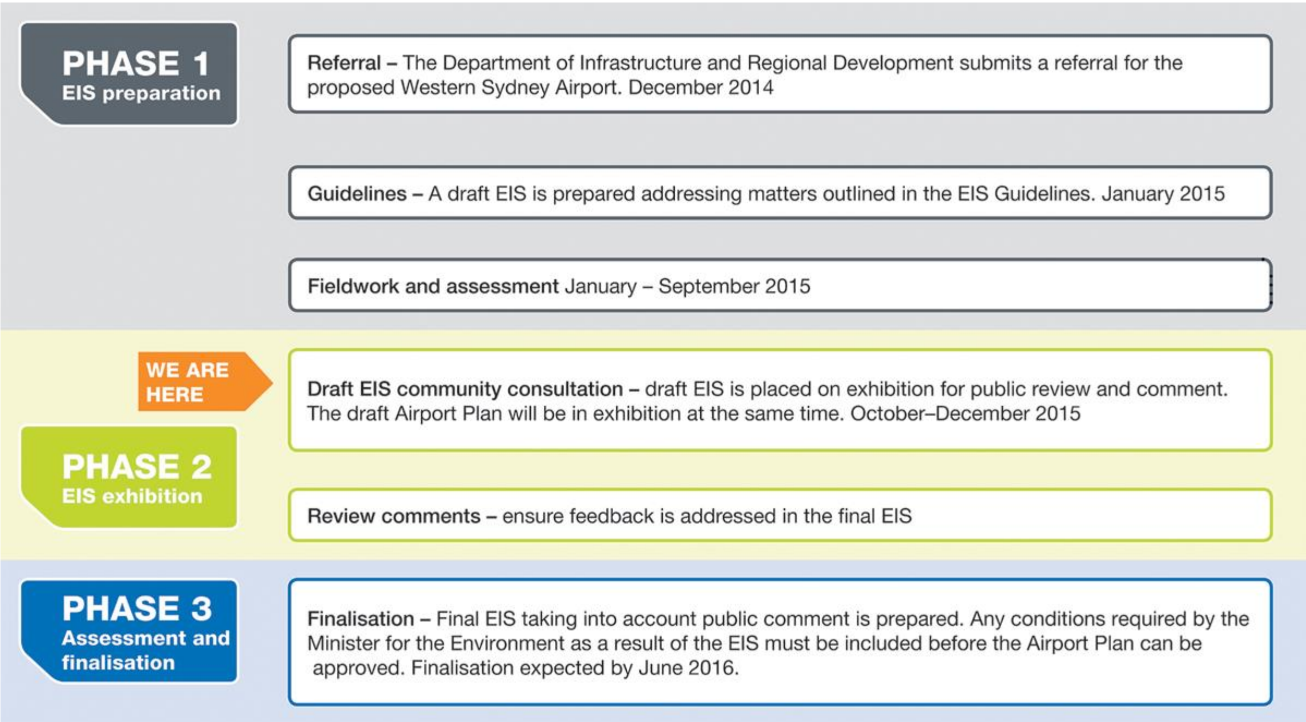

Figure 1-1 - Development approval process

This review has identified areas of uncertainty in the assessment provided in the EIS and has identified what further assessments or detail is reasonably considered to be required to reduce these uncertainties and satisfy the requirements of the EIS Guidelines.

Specifically this review:

- Evaluates whether the study meet the requirements of the EIS Guidelines
- Evaluates whether the conclusions reached in the studies are valid

- Evaluates whether the underlying assumptions are plausible
- Reviews the mitigation and management measures proposed
- Evaluates the level of uncertainty over impacts and the environmental risks
- Provides a summary of the key impacts and opportunities associated with the project in relation to aircraft noise as part of the noise and vibration study
- Discusses the approach to assessment of long term development.

A document review is provided in Appendix A of this report which provides comment and recommendations for specific areas items in the EIS.

In order to identify the scale of significance for items identified as part of the review, the significance ratings in Table 1-1 have been adopted.

Table 1-1 - Significance scale

Significance	Consequence
High	Likely to result in significantly different outcomes
Medium	Potential to change outcomes significantly
Low	Unlikely to result in significantly different outcomes
Noted for information	Unlikely to change outcomes, noted for information

1.2 Limitations

Noise modelling has not been conducted as part of this review as modelling files were not available for review. Therefore it is not possible to verify the validity of noise contour plots presented in the EIS. However, the review was conducted based on a visual inspection of the plots.

The review also relies on the source noise data included in the EIS. As the review is a desktop exercise it was not possible to undertake independent source noise measurements to verify the noise levels stated in the EIS for taxiing and engine ground running.

1.3 Components of the EIS reviewed

The EIS is divided into four volumes. For each volume the sections relevant to this review have been identified in Table 1-2.

Table 1-2 – EIS sections relevant to ground-based noise

EIS PART	Section Title	Page reference
Volume 1 — Project Background		
N/A	Executive Summary	p30 – 33, p49 - 52
Part B	Airport Plan	p125 - 256
Volume 2 — Stage 1 Development **—** EIS for Stage 1 development (single runway facility in 2030)		
Part D	9. Approach to impact assessment	p3 - 18
Part D	11. Noise (ground operations, construction, road and rail)	p75 - 100

EIS PART	Section Title	Page reference
	27. Cumulative impact assessment	p561 - 574
Part E	28. Environmental management framework	p577 - 620
Part F	29. Conclusion	p623 – 634
Volume 3 — Long Term Development — Strategic assessment of the long-term development (dual runway facility by 2063)		
Part G	Approach to impact assessment	p3 - 10
	Assessment of Long Term Impact - Noise	p11 - 72
Part H	Conclusion and recommendations	p193 – 200
Volume 4 — EIS Technical Reports		
Appendix E	E2 Airport ground-based noise and vibration	Separate report

1.4 Policy and guidance

The following documents, standards and guidance have been used to inform the EIS review process:

- Airports (Environment Protection) Regulations 1997 (to be ceased by 1 April 2019)
- Airports Act 1996
- AS 2021: 2015 Acoustics – Aircraft Noise Intrusion – Building Siting and Construction
- Assessing vibration: a technical guideline (Department of Environment and Conservation, 2006)
- Australian Government Department of Sustainability, Environment, Water, Population and Communities – Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies – Significant impact guidelines 1.2 – Environment Protection and Biodiversity Conservation Act 1999
- EIS Guidelines – Australian Government Department of the Environment (Commonwealth Government, 2015)
- German Standard DIN 4150-3 Structural Vibration: Effects of Vibration on Structures.
- NSW Industrial Noise Policy (Environmental Protection Authority, 2000)
- NSW Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009)
- NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2013)

2 Detailed findings - 1st stage airport

2.1 Summary

2.1.1 EIS Guidelines

A number of aspects were identified that did not satisfy the requirements of the EIS Guidelines.

- The assessment did not present sufficient evidence to support the noise levels used in the predictions. Changes to the noise source levels could potentially lead to significantly different outcomes.
- The identification of the type and magnitude of impact, both pre-mitigation and post-mitigation was not presented in the assessment.
- The effectiveness of identified noise mitigation measures is not able to be identified.
- The cumulative assessment does not consider the potential for noise impacts from the simultaneous operation of activities on the ground at the airport including ground based run ups and taxiing.
- The cumulative assessment does not include consideration of the operation of the M12 motorway and The Northern Road realignment which provide access to the airport and are likely to introduce an additional significant noise sources into the area.

2.1.2 Assumptions

- It has been assumed that Auxiliary Power Units (APU) would not be used at the airport. However, the type of ground power to be employed instead is not clearly defined. Ground power units (GPU) have the potential to cause additional noise impacts and the inclusion of either APU or GPU usage at the airport could adversely affect the outcome of the assessment.
- There is insufficient information regarding assumed noise source levels used in the assessment, particularly in relation to noise from taxiing aircraft.
- A single rating background level has been assumed for all receptors, rather than several location-specific values. This generalisation has underestimated the magnitude of noise impacts at receptors close to the airport that are currently exposed to low levels of environmental noise.
- The assumption that construction traffic will primarily travel on Elizabeth Drive does not include an assessment of roads that connect to Elizabeth Drive being used by construction vehicles.

2.1.3 Conclusions

- No consideration has been given to the cumulative noise impact from all ground noise sources at the nearest noise sensitive receptors both with and without mitigation measures. Additional assessment should also be undertaken for other ground noise sources, such as the compass calibration pad.
- The conclusions reported in the body of the EIS regarding operational traffic noise are misleading as they do not state that development of a new motorway or substantial realignment of an arterial road to accommodate the airport were excluded from the assessment.

2.1.4 Mitigation and management measures proposed

- It is recommended that the mitigation measures identified in the assessment, including the restriction of APUs and the limitation of engine ground run-ups during the night, should be formalised as part of the project approval.
- The assessment does not provide sufficient evidence that all reasonable and feasible mitigation measures have been considered to reduce noise impacts from taxiing and ground run-ups.

- Semi-enclosed pens and bunded areas to reduce noise impacts from engine ground run-up noise are considered in the assessment. It is recommended that these measures are considered further as part of the approvals and subsequent design stages.

2.1.5 Uncertainty of impacts and environmental risks

- There are noise sensitive receptors closer to the airport than those selected for noise monitoring, leaving uncertainty over the current noise environment for the potentially most affected noise sensitive receptors.
- The level of impact at the nearest sensitive receivers in Luddenham is not appropriately defined in the EIS and represents a potential risk to the validity of the assessments.

2.2 Detailed findings

2.2.1 Introduction

Appendix E2 – Airport ground-based noise and vibration is the primary document under review, as this appendix forms the technical basis for all other ground noise related documents, including the EIS chapters.

2.2.2 Scope

The scope of the ground noise assessment is limited to aircraft taxiing noise, engine ground run-ups, development generated road traffic noise and construction phase noise and vibration.

The noise impact of auxiliary power units (APUs) has been excluded, on the assumption that ground power and preconditioned air will be provided at all gates, negating the need to use APUs. The use of APUs is not discussed in the Airport Plan. Therefore there is a potential risk that APUs could be used in future, which could change the result of the noise assessment.

An assessment of the noise impact of APU usage should be undertaken, if they could potentially be routinely used.

There is a reference within the ground noise assessment to the use of reverse thrust at night-time, however it is assumed that reverse thrust has been included in the aircraft noise assessment.

2.2.3 Baseline noise survey

From a review of available aerial mapping, there are closer noise sensitive receptors in the area than those selected for noise monitoring, leaving uncertainty over the noise impacts on the most affected noise sensitive receptors, particularly for properties in Luddenham to the north west of the Site. Figure 2-1 shows the adopted noise monitoring locations that are closest to the Site boundary. Figure 2-2 shows that there are many noise sensitive receptors much nearer to the Site boundary (marked in grey). Further consideration should therefore be given to quantifying the existing noise environment for properties closest to the airport.

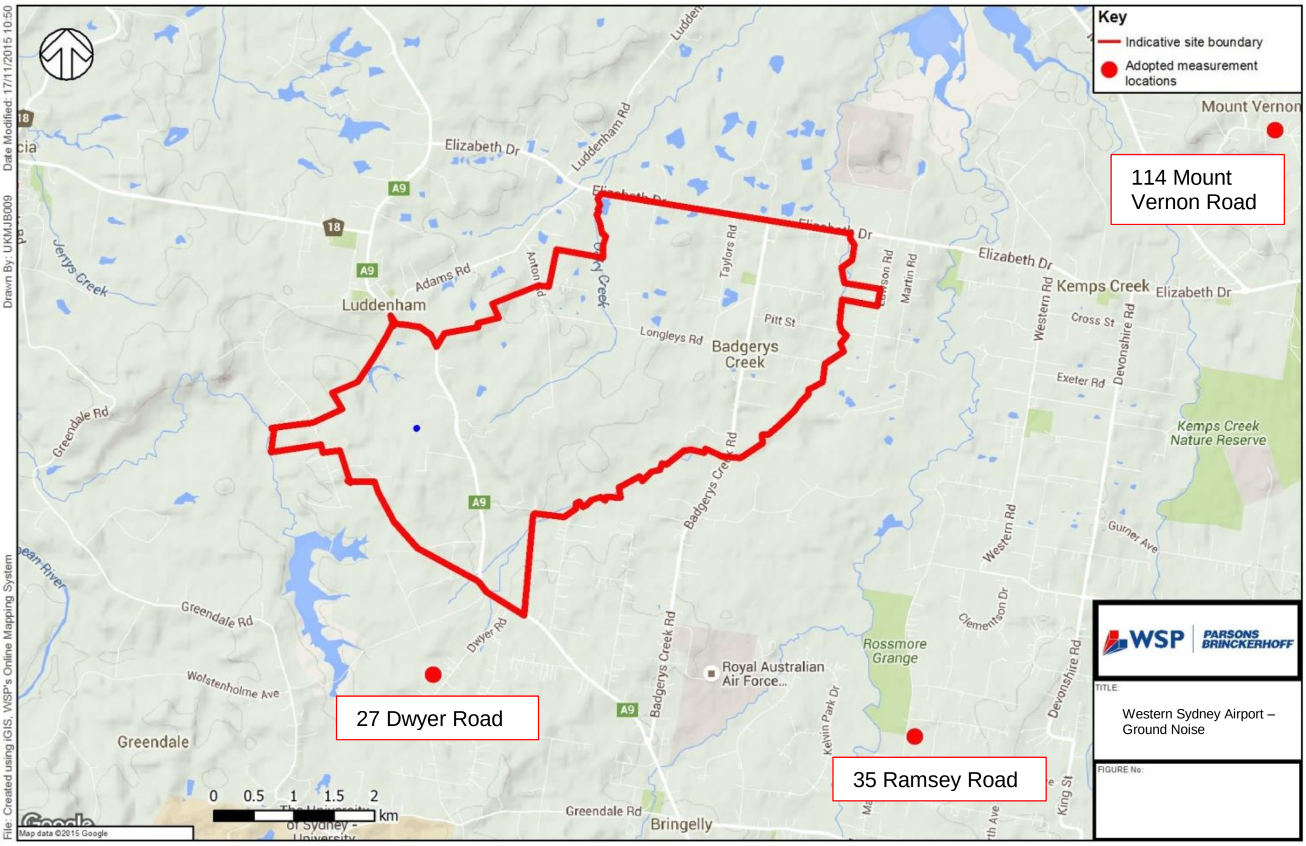

Figure 2-1 – Noise monitoring locations which are closest to the Site boundary

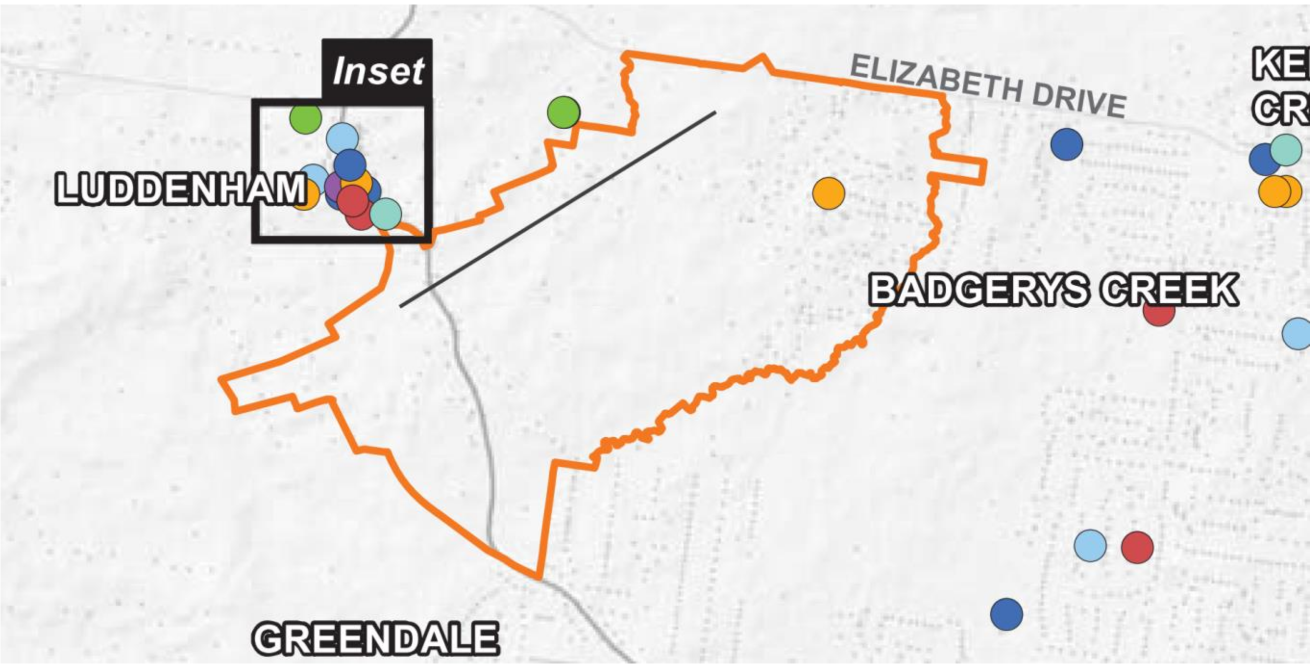

Figure 2-2 – Nearest noise sensitive residential receptors to the Site boundary (marked as light grey points)

There is insufficient detail provided to accurately determine the specific noise monitoring locations, whether noise measurements were taken in free-field conditions, or at what height above ground microphones were positioned at. It is not possible to determine whether microphones had direct line of sight to dominant noise sources such as main roads, or whether they were placed in backyards. There is a risk that existing noise levels have been overestimated if they have not been placed on quietest facades of residential receptors. The existing noise levels have been used to determine assessment criteria, so this information could potentially affect the conclusions of the assessment. Therefore the precise measurement locations should be defined.

Figure 11-2 (reproduced below in Figure 2-3) depicts the noise sensitive receptors surrounding the airport site. It identifies the location of nearby non-residential noise sensitive receptors in the area clearly, however the location of residential receptors is indicated by very small points in light grey, which are difficult to observe and could be considered misleading. It is recommended that Figure 11-2 is updated to show more clearly the location of residential receptors.

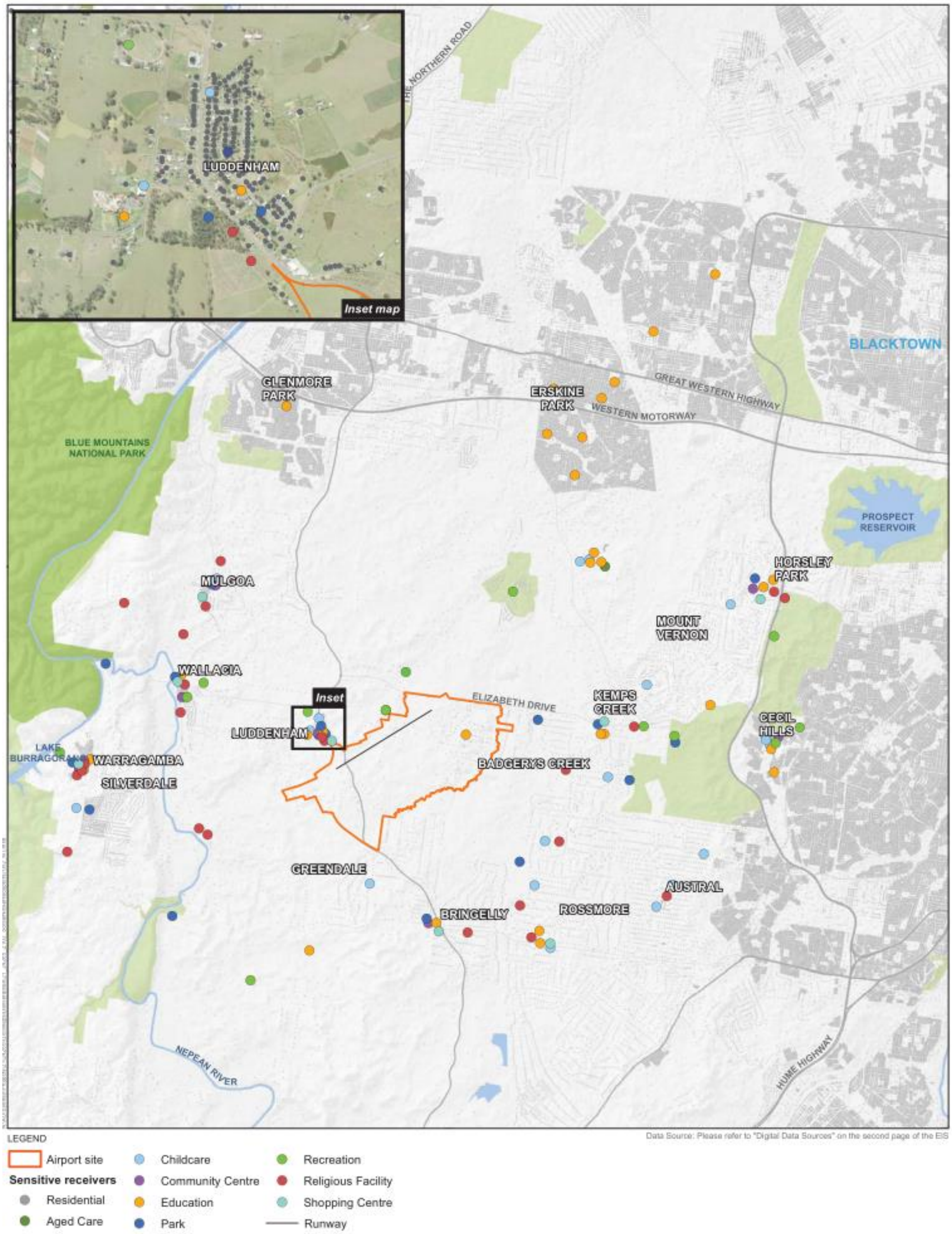

Figure 2-3 - Sensitive receivers surrounding the airport site (reproduced from Western Sydney Airport draft EIS)

2.2.4 Criteria

Ground based operations noise

There is insufficient evidence that the intrusiveness criterion is more stringent than the amenity criterion for all assessed locations. Based on the rural nature of the surrounding area, Table 2.1 of the NSW Industrial Noise Policy 2000 (INP) (presented in Table 2-1 of this report) recommends a noise level of 40 dB L_{Aeq} at night as “acceptable”. This is lower than some tabulated night-time values in Table 3-1 of Appendix E2 (albeit they are $L_{Aeq,15min}$, corrected). The incorrect criterion selection could potentially underestimate the extent of the noise impacts, therefore further evidence should be provided to demonstrate that the intrusiveness criterion is the more stringent at all locations.

Furthermore, the contribution from existing industrial noise sources was not quantified in the assessment, therefore there is insufficient evidence presented in the report

The approach of selecting one noise criterion undermines the results of the noise monitoring at multiple locations. Noise criteria at five of the ten locations are lower than 40 dBA, and as low as 35 dBA, which is 5 dB lower than the adopted criterion. As a result, noise impacts at some locations are considered to have been incorrectly identified, and should be reassessed for each measurement location using the criterion specific to that assessment location.

Table 3-2 of Appendix E2 sets out noise criteria for non-residential receivers based on recommended maximum L_{Aeq} levels. However Section 2.2 of the INP states that, in all cases, it is expected that all feasible and reasonable mitigation measures would be applied before the recommended maximum noise levels are referenced. Therefore the “acceptable” noise levels stated in Table 2.1 of the INP should be used in the first instance, rather than “Recommended Maximum”. The criteria adopted would therefore be 5 dB lower than that used in the assessment, which could potentially alter the assessment outcome.

No assessment of low frequency noise or other modifying factors as defined in Section 4 of the INP has been conducted. The assessment should be revised to include consideration of these aspects.

Table 2-1 – INP Amenity criteria (reproduced from Table 2.1 of the INP)

Recommended L_{Aeq} noise levels from industrial noise sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A) *(see Note 8 in Section 2.2.1)*	
(see Notes in Section 2.2.1)			Acceptable *(See Note 11)*	Recommended Maximum *(See Note 11)*
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface – for existing situations only	Day	65	70
		Evening	55	60
		Night	50	55
School classroom—internal	All	Noisiest 1-hour period when in use	35 *(See Note 10)*	40
Hospital ward —internal —external	All All	Noisiest 1-hour period Noisiest 1-hour period	35 50	40 55
Place of worship—internal	All	When in use	40	45
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Construction noise and vibration

It is unclear whether the adopted construction noise criteria are based on the NSW Interim Construction Noise Guideline (ICNG) or the Airports (Environment Protection) Regulations 1997. Usual hours of construction are proposed from 6.00 am, which is classed as night-time. Therefore, it is important that the appropriate criterion is used for night-time work, which will be included in standard hours of construction. It is recommended that clarification is provided for the appropriate criteria set to be used for the assessment during daytime and night-time periods.

Table 2 of the ICNG states that strong justification would typically be required for works outside of the recommended standard hours. No justification has been provided in the assessment.

The construction noise assessment identifies that, for some receptors, the noise management level (NML) should be 39 dBA, however 45 dBA (weekday) and 40 dBA (weekend and early morning works) have been adopted as the criteria set. This potentially underestimates the noise impacts from construction by up to 6 dB. Construction noise should be reassessed based on the different measurement locations adopted in the assessment, in order to more accurately quantify the potential noise impacts.

Road traffic noise

The Road Noise Policy (RNP) and RNP application notes provide specific criteria for the assessment of land uses affected by traffic generating developments on existing roads. Whilst the report does provide an assessment of impacts consistent with the RNP, the appropriate section of the RNP and RNP application notes should be referenced in the report.

2.2.5 Noise modelling

Assumptions

It has been assumed that there will only be one high power run up, which would occur for less than 5 minutes in any night. INP Section 4.2 states that the acceptable noise level may be increased by 5 dB to account for unusual and one-off events, but does not apply to regular high-noise levels that occur more frequently than once per day. Should there be more than one high power run-up in one night, it would be inappropriate to apply this correction. Clarification is required to determine the likelihood of high power ground run-ups in a given night-time period.

The assumed location for ground run-ups is defined in Figure 3-1 of Appendix E2 (presented in Figure 2-4 below), however the indicative building location near the location is not finalised nor is fixed within the application. Figure 3-2 of Appendix E2 (presented in Figure 2-5 below) shows that communities to the west and north west of the Site benefit from the screening afforded by this building. Noise impacts could significantly change if the buildings or run-up area change location. It is therefore considered appropriate to assess a scenario where the building does not provide any acoustic benefit, to take into account that final locations are not fixed and may change.

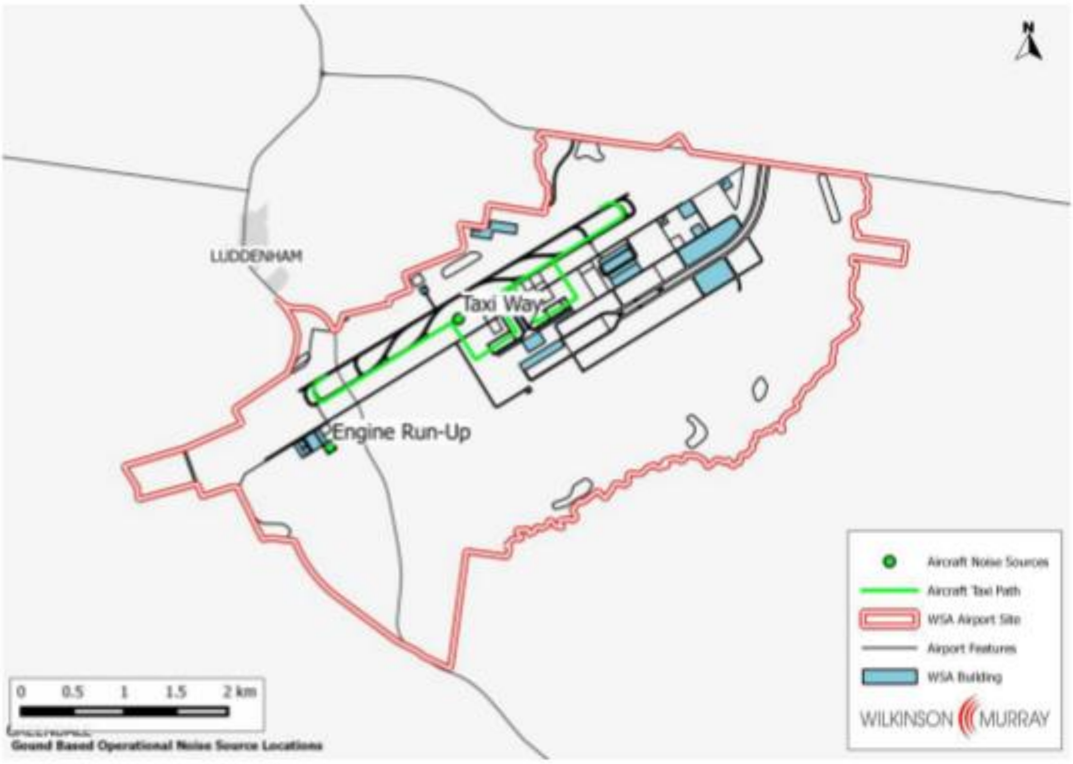

Figure 2-4 - Ground based operational noise source locations, 2030 (reproduced from EIS Appendix E2 Figure 3-1)

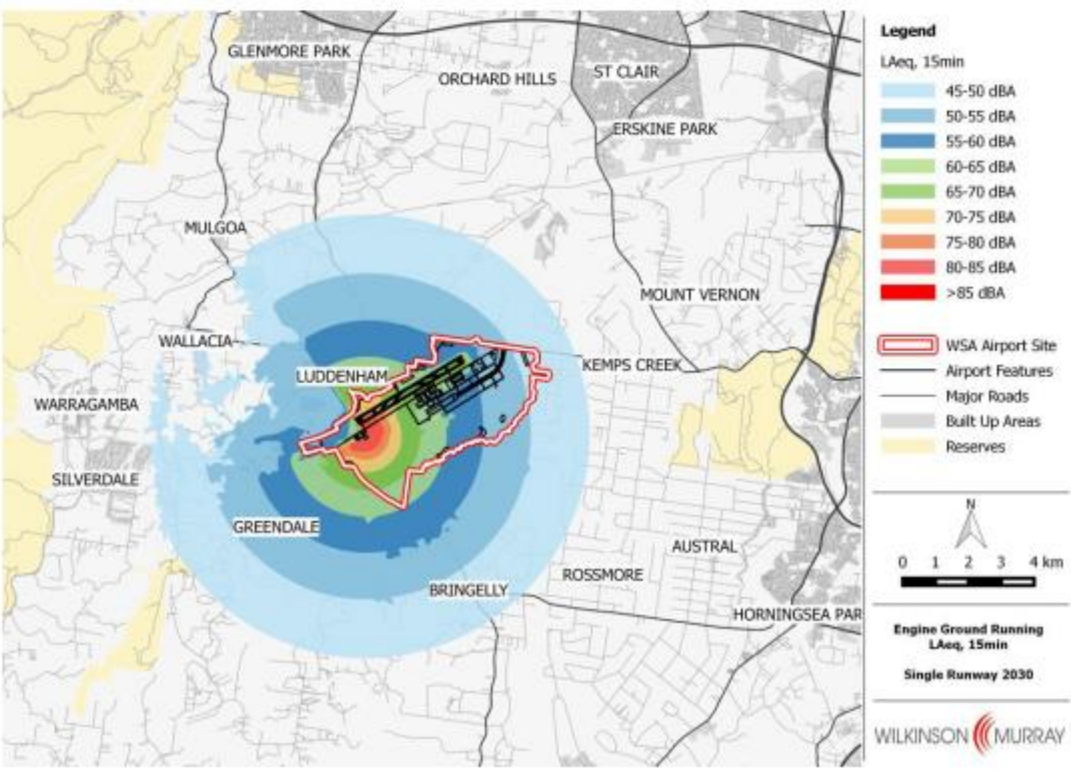

Figure 2-5 - Worst case $L_{Aeq,15min}$ engine ground running noise contours, 2030 (reproduced from EIS Appendix E2 Figure 3-2)

Source noise data

Chapter 9 Table 9-2 of the EIS presents EIS Guideline requirements and indicates where in the EIS they are addressed. In Table 9-2 Section 11 – Information sources it states that for information given in the EIS, the EIS must state (amongst other points) the source of the information, how recent the information is, and how reliable the information is. This requirement has not be fulfilled in the EIS as this information is not presented for the noise source levels in the ground based noise assessment.

A sound power level of 151 dBA has been assumed for aircraft engine ground running, based on measurements of aircraft taking off. There is no indication of which aircraft this refers to, or the range of typical levels that might be expected. It is assumed that this level is an A weighted Sound Power Level (L_{WA}), however it is not explicitly stated. More information should be provided regarding the adopted source noise level and the range of values expected from engine run-ups, given the anticipated fleet of aircraft for the airport.

A sound power level of 138 dBA has been assumed for taxiing aircraft. This is stated as the highest level measured, based on measurements of a B777, B747, B737, B717 and A330 aircraft. It is assumed that the 747 taxi noise has been used for the purposes of the noise modelling exercise. In addition, the directionality of the source has not been stated. As aircraft engines are directional sources, there is potential for an underestimation of impacts from a directional source with the same sound power level as an omni-directional source. As a result, it is unclear how this sound power level has been calculated.

Taxiing aircraft is in essence a moving point source. Depending on how the source has been modelled, this may not be the appropriate sound power level to use (e.g. series of point sources, line source with a total sound power, line source with a sound power per unit length). It is unclear whether taxiing was under two engine conditions, one engine conditions or engine off taxiing (EOT). Clarification is required on the method used to determine the sound power level for the line source, and the measurements that were undertaken in support of this.

2.2.6 Assessment

General

The requirements of Section 5 “Relevant Impacts” and Section 7 “Residual impacts and offsets” in Table 9-2 have not been met within Chapter 11, and this chapter should be updated to include clear statements on whether impacts are short term, long term, direct, indirect, unknown, predictable or irreversible, and a clear indication of the significance of the impacts, pre and post mitigation. This should include the reasons why avoidance or mitigation of impacts may not reasonably be achieved, where necessary.

A magnitude scale for impact significance should be set out at the beginning of the chapter and used for pre-mitigation and post mitigation assessments so that it can be seen what the residual noise impacts are predicted to be.

Ground based operations noise

The assessment year for Stage 1 is 2030, which is only five years after anticipated opening. Given that passengers and air movements are expected to steadily increase to 2050, when the single runway will be at full capacity, it could be considered more appropriate to take 2050 (i.e. 25 years after opening) as the assessment year so that realistic longer term impacts can be taken into account. Given that there is more certainty over this than a two runway scenario, it is important that the single runway noise impacts are fully explored.

Table 3-4 of Appendix E2 (reproduced in Table 2-2) shows the population affected above the adopted criteria for engine ground running and taxiing. The table may be subject to change when the issues identified in this review are addressed. It is recommended that it is stated how many receptors will be exposed to 5 dB above criterion, 10 dB above criterion etc. as there is currently no indication of the magnitude of exceedance that will be experienced by individual receptors. At this stage, it is likely that the population numbers will increase.

Table 2-2 - Predicted residential noise impact of ground-based operational noise under worst-case conditions (reproduced from appendix E2 Table 3-4)

Noise Type	Noise Criterion	Population Affected above Criterion
Engine Ground Running	45 dBA	7,258
Taxiing	40 dBA	3,117

Note: Population exposures are esitmates only

Similarly, Table 3-5 of Appendix E2 (shown in Table 2-3) shows other receivers and land uses affected above the adopted criteria for engine ground noise and taxiing. There may also be implications to this table as a result of the above issues. It is recommended that the actual noise levels anticipated at these buildings/areas are presented so that the magnitude of the exceedance can be understood.

Table 2-3 - Predicted noise impact of ground-based operational noise on other receiver types under worst-case conditions (reproduced from Appendix E2 Table 3-5)

Noise Type	Other Buildings and Land Uses Affected Above Criterion		
	Building or Land Use Type	Criterion	Number
Engine Ground Running	Educational Institutions	55 dBA	5
	Hospitals	60 dBA	0
	Place of Worship	60 dBA	2
	Passive Recreation	60 dBA	2
	Active Recreation	65 dBA	0
Taxiing	Educational Institutions	50 dBA	1
	Hospitals	55 dBA	0
	Place of Worship	55 dBA	0
	Passive Recreation	55 dBA	0
	Active Recreation	60 dBA	0

Note: Building numbers are based on information obtained in 2015, however datasets may be older. No verficiation of building types or uses has been undetaken.

Road traffic noise

The construction road traffic noise assessment only includes an assessment of impacts from vehicles accessing the site on Elizabeth Drive. No assessment or comment is provided for other stages of construction where there are additional entrances to the site, nor for roads which connect to Elizabeth Drive, which may carry construction traffic.

The road traffic noise assessment for the operational airport does not include the assessment of the planned M12 motorway or The Northern Road realignment which are being developed to accommodate the airport. The impacts of these projects has been excluded from the assessment as these are to be developed and approved by other authorities and proponents. However, the EIS does not state the limitations of the assessment, which does not include these major road projects, as presented in Appendix E2.

The assessment of road traffic noise only includes assessment of one year (2030). It does not provide sufficient justification for the omission of other operating years for example up to 2050. It is considered likely that traffic on the assessed roads would increase as a result of the second stage of development and no comment has been made on this.

2.2.7 Mitigation

General

Section 6 of the EIS Guidelines, "Avoidance and mitigation measures", states that the EIS must include an assessment of the expected or predicted effectiveness of mitigation measures. The draft EIS does present analysis to satisfy this requirement and it is recommended that an assessment of the expected or predicted effectiveness of each mitigation measure identified is provided.

Ground based operations noise

The restriction on the amount of high power running at night time is stated to substantially reduce the impact of ground running noise. As this assumption has been included the noise predictions, night-time engine ground run-up should be conditioned appropriately as part of the project approval.

Engine run-up noise mitigation measures are identified, including the construction of buildings, mounds or barriers near the run-up area to provide greater acoustic screening, and the possibility of relocating the run up area further to the south-east to reduce the noise impact on Luddenham. The quantifiable benefits to the closest noise sensitive receptors from the adoption of such measures should be defined, in terms of resultant noise levels and the residual exceedance of the criteria. The use of such measures should be included in the project approval for appropriate periods.

The assessment states that there is *"little that could be done to reduce noise levels emanating from the airport as a result of taxiing"*. However, there are a number of potential mitigation measures that could be considered, including single engine taxiing, engine off taxiing (EOT) and the installation of acoustic barriers at effective locations. It is therefore recommended that consideration should be given to these mitigation measures in a revised assessment. In addition, the unmitigated noise impact from taxiing and the residual noise impact following potential mitigation measures should be presented. The measures identified to be reasonable and feasible should be included in the project approval.

The assessment has assumed that APUs will not be used, and that instead ground power and pre-conditioned air will be available at all gates. However, ground power could be supplied either by fixed electrical ground power (FEGP), or by Ground Power Units (GPUs). GPUs could have the potential to cause noise impacts and should be assessed accordingly. An approval condition should be included that restricts the use of APUs, and the type of ground power to be employed on site.

The use of ground power and pre-conditioned air are not included in Table 11-13 of Chapter 11, which sets out the mitigation and management measures, nor is any mention of the restriction over APU usage.

Construction noise and vibration

The report identifies the need for a Construction Noise & Vibration Management Plan. This should be conditioned appropriately as part of a project approval.

2.2.8 Cumulative assessment

Cumulative noise impact from engine run-ups and taxiing have not been considered, and no assessment has been included for airside service vehicles, sirens, noise from fixed plant associated with the airport buildings or use of the compass calibration pad. As a minimum, consideration should be given to the cumulative noise impact from all ground noise sources at nearest noise sensitive receptors with and without mitigation measures.

The cumulative noise assessment is not consistent with the requirements of the EIS Guidelines as it does not include an assessment of cumulative noise impacts associated with the operation of the M12 motorway or realignment of The Northern Road, which are being developed to accommodate the airport. These planned road projects have the potential to significantly increase noise levels in the area surrounding the airport and should therefore be considered as part of a cumulative assessment.

2.2.9 Conclusions

Chapter 21 Table 29-1 provides a summary of the key environmental impacts. The “Noise – ground operations, construction and road traffic” section of the table does not provide an indication of the magnitude of significance of the noise sources stated, and whether mitigation measures are included. There is also no evaluation of the acceptability of the noise impacts. The table should be updated to include this detail.

The conclusions of the draft EIS that there are no significant operational traffic noise impacts is misleading, as it does not acknowledge the limitations of the assessment, which excludes the development of the M12 motorway and substantial realignment of The Northern Road to accommodate the airport. The statements relating to operational traffic noise should be updated to acknowledge the limitations of the road traffic noise assessment.

3 Detailed findings - long term development

3.1 Summary

The assessment is considered to contain an appropriate level of detail for the long term development as the potential noise impacts are predicted for a considerable time in the future (into 2063). It is acknowledged that the noise environment may change over time. The identified issues are summarised as follows:

- The comments raised in this review for the 1st stage airport assessment should be addressed and applied to the long term development assessment. Where this occurs, the current framework for further assessment of the long term development is considered appropriate.
- The draft EIS does not include ground-based noise in the summary or conclusion for the long term development. It is recommended that the outcomes of the revised long-term development ground-based noise assessment are included in these sections so that all impacts are clearly presented.
- The assessment does provide comment on the potential noise impacts from the long-term development of the airport. The trip generation of the fully developed airport is predicted to be over 300,000 vehicles per day and no comment has been made on potential noise impacts on the surrounding existing road network, including the M7 and The Northern Road.

3.2 Detailed findings

3.2.1 Modelling

Engine ground run-up noise in 2063 has been modelled at the location indicated in Figure 3-4 of Appendix E2, shown below in Figure 3-1. Figure 3-5 of Appendix E2 shows the noise propagation from this source but does not have the same level of acoustic screening afforded by nearby buildings as that shown in Figure 3-2 of Appendix E2, which is the corresponding noise contour plot for the single runway scenario. These two figures are compared in Figure 3-2 below). There is therefore uncertainty regarding the level of screening from buildings.

Clarification is also required regarding the assumption that, in the event of a two runway airport, there would continue to only be one ground run-up area.

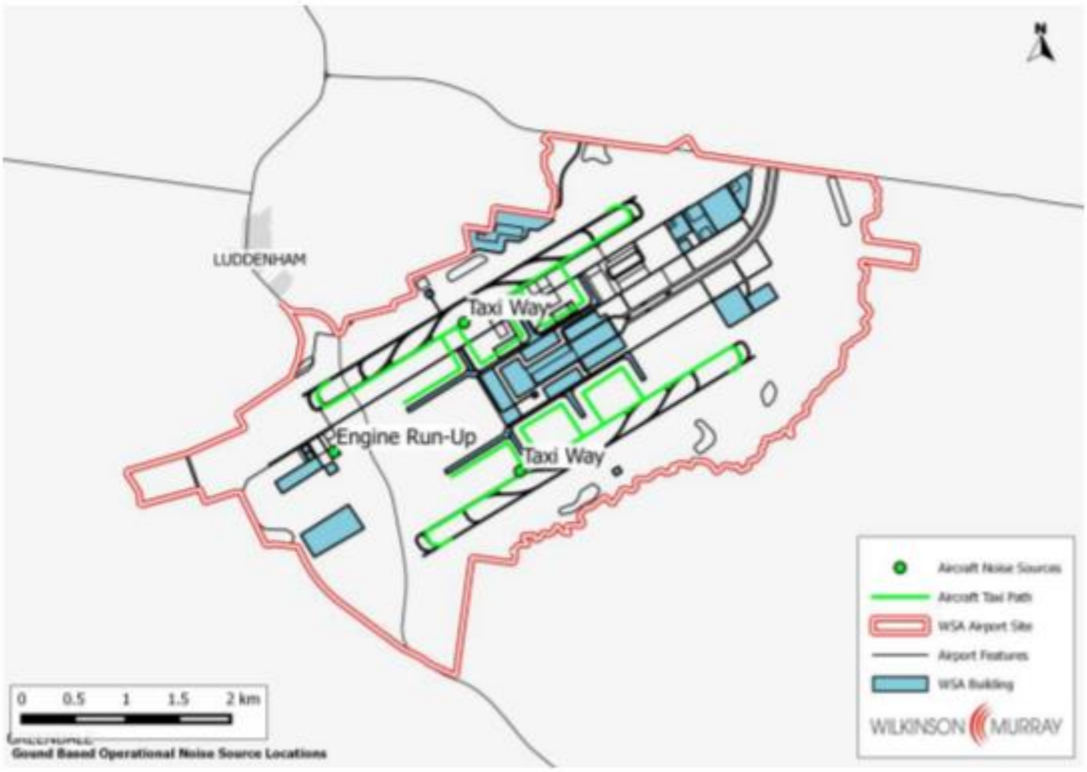

Figure 3-1 - Ground-based operational noise source locations, 2063 (reproduced from Appendix E2 Figure 3-4)

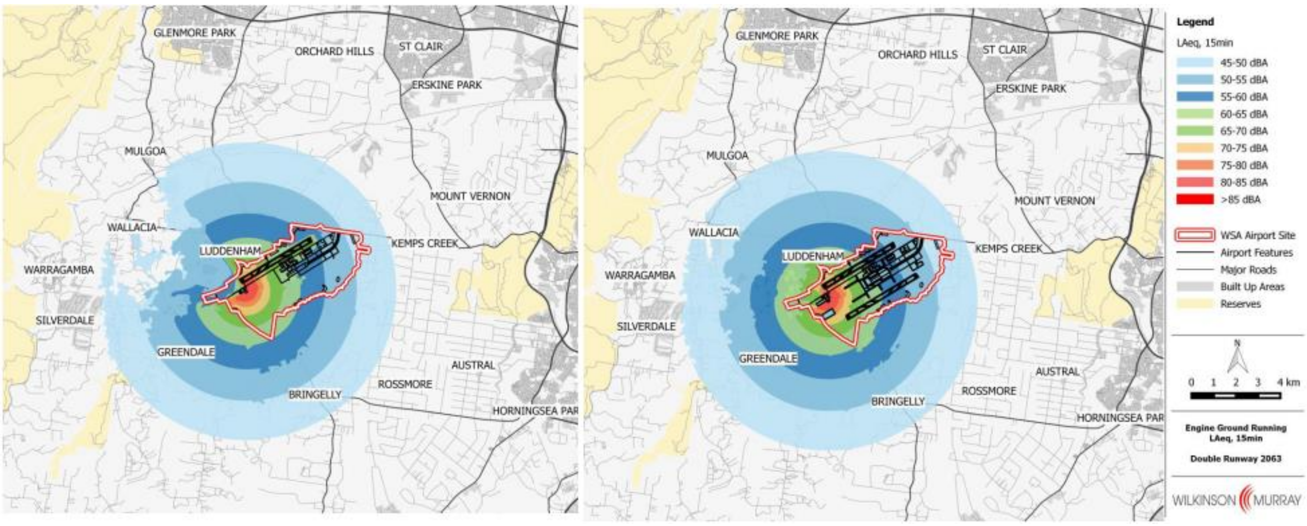

Figure 3-2 - Comparison between worst-case $L_{Aeq,15min}$ engine ground running noise contours for 2030 (single runway, left) and 2063 (two runway, right)

Figure 3-4 of Appendix E2 does not accurately represent Figure 5-3 of the draft EIS Volume 1 (p143) document which shows the indicative airport site layout – long term development. The two figures are compared in Figure 3-3 below. In particular, there are additional areas within that layout where aircraft would be taxiing that have not been included in the noise model. The model only accounts for the usage of 63 out of 95 aircraft gates. It is recommended that the model is updated to include the additional areas where aircraft will be taxiing. It is anticipated that there will be an increase of approximately 1 dB in including these additional areas.

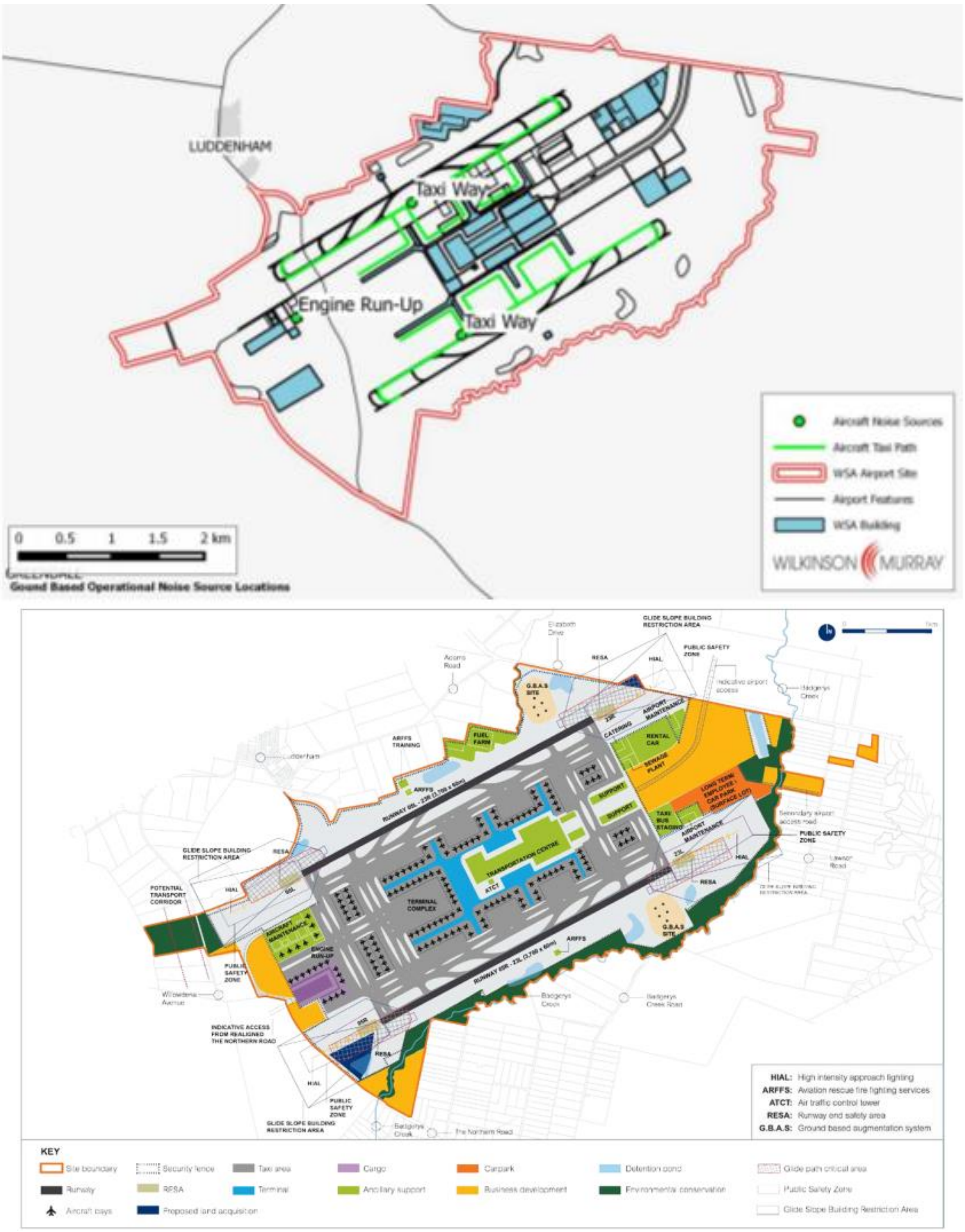

Figure 3-3 - Comparison between modelled noise sources in 2063 (Appendix E2 Figure 3-4, top image) and indicative airport site layout in 2063 (Volume 1 Chapter 5 Figure 5-3, bottom image)

3.2.2 Assessment

The 2063 aircraft taxiing noise contours shown in Volume 3 Chapter 31 Figure 31-39 show the increased number of aircraft movements and extend further south as a result of the commissioning of the second runway. The aircraft noise section (Volume 3 Chapter 31, Sections 31.2 to 31.4, Tables 31-7 to 31-9) has identified the population numbers affected by aircraft noise, however this information is not presented for ground noise.

There is no indication of the level of exceedance for nearest noise sensitive receptors in order to determine the magnitude of the impact. It is recommended that population number affected by ground noise is included, in 5 dB bands, in order to determine the magnitude of the potential noise impact.

The assessment does not comment on the potential road traffic noise impacts as a result of the long term development. The traffic and transport assessment (draft EIS Appendix J) includes predictions that indicate more than 300,000 additional trips would be generated by the development of the airport by 2063. This volume of traffic is more than the typical volumes currently carried by some motorways in Sydney. As a result it is recommended that comment is made to identify the potentially affected roads and noise impacts as a result of such traffic generation.

3.2.3 Conclusions

There is no reference to ground noise in the summary of findings or the Conclusion and Recommendation chapter (Chapter 40) of Volume 3. Ground noise impacts may therefore not be considered by decision makers. A summary of the ground noise impact assessment should be included in this chapter.

4 Key impacts and opportunities

Below is a summary of the key impacts and opportunities that have been identified as a result of the review.

- There is insufficient detail surrounding the selection of source noise data. Changes to the source noise data could potentially lead to a significantly different outcome.
- The draft EIS does not satisfy the EIS Guideline requirements to identify the type and magnitude of impact, both pre-mitigation and post-mitigation.
- The exclusion of Auxiliary Power Unit (APU) usage at the airport and uncertainty surrounding the method of alternative ground power could potentially adversely affect the outcome of the assessment.
- A single noise level has been used for existing noise levels at all receptors, rather than several location-specific values. This generalisation has underestimated the magnitude of noise impacts at receptors close to the airport that are currently exposed to low levels of environmental noise.
- No consideration has been given to the cumulative noise impact from all ground noise sources at nearest noise sensitive receptors with and without mitigation measures. Further consideration should also be given to noise from other ground noise sources, such as the compass calibration pad.
- Several mitigation measures have been put forward, including the restriction of APUs and the limitation of engine ground run-ups during the night. These measures should be included as part of any approval conditions.
- Sufficient analysis of feasible and reasonable mitigation measures to reduce taxiing noise has not been included. Several mitigation options exists which are not discussed in the assessment. It is recommended that further analysis is conducted for these measures.
- Semi-enclosed pens and bunded areas to reduce noise impacts from engine ground run-up noise are considered in the assessment. It is recommended that these measures are considered further as part of the approvals and subsequent design stages.
- Nearest noise sensitive receptors such as residences in Luddenham have not been included in the baseline noise monitoring. It is recommended further noise monitoring is undertaken in this area.
- The findings of the long term development ground noise impact assessment are not included in the draft EIS chapter summary or the conclusion chapter. A summary of the ground noise impact assessment should be included in these areas.
- The potential cumulative impact of the M12 motorway and realignment of the Northern Road which are being developed to accommodate the airport should be considered in the assessment.
- No comment is made on the long term developments potential noise impacts from significant traffic generation from the airport. It is recommended that this is included in the assessment.

The above issues currently indicate a high level of uncertainty over the accuracy and extent of the noise impact from ground noise currently. In particular, from ground noise related operations at the airport. It is recommended that each point above be considered and addressed in subsequent assessment of ground noise for the airport.

5 Qualifications of the study team

5.1 Project manager

Alex Campbell, Asia-Pacific Acoustics Manager

MEng, MAAS, MIOA, C.Eng

12 Years' Experience

Alex leads the WSP | Parsons Brinckerhoff acoustics team in the Asia-Pacific region. He has over 12 years industry experience, the last 9 years of which have been with WSP Acoustics - who are one of the world's largest globally connected acoustic specialist teams employing 150 engineers worldwide.

He has seen the successful completion of projects in a wide range of sectors, and has managed and been technically involved with projects including Review of Environmental Factors (REF) and Environmental Impact Statement (EIS) Noise & Vibration assessments throughout Australia. In addition to this, Alex has significant experience in delivering major international projects on-time and on-budget for both government and private sector clients.

5.2 Supporting technical team

Mike Barrett, Principal Acoustic Consultant

BSc(hons), MIOA

10 Years' Experience

Mike has worked on projects associated with many of the UK's largest airports, including Heathrow, Gatwick, Stansted, Manchester, London City and Luton Airports – many of which have been in the capacity of peer reviewer.

Mike is a Principal Acoustic Consultant for WSP | Parsons Brinckerhoff, and has 10 years' experience in the modelling, monitoring and assessment of noise and vibration. He has been involved with a wide range of environmental, architectural and building services projects, and regularly provides specialist advice to developers, architects, industry and local authorities.

During his time in consultancy experience has been gained across a number of different sectors including aviation, surface transport, residential, industrial, commercial, leisure and retail, and he presently sits on the Institute of Acoustics UK North West Branch Committee.

Adrian White, Associate Acoustic Consultant

BSc, MAAS

8 Years' Experience

Adrian has worked on major EIS projects throughout Australia. He has over eight years of experience working as a professional and acoustic consultant in Australia with internationally recognised noise and vibration consultancies. Adrian specialises in acoustics with niche expertise in a variety of areas such as environmental and industrial acoustics, architectural acoustics and transportation noise and vibration.

Chris Marsh, Senior Acoustic Consultant

MEng, MAAS, AMIMechE

5 Years' Experience

Chris is a senior acoustics engineer at WSP | Parsons Brinckerhoff experienced in environmental acoustics and monitoring projects. He has over five years' experience in the assessment, monitoring and management of environmental noise and has been involved in a number of major projects across transportation, industrial and resource sectors.

Appendix A Document review

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
Appendix E2 – Airport ground-based noise and vibration				
1.3 / p5 para 1	*"The use of auxiliary power units (APUs) on aircraft has not been assessed because it is assumed that power and pre-conditioned air would generally be supplied to aircraft at the terminal gates."*	There is no mention of the use of APUs in the Airport Plan. The potential effect of using APUs has not been covered, nor has it been expressly stated that they would not be used.	Clarification should be sought as to whether APUs will be used. Assessment of the noise impact of APU usage, should such usage be an option.	Medium
2 / p6	A description of the baseline noise survey that has informed the setting of noise limits	There is insufficient detail contained within the section to determine the specific noise monitoring locations. For example, it is unclear as to whether noise measurements were taken in free-field conditions, and what height above ground the microphone was positioned at. Crucially, it does not include a description of the exact measurement location to be able to determine whether microphones had direct line of sight to dominant noise sources such as main roads, or whether they were placed in rear gardens. There is a risk that existing noise levels have been overestimated if they have not been placed on quietest facades of residential receptors.	Clarification on exact noise measurement locations.	Low
2 / p6 para 2	"*The locations were also chosen to represent potentially-affected development in the surrounding area.*"	From a review of available aerial mapping, it is evident that there are closer noise sensitive receptors in the area than those selected for noise monitoring. There is a concern that the potential impacts on the most affected noise sensitive receptors have not been accurately quantified. Properties in Luddenham to the north west of the Site are particularly close yet there has been no noise monitoring undertaken in this area	Further consideration should be given to quantifying the existing noise environment for properties closest to the airport, particularly Luddenham.	Low

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3.1 / **p9, para 5,** **Table 3-1**	"*In the area surrounding the airport, the intrusiveness criterion is the more stringent at all locations*."	There is no evidence base for the conclusion that is drawn regarding the appropriate criteria set to be used. This could potentially underplay the extent of the noise impacts. Based on the rural nature of the surrounding area, Table 2.1 of the INP recommends a noise level of 40 dB L_{Aeq} at night as "acceptable". It is clear that this is lower than some tabulated night-time values in Table 3-1, albeit they are $L_{Aeq,15min}$ (corrected).	Evidence to demonstrate that the intrusiveness criterion is the more stringent at all locations.	Low
3.1 / **p10, para 2,** **Table 3-1**	*"So that the noise contours included below in this report can be readily interpreted, it is preferable to adopt one criterion for all residences an overall noise criterion of 40 dBA can be taken as generally appropriate for residential locations at night."*	The approach of selecting one criterion undermines the results of the noise monitoring at multiple locations. It is clear that noise criteria at five of the ten locations are lower than 40 dBA, and are as low as 35 dBA, which is 5 dB lower than the adopted criterion. Noise impacts at certain locations have been incorrectly identified.	Request reassessment for each measurement location using the appropriate criterion for that receptor, as set out in Table 3-1	Medium
3.1 / **p10, para 2**	*"By the time the proposed airport becomes operational, background noise levels in the general area are expected to have increased as a result of increased road traffic and associated development in the surrounding area. This would particularly be so for the lower background noise levels and would in turn raise the value of the appropriate noise criteria for the assessment of airport operational noise."*	The argument made in the paragraph is in reference to selecting an overall noise criterion of 40 dBA, which would be up to 5 dB higher than the locations-specific criteria set out in Table 3-1. However, an increase of 5 dB would be, in simple terms, equivalent to more than three times the amount of sound energy incident at the measurement location. Therefore, for road traffic to have this impact, there would need to be more than three times the amount of traffic that is currently on the road network, assuming no changes to the current road network.	None, comment for information only.	Noted for information

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3.1 / p11, Table 3-2	Table setting out "*noise criteria for other receiver types*", referring to those other than residential receivers. Values contained within the table are recommended maximum L_{Aeq} Noise Criteria.	Section 2.2 of the INP states the following: *"To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1. Meeting the acceptable noise levels in Table 2.1will protect against noise impacts such as speech interference, community annoyance and, to some extent, sleep disturbance. These levels represent current best practice for assessing industrial noise sources, based on research and a review of assessment practices used overseas and within Australia.* *Table 2.1 also includes recommended maximum noise levels for different land uses. These recommended maximum values provide guidance on an upper limit to the level of noise from industry.* ***In all cases it is expected that all feasible and reasonable mitigation measures would be applied before the recommended maximum noise levels are referenced****."*	The "Acceptable" noise levels stated in Table 2.1 of the INP should be used in the first instance, rather than "Recommended Maximum", which would in turn mean the criteria adopted would be 5 dB lower than used in the assessment.	Medium
3.2 / p11, para 3	*"For modelling purposes it has been assumed that high power run up would occur for less than 5 minutes in any night. Therefore, the night time residential criterion for this activity has been set using the industrial noise criterion as 5 dB over the general INP night time criterion for residential receivers; that is 45 dBA, in accordance with the INP duration adjustment."*	INP Section 4.2 states that the acceptable noise level may be increased by the adjustment shown in Table 4.2 of the INP, and that the adjustment is designed to account for unusual and one-off events, and does not apply to regular high-noise levels that occur more frequently than once per day. Should there be more than one high power run-up in one night, it would be inappropriate to apply this correction, and given that this is a realistic scenario, there is a concern that the criterion set is inappropriate.	Evidence to show the likelihood of high power ground run-ups in a given night-time period. Reassessment, where appropriate, of impact of high power ground running.	High
3.2 / p11, para 4	*"Like other major airports in Australia, the proposed airport is expected to have restrictions in place on engine ground runs, including limitations on night time run up activity."*	Assumption on future controls.	None, comment for information only. Consideration to condition.	Noted for information

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3.5.1 / **p13, para 2, Figure 3-1, Figure 3-2**	*"It has been assumed that aircraft ground runs would occur at the location shown in Figure 3-1."*	It is acknowledged that the assumed location for run-ups is defined in Figure 3-1, however there is a concern that, at this stage, the indicative building location near the position is not finalised nor is fixed within the planning application. It is evident from Figure 3-2 that communities to the west and north west of the Site benefit from the screening afforded by this building. Should the building or run-up area move, it is likely that it could significantly affect the resulting noise impact from the Site.	Given the indicative layout, and the level of assumed acoustic benefit provided, it is considered appropriate to assess a scenario where the building does not provide any acoustic benefit, to take into account that final locations are not fixed and may change.	High
3.5.1 / **p13, para 2,**	On the subject of source noise levels for aircraft engine ground running *"… a level of 151 dBA has been assumed, based on measurements of aircraft taking off."*	There is no indication of which aircraft this refers to, or the range of typical levels that might be expected. It is assumed that this level is an effective A weighted Sound Power Level (L_{WA}), however it is not explicitly stated. It would be expected that, given the potentially critical nature of the noise impact in the progression of the scheme, it would be appropriate to provide more information regarding the adopted source noise level.	More information is required regarding the range of values expected from engine run-ups given the anticipated fleet of aircraft for the airport, and more information regarding which aircraft the 151 dBA refers to.	Medium
3.5.2 / **p13, para 5**	*"A sound power level (noise level at source) for each aircraft of 138 dBA has been assumed. This is the highest level measured for aircraft taxiing, based on measurements of a B777, B747, B737, B717 and A330 aircraft."*	Typically, turboprops emit higher noise levels than jet aircraft whilst taxiing. It is anticipated that there will be a very low number of turboprops in service at the airport. It is unclear how this sound power level has been calculated. Taxiing is in essence a moving point source. Depending on how the source has been modelled, this may not be the appropriate sound power level to use. It is also unclear whether measured taxiing was under two engine conditions, one engine conditions or engine off taxiing (EOT).	Confirmation of the method used to determine the sound power level for the line source that has been used, and confirmation that measurements were undertaken to determine this. It would be useful to have the data presented in a table within the report.	Medium

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3.6 / **p15, Table 3-4**	Table 3-4 shows population affected above criterion.	There may be implications to this table as a result of the above issues. It would also be helpful to understand how many receptors will be exposed to 5 dB above criterion, 10 dB above criterion etc.	Update table based on the outcome of the above recommendations. It is likely that the population numbers will increase. Provide number of people exposed to 5 dB above criterion, 10 dB above criterion etc.	Noted for information
3.6 / **p16, Table 3-5**	Table 3-5 shows other buildings and land uses affected above criterion.	There may be implications to this table as a result of the above issues. It would be helpful if the actual noise levels anticipated at these buildings/areas are presented, given the small number of them, so that the magnitude of the exceedance can be understood.	Update table based on the outcome of the above recommendations. It is likely that the population numbers will increase. Provide noise levels anticipated at each receptor.	Noted for information
3.6 / **p16, para 2**	The text refers to the use of reverse thrust at night.	It is assumed that reverse thrust at night has been included in the aircraft noise assessment.	Consider removing reference	Noted for information
3.7 / **p17, para 2, Figure 3-4, Figure 3-5**	*"Ground-based noise levels have been predicted for the longer term airport development using the same methods as for the initial airport development. The noise source locations are shown in Figure 3-4 and the resulting contours are shown in Figure 3-5 and Figure 3-6."*	The text infers that, even with two runways and a significant increase in aircraft movements as a result, there would still be only one engine run-up for less than 5 minutes in any 15 minute period. This single point source of noise has been modelled as indicated in Figure 3-4, however Figure 3-5 (which shows the noise propagation) does not appear to have the same level of acoustic screening from nearby buildings as the similar situation in Figure 3-2, which suggests that either Figure 3-2 overestimates the level of acoustic screened afforded by buildings, or Figure 3-5 underestimates this.	Clarification that, in the event of a two runway airport, there would continue to only be one ground run-up area. Confirmation that the acoustic screening from buildings has been correctly accounted for in both Figure 3-2 and Figure 3-5	Medium
3.7 / **Figure 3-4**	The figure shows ground-based operational noise source locations in 2063	The figure does not accurately represent Figure 5-3 of the EIS Volume 1 (p143) document which shows the indicative airport site layout – long term development. In particular, there are additional areas within that layout where aircraft would be taxiing that have not been included in the noise model. The model roughly only accounts for the usage of 63 out of 95 aircraft gates.	It is recommended that the model be updated to include the additional areas where aircraft will be taxiing.	Low

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3.8 / p19, para 3	*"High power running at night time should be restricted to special circumstances where high power testing is required after maintenance activity prior to an aircraft taking off […] Restricting the amount of high power running at night time would substantially reduce the impact of ground running noise."*	The paragraph refers to mitigation measures, however this has already been factored in to the original noise assessment. It is therefore important that this mitigation measure is carried through to operation.	Condition night-time engine ground run-up appropriately.	Noted for information
3.8 / p19, para 3	*"It may also be practical to construct buildings, mounds or barriers near the run-up area to provide greater noise shielding, particularly on the northern side to shield the closest area of Luddenham. It is possible that reductions of around 10 dBA could be achieved with mounds or buildings at least 10 m high, but moderate residual impacts would still occur under worst-case meteorological conditions. There may also be a benefit in relocating the run up area further to the south-east to reduce the noise impact on Luddenham, but practical operational issues would need to be considered for this."*	It is unclear within the report what the quantifiable benefits to the closest noise sensitive receptors would be from moving the run-up area and installing run-up pens or barriers, in terms of resultant noise levels and the residual exceedance of the established criteria. It is unclear as to whether the impact during the day would be acceptable.	Given that moderate residual impacts are predicted with run-up pens, it is recommended that consideration be given to a more thorough assessment of the acoustic benefits of including such an area, and that its use should be conditioned during appropriate periods. Confirmation of the level of impact during the day.	Noted for information
3.8 / p19, para 4	*"Aircraft taxiing noise would be relatively low in comparison to other noise associated with operation of the airport. There would be little that could be done to reduce noise levels emanating from the airport as a result of taxiing."*	The statements made do not appear to be accurate. On inspection of the noise contours, particularly for the long term scenario, noise from taxiing is on a similar scale to noise from engine run-ups. There are a number of potential mitigation measures that could be considered, including single engine taxiing, engine off taxiing (EOT), the installation of acoustic barriers at effective locations	Consideration to the unmitigated noise impact from taxiing and the residual noise impact following possible mitigation measures, which could be conditioned.	High
3.8 / p20, para 2	*"The proposed use of ground power and pre-conditioned air for aircraft at the gates avoids the use of aircraft auxiliary power units and the associated noise."*	The assessment has assumed no use of auxiliary power units (APUs). The report assumes that ground power and pre-conditioned air will be available at all gates. However, ground power could be supplied either by fixed electrical ground power (FEGP), or by Ground Power Units (GPUs). Should the latter be used, it would be expected that they could have the potential to cause a noise impact and should be assessed accordingly.	Recommend that a condition is included that restricts the use of APUs. Clarify the type of ground power to be used. If GPUs are to be used, assess their noise impact.	Medium

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
3 / General	There is no consideration given to the cumulative noise impact from engine run-ups and taxiing, and no assessment has been included for airside service vehicles, sirens, noise from fixed plant associated with the airport buildings or use of the compass calibration pad.	As a minimum, it would be expected that some consideration would be given to the cumulative noise impact from all ground noise sources at nearest noise sensitive receptors with and without mitigation measures.	Recommend a cumulative ground noise assessment is included, and further consideration be given to noise from other ground noise sources.	Medium
4.1.1 / P21, para 4	Various construction noise criteria are discussed.	It is unclear as to whether the criteria is based on the NSW Interim Construction Noise Guideline (ICNG) or the Airports (Environment Protection) Regulations 1997. Usual hours of construction are proposed from 6.00 am, which is classed as night-time. Therefore, it is particularly important that the appropriate criterion is used for night-time work as this will be the norm. In addition where the ICNG is used, the guidelines states that strong justification should be provided for works that occur outside of standard hours.	Clarification of the appropriate criteria set to be used for this assessment for daytime and night-time.	Medium
4.1.1 / P21, para 5	*"Based on the daytime background noise levels shown in Table 2-1, the daytime residential NML would be between 39 dBA and 49 dBA for standard hours. For assessment of construction noise, a NML of 45 dBA may reasonably be adopted for all residential receivers, for week-day construction. Equally, for weekend works and early morning works, an NML of 40 dBA may be adopted."*	The report identifies that, for some receptors, the NML should be 39 dBA, however 45 dBA (weekday) and 40 dBA (weekend and early morning works) have been adopted as the criteria set. This potentially underplays the noise impacts from construction by up to 6 dB.	Reassess based on the different measurement locations adopted in the assessment in order to more accurately quantify the potential noise impacts.	Low
4.4 / P29, para 4	*"It is proposed that these strategies be applied to areas of exceedance identified in the preceding section. The contractors responsible for the construction works should implement a Construction Noise & Vibration Management Plan. The Plan should provide for ongoing communication with potentially-affected residents and establish a complaint management and response system."*	The report identifies the need for a Construction Noise & Vibration Management Plan.	Recommend that this be included as a planning condition.	Noted for information

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
4.6 / **P31, para 1**	*"All construction traffic is expected to travel to the site via Elizabeth Drive."*	No assessment has been made for construction vehicles on roads accessing Elizabeth Drive for example The Northern Road, Luddenham Road, Mamre Road etc. No justification for excluding these roads is provided. In addition, Section 6.2.4 of the EIS indicates that for site establishment works, additional site accesses would be utilised on roads other than Elizabeth Drive.	Additional assessment of construction vehicles accessing Elizabeth Drive and other site accesses should be included.	Medium
4.6 / **Table 4-7**	Results table presents predicted increases in noise level for three sections of Elizabeth Drive.	The construction traffic assessment only considers three sections of Elizabeth Drive, whereas the Operational traffic assessment considers five sections which include additional sections: West of Badgerys Creek and West of Luddenham Road. No assessment has been provided for these sections in the construction traffic assessment	Justification should be provided for why there are inconsistencies between the operational and construction traffic assessment.	Medium
4.6 / **p31, para 3**	*Using the traffic noise criterion discussed in Section 5.2 below, it is concluded that this level of noise change resulting from the proposed construction works would not represent a perceptible noise increase.*	As calculation details are not available for review, the results are not able to be verified. However, for the results presented in the report, this conclusion is considered acceptable.	None	For information only
5 / **P32**	-	The assessment acknowledges the future development of the M12 motorway, however does not specifically mention the planned realignment of The Northern Road to accommodate the airport.	The Northern Road realignment is acknowledged and considered in the report.	For information only
5 / **P32**	*"Future road works would be the subject of separate approval processes by the relevant authorities undertaking these actions and the assessment of these is not covered in this document. However, a preliminary assessment of the general impact of the expected change in road traffic associated with operation of the proposed airport has been undertaken."*	Whilst it is understood that details may not be available for the M12 or Northern Road realignment projects and they are subject to a separate approvals process, the report does not provide "a preliminary assessment of the general impact" as it subsequently excludes the potential impacts from these roads.	A statement in the report should be included to acknowledge the limitations of the assessment that only considers existing roads and acknowledges that whilst it does not consider impacts from new motorways or realigned arterial roads, additional impacts as a result of the airport may occur from these roads.	Major

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
5.1 / **p32, para 1 and 2**	*Reference has been made to the NSW Road Noise Policy (RNP) to assess the effect of the proposed airport on road traffic noise in the area. The RNP recommends noise assessment criteria for residential and non-residential land uses affected by traffic generating developments. These criteria are more relevant to the assessment of new road infrastructure works, and they do not assist greatly in determining the impact of road traffic noise increases on existing roads due to the proposed airport and associated development.* *In Section 3.4, the RNP document indicates that …. "an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person". It is this statement which is useful in assessing the significance of traffic noise level increases due to the proposed airport development.*	The RNP provides specific guidance for land uses affected by additional traffic on existing roads generated by land use developments in Step 4 of Section 3.4.1. The guidance was clarified in the RNP Application Notes (EPA, 2013) as follows: *"The second paragraph in Step 4 should therefore be read to mean: 'After taking Steps 1 to 3, for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion."*	The report should be amended to include the appropriate RNP assessment criteria.	For information only
5.2 / **p32, para 1**	*"Road traffic projections for major roads in the vicinity of the airport have been provided by traffic planners for the year 2030 (GHD 2015a (R9)) with and without the airport."*	The suggested approach in Section 2.5.3 of the RNP is to assess a project at the year of opening and a design year, typically ten years after opening. The intention of the design year is provide an indication of road traffic noise impacts in the longer term when the project is established. The project opening year for the airport is stated to be around 2025 in the EIS.	The road traffic assessment should consider the project's impacts at the opening year and at a design to assess potential long term impacts, or else provide justification for an alternative approach.	Medium
5.2 / **p32, para 1**	*Noise levels at typical distances from these roads have been calculated using the CoRTN (R7) procedure which has allowed the increase in road traffic noise due to the proposed airport development to be forecast.*	The typical offset distance is not stated.	The typical offset distances for each road should be stated	For information only
5.2 / **P 33 Table 5-1**	*"The highest noise level increase expected is less than 2 dB and accordingly, it is concluded that there would not likely be a perceptible noise increase resulting from road traffic as a result of the proposed airport development."*	The traffic volumes used to generate these results are not presented in the report and therefore the results are not able to be verified. However, for the results presented in the report, this conclusion is considered acceptable.	None	For information only

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
6 / P34	Conclusions section	This section may require updating based on the resolution of the previously stated issues.	Update where appropriate based on the outcome of the considerations above	Noted for information
6 / p35, para 9	*"Although heavy and light vehicles would need to access the proposed airport during the construction stage, the resulting increase in traffic noise would not be significant."*	Insufficient evidence presented in the assessment to support this conclusion, as vehicles accessing Elizabeth Drive on surrounding roads were not included in the assessment.	Additional assessment of roads that link to Elizabeth Drive	Medium
6 / p35, para 10	*"During operation of the proposed airport, road traffic noise level increases in the surrounding area are predicted to be insignificant. This is without considering the impact of the newly proposed M12 motorway and any road realignments which would be subject to separate applications and approvals by the relevant authorities."*	This statement acknowledges the limitations of the assessment. The main body of the EIS does not includes the same statement of limitations.	The limitations of the assessment should be reflected in statements throughout the EIS.	High
6 / p35, para 10	*"During operation of the proposed airport, road traffic noise level increases in the surrounding area are predicted to be insignificant. This is without considering the impact of the newly proposed M12 motorway and any road realignments which would be subject to separate applications and approvals by the relevant authorities."*	Section 5(b) of the EIS Guidelines state: *"The EIS should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity)."*	Impacts of the associated new motorway and road redevelopments/realignments should be considered as part of a cumulative impact assessment in accordance with 5(b) of the EIS Guidelines.	High
Volume 2 – Chapter 9. Approach to impact assessment				

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
9.3.2, p6, Table 9-2	Table presents EIS Guideline requirements and indicates where in the EIS they are addressed. Under "Section 5 – Relevant Impacts" it states the following requirements:- *"a detailed assessment of the nature and extent of the likely short-term and long-term relevant impacts (detailing direct and indirect impacts);* *a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;* *analysis of the significance of the relevant impacts; and* *any technical data and other information used or needed to make a detailed assessment of the relevant impacts."*	These guidelines have not been followed adequately within Chapter 11.	Update Chapter 11 to include clear statements on whether impacts are short term, long term, direct, indirect, unknown, predictable or irreversible, and the significance of the impacts.	Noted for information
9.3.2, p11, Table 9-2	Table presents EIS Guideline requirements and indicates where in the EIS they are addressed. Under "Section 6 – Avoidance and mitigation measures" it states that the EIS must include an assessment of the expected or predicted effectiveness of mitigation measures.	These guidelines have not been followed clearly within Chapter 11.	Update Chapter 11 to provide a clearer assessment of the expected / predicted effectiveness of mitigation measures.	Noted for information
9.3.2, p11, Table 9-2	Table presents EIS Guideline requirements and indicates where in the EIS they are addressed. Under "Section 7 – Residual impacts and offsets" it states that the EIS must include the reasons why avoidance or mitigation of impacts may not reasonably be achieved, and quantification of the extent and scope of significant residual impacts.	These guidelines have not been followed adequately within Chapter 11.	Update Chapter 11 to include clear statements on whether residual impacts are short term, long term, direct, indirect, unknown, predictable or irreversible, and the significance of the residual impacts. Include the reasons why avoidance or mitigation of impacts may not reasonably be achieved, where necessary.	Noted for information

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
9.3.2, p13, Table 9-2	Table presents EIS Guideline requirements and indicates where in the EIS they are addressed. Under "Section 11 – Information sources" it states that, for information given in the EIS, the EIS must state (amongst other points) the source of the information, how recent the information is, and how reliable the information is.	These guidelines have not been followed adequately within Chapter 11.	Update Chapter 11 to include this information – specifically regarding the source noise data used as a basis for the engine ground running noise assessment and the aircraft taxiing noise assessment.	Noted for information
Volume 2 – Chapter 11. Noise (ground operations, construction, road and rail)				
Summary, p75	*"Under worst case meteorological conditions, noise associated with engine run-up has the potential to affect Luddenham, Badgerys Creek, Bringelly and Greendale."*	Appendix E2 states that this noise also has the potential to affect Wallacia. This location has not been brought through from the technical appendix.	Update summary to include Wallacia	Noted for information
Summary, p75	*"During operation of the proposed airport, increased noise levels due to airport generated road traffic in the surrounding area are not expected to be significant."*	This statement is misleading as it implies that development of the airport will not result in increases in road traffic noise in the project area. However, a new motorway (M12) is being built to service the airport. Whilst the assessment of the new road would be assessed and approved under a different approvals process, the impact of a new motorway would likely increase noise levels in the surrounding area as a direct result of airport generated traffic. The summary also does not include the limitations stated in Appendix E2 which acknowledges that the M12 and other road realignments have not been considered in the assessment.	Revision of statements for operational road traffic noise to include limitations and acknowledging that operation of the M12 and realignment of The Northern Road are not included in the impact assessment.	High
11.2.2, p76-77	*"A sound power level for each aircraft of 138 dBA has been assumed, being the highest level measured for aircraft taxiing (B777, B747, B737, B717 and A330) […]* *[…] the Boeing 747 is the loudest aircraft anticipated to operate at the proposed airport"*	It is assumed that the 747 taxi noise has been used for the purposes of the noise modelling exercise.	Clarify that the source noise level for the 747 aircraft has been used as a basis for the taxi noise assessment	Noted for information
11.2.3 **P 78, para 1**	*"The traffic projections were used to calculate noise levels at typical distances from roads near the airport site using the 'Calculation of road traffic noise' procedure (CoRTN)"*	No predicted traffic noise levels are presented in the EIS or Appendix E2. Noise levels presented are the change in noise level.	Amend statement to reflect that traffic noise levels are not presented in the report, only predicted increase.	For information only

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
11.3, Figure 11-2, p79	A figure depicting noise sensitive receptors surrounding the airport site	It is difficult to see the location of nearest residential receptors, as their location appears to be indicated by very small points in light grey – whereas the other types of receptor are more clearly marked. It is also difficult to see this in the inset image displaying Luddenham. The initial impression that the figure currently gives is that there are little, if any.	Recommend that the figure is updated to show more clearly the location of residential receptors, particularly in Luddenham.	Noted for information.
11.7, p97, Table 11-13	The table details the mitigation/management measures to be put forward.	It is important that these proposals are brought forward and conditioned appropriately. The use of ground power and pre-conditioned air are not included in the table, nor is any mention of the restriction over APU usage.	Given the anticipated impact of noise from engine ground running, consideration should be given to the inclusion of a condition relating to the installation and use of a ground run-up pen or other such structure to provide effective acoustic screening. Given that the assessment has been based on no APU usage, a condition should be imposed on APU usage. Recommend that the mitigation measures be conditioned and adopted.	Noted for information
11	**General**	**A number of points/issues from Appendix E2 have been carried through to this document.**	**Update based on the outcome of the Appendix E2 updates.**	**High**
11	General	Magnitude of significance of ground noise impacts, the extent of their impacts, and whether they are temporary or permanent have not been identified. This is a fundamental flaw in the EIS chapter.	Recommend that a magnitude scale for impact significance is used for pre-mitigation and post mitigation assessments so that it can clearly be seen what the residual noise impact is predicted to be.	Noted for information
Volume 2 Chapter 27. Cumulative impact assessment				

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
27.3.1	*"There is also anticipated to be a general increase in background noise levels associated with the ongoing urbanisation and development of Western Sydney. For example, certain proposed road projects, such as the proposed relocation and upgrade of The Northern Road, would contribute to changed background noise levels in the vicinity of the airport site. An increase in background noise would effectively limit the incremental increase associated with noise generated by the airport operations."*	There are two major road projects being developed due to the airport is being built: the M12 motorway and The Northern Road realignment. The cumulative assessment does not mention the operation of the M12 motorway and does not indicate the degree of impact from The Northern Road realignment. The omission of these items is not consistent with Section 5(b) of the EIS Guidelines. Whilst it is recognised that the mitigation and management of these road projects may not be the responsibility of the proponent, the EIS guidelines require that cumulative impacts from known potential future projects are considered.	Further cumulative assessment should be provided to indicate the potential impact of the operation of the M12 and The Northern Road realignment.	High
Volume 2 Chapter 28. Environmental Management Framework				
28.4.2, Table 28-5	The table provides a list of mitigation and management measures applicable to Stage 1 operation	It is important that these proposals are brought forward and conditioned appropriately. The use of ground power and pre-conditioned air are not included in the table, nor is any mention of the restriction over APU usage.	Given the anticipated impact of noise from engine ground running, consideration should be given to specific item relating to the installation and use of a ground run-up pen or other such structure to provide effective acoustic screening. Given that the assessment has been based on no APU usage, a specific item should be imposed on APU usage. Recommend that the mitigation measures be conditioned.	Noted for information
Volume 2 Chapter 29. Conclusion				
29.3, p625, Table 29-1	The tables provides a summary of the key environmental impacts	The "Noise – ground operations, construction and road traffic" section of the table does not provide an indication of the magnitude of significance of the noise sources stated, and whether this is with or without mitigation measures in place	Recommend that the magnitude of the noise impacts is included to assist in the decision making process.	Noted for information
Volume 3 Chapter 31. Noise				

Section / Paragraph Reference	Text Reference / Figure Description	Comment	Recommendation	Significance of Issue
31.5.1, p66, para 2	*"It is not anticipated that taxiing and engine run-up noise levels would increase, but these types of noise may become more frequent in the 2050 scenario."*	It is assumed that the text refers to the effective source noise associated with a single taxiing movement or engine run-up would not increase, rather than the resultant noise impact associated with the number and intensity of operational noise.	None. For information only.	Noted for information
31.5.2, p67, para 4	*"The 2063 aircraft taxiing noise contours reflect the increased number of aircraft movements and would extend further south as a result of the commissioning of the second runway."*	The increased impact is not adequately quantified. The aircraft noise section has identified the population numbers affected, however this information in absent for ground noise. There is no indication of the level of exceedance for nearest noise sensitive receptors in order to determine the magnitude of the impact.	Recommend that population number affected by ground noise is included. Recommend that population number affected is in 5 dB bands in order to understand the magnitude of the potential noise impact.	Noted for information
31.5.2, p67, para 4	*"Ground run-up noise would also likely occur more frequently in the long term, although the noise contours are not predicted to change based on the modelling assumptions adopted for this assessment."*	On comparison of the ground run-up noise contours for 2030 and 2063, the shape of the contour changes, therefore the statement is incorrect.	Revise the statement	Noted for information
31.5.2, p68 - 69, Figure 31-38, Figure 31-39	Figure 31-38 and Figure 31-39 show predicted noise levels for engine ground running and taxiing, respectively.	The figures are incorrectly labelled "maximum noise levels". They should be labelled "$L_{Aeq,15min}$ noise levels".	Correct the labelling of the figures	Noted for information
31.7, p70-72	These pages contain a summary of the findings from the chapter.	The summary of findings does not make any reference to ground noise.	Include a summary of the ground noise impact assessment	Noted for information
Volume 3 Chapter 40. Conclusion and recommendations				
40	The Chapter provides a summary of the key environmental impacts	The summary of findings does not make any reference to ground noise.	Include a summary of the ground noise impact assessment	Noted for information

Acoustics@WSPGroup.com

WSP | PARSONS BRINCKERHOFF

Appendix C

Air quality and greenhouse gas (Katestone Environmental)

katestone
www.katestone.com.au

Western Sydney Airport: Peer Review of Air Quality and Greenhouse Gas Assessment

Prepared for:

WSP | Parsons Brinckerhoff

November 2015

Final

Prepared by:

Katestone Environmental Pty Ltd
ABN 92 097 270 276
Ground Floor, 16 Marie Street | PO Box 2217
Milton, Brisbane, Queensland, 4064, Australia

www.katestone.com.au
us@katestone.com.au
Ph +61 7 3369 3699
Fax +61 7 3369 1966

katestone
www.katestone.com.au

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Prepared by:	Michael Burchill, Natalie Shaw, Simon Welchman
Reviewed by:	Simon Welchman
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Disclaimer

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Contents

Tables

Glossary

Term	Definition
$\mu g/m^3$	micrograms per cubic metre
Nomenclature	
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalents
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
PM_{10}	particulate matter with a diameter less than 10 micrometres
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
SO_2	sulfur dioxide
TSP	total suspended particulates
VOC	volatile organic compounds
Abbreviations	
AEPR	Airport Environment Protection Regulation 1997
AERMOD	US EPA approved dispersion model
Air NEPM	National Environment Protection (Ambient Air Quality) Measure
Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
DEC	Department of Environment and Conservation (NSW)
EDMS	Emissions and Dispersion Modelling System
EIS	Environmental Impact Statement
EPA	Environmental Protection Authority
GHG	Greenhouse gases
NPI	National Pollutant Inventory database
MACROC	Macarthur Regional Organisation of Councils
OEH	New South Wales Office of Environment and Heritage
US EPA	United States Environmental Protection Agency
WSROC	Western Sydney Regional Organisation of Councils

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by WSP | Parsons Brinckerhoff on behalf of the Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC) to complete a peer review of the local and regional air quality studies completed as part of the Environmental Impact Statement (EIS) for the Western Sydney Airport.

Limitations of peer review

Katestone's peer review has considered the air quality and greenhouse gas assessments presented in the EIS. A separate health risk assessment was also conducted and presented in the EIS. Katestone's peer review has not considered the separate health risk assessment. The separate health risk assessment has been the subject of a separate peer review by another party.

To assist with its review, Katestone requested access to all relevant input and output files that were integral to the air quality assessment studies as this information was not contained in the EIS. The provision of such information is a routine expectation and is a minimum requirement of the EPA for such studies. For a peer review the data is integral to demonstrating the integrity of the assessment. However, this information was not made available to Katestone for its review. Consequently, Katestone has relied only upon the information contained in the relevant chapters of the EIS to complete its review. Where apparent errors and inconsistencies were found within and between documents, Katestone has noted these, but in most cases has not been able to discern the full significance of these on the assessment outcomes.

Overall Comments on air quality study

The air quality study is contained in Volume 2 Chapter 12, Volume 3 Chapter 32 and Volume 4 Appendix F1 of the Western Sydney Airport EIS. Katestone has noted that these documents contain many typographical errors and inconsistencies that undermine the credibility of the air quality assessment. These sections require a thorough technical and editorial review by its authors to address the issues outlined in this review to improve transparency and credibility of the air quality assessment. To enable confidence in the assessment, all information and data used in the emission estimation, model inputs and outputs should be made available to any interested party.

The air quality study did not adequately address the sensitive receptors as it:

- Failed to identify all sensitive receptors
- Failed to identify a representative subset of sensitive receptors - whilst a small subset of sensitive receptors was identified, the subset does not appear to be representative of potential air quality impacts at all existing locations of sensitive receptors
- Did not identify future sensitive receptors
- Incorrectly classified community receptors separately and as having a lesser importance than residential receptors. Community receptors included various land-uses such as schools, parks, childcare facilities, churches and shopping centres.

Stage 1 Development

<u>Local Air Quality</u>

Setting aside the issues identified above, if the assessment results are taken as presented in Tables F1 to F8 and Table G1 to G5 (Volume 4, Appendix F1) of the EIS, they indicate the following:

- The maximum 1-hour average concentration of NO_2 was predicted to **exceed** the EPA's impact assessment criterion of 246 µg/m^3 at one receptor. Three other receptors have maximum 1-hour average concentrations of NO_2 that are 92% to 98% of the EPA's impact assessment criterion.

- The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard.
- The 99.9th percentile 1-hour average concentration of formaldehyde was predicted to **exceed** the EPA's impact assessment criterion at two receptors.
- The predicted concentrations of all other air pollutants were below their respective assessment criteria.
- The major contributor to elevated levels of air pollutants is aircraft emissions. However, for receptors close to existing or new roads, the major contributor is external roadways.
- Mitigation measures were recommended. However, the effectiveness of the measures in achieving compliance was not quantified.

Regional air quality

The methods used to assess the regional air quality are acceptable. The assessment of regional air quality showed that only marginal increases in ozone concentrations would result from Stage 1 Development.

Greenhouse gases

The methods used to estimate greenhouse gas emissions are acceptable. The estimates of greenhouse gas emissions are reliable and the contribution of greenhouse gas emissions from the project will be relatively small with Stage 1 Development emissions approximately 0.11% of Australia's projected 2030 transport-related GHG inventory.

Overall comments

The Stage 1 Development assessment was based on the annual throughput of the airport would be 63,302 ATM in 2030. The stated maximum capacity of the airport following completion of Stage 1 is three times higher at 185,000 ATM in 2050. The local air quality assessment, regional air quality and greenhouse gas assessment all use this assumption in the generation of the emissions and resultant impacts. Consequently, the assessment has underestimated the potential impact of the Stage 1 Development by a considerable margin.

Longer Term Development

Local Air Quality

The assessment results are taken as presented in Tables F9 to F11 (Volume 4, Appendix F1) of the EIS, they indicate the air quality assessment of the Longer Term Development shows:

- The maximum 1-hour average concentration of NO_2 was predicted to exceed the EPA's impact assessment criterion of 246 µg/m^3 at 41 of the 96 receptors.
- The maximum 24-hour average PM_{10} concentrations was predicted to exceed the EPA's impact assessment criterion at three receptors.
- The maximum 24-hour average concentrations of $PM_{2.5}$ were predicted to exceed the NEPM Advisory Reporting Standard at three receptors.
- The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. The annual average concentrations of $PM_{2.5}$ were predicted to exceed the Air NEPM Advisory Reporting Standard at 13 receptors (concentrations are reported as 9 µg/m^3 or higher). A number of receptors were predicted to

have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard.

- Whilst a number of mitigation and management measures were listed within the Western Sydney Airport EIS, the effectiveness of the measures was not quantified and therefore the air quality assessment failed to demonstrate that compliance with the relevant air quality criteria could be achieved.

Regional air quality

The assessment of regional air quality showed:

- The change in daily maximum 1-hour ozone concentration from the addition of the airport was 4.5 ppb which is significantly above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach
- The change in daily 4-hour average ozone concentration from the addition of the airport was 3.7 ppb which is significantly above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach.

However, the regional air quality assessment for the Longer Term Development is hypothetical as:

- The impacts had to be assessed in context of the 2030 base case emissions as a base case inventory has not been projected for 2063
- Changes in emissions to other existing sources had not been accounted for
- Assumes that the rail network exists

Greenhouse gases

The methods used to estimate greenhouse gas emissions are acceptable.

Overall comments

The Longer Term Development contained in the Western Sydney Airport EIS includes a second runway, which relies upon the existence of rail services to be feasible. The Western Sydney Airport EIS states "*As it is not possible for the longer term development to achieve the project passenger numbers without the rail network the traffic scenario that does not include the rail network was disregarded.*"

Air quality associated with Stage 1 is critically dependent on the traffic volumes generated by the airport. Consequently, the impact on air quality due to the Longer Term Development is critically dependent on the existence of the assumed rail services to the airport. The Western Sydney Airport EIS is not seeking approval for the rail infrastructure that is necessary for its feasibility and the EIS does not contain a detailed proposal for the rail infrastructure. As a consequence, the air quality assessment of the Longer Term Development is speculative at best and does not provide a sufficiently robust basis to support approval of the Longer Term Development at this stage.

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by WSP | Parsons Brinckerhoff acting on behalf of the Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC) to complete a peer review of the local and regional air quality studies completed as part of the Environmental Impact Statement (EIS) for the Western Sydney Airport.

1.1 Approach

WSP | Parsons Brinckerhoff requested a peer review that:

- *Evaluates whether the local and regional air quality studies meet the requirements of the EIS Guidelines and relevant other guidelines and methodologies.*
- *Evaluates whether the conclusions reached in the studies are valid – i.e. an independent evaluation of whether the predicted impacts are in accordance with published standards and guidelines, and whether the conclusions of the assessment are a realistic reflection of the actual impacts.*
- *Evaluates whether the underlying assumptions used to inform the assessment (including any construction or operational assumptions, and modelling assumptions where appropriate) are plausible.*
- *Review the mitigation and management measures proposed and advises on their adequacy in mitigating impacts.*
- *Evaluates the level of uncertainty over impacts and the environmental risks that will arise as a result.*
- *Provides a summary of the key impacts and opportunities associated with the project in relation to the local and regional air quality studies*.

WSP | Parsons Brinckerhoff also requested that the following be considered:

- *...a key part of the peer review role to identify any gaps in information, errors or shortcomings.*
- *The purpose of this review is to present factual unbiased information about the technical rigour of the studies and both the positive and negative aspects of the proposal. All views expressed within the peer review should be substantiated with reference to information in the EIS or published elsewhere.*
- *The peer review is intended to assess the merits of the proposal as presented in the EIS – it is not at this stage intended that the peer review will develop recommendations for alternative designs for the project.*

1.2 Limitations

Katestone's peer review has considered the air quality and greenhouse gas assessments presented in the EIS. A separate health risk assessment was also conducted and presented in the EIS. Katestone's peer review has not considered the separate health risk assessment. The separate health risk assessment has been the subject of a separate peer review by another party.

To assist with its review, Katestone requested access to all relevant input and output files that were integral to the air quality assessment studies as this information was not contained in the EIS. The provision of such information is a routine expectation, is a minimum requirement of the EPA for such studies and is integral to demonstrating the integrity of the assessment.

The EPA's requirements an air quality assessments are detailed in its *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005) (Approved Methods). The Approved Methods specifies the minimum requirements for the information to be contained within impact assessment reports. In relation to air pollutant emissions, the following is expected to be included in the report:

> *Detailed calculations of pollutant emission rates for each source*

In relation to dispersion modelling, the following is expected to be included in the report:

> *All input, output and meteorological files used in the dispersion modelling supplied in a Microsoft Windows-compatible format*

However, this information was not made available to Katestone for its review. Consequently, Katestone has relied only upon the information contained in the relevant chapters of the EIS to complete its review. Where apparent errors and inconsistencies were found within and between documents, Katestone has noted these, but in most cases has not been able to discern the full significance of these on the assessment outcomes.

As a minimum, the following information should be provided within the technical air quality reports for review:

- Local air quality
  - Construction
    - Assumptions used in the emission estimation such as tonnages of material moved, equipment numbers and control measures
    - Spreadsheet of emissions information for input into AERMOD model
    - AERMOD input files and output files, including post processing information.
  - Operation
    - Assumptions used in the emission estimation such as engine type assumed for each aircraft, taxiing length
    - Spreadsheet for emissions information from EDMS
    - AERMOD input and output files, including post processing information.

1.3 Components of the EIS Considered in Peer Review

This report presents the outcomes of Katestone's independent peer review of the following components of the EIS:

- Local air quality
- Regional air quality
- Greenhouse gases.

In conducting its peer review of the Western Sydney Airport EIS, Katestone has had specific regard to the following information and relevant documents:

- Western Sydney Airport EIS Volume 2 Chapter 12 Air Quality and Greenhouse Gases
- Western Sydney Airport EIS Volume 3 Chapter 32 Air Quality
- Western Sydney Airport EIS Volume 4 Appendix C Airport EIS Guidelines
- Western Sydney Airport EIS Volume 4 Appendix F1 – Local Air Quality and Greenhouse Gas Assessment
- Western Sydney Airport EIS Volume 4 Appendix F2 – Regional Air Quality

- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005) (*Approved Methods*).
- *National Environment Protection (Ambient Air Quality) Measure 1998*.

2. EIS GUIDELINES

The EIS Guidelines that relate to air quality and greenhouse gas emissions are as follows:

"2 DESCRIPTION OF THE ACTION

All construction, operational and (if relevant) decommissioning components of the action should be described in detail. This should include the precise location (including coordinates) of all works to be undertaken, structures to be built or elements of the action that may have impacts on matters of National Environmental Significance. The description of the action must also include details on how the works are to be undertaken (including stages of development and their timing) and design parameters for those aspects of the structures or elements of the action that may have relevant impacts.

5 RELEVENT IMPACTS

…

(g) Impacts to the environment (as defined in section 528) should include but not be limited to the following:

…

- *Changes to air quality during construction and operation (associated with both passenger movements and workers)*
- *Potential fuel dump impacts*
- *…*

Quantification and assessment of impacts should:

- *Be against appropriate background/baseline levels*
- *Be prepared according to best practice guidelines and compared to best practice standards*
- *Consider seasonal and temporal variations where appropriate (including temporal changes in the sensitivity of the receptor)*
- *Be supported by maps, graphs and diagrams as appropriate to ensure information is readily understandable*

Guidelines and standards used to quantify baselines and impacts should be explained and justified.

6 AVOIDANCE AND MITIGATION MEASUES

(a) The EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impact of the action on a matter protected by a controlling provision (as listed in the preamble of this document).

...

(c) The EIS must include specific and detailed descriptions of the proposed avoidance and mitigation measures based on best available practices..."

The air quality and greenhouse gas assessments appear to satisfy the EIS guidelines because they refer to the correct legislation and technical guidance. However, it has been very difficult to verify this independently via an analysis of the EIS due to the many typographical errors and inconsistencies (refer to Section 3, Section 4 and Appendix A) and because critical information was not made available (Section 1.2).

3. REVIEW FINDINGS –STAGE 1 DEVELOPMENT

3.1 Local air quality

3.1.1 Methodology

The EIS Guidelines require the assessment of impacts to be prepared according to best practice guidelines and compared to best practice standards. The key documents that contain best practice assessment guidelines and standards are:

- The Environment Protection Authority's *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005) (Approved Methods)
- *National Environment Protection (Ambient Air Quality) Measure 1998*.

The air quality assessment of the Western Sydney Airport is stated to have been conducted in accordance with the Approved Methods. There is insufficient information contained within the EIS documentation to allow our review to determine if this is a true statement. As detailed in Section 1.2, critical information was not made available to Katestone for its review, which makes it very difficult to verify independently whether the assessment has been conducted in accordance with the Approved Methods.

The table below summarises the elements of the assessment and whether the method used was acceptable. Sections 3.1.2, 3.1.3 and 3.1.4 elaborate further on these issues. A detailed description of each element is provided in Appendix A.

Table 1 Methodology overview

Chapter of Approved Methods	Section of Approved Methods	Comments
3. Emissions inventory	3.1 Identify all sources of air pollution and potential emissions	Construction - acceptable.
		Operations - acceptable.
	3.2 Determine source release parameters	Construction - cannot verify - No details provided.
		Operation – cannot verify - some parameters acceptable but not all parameters were provided.
	3.3 Estimate emission rates	Construction – cannot verify - Insufficient information to fully verify.
		Operations – cannot verify - EDMS used, which is acceptable. However, insufficient information to fully verify.
	3.6 Presentation of emissions inventory	Construction – cannot verify - errors in presentation of emissions inventory.
		Operations – cannot verify - inconsistencies and errors in presentation of emissions inventory.
4. Meteorological data	4.1 Minimum data requirements	Acceptable.
	4.2 Siting and operating meteorological monitoring equipment	Acceptable.
	4.4 Preparation of Level 2 meteorological data	Acceptable.

Chapter of Approved Methods	Section of Approved Methods	Comments
5. Background air quality, terrain, sensitive receptors and building wake effects	5.1 Background air quality data	Acceptable.
	5.2 Terrain and sensitive receptors	Terrain – cannot verify - no information on terrain provided. Sensitive receptors – not acceptable – all sensitive receptors have not been identified. A small subset of sensitive receptors was included; however, the reason for selecting certain sensitive receptors and not others is unclear. Justification and appropriateness needs to be provided. As a minimum, the subset of sensitive receptors should be representative of potential air quality impacts at all existing and possible future locations of sensitive receptors.
6. Dispersion modelling	6.1 Dispersion models	Acceptable. Has used AERMOD.
7. Interpretation of dispersion modelling results	7.1.1 Impact assessment criteria	All acceptable except for NO_2. The EIS refers to an NO_2 criterion of 320 µg/m³, which is incorrect. The correct criterion for 1-hour average concentrations of NO_2 is 246 µg/m³ as specified in the Approved Methods.
	7.1.2 Application of impact assessment criteria	Construction – cannot verify odour – insufficient information has been provided to determine whether odour assessment criteria have been applied correctly. Other air pollutants - acceptable. Operations – cannot verify odour – insufficient information has been provided to determine whether odour assessment criteria have been applied correctly. Incorrect 1-hour average NO_2 criterion applied in places. Other air pollutants – acceptable.
	Summary of impacts	Construction – cannot verify - Inconsistencies with presentation of results and reporting of results. Operations – cannot verify - Inconsistencies with presentation of results and reporting of results.
8. Modelling pollutant transformations	8.1 NO_2 assessment	Acceptable.
	8.2 Detailed assessment of ozone and NO_2	Approach based on tiered assessment approach. Acceptable.
9. Impact assessment report	9.1 - 9.6	Not acceptable – the report includes many typographical errors and inconsistencies. The report requires a thorough editorial and technical review. Dispersion modelling inputs and outputs were not supplied.

3.1.2 Key assumptions

The air quality and greenhouse gas assessment for the Stage 1 Development was based on the key assumption that Stage 1 Development represented 10 million passengers and 63,302 Aircraft transport movements (ATM) for 2030. The Western Sydney EIS states that the capacity of the single runway is 37 million passengers and 185,000 ATM. Whilst it is stated that the capacity of the Stage 1 Development won't be reached until 2050, the ATMs are three times higher than those assessed for the Stage 1 Development. Therefore, the ATM assumption for Stage 1 is critical to the outcome of the assessments for local air quality, regional air quality and greenhouse gas.

- Other assumptions that will affect the emission rates of air pollutants are: specific aircraft fleet breakdown as detailed in Appendix C of Volume 4, Appendix F1, engine type and taxiing time. Details were not provided regarding the engine type(s) and taxiing time assumed in the assessment, therefore, the appropriateness of the assumptions could not be verified.

3.1.3 Construction

The review of the local air quality assessment for construction found the following:

- The emission rates associated with bulk earthworks, concrete batching and asphalt batching appeared reasonable; however, the emission rates were not able to be verified due to insufficient information provided in Volume 4 Appendix F1 of the EIS regarding construction activities and mitigation measures assumed.
- The emission rates associated with aviation infrastructure (Table 3-6 (Volume 4, Appendix F1) have been reported incorrectly as the total $PM_{2.5}$ emissions associated with aviation infrastructure are higher than those reported for PM_{10}. $PM_{2.5}$ is a subset of PM_{10} and therefore it is not possible for $PM_{2.5}$ emission rates to be higher than PM_{10} emission rates. It was not possible to verify whether the correct emission rates were used in the modelling as the modelling files were not available for review.
- The dispersion modelling results (shown in Tables 12-19 to 12-22 (Volume 2, Chapter 12) and Tables 7-1 to 7-4 and G1 to G4 (Volume 4, Appendix F1)) showed that construction of the aviation infrastructure will result in higher concentrations of PM_{10} and $PM_{2.5}$ than the bulk earthworks. This is inconsistent with the emissions inventories (shown in Table 3-6 (Volume 4, Appendix F1), that indicates that emissions of TSP and PM_{10} for the bulk earthworks are at least twice those for construction of the aviation infrastructure.
- The dust deposition results appear to be very low when compared to PM_{10} concentrations. The dust deposition rates appear to be 1000 times lower than what would be expected considering the PM_{10} concentrations.
- Inconsistencies in the air pollutant concentrations at sensitive receptors that are presented in tables (Table G1 to Table G5 (Volume 4, Appendix F1)) compared with the concentration that may be inferred by considering the relevant contour plots (Figure G1 to Figure G5 (Volume 4, Appendix F1)).
- The odour concentration is described in Table 12-23 (Volume 2 Chapter 12) and Table 7-5 and G5 (Volume 4, Appendix F1) as a 1-hour average concentration. The Approved Methods specifies impact assessment criteria for odour as "nose-response time" averages not 1-hour averages. Consequently, it is possible that odour levels have not been correctly assessed and may be much higher than presented.

3.1.4 Operations

The review of the local air quality for operations found:

- The emission rates due to operations were not able to be verified due to insufficient information provided in Volume 4 Appendix F1 of the EIS regarding assumptions relating to taxiing time, aircraft type and engines.
- The air quality assessment defined three types of receptors: residential receptors, on-site receptors and community receptors. Community receptors included various land-uses such as schools, parks, childcare facilities, churches and shopping centres. Whilst the technical air quality report (Volume 4 Appendix F1) presented air pollutant concentrations at each of the three receptor types, the Volume 2 air quality chapter focused on residential receptors and on-site receptors. The delineation between residential and community receptors is not supported by the Approved Methods, which defines a sensitive receptor as:

  > *A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area. An air quality impact assessment should also consider the location of known or likely future sensitive receptors.*

  Community receptors are therefore sensitive receptors, and as such should be assessed on the same basis as residential receptors. Therefore the Volume 2 air quality chapters should also present predicted concentrations at these community receptors. Concentrations at some of these community receptors were predicted to be higher than concentrations at residential receptors.
- The EIS refers variously to two impact assessment criteria for 1-hour concentrations of NO_2, namely: the *Airport Environment Protection Regulation 1997* criterion of 320 µg/m^3; and the Approved Methods' impact assessment criterion of 246 µg/m^3. Volume 2 Chapter 12 states that where there are multiple criteria the most stringent criterion has been used. However, it appears that the less stringent criterion of 320 µg/m^3 has been used. If the stricter impact assessment criterion were used, there would have been one exceedance of the impact assessment criterion instead of none.
- The odour concentration relating to aircraft exhaust is described in Table 12-35 (Volume 2, Chapter 12) and Tables 5-13 and F-8 (Volume 4, Appendix F1) as a 1-hour average concentration. The Approved Methods specifies impact assessment criteria for odour as "nose-response time" averages not 1-hour averages. Consequently, it is possible that odour levels have not been correctly assessed and may be much higher than presented.
- A number of errors within the report were identified. Examples of errors are provided in Table A1 and Table A2. A summary of errors are as follows:
  - Inconsistencies in emissions inventories presented in Volume 2 Chapter 12 and Volume 4 Appendix F1.
  - Inconsistencies in the air pollutant concentrations at sensitive receptors that are presented in tables compared with the concentration that may be inferred by considering the relevant contour plots (Volume 4, Appendix F1 (refer to Appendix A of this review report for details)).
  - Errors in the total emission rates due to airport and roadways presented in all tables.
  - A number of typographical errors in relation to presentation of results where incorrect pollutants or averaging periods were reported.
  - Incorrect units stated for result tables, resulting in concentrations being reported as 1000 times lower than actual.
  - Contour lines on the figures do not cover all identified receptors, indicating that some receptors may not have been included in the modelling.

Whilst many of these "errors" may be typographical, insufficient information was provided in the reports and, consequently, Katestone could not conduct cross-checking to determine their importance. For example, the dispersion model input files were not available for review and therefore it was not possible to verify the emissions, modelling or results.

3.1.5 Fuel dumping

The potential impacts due to fuel dumping were not quantified. The EIS stated "*fuel dumping is not considered likely to have a significant immediate or future impact on air quality*" due to "*the inability of many aircraft to perform dumps, the rapid vaporistation and wind dispersion of jettisoned fuel, the strict guidelines on fuel dumping altitudes and locations, and the anticipated reduction in fuel dumping events and volumes in the future*."

3.1.6 Mitigation and management measures

Recommended mitigation and management measures in the Western Sydney EIS included, but were not limited to:

- Construction
  - Development and implementation of stakeholder communications plan
  - Development and implementation of a dust management plan
  - Specific dust management, demolition, earthworks, construction and track out mitigation measures
- Operation
  - Development and implementation of an operational air quality and odour management plan as part of the operational plan for the proposed airport
  - Installation of an air quality monitoring station at the airport site to monitor NOx, NO, NO_2, CO, O_3, PM_{10}, $PM_{2.5}$ and VOCs
  - Consider best available techniques to reduce emissions of ozone precursors.

Whilst these mitigation and management measures should be part of conditions of approval for the project, the effectiveness of these measures to mitigate exceedances was not quantified.

3.2 Regional air quality

The regional air quality assessment (Volume 4, Appendix F2) methodology was based on the NSW EPA's Tiered Procedure for Estimating Ground-level Ozone Impacts from Stationary Sources (Environ, 2011). The EIS acknowledges that "*Stationary sources are defined as scheduled activities listed in Schedule 1 of the Protection of the Environment Operations (POEO) Act (1997) (NSW). The most significant sources at the proposed airport (e.g. aircraft in flight) would not be designated as scheduled activity under the POEO Act and, as such, the tiered procedure for ozone assessment is only applicable for minor emission sources such as boilers. Notwithstanding, the tiered procedure provides guidance on how ozone assessment should be conducted in NSW and there are aspects of the guidance that are relevant and applicable*."

Details of the method for the regional air quality assessment are summarised in Appendix A. Adoption of the NSW EPA's tiered assessment approach is appropriate for this project. The regional air quality technical report (Volume 4, Appendix F2) was well written and edited. It provided all the relevant information regarding how the regional air quality assessment was undertaken, with the exception of detailing how the airport sources were parameterised within the model.

The assessment showed:

- The change in daily maximum 1-hour ozone concentration from the addition of the airport was 1.1 ppb, which is marginally above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach
- The change in daily 4-hour average ozone concentration from the addition of the airport was 0.9 ppb, which is below the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach.

Mitigation measures that had a focus on reducing NOx emissions were also recommended for consideration.

Whilst the change in the daily maximum 1-hour ozone concentration was marginally higher that the 1 ppb defined in the EPA's tiered approach, the base concentration at the location of the incremental change was approximately 50 ppb (well below the EPA's impact assessment criterion of 100 ppb). The maximum 1-hour concentrations within the region were not predicted to increase as a result of the Stage 1 Development.

3.3 Greenhouse gas

Greenhouse gas emissions were quantified due to construction and operations. The report did not specify the emission factors that were used to quantify emissions; however, Katestone was able to produce similar emission estimates using the emission factors in the National Greenhouse and Energy Reporting Determinations with the exception of emissions associated with waste water treatment. It is possible that assumptions not documented have been included in the calculations emissions associated with waste water treatment. Overall, waste water treatment emissions were found to be a relatively small proportion of total greenhouse gas emissions.

Notwithstanding the above, the greenhouse gas assessment appears to have provided reliable estimates of greenhouse gas emissions from the Stage 1 development, as follows:

- *Direct (scope 1) and indirect (scope 2) GHG emissions from Stage 1 Development of the airport have been estimated to comprise 0.13 Mt CO2-e/annum, with the majority of emissions associated with purchased electricity. The Stage 1 Development Scope 1 and Scope 2 emission estimates represent approximately 0.11% of Australia's projected 2030 transport related GHG emission inventory. From this it can be concluded the GHG emission from the airport will not be material in terms of a national inventory, however a number of mitigation measures have been suggested.*

Measures to reduce or offset direct and indirect GHG emission from airport and aviation activities were listed. It is recommended that these be included in the conditions of approval.

3.4 Review of the conclusions of the Western Sydney Airport EIS

In relation to air quality and greenhouse gases the Western Sydney Airport EIS concluded:

- Air quality – local
  - *"Predicted dust impacts during construction would be below the air quality assessment criteria at all sensitive residential receptors. Odour from the asphalt plant is also predicted to be below the relevant criteria at all sensitive residential receptors*
  - *Operation of the proposed Stage 1 Development would result in an increase in emissions of NO_2, particulate matter (PM_{10} and $PM_{2.5}$), CO, SO_2 and air toxics. There would also be odour emissions from exhaust and from the on-site waste water treatment plant.*
  - *There were almost no predicted exceedances of the air quality assessment criteria at any of the sensitive residential receptors investigated as part of the assessment of the Stage 1 Development. The exception was the maximum (99.9^{th} percentile) 1-hour concentration of formaldehyde with an exceedance shown at on-site receptor.*

- *Predicted off-site odour concentrations were expected to be below odour detection limits for both aircraft exhaust emissions and odour from the on-site waste water treatment plant."*

- Air quality – regional
  - *"Only marginal ozone impacts would result from the operation of the Stage 1 development. These emissions would be managed using best available techniques and/or offsets."*
- Greenhouse gas
  - "*It can be concluded that the greenhouse gas emissions from the proposed airport would not be material in terms of a national inventory."*

3.5 Overall comments

The EIS conclusions presented for the greenhouse gas and regional air quality assessments are acceptable assuming that the emissions scenario of 63,302 ATM is appropriate.

The air quality study is contained in Volume 2 Chapter 12, Volume 3 Chapter 32 and Volume 4 Appendix F1 of the Western Sydney Airport EIS. Katestone has noted that these documents contain many typographical errors and inconsistencies that undermine the credibility of the air quality assessment. These sections require a thorough technical and editorial review by its authors to address the issues outlined in this review to improve transparency and credibility of the air quality assessment. To enable confidence in the assessment, all information and data used in the emission estimation, model inputs and outputs should be made available to any interested party. Based on these issues and those identified in Section 3.1 it is not possible to verify the conclusions of the EIS in relation to local air quality.

Setting aside the issues identified above, if the assessment results are taken as presented in Tables F1 to F8 and Table G1 to G5 (Volume 4, Appendix F1), they indicate the:

- Maximum 1-hour average concentration of NO_2 is predicted to exceed the EPA's impact assessment criterion of 246 µg/m^3 criterion at one sensitive receptor (Table F1, Volume 4 Appendix F1, Appendix F)
- Three other sensitive receptors have maximum 1-hour average concentrations of NO_2 that are predicted to be 92% to 98% of the EPA's impact assessment criterion.
- The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard.
- The 99.9th percentile 1-hour average concentration of formaldehyde was predicted to **exceed** the EPA's impact assessment criterion at two receptors.
- The predicted concentrations of all other air pollutants were below their respective assessment criteria.
- The major contributor to elevated levels of air pollutants is aircraft emissions. However, for receptors close to existing or new roads, the major contributor is external roadways.
- Mitigation measures were recommended. However, the effectiveness of the measures in achieving compliance was not quantified.

  With regards to the key assumption of the Stage 1 Development assessment, if the ATMs for Stage 1 Development are higher than 63,302 ATM there is a high probability that the assessment will result in additional exceedances of the EPA's impact assessment criterion for NO_2.

4. REVIEW FINDINGS – LONGER TERM DEVELOPMENT

4.1 Local air quality

4.1.1 Methodology

The methodology used for the Longer Term Development was the same as used for the Stage 1 assessment. It is relatively unusual for an air quality assessment to project potential impacts almost 50 years into the future. The assessment of major road projects is an area where similar projections are attempted, albeit over shorter time horizons of 20 or 30 years. In such instances, future projections are normally conducted by quantifying the change induced by the project over time and assuming the status quo or a reasonable foreseeable change for other key features. For example, it might be assumed that background air quality and impact assessment criteria would remain unchanged but that improvements in motor vehicle emissions would occur. There is no strict framework or guideline for assessing future impacts decades into the future.

The Longer Term Development has adopted an equivalent assessment framework to the Stage 1 assessment. No attempt has been made to project key variables except the increase in flights.

The comments presented in Section 3.1.1 regarding methodology are also relevant to peer review of the Longer Term Development.

4.1.2 Key assumptions

The air quality and greenhouse gas assessment for the Longer Term Development was based on the following key assumptions:

- Longer Term Development is based on 82 million passengers and 365,000 ATM
- There is no improvement in aircraft emissions
- A specific aircraft fleet breakdown as detailed in Appendix C of Volume 4, Appendix F1
- The air quality assessment criteria is unchanged
- Background air quality is unchanged from that derived from recent measurements; hence, there would be no change in the sources of air pollutants in the broader region nor their spatial distribution
- Projected increases in flights at the airport and traffic volumes on external major roads associated with the airport contribute to increased emissions
- No account was taken of the locations of possible future sensitive receptors
- A rail network that is yet to be planned or approved would be implemented to transport a significant proportion of airport passengers.

4.1.3 Construction

Construction emissions were not quantified for the Longer Term Development. The EIS stated that the activities will need to be well managed to satisfy airport safety requirements; however, the EIS did not demonstrate that impacts would be below the relevant air quality criteria.

4.1.4 Operations

The review of the local air quality for Longer Term Development operations found:

- The emission rates due to operations were not able to be verified due to insufficient information provided in Volume 4 Appendix F1 of the EIS regarding assumptions relating to taxiing time and aircraft type and engines.
- As with the Stage 1 Development, the air quality assessment defined three types of receptors: residential receptors, on-site receptors and community receptors. Community receptors included various land-uses such as schools, parks, childcare facilities, churches and shopping centres. Whilst the technical air quality report (Volume 4 Appendix F1) presented air pollutant concentrations at each of the three receptor types, the Volume 3 air quality chapter focused on residential receptors and on-site receptors. The delineation between residential and community receptors is not supported by the Approved Methods, as detailed above. Community receptors are also sensitive receptors under the Approved Methods and, as such, should be assessed on the same basis as residential receptors. Therefore the 3 air quality chapters should also present predicted concentrations at these community receptors. Concentrations at some of these community receptors were predicted to be higher than concentrations at residential receptors.
- The air pollutant levels predicted for the Longer Term Development are fundamentally reliant upon the development of a rail network to transport airport passengers to and from the airport. The rail network is not yet at the planning stage and there is no guarantee that the rail network will go ahead and, as a consequence, there is no guarantee that the predicted levels of air pollutants that are associated with traffic will be achieved in practice..
- A number of errors within the report were identified. Examples of errors are provided in Table A1 and Table A2. A summary of errors are as follows:
  - Inconsistencies in emissions inventories presented in Volume 3 Chapter 32 and Volume 4 Appendix F1. Inconsistencies in concentrations presented in tables compared with figures for various receptors.
  - Errors in the total emissions due to airport and roadways presented in all tables.
  - Contour lines on the figures illustrating predicted concentrations did not cover all receptors assessed, indicating that all receptors may not have been modelled.

Whilst many of these “errors” may be typographical, insufficient information was provided in the reports and, consequently, Katestone could not conduct cross-checking to determine their importance. For example, the dispersion model input files were not available for review and therefore it was not possible to verify the emissions, modelling or results.

4.1.5 Mitigation and management measures

A number of mitigation and management measures that could be considered in the future as the number of passengers using the airport increases were listed within the Western Sydney Airport EIS based on a literature review of emission mitigation measures adopted at various international airports. It was also acknowledged that some of the measures listed were up to the individual airline and out of control of the airport operator.

Notwithstanding the list of mitigation and management measures, the effectiveness of the measures was not quantified and therefore the air quality assessment failed to demonstrate that compliance with the relevant air quality criteria could be achieved.

4.2 Regional air quality

The regional air quality assessment for the Longer Term Development used the same methodology as for the Stage 1 Development.

The assessment showed:

- The change in daily maximum 1-hour ozone concentration from the addition of the airport was 4.5 ppb, which is significantly above the maximum allowable increment of 1 ppb defined in the EPA's Tiered approach
- The change in daily 4-hour average ozone concentration from the addition of the airport was 3.7 ppb, which is significantly above the maximum allowable increment of 1 ppb defined in the EPA's Tiered approach.

Mitigation measures that had a focus on reducing NOx emissions were recommended for consideration.

However, the regional air quality assessment for the Longer Term Development is hypothetical as:

- The potential impacts had to be assessed in context of the 2030 base case emissions as a base case inventory has not been projected for 2063
- Changes in emissions to other existing sources had not been accounted for
- Assumes that the rail network exists.

4.3 Review of the conclusions of the Western Sydney Airport EIS

In relation to air quality, the Western Sydney Airport EIS concluded:

- Air quality – local
    - *The results indicate that exceedances of the 1-hour average NO_2 criterion of 246 µg/m^3 maybe experienced at 11 residential receptors. These exceedances are predicted to occur for between one and four hours per year.*
    - *Under conservative assumptions there may be exceedances of the 1-hour AEPR objective of 320 µg/m^3 at up to seven residential receptors. These exceedances are predicted to occur for between one and two hours per year.*
    - *Predicted (cumulative) PM_{10} concentrations are anticipated to be above the NSW EPA impact assessment criterion of 50 µg/m^3 on occasion at one on-site receptor.*
    - *Predicted (cumulative) $PM_{2.5}$ concentrations are anticipated to be above NEPM advisory reporting goals at a number of receptors.*
- Air quality – regional
    - *The change in daily maximum 1-hour ozone concentration from the addition of the airport was 4.5 ppb which is significantly above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach*
    - *The change in daily 4-hour average ozone concentration from the addition of the airport was 3.7 ppb which is significantly above the maximum allowable increment of 1 ppb defined in the NSW EPA's tiered approach.*

4.4 Overall comments

If the assessment results are taken as presented in Tables F9 to F11 (Volume 4, Appendix F1), the air quality assessment of the Longer Term Development shows:

- The maximum 1-hour average concentration of NO_2 was predicted to exceed the EPA's impact assessment criterion of 246 µg/m^3 at 41 of the 96 receptors (Table F9, Volume 4 Appendix F1, Appendix F)
- The maximum 24-hour average PM_{10} concentration was predicted to exceed the EPA's impact assessment criterion at three receptors.
- The maximum 24-hour average concentrations of $PM_{2.5}$ were predicted to exceed the NEPM Advisory Reporting Standard at three receptors (Table F11, Volume 4 Appendix F1, Appendix F).
- The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. The annual average concentrations of $PM_{2.5}$ are exceeded at 13 receptors (concentrations are reported as 9 µg/m^3 or higher). A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard.

The Longer Term Development adopted the same air quality assessment framework as the Stage 1 Development. In particular, the assessment considered the existing air quality assessment criteria, background air quality derived from recent measurements and with no account taken of possible changes in the sources of air pollutants nor their spatial distribution over time. The assessment of the Longer Term Development indicates that concentrations will exceed the current air quality assessment criteria at existing sensitive receptors.

The most important issue with regards to the Longer Term Development is the assumption regarding the development of a new rail network. The Western Sydney Airport EIS states "*As it is not possible for the longer term development to achieve the project passenger numbers without the rail network the traffic scenario that does not include the rail network was disregarded.*"

Air quality associated with Stage 1 is critically dependent on the traffic volumes generated by the airport. Consequently, the impact on air quality due to the Longer Term Development is critically dependent on the existence of the assumed rail services to the airport. The Western Sydney Airport EIS is not seeking approval for the rail infrastructure that is necessary for its feasibility and the EIS does not contain a detailed proposal for the rail infrastructure. As a consequence, the air quality assessment of the Longer Term Development is speculative at best and does not provide a sufficiently robust basis to support approval of the Longer Term Development at this stage.

5. QUALIFICATIONS

This review has been undertaken by Simon Welchman, Natalie Shaw and Michael Burchill.

Simon is a Director at Katestone has a background of proven success over 20 years working as an environmental engineer in the private sector and for the environmental regulator. His expertise includes: air quality impact assessment of major industrial, infrastructure and mining projects; licensing, approvals and regulations; peer review and advice on air quality planning matters; odour impact assessment; greenhouse and air pollution control and management. Simon also provides expert witness services for matters relating to air quality and odour assessment in the Planning and Environment Court in Queensland and the Land and Environment Court in New South Wales. Most recently Katestone completed the air quality and greenhouse gas impact assessment for the Sunshine Coast Airport Expansion Project, for which Simon was the project director.

A summary of qualifications and role of each team member in project is provided in Table 2.

Table 2 Key personnel and project team

Name	Qualifications	Role on Project	Skills
Simon Welchman *Director*	BEng (Environmental) (Hons) 20+ years experience	Project Director	• Project direction and management • Expert advice on emissions regulation • Emissions benchmarking and assessment of best available control technologies • Air quality impact assessment studies of major industrial and infrastructure projects • Developing government policy for air quality and odour impact assessment • Developing environmental regulation • Air pollution emissions monitoring and ambient air quality monitoring
Natalie Shaw *Principal Air Quality Consultant*	BAppSc (Chemistry), MAppSc 15 years experience	Project Team	• Project management • Air quality modelling including TAPM, CALMET, CALPUFF, Ausplume, ISC3, CAL3QHCR, AERMOD • Photochemical modelling using TAPM-CTM • Air quality impact assessments for major industrial and infrastructure projects • Air pollution emission estimation • Assessment of site meteorology for industries including site specific meteorological data for inclusion in dispersion modelling • Air pollution emissions monitoring and ambient air quality monitoring
Dr Michael Burchill *Air Quality Consultant*	BAppSc (Physics)(Hons), PhD 4 years experience	Project Team	• Air quality modelling including TAPM, CALMET, CALPUFF, Ausplume, CAL3QHCR, AERMOD • Air quality impact assessments for major industrial and infrastructure projects • Air pollution emission estimation • Assessment of site meteorology for industries including site specific meteorological data for inclusion in dispersion modelling

APPENDIX A – DETAILED REVIEW

Table A1 Review of air quality assessment against Approved Methods

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		

3. Emissions inventory	3.1 Identify all sources of air pollution and potential emissions	Volume 2, Chapter 12
		- Section 12.3.2
		
		Volume 4, Appendix F1
		- Section 3.6
			Construction - acceptable
			• Construction impacts were quantified for Stage 1 Development. Construction impacts were not quantified for the Longer Term Development.
			• The following sources were included:
			  o Bulk earthworks including dozers, scrapers, loading and unloading material, hauling on paved and unpaved roads, wind erosion and grading
			  o Aviation infrastructure including working crew, asphalt plant and concrete batching plant
			• Potential emissions identified as TSP, PM_{10}, $PM_{2.5}$ and odour

		Volume 2, Chapter 12
		- Section 12.6.1
		
		Volume 4, Appendix F1
		- Section 3.1.2.3
		- Appendix C
			Operation – Stage 1 Development - acceptable
			• The following sources were included:
			  o Aircraft main engines, including approach mode, taxi/idle, take-off and climb-out mode
			  o Auxiliary power units (APUs)
			  o Ground support equipment (GSE) including but not limited to aircraft push back, mobile generators, tractors, powered passenger stairs, tractors, catering trucks, etc
			  o Parking facilities
			  o Stationary sources including boilers, engine tests, fuel tanks, generators, paints and solvents
			  o Training fires
			  o Terminal traffic
			  o Road traffic
			  o Waste water treatment plant
			
			• Potential emissions identified as NOx, SO_2, CO, VOCs, lead, PM_{10}, $PM_{2.5}$ and odour

		Volume 4, Appendix F1
		- Section 3.1.2.3
		- Appendix C
			Operation – Longer Term Development - acceptable
			• The following sources were included:
			  o Aircraft main engines, including approach mode, taxi/idle, take-off and climb-out mode
			  o Auxiliary power units (APUs)
			  o Ground support equipment (GSE) including but not limited to aircraft push back, mobile

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		
			generators, tractors, powered passenger stairs, tractors, catering trucks, etc ○ Parking facilities ○ Stationary sources including boilers, engine tests, fuel tanks, generators ○ Training fires ○ Terminal traffic ○ Road traffic • Potential emissions identified as NOx, SO_2, CO, VOCs, lead, PM_{10}, $PM_{2.5}$ and odour
	3.2 Determine source release parameters	Not provided.	**Construction – cannot verify** • No detail was provided in the report • Modelling files were not available for review
		Volume 4, Appendix F1 - Appendix C	**Operation – Stage 1 Development – cannot fully verify – some parameters acceptable but not all parameters provided** • Source characteristics were provided for parking facilities, boilers, generators, fuel tanks, surface coating/painting and training fires • There was no information on source release parameters for the aircraft main engines, auxiliary power units, terminal traffic or road traffic in the report • Emission concentrations limits for the boilers and generators were not specified. • Modelling files were not available for review
		Not provided.	**Operation – Longer Term Development – cannot verify** • No specific information was provided for the Longer Term Development scenario
	3.3 Estimate emission rates	Volume 4, Appendix F1 - Section 3.6	**Construction – cannot fully verify due to insufficient information** • Emission factors were stated to be based on local and US EPA factors which is acceptable, if the correct factors are used. However the specific references were not provided. • Emissions were estimated for construction in relation to the Stage 1 Development only. • There was no information on construction information used to calculate emission rates. For example quantity of material moved, stockpile areas, number of trucks etc • There was no information on control measures incorporated in the emission rate calculation. • The correct pollutants were included in the assessment (TSP, PM_{10}, $PM_{2.5}$ and odour)

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		

		Volume 4, Appendix F1 - Appendix C	**Operation – Stage 1 Development – cannot fully verify due to insufficient information**
			• Emissions were estimated using the Emissions and Dispersion modelling system (EDMS (v5.1.4)) for the airport related activities. EDMS is appropriate for this use.
			• Emissions were based on 10 million passengers and 63,302 aircraft movements
			• The correct pollutants were assessed (NOx, CO, PM_{10}, $PM_{2.5}$, SO_2, VOCs and odour)
			• Lead was deemed to not require assessment due to only 5% of planes having a pistol engine. However, it is recommended that the emission rates of lead be quantified and compared to the emissions for other pollutants.
			• There were a number of assumptions made regarding:
			  ○ Taxiing (a 50 / 50 split was assumed in each direction) The report states "It is acknowledged that in reality the runway combinations are a function of the prevailing weather conditions" and therefore operations may occur in a single combination for an extended period of time. Averaging operations may underestimate impacts under these circumstances, in particular for the shorter term averaging periods.
			  ○ Duration of taxiing was estimated; however, assumption was not specified
			  ○ Engine type; however, assumption was not specified
			• There was no detail provided as to the sensitivity to emissions based on the above assumptions

		Volume 4, Appendix F1 - Appendix C	• **Operation – Longer Term Development – cannot fully verify due to insufficient information**
			• Emissions were estimated using the Emissions and Dispersion modelling system (EDMS) for the airport related activities. EDMS is appropriate for this use.
			• Emissions were based on 82 million passengers and 369,952 aircraft movements
			• NOx, CO, PM_{10}, $PM_{2.5}$, SO_2 and, VOCs were correctly included in the assessment, as above lead should also have been considered.
			• .
			• There were a number of assumptions made regarding:
			  ○ Taxiing (a 50 / 50 split was assumed in each direction) The report states "It is acknowledged that in reality the runway combinations are a function of the prevailing weather conditions" and therefore operations may occur in a single combination for an extended period of time. Averaging operations may underestimate impacts under these circumstances, in particular for the shorter term averaging periods.
			  ○ Duration of taxiing was estimated; however, assumption was not specified
			  ○ Engine type; however, assumption was not specified

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		
			• There was no detail provided as to the sensitivity to emissions based on the above assumptions

	3.6 Presentation of emissions inventory	Volume 4, Appendix F1
		- Section 3.6.2
		- Section 3.6.3
		- Section 3.6.4
			Construction – cannot fully verify – errors in presentation of emissions inventory
			• Emission inventories for TSP, PM_{10} and $PM_{2.5}$ have been presented for:
			  ○ Bulk earthworks (Table 3-6)
			  ○ Aviation infrastructure works (Table 3-6)
			  ○ Concrete batching plant (Table 3-7)
			  ○ Asphalt batching plant (Table 3-8)
			• As there was insufficient information provided in the Volume 4, Appendix F1 the emissions were for bulk earthworks, aviation infrastructure works, concrete batching and asphalt batching were not able to be reproduced. Notwithstanding this:
			  ○ The emission inventory for bulk earthworks appears reasonable
			  ○ The emissions inventory for concrete batching plant appears reasonable
			  ○ The emissions inventory for asphalt batching plant appears reasonable
			  ○ As presented in Volume 4, Appendix F1, the emissions due to the construction of aviation infrastructure does not appear to be correct as the total emissions of $PM_{2.5}$ are higher than that for PM_{10}. As $PM_{2.5}$ is a subset of PM_{10} this is not correct. As the emissions spreadsheets and model inputs were not available for review it was not possible to determine whether this was a typographical error or an error in the assessment.

		Volume 2, Chapter 12
		- Section 12.6.1
		
		Volume 4, Appendix F1
		- Section 5.1.1
			Operation – Stage 1 Development – cannot verify – inconsistencies and errors in presentation of inventory
			• Emissions inventories for NOx, CO, PM_{10}, $PM_{2.5}$, SO_2 and VOCs are presented in both Volume 2, Chapter 12 and Volume 4, Appendix F1
			• The emission inventory (Table 12-24 in Volume 2 Chapter 12 and Table 5-1 in Volume 4 Appendix F1) appears to include typographical errors.
			  ○ The total including external roadways is different in the two tables; however, the tables are supposed to represent the same emissions
			  ○ Emissions from stationary sources should consist of the individual emissions from boilers, engine tests, fuel tanks, generators and paint solvents. However, in providing the total emissions from the airport, these stationary sources have been double counted in both tables. The percentage contribution of all of the individual sources is therefore also incorrect.
			  ○ The total (tonnes per year) for the airport is incorrect for all pollutants in both tables
			• Figures 12-6 and 12-7 (Volume 2 Chapter 12) and Figures 5-1 and Figure 5-2 (Volume 4 Appendix

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	**Section of Approved Methods**		
			F1) which reflect the emissions and percentages presented in the emission inventories are incorrect and should be updated. • The inventory (Table 5-1 Volume 4, Appendix F1) has a $PM_{2.5}/PM_{10}$ ratio of 0.43 for external roads. From the NSW Greater Metropolitan Region Inventory the $PM_{2.5}/PM_{10}$ ratio was 0.74. • As there was insufficient information provided in the Volume 4, Appendix F1 the emissions for Stage 1 Development were unable to be reproduced exactly. Whilst some pollutants for some sources were able to be replicated this could not be done for all pollutants and all sources.
		Volume 3, Chapter 32 - Section 32.4.1 Volume 4, Appendix F1 - Section 5.1.2	**Operation – Longer Term Development – cannot verify – inconsistencies and errors in presentation of emissions inventory** • Emissions inventories for NOx, CO, PM_{10}, $PM_{2.5}$, SO_2 and VOCs are presented in Table 32-1 in Volume 3 Chapter 32 and Table 5-3 in Volume 4 Appendix F) • These tables appear to include typographical errors. ○ Emissions from stationary sources should consist of the individual emissions from boilers, engine tests, fuel tanks, generators and paint solvents. However, in providing the total emissions from the airport, these stationary sources have been double counted in both tables. The percentage contribution of all of the individual sources is therefore also incorrect. ○ The total (tonnes per year) for the airport is incorrect for all pollutants in both tables • Figures 32-1 and 32-2 (Volume 3 Chapter 32) and Figures 5-4 and Figure 5-5 (Volume 4 Appendix F1) which reflect the emissions and percentages presented in the emission inventories do not match the data in the tables • As there was insufficient information provided in the Volume 4, Appendix F1 the emissions for Longer Term Development were unable to be reproduced exactly. Whilst some pollutants for some sources were able to be replicated this could not be done for all pollutants and all sources.
4. Meteorological data	4.1 Minimum data requirements	Volume 4, Appendix F1 - Section 4.1	**Acceptable** • Data from Bureau of Meteorology (BoM) Badgerys Creek site and Camden Airport site was used. • At least one year of data – this has been addressed adequately • At least 90% complete – this has been addressed adequately • Correlated against a longer-duration site-representative meteorological database of at least five *years* – this has been addressed adequately
	4.2 Siting and	Volume 4, Appendix F1	**Acceptable**

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	**Section of Approved Methods**		
	operating meteorological monitoring equipment	- Section 4.1	• It is stated in Section 4.1 that the Badgerys Creek site is compliant with the Australian Standards AS 2923-1987 Guide for Measurement of Horizontal Wind for Air Quality Applications.
	4.4 Preparation of Level 2 meteorological data	Volume 4, Appendix F1 - Appendix D Section D.1 .2	**Acceptable** • A meteorological file suitable for use in the dispersion model AERMOD was generated using USEPA approved meteorological pre-processor AIRMET to process the Badgerys Creek and Camden Airport data into suitable format for AERMOD.
5. Background air quality, terrain, sensitive receptors and building wake effects	5.1 Background air quality data	Volume 4, Appendix F1 - Section 4.2	**Acceptable** • Ambient monitoring data from the NSW Office of Environment (OEH) sites at Bringelly, Liverpool and Richmond has been used in the assessment. Data was used from the year 2014 to coincide with the meteorological year used in the assessments. It is noted that based on the ambient monitoring summary pollutant concentrations in particular NO_2, appear to be lower than other years. No commentary was provided for the decrease in NO_2 concentrations. This should be provided to provide some comfort that selection of another year would not result in exceedances for the 1-hour NO_2 concentrations. • Specific requirements of the Approved Methods are: ○ Obtain ambient monitoring data that includes at least one year of continuous measurements and is contemporaneous with the meteorological data used in the dispersion modelling – this has been adequately addressed. ○ At each receptor, add each individual dispersion model prediction to the corresponding measured background concentration (e.g. add the first hourly average dispersion model prediction to the first hourly average background concentration) to obtain hourly predictions of total impact - this has been adequately addressed. ○ At each receptor, determine the 100th percentile total impact for the relevant averaging - this has been adequately addressed.
	5.2 Terrain and sensitive receptors	Volume 4, Appendix F1 - Appendix E	**Terrain – cannot verify - no information on terrain provided.** • Sensitive receptors – not acceptable – all sensitive receptors have not been identified. A small subset of sensitive receptors was included; however, the reason for selecting certain sensitive receptors and not others is unclear. Justification and appropriateness needs to be provided. As a minimum, the subset of sensitive receptors should be representative of potential air quality impacts at all existing and possible future locations of sensitive receptors.
	5.3 Building wakes		• Building wakes have been stated to be included in the modelling. However, as no modelling files

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	**Section of Approved Methods**		
			were available for review these could not be verified.
6. Dispersion modelling	6.1 Dispersion models	Volume 2 Chapter 12 -Section 12.3 Volume 4 Appendix F1 - Appendix D	• The US EPA approved dispersion model AERMOD was used. Whilst the model is not specified within the Approved Methods, it is been accepted for use in Australia.

7. Interpretation of dispersion modelling results	7.1.1 Impact assessment criteria	Volume 2 Chapter 12
		
		Volume 4 Appendix F1
		- Section 2.2
		- Section 2.3
			• The following impact assessment criteria were used:
			  ○ Approved Methods
			  ○ *Airports (Environment Protection) Regulations 1997*
			  ○ *National Environment Protection (Air Toxics) Measure*
			• It is relevant to note that, in places, the EIS refers to an NO_2 criterion of 320 µg/m^3, which is incorrect. The correct criterion for 1-hour average concentrations of NO_2 is 246 µg/m^3 as specified in the Approved Methods.

	7.1.2 Application of impact assessment criteria	Volume 2 Chapter 12 - Section 12.5 -Section 12.6 Volume 3 Chapter 32 - Section 32.4.2 Volume 4 Appendix F1 - Section 5 - Section 7 - Appendix F - Appendix G	• Construction – cannot verify for odour – insufficient information has been provided to determine whether odour assessment criteria have been applied correctly. Other air pollutants - acceptable. • Operations – cannot verify for odour – insufficient information has been provided to determine whether odour assessment criteria have been applied correctly. Incorrect 1-hour average NO_2 criterion applied in places. Other air pollutants – acceptable.
	Summary of impacts	See below	• See results for Construction, Stage 1 Development and Longer Term Development below.

	Construction results	Volume 2 Chapter 12
		- Section 12. 5
		
		Volume 4 Appendix F1
		- Section 7
			• For bulk earthworks (as reported in EIS)
			  ○ Maximum 24-hour and annual concentrations of PM_{10} and $PM_{2.5}$ are well below the relevant air quality criteria
			  ○ Annual dust deposition rates are well below the criterion
			• For aviation infrastructure (as reported in EIS)

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		
		- Appendix G	○ Maximum 24-hour and annual concentrations of PM_{10} and $PM_{2.5}$ are well below the relevant air quality criteria ○ Annual dust deposition rates are well below the criterion • The results indicate that construction of the aviation infrastructure is likely to result in higher concentrations of particulate than the bulk earthworks associated with construction. This does not agree with the emissions inventory presented for both which indicates that emissions of TSP and PM_{10} for the bulk earthworks are at least twice those for aviation infrastructure. • The dust deposition results appear to be very low when compared to PM_{10} concentrations. The dust deposition rates appear to be 1000 times lower than what would be expected. • For asphalt batching plant (as reported in the EIS) ○ The odour concentration is below relevant odour criterion. • The odour concentration is presented as 99^{th} 1-hour concentration. The Approved Methods specifies impact assessment criteria for odour as “nose-response time” averages not 1-hour averages. • Both the concrete batching plant and asphalt plant emit dust. It is not clear whether the emissions of dust from these facilities are included in the bulk earthworks or aviation infrastructure results.
	Stage 1 Development	Volume 2 Chapter 12 - Section 12. 6 Volume 4 Appendix F1 - Section 5 - Appendix F	• For the Stage 1 development (as reported in the EIS) local air quality is as follows: ○ Maximum 1-hour and annual average concentrations of NO_2 are below the air quality assessment criteria at all residential receptors, with maximum 1-hour NO_2 predicted to be 60% and 70% of the AEPR criterion of 320 µg/m^3. (The EIS did not compare against the EPA criterion of 246 µg/m^3.) ○ Maximum 24-hour average and annual average concentrations of PM_{10} and $PM_{2.5}$ are below the assessment criteria at all residential receptors ○ Maximum 10-minute, 1-hour, 24-hour and annual average concentrations of SO_2 are well below the assessment criteria at all residential receptors ○ Concentrations of air toxics at residential receptors are well below the air quality assessment criteria for the 99.9^{th} percentile ○ The 99.9^{th} percentile 1-hour average concentration of formaldehyde is predicted to exceed the on-site receptor R24. ○ The predicted 99^{th} percentile odour concentration for aircraft exhaust is well below the criterion at all residential receptors. ○ The predicted 99^{th} percentile odour concentration for waste water treatment is well below the criterion at all residential receptors. • The summary of local air quality in Volume 2 Chapter 12 focused on the residential receptors.

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		
			However, there are 75 community receptors identified in Volume 4 Appendix F1. Taking into consideration these receptors and the most stringent air quality criteria, the review found the following: ○ Maximum 1-hour average concentration of NO_2 is above the EPA criterion of 246 µg/m^3 at one receptor (Table F1, Volume 4 Appendix F1, Appendix F) ○ Three other receptors have maximum 1-hour average concentrations of NO_2 that are 92% to 98% of the EPA criterion. ○ The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard. ○ The 99.9th percentile 1-hour average concentration of formaldehyde is predicted to exceed at two receptors ○ The predicted concentrations of all other air pollutants were below their respective assessment criteria.

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	**Section of Approved Methods**		
	Longer Term Development	Volume 3 Chapter 32 - Section 32.4 Volume 4 Appendix F1 - Section 5 - Appendix F	• For the Longer term development (as reported in the EIS) ○ Annual average concentrations of NO_2 are below the air quality assessment criteria at all residential receptors ○ Maximum 1-hour concentrations of NO_2 are predicted to exceed the AEPR criterion of 320 µg/m^3 at seven of the 20 receptors. (The EIS did not compare against the EPA criterion of 246 µg/m^3.) ○ Annual average concentrations of PM_{10} are below the assessment criteria at all residential receptors ○ Maximum 24-hour average concentrations of PM_{10} are below the criterion at all receptors with the exception of R24 (on-site receptor) ○ Maximum 24-hour and annual average concentrations of $PM_{2.5}$ will be above the relevant criteria for a number of receptors (one receptor for 24-hour average and four receptors for annual average). • The summary of local air quality in Volume 3 Chapter 32 focused on the residential receptors. However, there are over 100 community receptors identified in Volume 4 Appendix F1. Taking into consideration these receptors and the most stringent air quality criteria, the review found the following: ○ Maximum 1-hour average concentration of NO_2 is above the EPA criterion of 246 µg/m^3 at 41 of the 96 receptors (Table F9, Volume 4 Appendix F1, Appendix F) ○ The NO_2 criterion contour has not been added to Figure F55. This should be added to demonstrate the extent of the exceedance. ○ The maximum 24-hour average PM_{10} concentrations exceed the criterion at three receptors. ○ The PM_{10} criterion contour has not been added to Figure F61. This should be added to demonstrate the extent of the exceedance. ○ The maximum 24-hour average concentrations of $PM_{2.5}$ are exceeded at 3 receptors (Table F11, Volume 4 Appendix F1, Appendix F). ○ The annual average concentrations of $PM_{2.5}$ were rounded to one significant figure. The annual average concentrations of $PM_{2.5}$ are exceeded at 13 receptors (concentrations are reported as 9 µg/m^3 or higher). A number of receptors were predicted to have an annual concentration of $PM_{2.5}$ of 8 µg/m^3 – equal to the Air NEPM Advisory Reporting Standard. These results are potentially indicative of minor exceedances (<0.4 µg/m^3) of the Advisory Reporting Standard. (Table F11, Volume 4 Appendix F1, Appendix F).

Approved Methods		Section of EIS Addressed	Comment
Chapter of Approved Methods	Section of Approved Methods		
8. Modelling pollutant transformations	8.1 NO_2 assessment	Volume 4 Appendix F1	Acceptable.
	8.2 Detailed assessment of ozone and NO_2	Volume 4 Appendix F2	Approach based on tiered assessment approach. Acceptable.
9. Impact Assessment Report	9.1 – 9.6	Volume 4 Appendix F1	Not acceptable - the report includes many typographical errors and inconsistencies. The report requires a thorough editorial and technical review. Dispersion modelling inputs and outputs were not supplied.

Table A2 General comments relating to air quality sections of EIS

Section of EIS	Comment
Volume 2 Chapter 12	• Table 12-29 – Incorrect units presented for CO concentrations. Concentrations should read “mg/m^3” not “µg/m^3” • Table 12-34 – Incorrect pollutant names in header row of table. The columns should read Benzene, Toluene, Xylene not Toluene, Xylene and Formaldehyde
Volume 4 Appendix F1 - Section 3.1.2.3 - Appendix F1 Section C.4 - Appendix F1 Section C.5	• It is not clear what emission factors were used to determine emissions for parking facilities and road traffic ○ Section 3.1.2.3 states that “…roadways and parking emissions have been based on the Australian traffic emissions data developed by PIARC”. ○ Appendix F Section C.4 states “Emissions from a given car park were calculated in EDMS for vehicles moving and idling” ○ Appendix F Section C.5 states “emissions from road traffic were calculated using the emission factors developed by the EPA for the latest emissions inventory for the Greater Metropolitan Region (GMR).”

<table>
<tr><th>Section of EIS</th><th>Comment</th></tr>
<tr><td>Volume 4 Appendix F1

- Section 5.2</td><td>

Table 5-7 – Incorrect units presented for CO concentrations. Concentrations should read “mg/m^3” not “$\mu g/m^3$”
Table 5-10 – Table heading indicates the 99th percentile 1-hour average concentrations are presented. Should read 99.9th percentile.
Table 5-12 – Incorrect pollutant names in header row of table. The columns should read Benzene, Toluene, Xylene not Toluene, Xylene and Formaldehyde
Table 5-13 – Averaging period for odour is stated as 1-hour 99.9th. This should be 1-s nose-response-time average. Not clear whether typographical error or incorrect averaging period for concentrations.

</td></tr>
<tr><td>Volume 4 Appendix F1

- Section F1 Stage 1 Development</td><td>

Table F1 – Predicted NO_2 concentrations due to the airport in isolation are higher than predicted NO_2 concentrations due to cumulative assessment. Affected receptors are R59, R99, R124, R126, R127 and R138
Table F1 and Figure F1 – Inconsistencies between reported 1-hour concentration in the Table F1 and Figure F1. Examples are provided below.

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Cumulative 1-hour NO_2 ($\mu g/m^3$)</th></tr>
<tr><th>Table F1</th><th>Figure F1</th></tr>
<tr><td>R104</td><td>305</td><td>100</td></tr>
<tr><td>R118</td><td>241</td><td>Between 100 and 120</td></tr>
</table>

Figures F2 – F6, F8 – F12, F14 – F60, F62 – F66 and F68 have contours that do not cover the entire domain. This has resulted in lines disappearing. For some receptors it is difficult to compare concentrations presented in the Figures with the corresponding concentrations presented in the Tables. There are also inconsistencies between the concentrations in the tables and figures.
Table F4 and Figure 14 – Inconsistencies in predicted 1-hour CO concentration at R24 due to airport in isolation
Table F5-b and Figure F26 - Inconsistencies in predicted 1-hour SO_2 concentrations at some receptors due to cumulative impact. Examples are provided below.

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Cumulative 1-hour SO_2 ($\mu g/m^3$)</th></tr>
<tr><th>Table F5-b</th><th>Figure F26</th></tr>
<tr><td>R4</td><td>50</td><td>80</td></tr>
</table>
</td></tr>
</table>

Section of EIS	Comment
	<table><tr><td>R6</td><td>115</td><td>Between 60 and 80</td></tr><tr><td>R17</td><td>122</td><td>Between 60 and 80</td></tr><tr><td>R117</td><td>141</td><td>Between 100 and 120</td></tr></table> • Table F7-a – Incorrect pollutant names and NEPM-AAQ Investigation level in header row of table. • Table F7b – Incorrect NEPM-AAQ Investigation level in header row of table.
Volume 4 Appendix F1 - Appendix F	• Table F9 – incorrect averaging period in table header. Should read “1-hour” not "24-hour” • Figure F56 and Table F9 – Inconsistencies in 1-hour NO_2 concentrations in the table and figure • Figure F56 – Contour line displaying criterion is not presented on figure. This should be included as it would indicate areas where exceedance of the criterion is predicted for NO_2. • Figure F57 and Table F10 – Inconsistencies in 24-hour PM_{10} concentrations in the table and figure • Figure F61 - Contour line displaying criterion is not presented on figure. This should be included as it would indicate areas where exceedance of the criterion is predicted for PM_{10}.
Volume 4 Appendix F1 - Section G.1.2	• Table G2 – Typographical error regarding table description. Should read “Predicted cumulative results during bulk earth works” not “Predicted cumulative results during site preparation works” • Table G3 – Typographical error regarding averaging period in header row of table. Sixth column across should read “Annual” not “24-hour hour” for the pollutant $PM_{2.5}$. • Table G4 – Typographical error regarding averaging period in header row of table. Sixth column across should read “Annual” not “24-hour” for the pollutant $PM_{2.5}$. • Table G5 and Figure G17 - Inconsistencies in odour concentrations in the table and figure. Examples are provided below. <table><tr><th rowspan="2">Receptor</th><th colspan="2">99th percentile Odour (ou)</th></tr><tr><th>Table G5</th><th>Figure G17</th></tr><tr><td>R14</td><td>1.7</td><td>Between 0.02 and 0.04</td></tr><tr><td>R17</td><td>0.4</td><td>Between 0.02 and 0.04</td></tr><tr><td>R18</td><td>0.5</td><td>0.04</td></tr></table>

Section of EIS	Comment
	• Table G5 – Averaging period referred to as "1-hour". The odour criterion is a "nose-response" average. It is not clear whether the 1-hour concentrations have been converted to a "nose-response" average using the peak to mean ratios in the Approved Methods.

Table A3 Review of regional air quality assessment against NSW EPA's tiered assessment approach

Documentation required for NSW EPA's Tiered Ozone Assessments		Comment
Photochemical model used		• Comprehensive Air Quality Model with extensions (CAMx) used. This is acceptable
Chemical mechanism used		• CB05. This is acceptable.
Source of input data	• Emissions	• Acceptable • Scenarios – 2008/2009 base case, 2030 future base case, 2030 Airport case, 2063, Airport case • Base emissions used 2030 projected inventory for Greater Metropolitan Region (with the exception of biogenics • Biogenics derived using Model of Emissions of Gases and Aerosols from Nature (MEGAN) • Airport emissions for 2030 • Road emissions due to airport only (excluded existing as incorporated in base emissions)
	• Meteorology	• Acceptable • TAPM derived meteorology using OEH and BoM data for data assimilation. • TAPM configuration in accordance with recommendations in TAPM manual. Justification provided for deviation in nesting of grids ratio

Documentation required for NSW EPA's Tiered Ozone Assessments		Comment
		• Used November 2008 to February 2009
Source of input data	• Boundary conditions	• Acceptable • Obtained using global model MOZART
	• Modelling periods	• Acceptable • November 2008 to February 2009 for model validation • 12 case days for impact assessment
Procedures for evaluating base case model performance		• Acceptable
Sources of ambient data		• Acceptable • OEH data
Statistical evaluation methods		• Acceptable
Graphical evaluation methods		• Acceptable
Characteristics of new source	• Location	• Not provided
	• Stack parameters	•
	• Emissions rates	• Acceptable
	• VOC speciation	• Acceptable
Procedures for selecting days to evaluate ozone impacts		• Acceptable

Documentation required for NSW EPA's Tiered Ozone Assessments		Comment
Ozone increases from new source emission on evaluation days	• Results for 1-hour and 4-hour ozone	• Acceptable
	• Maximum ozone increases	• Acceptable
	• Base case ozone at location of maximum increase	• Not provided in tables; however, can see in figures provided.
Significance assessment of new source ozone increases against 1-hour and 4-hour average incremental ozone criterion		• Acceptable. • As the project is in a nonattainment area assessed against maximum increment of 1ppb
Ozone impact (increase plus background) due to new source emissions on evaluation day		• Acceptable
Significance assessment of new source ozone impact against 1-hour and 4-hour average Air NEPM ozone standards		• Acceptable

Appendix D

Traffic and Transport (ARUP)

WSROC and MACROC Councils

Western Sydney Airport EIS Peer Review

Peer Review: Traffic and Transport sections within the Western Sydney Airport EIS

Final | 20 November 2015

Job number 24624100

Arup
Arup Pty Ltd ABN 18 000 966 165

Arup
Level 10 201 Kent Street
PO Box 76 Millers Point
Sydney 2000
Australia
www.arup.com

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Document Verification

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Contents

1 Executive Summary

Background and Scope

Arup has been commission by WSP | Parsons Brinckerhoff on behalf of the Western Sydney Regional Organisation of Councils (WSROC) and Macarthur Regional Organisation of Councils (MACROC) to provide Peer Review Services of the traffic and transport sections of the draft environmental impact statement (EIS) for Western Sydney Airport.

The purpose this review was to inform these member authorities regarding the technical adequacy and completeness of this traffic and transport impact assessment. As such this peer review purpose is to present factual, unbiased information about the technical rigour of the study (both the positive and negative aspects contained within). All views expressed within the peer review will be substantiated with reference to information in the draft EIS or published elsewhere.

The peer review has been intended to assess the merits of the proposal as presented in the draft EIS – it has not been intended that the peer review will develop recommendations for alternative designs for the project.

The results of the peer review will be provided to the member authorities of WSROC and MACROC to assist them in making their submissions to the draft EIS.

In relation to Arup's comments regarding any short comings of this assessment, it should be noted that Arup has not been privy to any specific requirements above and beyond those described in the *Guidelines for the Content of a Draft Environmental Impact Assessment Statement, Western Sydney Airport, Environment Protection and Biodiversity Conservation Act, 1999.*

It is understood traffic and transport is likely one of the key environmental issues associated with the Airport. Arup has provided independent traffic and transport reviews relating to the adequacy of the documentation provided in and the appropriateness of the mitigation measures proposed in:

- *"WSA EIS 19 volume 2 chapter 15"*
- *"WSA EIS 39 volume 3 chapter 33"*
- *"WSA EIS GHD volume 4 appendix j surface transport and access"*

Stage 1 Airport

Issues identified in terms of predicted traffic impacts as a result of the Stage 1 airport include:

- Limitation of the strategic traffic model's (STM3) ability to capture traffic impacts at a detailed level
- Detailed intersection traffic modelling not undertaken

- Intersection operations and performance not assessed
- Future land take impacts as a result of intersection operations
- Freight traffic generation and associated impacts (outside of specific air cargo) not assessed
- Traffic generation and associated impacts caused by the zoned lands within the Airport precinct not assessed
- Impact to public transportation operations (bus network) not assessed

The above issues and limitations are considered significant. Further information would need to be provided to enable Arup to reach a firm opinion as to whether the conclusions reached in the study are valid. Until these comments are addressed or further information supplied, Arup is unable to comment on the validity of the traffic impact conclusions reached in this draft EIS.

Long Term Airport Development

The predicted traffic impacts of the long term development of the Western Sydney Airport largely followed the Stage 1 assessment. A number of the issues identified for Stage 1 are also apparent in the longer term development including:

- Limitation of the strategic traffic model's (STM3) ability to capture traffic impacts at a detailed level
- Detailed intersection traffic modelling not undertaken
- Intersection operations and performance not assessed
- Future land take impacts as a result of intersection operations
- Freight traffic generation and associated impacts (outside of specific air cargo) not assessed
- Traffic generation and associated impacts caused by the zoned lands within the Airport precinct not assessed
- Impact to public transportation operations (bus network) not assessed

Additionally, a number of issues identified in the longer term development (above and beyond Stage 1) include:

- The local road network adjacent to the Airport reaches capacity by 2063. No road planning mitigation measures were provided
- Airport Access Drive (from M12) reaches capacity by 2050, 13 years before long term development year of 2063. Capacity is predicted to be reached for approximately 15 hours a day.
- Insufficient information was provided to determine how air passenger demands would access and egress the Airport beyond 2050 (when the Airport Access Road reaches capacity)

- No assessment was included to understand what impact the air passenger demands using the SWRLe would have on the wider Sydney Rail Network.

Prior to the long term development of the airport being constructed, a major development plan (managed in accordance with the Commonwealth Airports Act 1996) will be required with final approval provided by the Minister of Infrastructure and Regional Development.

As such, Arup believes the above issues and limitations should be viewed in conjunction with this context

Key Impacts and Opportunities

The traffic impacts caused by Stage 1 of the Airport is predicted to be relatively low. With consideration to the methodology used, the draft EIS states the future road network is able to accommodate the predicted Airport traffic demand.

Nonetheless, it was difficult for Arup to confirm the validity of these impacts with confidence. Arup has identified further information that could be provided to quantify the potential impacts, including:

- Freight traffic generation within the Airport precinct (outside of air cargo)
- Private vehicle traffic generation from land uses within the Airport precinct (outside of air passengers)
- Vehicle travel time comparison (as predicted by strategic modelling)
- Intersection performance (as predicted by intersection modelling)
- Intersection layout requirements (as predicted by intersection modelling)

The following describes the predicted traffic impacts caused by the long term development of the Airport as described in the draft EIS:

- The traffic impacts caused by the Airport is predicted to be significant. The Airport Access Drive from the M12 is predicted to fail in 2050. This is approximately 13 years before the ultimate long term airport development year (2063).
- The traffic impacts also effect the wider road network with significant congestion predicted on key road links in 2063. The assessment acknowledges this is a result of significant background growth in conjunction with unknown road infrastructure commitments past 2041.
- The Airport also impacts wider transport modes. The assessment suggests additional rail link capacity (above and beyond the SWRLe) would be required to accommodate both the Airport trips and background growth trips by 2063.

With consideration to the above potential impacts, it is recommended that detailed transport network planning including road and rail network planning be undertaken.

2 Peer Review Methodology

2.1 Approach

Arup reviewed the traffic and transport assessment of the draft EIS of the proposed Western Sydney Airport with respect to its technical adequacy and completeness. The review considered relevant guidelines, requirements and legislation.

Specifically, Arup undertook the following tasks:

- Consider whether the traffic and transport study meet the requirements of the EPBC EIS Guidelines and relevant other guidelines and methodologies.
- Reviewed the validity of the draft EIS conclusions – i.e. an independent evaluation of whether the predicted impacts are in accordance with published standards and guidelines, and whether the conclusions of the assessment are likely to be a realistic reflection of the actual impacts.
- Evaluated the appropriateness of the underlying assumptions used to inform the assessment (including any construction or operational assumptions and modelling assumptions) are plausible.
- Reviewed the mitigation and management measures proposed and advised on their adequacy in mitigating impacts.
- Assessed the level of uncertainty over impacts and the environmental risks identified in the draft EIS.
- Reviewed the transport modelling and analysis presented in the report of the construction scenario and the Stage 1 and long term development scenarios for the Airport and assessed each models fitness to draw conclusions of the Airports impacts
- Provided a summary of the key impacts and opportunities associated with the projects traffic and transport impact assessment based on the information provided.

2.2 Limitations

The following details the limitations within Arup's peer review assessment:

- The peer reviews was based on the draft EIS reports provided, with no fieldwork undertaken or any direct communication with the specialists preparing the report, or regulators.
- No detailed model auditing was undertaken, Arup only provided comment on the modelling methodology and results presented in the draft EIS documentation
- Arup did not undertake any additional modelling or analysis to assess the adequacy of the modelling results provided

2.3 Draft EIS Sections Reviewed

Arup reviewed the following specific sections of the Environmental Impact Statement (EIS) for the proposed Western Sydney Airport, including:

- *"WSA EIS 19 volume 2 chapter 15"*
- *"WSA EIS 39 volume 3 chapter 33"*
- *"WSA EIS GHD volume 4 appendix j surface transport and access"*

3 Detailed Findings: Construction & Stage 1

The following details Arup's peer review of the construction and operational traffic impacts caused by Stage 1 of the proposed Western Sydney Airport.

3.1 Compliance of the report with the (EPBC Act) EIS Guidelines

The following describes Arup's consideration of the key Traffic and Transport sections of the Western Sydney Airport draft EIS compared to the requirements set out in the EPBC Guidelines.

a. The *EPBC guidelines, Section 5 Relevant Impacts* suggests that the EIS should assess *changes in traffic movements during construction and operation (associated with both passenger movements and workers)* where this assessment should *be prepared according to best practice guidelines and compared to best practice standards.*

The Sydney Strategic Travel Model (STM3) model has been used to forecast and assess the changes in traffic movements as a result of construction and operational traffic generated by the Airport. STM3 is the accepted travel demand forecasting tool for Greater Sydney Metropolitan Area (GMA) that is operated and maintained by the Bureau of Transport Statistics within Transport for New South Wales. STM's features include:

- Examining the effects of significant land use changes and significant transport initiatives which may include packages of road, rail and travel demand management measures
- Travel demand forecasts for the Greater Sydney Metropolitan Area by travel zone by mode choice and distribution.
- Private vehicle assignment on the strategic road network based on link based delay functions
- Transport mode choice and distribution for trips to/from the Airport. It therefore has additional rigour when conducting its vehicle assignment.
- When calibrated and validated, the STM3 is best suited to forecasting changes in demand or growth rather than absolute forecasts on a corridor.

With consideration of the above, the STM3 is likely to be a well suited model that is able to capture the effects of the Airport at a strategic level.

However, Arup also appreciates the strategic nature of the STM3 and the limitations inherent within the model, namely:

- The STM3 is a large area travel demand model that includes complex functions and interactions that approximate travel behavioural characteristics based on relatively large input dataset. The model therefore approximates travel patterns experienced in the real world.

- The STM3 contains road link geometry that is relatively simplified, using only link lengths and number of lanes as inputs. For example, turning bays at intersections are not specifically modelled.
- The STM3 models vehicle operations on the road links in a relatively simplified manner. Predicted traffic delays and congestion follow only basic 'volume to speed' relationships.
- Vehicle operations at intersections are not specifically modelled. For example, traffic delays and congestion caused by inefficient intersection geometry and/or inefficient signal phasing is not captured.

Furthermore, as disclosed in the draft EIS assessment, there is a risk that the STM3 is not effectively calibrated and validated for the purposes of this draft EIS. The assessment states "*STM3 models were provided by Transport for NSW for this task. The models are currently in development by Transport for NSW. However, due to the time constraints for the Western Sydney Airport EIS, GHD has used the latest available versions as the basis for the analysis in this study. GHD has not reviewed or corroborated the models provided beyond consistency checks of outputs*" (WSA EIS GHD volume 4 appendix j surface transport and access). This is a limitation of the draft EIS methodology and is considered a risk.

With consideration to both the STM's features and limitations listed above, Arup further acknowledges the industry standards that suggest strategic models like the STM3 be only applied for strategic purposes. It is generally accepted that strategic models can form strong baselines for transport impact assessments, but are not considered the best tool for detailed assessments. *(BTS Technical Documentation, February 2011)*

The BTS describes that "*For specific projects, the STM outputs should be used as a starting point to produce estimates of overall demand in response to alternative land use and/or transport supply scenarios. However, the STM, due to its limitations as a strategic modelling tool, may need to be supplemented with more detailed analyses for project evaluation purposes" (BTS InfoSheet, December 2013)*

Hence the STM analysis undertaken for the draft EIS would have captured the effects of changing traffic movements as a result of the Airport at a strategic rather than detailed level. STM, as a strategic travel demand model, does not include representation of intersections and would not provide confidence in traffic forecasts at a corridor level. This is why a model hierarchy exists in Sydney with STM providing strategic travel forecasts, and more detailed traffic and public transport patronage assessments being undertaken in the Roads and Maritime's traffic model and the BTS's PTPM model respectively. Furthermore, various project specific models can be developed on a project by project basis for detailed traffic analysis.

b. Section 5 of the *EPBC guidelines* , *Section 5 Relevant Impacts* suggests that the EIS should assess *changes in traffic movements during construction and operation (associated with both passenger movements and workers)* where this assessment should *be prepared according to best practice guidelines and compared to best practice standards.*

The draft EIS did not include intersection modelling to assess the Airports potential traffic impacts. This is a key limitation of the assessments methodology and is considered a significant risk.

Traffic intersection modelling could supplement the broad strategic baseline set by strategic traffic models, and further capture impacts on road networks at a detailed level. For example, unlike strategic traffic models, intersection traffic models can capture the relationship between intersection capacity and intersection lane geometry. Namely, they can be used to assess if additional land take would be required to widen intersections to allow for acceptable traffic operations. Hence, unlike strategic models, they can be used to capture the direct effects of traffic impacts on land acquisition. In relation to adhering to the EPBC requirements for 'best practice', Arup acknowledges the use of both strategic traffic modelling and intersection traffic modelling in other EIS submissions. The following large scale infrastructure projects in Sydney used detailed intersection traffic modelling coupled with strategic traffic modelling to capture future traffic impacts:

- Sydney Metro Northwest (North West Rail Link): Intersection modelling of construction and operational impacts
- WestConnex Stage 1a: Intersection modelling of construction and operational impacts
- WestConnex Stage 1b: Intersection modelling of construction and operational impacts
- NorthConnex (M1-M2 Link): Intersection modelling of construction and operational impacts

c. The *EPBC guidelines, Section 5 Relevant Impacts* suggests that the EIS should assess *changes in traffic movements during construction and operation (associated with both passenger movements and workers)* where the assessments should *be supported by maps, graphs and diagrams as appropriate to ensure information is readily understandable,* and where this assessment should *be prepared according to best practice guidelines and compared to best practice standards*.

The following tables and diagrams are contained within the assessment (but not limited to):

- Mid-block Volume/Capacity Diagrams (existing)
- Mid-block Level of Service Diagrams (existing)
- Mid-block Level of Service Tables (existing)
- Mid-block Volume/Capacity Diagrams (future)
- Mid-block Level of Service Diagrams (future)
- Mid-block Level of Service Tables (future)
- Mid-block Volume Difference Diagrams (future)

When considering Level of Service, Arup acknowledges that the worst Level of Sevice reported is F and also acknowledges that comparative distinctions can be made when Level of Service changes within the A to F spectrum. For example, '*as a result of the future traffic generated by the shopping centre, the existing road deteriorates in performance from Level of Service C to E*'.

However, when roads links already operate at Level of Service F the addition of traffic and associated impacts can be hidden within Level of Service results. For example *Level of Service F to F*. For this reason, a table of midblock volume to capacity values should be provided to gauge and quantify any potential traffic impacts caused above and beyond Level of Service F.

The draft EIS provided mid-block volume to capacity diagrams, but did not provide tables with explicit volume to capacity values. When comparing to other large scale infrastructure EIS assessment, Arup notes the provision of these values is generally accepted as industry best practice.

Vehicle travel time comparisons were not provided in this draft EIS assessment. These are important metrics that identify future congestion levels and accessibility to the airport. This is a limitation of the assessments methodology and is considered a risk. Arup notes that strategic modelled travel time comparison metrics were used in the WestConnex, NorthConnex and NWRL EIS assessments.

The STM3 could be used to predict vehicle travel times along road links 'with' and 'without the Airport' to further quantify the traffic impacts.

d. The *EPBC guidelines, Section 3 Feasible Alternatives* suggests the EIS should consider feasible alternatives, provide comparative analysis and commentary of the alternative, and also make clear which alternative is preferred.

Importantly, one such alternative could be the 'do nothing' alternative (i.e do not build the Airport). Arup acknowledges that the traffic and transport sections of this assessment did provide analysis and commentary pertaining to the 'do nothing' alternative. Through the use of the STM3 strategic model, this assessment provided commentary on performance of the road network 'with Airport' and 'without Airport (do nothing).

However, Arup also understands that the potential use of Wilton or the RAAF Base Richmond were also considered alternatives. The Traffic and Transport sections of this draft EIS did not provide analysis and commentary pertaining to either of these alternatives.

e. The *EPBC guidelines, Section 5 Relevant Impacts* suggests the EIS should identify and address the cumulative impacts of the project in addition to existing impacts of other activities. Critically, the impacts should include future developments from other proponents in the region or vicinity.

This assessment provided analysis and commentary pertaining to the existing impacts of other activities (including future developments) in the region or vicinity. As described, these future regional impacts will arise from key land use developments from the South West Growth Centre (SWGC), the Broader Western Sydney Employment Area (BWSEA) and the Greater Macarthur Land Release Area. The STM3 strategic model captured the combined effects of traffic generation from the proposed Airport land uses and also traffic generation of these future land uses in the in the region. Hence, through the use of the STM3, this assessment made commentary on the cumulative impacts of the Airport land uses above and beyond future non-airport land uses.

However, no commentary pertaining to future land use assumptions were provided. This assessment makes the following comment in relation to the traffic impacts of the Airport in 2031 "*the substantial package of road improvements proposed as part of the WSIP, in addition to those identified in the BWSEA and SWGC, would have sufficient capacity to cater for the expected airport passenger and employee traffic demand in 2031"*. As land use is one of the key underlying drivers of traffic generation, the explicit future land uses in the region should be provided. This would hence cater for improved comparisons between future land use traffic generation and future roadway capacity. To support this claim Section 5 of the EPBC guidelines suggests that the EIS should assess *changes in traffic movements during construction and operation (associated with both passenger movements and workers)* where *standards and guidelines used to quantify baselines and impacts should be explained or justified*. Arup believes the disclosure of the explicit land use assumptions of future land uses in the area is justified by the EPBC Act.

f. The *EPBC guidelines, Section 5 Relevant Impacts* suggests that the EIS should assess *changes in traffic movements during construction and operation (associated with both passenger movements and workers)* where this assessment should *be against appropriate background/baseline levels*.

As described in point (e) above, the draft EIS has captured effects of traffic generation from the future non-airport related land uses in the in the region and has therefore established and 'appropriate background/baseline level'. Nonetheless, this should be viewed in conjunction with lack of information provided on the specifics of these land use assumptions.

3.2 Commentary on validity of assumptions

The following describes Arup's consideration on the validity of the assumptions used in the Traffic and Transport sections of the Western Sydney Airport draft EIS.

3.2.1 Traffic Generation Assumptions

a. Non Direct Airport Related Traffic – As described in the methodology section of the Traffic and Transport assessment, trips originating in and destined for the Airport site were defined as

- Construction traffic
- Air passenger arrival and departing vehicle traffic
- Airport related employee traffic (only those who work directly for the Airport)
- Freight traffic (only those vehicles required to service the predicted tonnage of air cargo)

From above, the traffic impact assessment of Stage 1 only considered traffic generation from these 'direct airport-related trips'. Any traffic generation caused by other land uses (either by staff, businesses or general public) within the Airport site has not been presented in the draft EIS. As in, the assessment has not considered the impacts from non-directly related airport traffic, but traffic that would otherwise not be in existence without the Airport being constructed.

As described in section 2.3 of *Draft Airport Plan – Western Sydney Airport (October 2015)*, 229 hectares and 167 hectares would be zoned for 'Terminal and Support Services' and 'Business Development' respectively.

Section 2.4.2.2 states that 'Terminal and Support Services' would include "*Developments to facilitate the provision of goods and services necessary to meet the quality and standards that international, domestic and regional travellers have come to reasonably expect*" including, but not limited to the following uses:

- Business premises
- Markets
- Kiosks
- Freight handling and transport facility
- Hotel or motel accommodation
- Office premises

Section 2.4.2.5 states that 'Business Development' would "enable a mix of business, retail and industrial uses in locations that are close to and that support the functioning of the Airport" including, but not limited to the following uses:

- Business premises
- Retail premises
- Recreational facility
- Hotel or motel accommodation
- Freight handling and transport facility
- Warehouse and distribution centres
- Light Industry
- Office premises

The scale and function of the above land use developments could generate a significant cumulative amount of traffic. This draft EIS did not make any assumptions to account for this potential traffic and associated potential impacts.

Adjustments to the land use assumptions that inform STM and the use of traffic generation first principles or empirical benchmarking data (of other airports) could have been used to capture and assess this potential traffic impact.

b. Flight Related Traffic – Commentary on the validity of the assumptions used in the draft EIS are found in Section 2.2.2 Aviation Demand and Activity of the Arup document entitled "Western Sydney Airport EIS Peer Review - Aviation Planning and dated 6 November 2015":

With respect to passenger transfer reductions and in relation to traffic generation, it is noted the draft EIS did not account for the potential transfer of air passengers between flights. Namely, no assumptions were made pertaining to whether any passengers may arrive by one flight, transfer, and then depart on a subsequent flight. A behaviour sequence like this would result in the passenger not impacting on the landside road network.

This passenger transfer information would likely be available for other airports of similar size and type to the proposed Airport. Hence, Arup believes a benchmarking exercise could be undertaken that would result in an informed assumption of 'transfer of air passengers'. Arup understands that without such an assumption, all arriving airside passengers convert into landside trips. This represents a worst case scenario, but also an unlikely scenario.

c. Airport Related Staff Traffic – Arup acknowledges the level of detail and rigour used to predict the quantity and mode share of trips created by Airport staff. Considering that the Airport is in early stages of planning, Arup believes the assumptions used in these predictions are fit for purpose for the draft EIS assessment.

However, Arup does not agree with the validity of the assumption that states "*For each shift, 50 percent of employees have been assumed to arrive in the hour before their shifts starts…"* Arup believes it is unlikely that many staff members (if any) would arrive more than a full hour prior to their shift start. Nonetheless, Arup does not believe this assumption would significantly affect the outcomes of this assessment.

d. Air Freight Cargo Traffic – For commentary on the validity of the assumptions used to predict peak hour air freight cargo for the Airport are found in Section 2.2.2 Aviation Demand and Activity of the Arup document entitled "Western Sydney Airport EIS Peer Review - Aviation Planning and dated 6 November 2015".

Regarding the predicted vehicle trips generated by the air freight cargo only, Arup notes a discrepancy between the freight trips tabulated in Table 6-10 and the freight trips described in section 7.4 of *WSA EIS GHD volume 4 appendix j surface transport and access.* Table 6-10 indicates a total of 9 and 13 freight trips to/from the Airport in the 2 hours AM and PM peaks respectively. While section 7.4 describes a total of 3,966 freight trips to the Airport in the 2 hour AM peak and a total of 1,905 freight trips from the Airport in the 2 hour PM peak. It is unknown where this discrepancy has come from. It should be noted the 3,966 and 1,905 trip volumes seem to relate to the total traffic trips to/from the Airport shown in Table 6-10.

e. Public Transport Trip Generation –

Air Passenger Public Transportation Use

As described in Table 6-3 of '*WSA EIS GHD volume 4 appendix j surface transport and access'*, public transportation use (for air passenger trips) originating in and destined for the Airport in 2031 were assumed as:

- 5% Shuttle
- 5-10% Bus
- 0% Train

The draft EIS indicates the Sydney Airport Land Transport Model (SALTM) was used to predict the proportions of each transport mode used by air passengers to and from the Airport (no rail trips) in 2031. It appears that adjustments were made to these mode proportions to respond to the predicted capacity constraint of the Airport Access Drive. The approach in determining these adjustments is unclear.

However, the results shown in Figure 7-6 and 7-7 of '*WSA EIS GHD volume 4 appendix j surface transport and access'*, contradicts the suggestion that the Airport Access Drive forms a constraint in 2031. The figures show the Airport Access Drive is not coloured pink or red, and therefore operates below capacity in 2031.

It is hence unclear why road link capacity was used to adjust transport mode proportions.

The NSW Government is currently planning the SWRLe. At the time of the draft EIS publication, no commitment to its construction had been made. As a result, this draft EIS assumed no rail link would service the Airport by 2031. This lack of rail service is likely to generate higher dependency on private vehicle usage and possibly higher dependency on buses and shuttles. The draft EIS did not specifically assess any predicted impacts of future Airport bus servicing on the local bus network.

There is insufficient supporting information in the Draft EIS for Arup to comment on the methodology used to assess air passenger public transport use in 2031. Further modelling and benchmarking the public transportation use of the proposed Airport against other airports of comparative size and function should be considered.

Airport Employees Public Transportation Use

The draft EIS indicates the 2031 airport employee transport mode splits were determined using journey to work (JTW) data for the existing Kingsford Smith Airport.

As it was assumed that the airport in 2031 will not be serviced by rail, the rail trips found in the JTW were apportioned to the other modes. The draft EIS then compared these apportioned mode splits with JTW data for other employees in adjacent areas to the proposed Airport site (Liverpool, Penrith, Camden, Fairfield, Campbelltown, Blacktown and Holroyd).

The comparison suggested the JTW splits for the proposed Airport contained higher private vehicle usage than the JTW splits for the adjacent areas. Hence its use is considered conservative for the assessment of employee traffic impacts of the proposed airport in 2031.

3.2.2 Strategic Modelling Assumptions

To assess the changes in traffic movements as a result of construction and operational traffic of the proposed Airport, this assessment used the STM3 transport model. Arup believes the STM3 is likely to contain the most up to date assumptions and hence be well suited to capture the effects of the Airport at a *strategic level*.

However, the following lists those assumptions that may be considered invalid or lack supportive information:

a. Road Link Calibration and Validation – As stated in Appendix J of this draft EIS, at the time of the assessment, the STM3 models were currently in development by BTS. This assessment used the latest available version as the basis for the draft EIS assessment. No model calibration or validation statistics have been provided in this assessment, in particular for the existing major road links in the vicinity of the Airport site. Arup appreciates the calibration challenges of previous versions of the STM (STM and STM2). Poor calibration of existing road links in base models can generate large errors in the forecast performance of these road links in the future. Alternatively the previously calibrated STM2 could have been used as the strategic model for this assessment.

b. Model Road Toll Choice – The STM3 does not contain sophisticated toll choice functionality. Arup notes that other large scale infrastructure EIS assessments used a separate toll choice model to capture these effects with greater confidence. Westconnex 1a and 1b used "*…a toll choice model for assigning road traffic to toll routes through the application of a toll choice diversion model, known as a distributed value of time (VOT) multi-class equilibrium assignment model*" (Westconnex Stage 1B EIS). As stated in Appendix J of this draft EIS, the use of a two-stage process to assign vehicles to road links was used for the base year and future year road networks. The second stage used a toll-choice assignment to reflect those vehicle drivers who are willing to pay for tolls and those who are not. The methodology used to model toll choice was not disclosed in the draft EIS. This is a potent a risk as several major toll roads would provide access to the airport in the future including:

   - M4
   - WestConnex
   - M7

c. Base year selection – This draft EIS indicated that 2011 was modelled as the base year to represent existing conditions. Observed traffic data from 2011 was used to validate the model.

As stated in the assessment, the use of 2011 data does not include recent land use developments in the region. This includes vehicles trips that are generated by the BWSEA and SWGC today in 2015. As described in the assessment, some of the road links in the region have grown by up to 2.8% per year between 2008 and 2014.

Future years modelled in this assessment include the construction year (2021), Stage 1 operation (2031) and longer term airport development year (2063) are all forecast based on the 2011 base year calibration. There were no calibration and validation results provided in the draft EIS. Furthermore, as described by BTS "*there may be some variation between (existing) modelled results and on the ground results for the base year. For this reason the BTS recommends using STM growth factors applied to known base year numbers, rather than the directly predicted STM volumes*" *(*BTS Technical Documentation, February 2011*).* This suggests the importance of using correct 'known' base year data for all future forecast modelling.

d. Future year selection – The draft EIS identified that 2031 was selected as the year to represent Stage 1 Airport conditions.

As stated in the *Draft Airport Plan – Western Sydney Airport (October 2015),* the Plan's primary concern relates to '*the Stage 1 Development… (which) would cater for the predicted demand for the first five years of operation to around 2030'.*

It also identifies that any airport development beyond this time (including a rail link) will be '*staged in line with demand'* and that *'Developments after Stage 1 will be undertaken under the existing planning framework in Part 5 of the Act (Airports Act 1996*)*'.*

Arup understands the above to mean that prior to any long term development of the airport being constructed, a major development plan (managed in accordance with the Airports Act 1996) will be required with final approval provided by the Minister of Infrastructure and Regional Development.

Hence, the use of 2031 as the year that represents Stage 1 of the Airport is considered appropriate for this draft EIS.

e. Freight Traffic – The draft EIS considered future freight vehicle trips as a result of the Airport. However, Arup notes these generated vehicle trips are only related to the predicted tonnage of air cargo in 2031. It was identified this would equate to approximately 9 and 13 heavy vehicle trips to/from the Airport in the 2 hour AM and PM peaks respectively.

This heavy vehicle freight traffic is the only freight traffic predicted in this draft EIS assessment. No allowance, assumption or testing of any other freight traffic has been made in the assessment. Arup understands the proposed Airport is predicted to serve freight operations (24 hours per day) that would generate vast economic benefits to the region. The freight operations are predicted to unlock economic benefits of Western Sydney's growing population (SWGC) and growing economy (BWSEA). Considering this strategic objective, and also that this draft EIS assessment noted "*the analysis excludes the traffic to and from the proposed Airport generated by associated commercial development or freight traffic for consumables*", there may be insufficient assumptions being made regarding the likely freight traffic generation caused by the Airport.

Without a detailed terminal plan, it would be difficult to determine the heavy vehicle traffic required to service the Airport with full confidence. However, as stated in section 2.3 of the *Draft Airport Plan – Western Sydney Airport (October*

2015), provision for specific types and quantity of zoned areas within the Airport precinct is made. It also provides the potential uses within these zones. Hence, the lack assumption regarding wider freight traffic generation and subsequent lack of inclusion of such in this draft EIS is considered a risk.

It is not clear what assumptions were made regarding future freight movements in the strategic modelling undertaken as part of the draft EIS. The Freight Movement Model (FMM) has been used in other transport planning assessments. Like the (STM3), the FMM is government owned and operated (by BTS). It predicts freight movements by professional drivers that are not found explicitly in the STM.

It should be noted, the FMM contains the Kingsford Smith Airport (both domestic and international terminals) modelled and calibrated as a 'special generator'. *TDC Heavy Vehicle Forecasts - February 2010 Release.*

3.3 Discussion whether the conclusions reached in the studies are valid

With consideration to Arup's comments described in sections 3.1 and 3.2, Arup notes some limitations within the Traffic and Transport sections of this assessment, namely:

- Potential gaps in and/or potential lack of supportive information for:
    - Explicit future land use assumptions in the region of the Airport
    - Potential land use within the Airport precinct that has not been accounted for
    - Airport related freight generation (above and beyond air cargo tonnage)
- Methodologies that measure traffic impacts that may not be considered industry best practice, including:
    - Intersection modelling not undertaken
- Sections of analysis and commentary that may not be considered industry best practice, including:
    - Quantifiable values of road capacity (volume to capacity)
    - Vehicle travel time comparisons on major road links, 'with' and 'without' the Airport not provided
    - Intersection performance values, 'with' and 'without' the Airport, are not provided (intersection modelling not undertaken)
    - Intersection layouts (and subsequent potential land acquisition impacts) required to accommodate future Airport traffic are not provided or not described.

Based on our review, these limitations could be considered significant. Further information would need to be provided to enable Arup to reach a firm opinion as to whether the conclusions reached in the study are valid. Until these comments are addressed or further information supplied, Arup is unable to comment on the validity of the conclusions reached in this draft EIS.

3.4 Review of proposed mitigation and management measures

Regarding the traffic impacts caused by construction activities, industry standards and best practice allow EIS documents to refer to the requirement of a Construction Traffic Management Plan (CTMP) as part of a Construction Environment Management Plan (CEMP) to capture and mitigate specific construction disruptions to the community. This assessment nominates these requirements. Arup believes this approach is fit for purpose.

Regarding the traffic impacts caused by the operation of Stage 1 of the Airport, this assessment concluded that the Western Sydney Infrastructure Plan will provide sufficient road capacity that will accommodate airport related traffic. Nonetheless, this assessment also mentions that mitigation and management measures that will reduce any other impacts will be delivered via a Ground Transport Plan (as part of detailed design). Subject to the comments raised by Arup in the rest of this peer review, this approach could be considered in accordance with industry standards.

3.5 The level of uncertainty over impacts and the environmental risks

The following matrix tabulates what Arup believes to be the level of uncertainty to the traffic and transport impacts caused by the Airport.

Issue	Level of Uncertainty: Low	Medium	High	Unknown
Assumption gaps + Lack of supportive information				
Explicit future land use in region and subsequent traffic generation	X			
Potential land use within the Airport precinct subsequent traffic generation		X		
Freight generation (outside of air cargo)				X
Assessment Methodology				
Intersection performance				X
Analysis and Commentary				
Explicit volume to capacity ratios of midblock road links	X			
Vehicle travel time comparisons				X
Public transport operations				X
Intersection layout descriptions				X

4 Detailed Findings: Long Term development

Arup understands that the assessment of the long term development of the Western Sydney Airport should be viewed as 'preliminary consideration'. Prior to the long term development of the airport being constructed, a major development plan (managed in accordance with the Commonwealth Airports Act 1996) will be required with final approval provided by the Minister of Infrastructure and Regional Development.

4.1 Approach of Airport long term development assessment

The predicted traffic impacts of the long term development of the Western Sydney Airport largely followed the Stage 1 assessment, including:

- Similar Airport vehicle traffic generation
  - Air Passengers (private vehicles, taxis and buses)
  - Airport Employees (private vehicles, taxis and buses)
  - Air Cargo Tonnage (freight vehicles)
- Similar road network modelling assessment (traffic impacts)
  - Midblock capacity assessment (STM3)
- Similar presentation of analysis, results and commentary

However, the key difference between the Stage 1 and long term development assessment are:

- Road network configuration
  - Introduction of Castlereagh Highway connection to the M7
- Introduction of passenger rail link
  - South West Rail Link Extension (SWRLe)
  - North and south connection of the SWRLe to St Marys and Narellan respectively

4.2 Potential 'gaps' of long term development assessment relative to a conventional EIS assessment

When identifying the potential gaps in the long term airport development impact assessment, Arup broadly considered the following:

- Arup's comments regarding the limitations of the Stage 1 assessment described in sections 3.1 to 3.4,

- The long term development impact assessment largely follows the Stage 1 assessment
- Prior to the long term development of the airport being constructed, a major development plan (managed in accordance with the Commonwealth Airports Act 1996) will be required with final approval provided by the Minister of Infrastructure and Regional Development.

The following are specific gaps or areas of concern that Arup believes are related to the long term development impact assessment:

- The draft EIS states that the Airport Access Drive (from M12) is predicted to fail in 2050
    - Failure of the Airport Access Drive has been defined as when the midblock reaches LoS of D. This corresponds to a midblock capacity of 1,700 vehicles per hour per lane.
    - When considering the environment of an airport access road (multi decision points, merging and weaving effects, passenger drop offs effects), Arup notes the 1,700 vehicles per hour per lane capacity is likely to be overestimated. Nonetheless without a detailed layout plan of the internal road network, it is difficult to comment on the appropriateness or the likely effects of this capacity assumption.
    - Arup inferred (via the graphical results provided) the inbound or outbound vehicle movements on the Airport Access Road will be over capacity for 15 hours out of 24 hours per day
    - The road link capacity is reached approximately 13 years before the long term airport development impact assessment scenario year (2063)
- The Northern Road, M7, Elizabeth Drive, Mamre Road, Luddenham Drive reach capacity with the Airport in 2063. The assessment has not provided any strategic measures to mitigate these constraints.
- Passenger Rail Link Provision (SWRLe)
    - Insufficient information has been provided to determine how air passenger demand would access and egress the Airport beyond 2050 (when the Airport Access Road reaches capacity). The *WSA EIS GHD volume 4 appendix j surface transport and access* does identify:
        - "*…… that this forecast level (access road failure) is predicted to be achieved in based on current airport passenger volumes 2050 and investment in rail infrastructure would be required beyond this point… to enable the Airport to reach the desired 82 MAP*"
        - "*the modelling undertaken for the concept plan requires the capacity of the proposed access road network to be a*

constraint, the mode split proportions are required to be an input….(and) are shown in Table 9.3"

    - "*the mode split for car modes was modified down based on the capacity of a potential staff car park when the access road reaches its nominal capacity*"

  - Arup has hence inferred (from above) that a large proportion of air passenger and airport staff trips will be required to shift from vehicles to rail beyond 2050. However:

    - The STM3 does not account for rail capacity constraints Passengers are therefore not deterred from catching trains even if they are crowded

    - The graphs contained within the long term airport development assessment suggest train arrival and departure demands of approximately 2,000 trips per hour for many hours of the day. No information has been provided as to assess what impact this would have on the Sydney Rail Network.

    - STM3 modelling only considered the morning peak public transportation network only.

Arup understands the long term airport development assessment to be in a 'preliminary consideration' phase and may not require the level of detail of an EIS assessment. Hence the issues or 'gaps' noted above should be viewed in this context.

Arup recommends a future airport long term development assessment could be undertaken with additional rigour which could explicitly address the issues relating to detailed passenger rail planning and detailed road network planning.

4.3 Key risks and implications as a result of the gaps

As Arup understands the long term airport development assessment to be in a 'preliminary consideration' phase it may not require the level of detail of an EIS assessment. As a result, the implications of the aforementioned gaps are less severe. This is subject to a commencement of further investigations.

4.4 Effectiveness of the assessment in setting a framework for further assessment.

The assessment of the long term airport development impact has mentioned limitations within the methodology and/or limitations in available information required for the assessment. These are:

- Committed road network beyond 2041 (to 2063)
- Commitments to the nature of the SWRLe.

Arup hence believes the assessment has eluded to further studies that may be required to assess the long term airport development and hence has effectively provided some of the framework required for further assessment.

5 Summary of key impacts and opportunities

5.1 Construction

The following describes the predicted construction traffic impacts caused by the Airport as described in the draft EIS:

- The traffic impacts of construction of the Airport on the local road network is predicted to be relatively low. The proponent predicts the local road performance and operations 'with' and 'without' construction traffic to remain relatively stable.

With regard to above, it is difficult for Arup to confirm the validity of these impacts with confidence. Arup has identified further information that could be provided to quantify the potential impacts, including:

- Vehicle travel time comparison (as predicted by strategic modelling)
- Intersection performance (as predicted by intersection modelling)
- Intersection layout requirements (as predicted by intersection modelling)

5.2 Stage 1

The following describes the predicted traffic impacts caused by Stage 1 of the Airport as described in the draft EIS:

- The traffic impacts caused by Stage 1 of the Airport is predicted to be relatively low. The draft EIS states "*the substantial package of road improvements proposed as part of the WSIP, in addition to those identified in the BWSEA and SWGC, would have sufficient capacity to cater for the expected airport passenger and employee traffic demand in 2031*" (WSA EIS GHD volume 4 appendix j surface transport and access*)*. With consideration to the methodology used, the draft EIS states the future road network is able to accommodate the predicted Airport traffic demand.

With regard to above, it is difficult for Arup to confirm the validity of these impacts with confidence. Arup has identified further information that could be provided to quantify the potential impacts, including:

- Freight traffic generation within the Airport precinct (outside of air cargo)
- Private vehicle traffic generation from land uses within the Airport precinct (outside of air passengers)
- Vehicle travel time comparison (as predicted by strategic modelling)
- Intersection performance (as predicted by intersection modelling)
- Intersection layout requirements (as predicted by intersection modelling)

5.3 Long term Airport development

The following describes the predicted traffic impacts caused by the long term development of the Airport as described in the draft EIS:

- The traffic impacts caused by the Airport is predicted to be significant. The Airport Access Drive from the M12 is predicted to fail in 2050. This is approximately 13 years before the ultimate long term airport development year (2063).
- The traffic impacts also effect the wider road network with significant congestion predicted on key road links in 2063. The assessment acknowledges this is a result of significant background growth in conjunction with unknown road infrastructure commitments past 2041.
- The Airport also impacts wider transport modes. The assessment suggests additional rail link capacity (above and beyond the SWRLe) would be required to accommodate both the Airport trips and background growth trips by 2063.

For the purposes of the Peer Review, Arup was not privy to the specific requirements of the draft EIS. Arup recommends detailed transport network planning including road and rail network planning.

6 Peer Reviewers Qualifications

Sam Gray

Sam is a Senior Traffic Engineer based in Sydney with extensive experience in the development, design and management of transport planning and road design projects. Sam is a specialist in planning and operational assessments of road networks, motorways and public transportation.

Specifically, Sam has vast experience in the application of land used changes on motorway and surface road networks. His has expertise working with forecasting demands and operational flows to suitably assess road and motorway projects. His strategic and operational assessments include road construction staging, interim network staging and ultimate layouts. He completes design options analysis, traffic impacts and environmental impacts to validate a wide variety of projects.

Sam also understands the strategic elements of road planning and the relationship between modal shifts which is evidenced by his involvement on related projects that incorporate wider transportation solutions. His qualities and experience allow him to identify project hurdles early and he has shown that he can overcome these project hurdles by relaying the critical information pieces above and below first hand. This practise allows for quality decisions making across the project, manages expectations of possible project changes, and ultimately allows for timely delivery of quality project outcomes.

Project Experience

NorthConnex (M1-M2) EIS Approvals, Sydney

Mona Vale Road REF Traffic and Transport Study, Sydney

North West Rail Link EIS Approvals, Sydney

WestConnex Stage 3 Road Operations Assessment, Sydney

WestConnex Full Scheme Business Case, Sydney

WestConnex Alignment and Interchange Assessment, Sydney

Northern Beaches Hospital Road Network Assessment, Sydney

Old Wallgrove Road Upgrade Design Construction Staging, Sydney

Camden Valley Way Road Upgrade Design, Sydney

Edmondson Park Road Network Assessment, Sydney

Inner Newcastle Road Network Study and Concept Designs, Newcastle

Peter Dunn

Peter is a transport planner specialising in strategic transport planning, economic evaluation, demand forecasting, and design of transport infrastructure. He has extensive international experience in major transportation projects. As an Associate Principal, Peter is responsible for the project management of transport related work undertaken in Australia and New Zealand. Peter has a firm understanding of transport issues as they relate to the needs of different cities, through being responsible for significant transport planning studies in Australia, New Zealand, England, Ireland and Hong Kong. He is experienced in the application of analytical techniques to assess and provide solutions to complex transport issues. His design experience includes numerous road planning and intersection design studies.

Project Experience

Public Transport Project Model Audit, Sydney

NSW Long Term Transport Master Plan: Transport for New South Wales

Auckland Public Transport Model: Review of mode specific constant

Wellington Strategic Transport Model Peer Review, New Zealand.

AMETI Model Peer Review, Auckland New Zealand

Wellington Public Transport Model Review

Sydney Metro Demand Analysis Advisor, New South Wales

Sydenham to Bankstown Corridor Study

Central to Eveleigh Transport Study

Canberra Light Rail Master Plan

Andrew Hulse

Andrew is an Associate Principal in the Transport Planning division of Arup, Sydney. He provides transport planning advice and design input on a range of major development projects. Andrew has worked with Arup for 30 years in a number of the Arup Australian offices, in London for a two year secondment and Hong Kong and Singapore on specific projects.

He has particular skills in the areas of traffic management, bicycle planning, traffic calming, hospital parking demand and town centre traffic and parking design. Many of these projects have involved public consultation and Andrew has acted as an expert witness on a range of project types.

Andrew provides transport advice on multi-disciplinary projects working closely with planners and architects on projects such as CBD office developments, land rezoning studies and site master planning. He provides patronage assessment, interchange design and route assessment for public transport infrastructure projects, and undertakes traffic assessment for major road projects.

Project Experience

Melbourne Airport Southern Precinct Project

Brisbane Domestic Terminal (Precinct) Expansion Projects, QLD, Australia

Sydney Airport International Terminal, Ground Access Project

Newcastle Airport Car Park

Canberra Airport Master Plan

FIFA World Cup Transport Strategy

Sydney International Convention and Exhibition Centre Peer Review

Barangaroo Development

TfNSW Transport Access Program