Project: Greater Blue Mountains Aircraft Noise Monitoring
Reference F03800-17/46669

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EXECUTIVE SUMMARY

The planned Western Sydney Airport at Badgerys Creek could result in a significant increase in the number of aircraft movements over the Greater Blue Mountains World Heritage Area and Greater Blue Mountains National Park area (collectively referred to as the Greater Blue Mountains area herein).

Monitoring of existing aircraft noise levels has been conducted at two (2) locations within the Greater Blue Mountains area; Darling Causeway in the upper mountains and Glenbrook in the lower mountains areas. The purpose was to provide an indication of the baseline level of aircraft noise intrusion as a result of existing aircraft overflight associated with operations of Kingsford Smith Airport.

A literature review was conducted to identify noise metrics to reflect the type of noise impact that could occur as a result of aircraft overflight of quiet locations within the Greater Blue Mountains area. These metrics include methods for describing both the natural sound environment and the noise of aircraft overflight as follows:

- Background sound levels in the absence of aircraft operations;
- The number of audible aircraft overflight events;
- Maximum sound pressure levels of individual aircraft overflights; and
- Time-based metrics which provide an indication of the amount of time that aircraft noise is audible.

A summary of the findings is provided in Table 1.

Table 1: Summary of data

<table>
<thead>
<tr>
<th>Item</th>
<th>Darling Causeway</th>
<th>Glenbrook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background noise level</td>
<td>Day: 24 dB L_{A90}</td>
<td>Day: 24 dB L_{A90}</td>
</tr>
<tr>
<td></td>
<td>Evening: 22 dB L_{A90}</td>
<td>Evening: 19 dB L_{A90}</td>
</tr>
<tr>
<td></td>
<td>Night: 23 dB L_{A90}</td>
<td>Night: 18 dB L_{A90}</td>
</tr>
<tr>
<td>Number of audible aircraft events in a 24 hour period</td>
<td>Average 28 events</td>
<td>Average 79 events</td>
</tr>
<tr>
<td></td>
<td>Range 11 - 68 events</td>
<td>Range 42 - 115 events</td>
</tr>
<tr>
<td>Maximum sound pressure level per event</td>
<td>Average 46 dB L_{Amax}</td>
<td>Average 49 dB L_{Amax}</td>
</tr>
<tr>
<td></td>
<td>Range 35 – 73 dB L_{Amax}</td>
<td>Range 33 – 58 dB L_{Amax}</td>
</tr>
<tr>
<td>Time audible aircraft noise in a 24 hour period</td>
<td>Average 59.3 minutes</td>
<td>Average 145.9 minutes</td>
</tr>
<tr>
<td></td>
<td>Range 23.3 - 138 minutes</td>
<td>Range 74.3 – 214.1 minutes</td>
</tr>
<tr>
<td>Individual audible aircraft event duration</td>
<td>Average 2 minutes</td>
<td>Average 1.8 minutes</td>
</tr>
<tr>
<td></td>
<td>Range 1.2 – 3.5 minutes</td>
<td>Range 0.9 – 4 minutes</td>
</tr>
</tbody>
</table>

The data obtained as part of this study provides an example of the type of baseline information which may need to be obtained more broadly across the GBMWHA when evaluating future impacts associated with the planned Western Sydney Airport.

Importantly, determining these metrics over wide areas, for both existing and future aircraft operations, will involve modelling noise at low sound pressure levels that are below the validated range of practical noise modelling tools. Validation work is therefore recommended to improve the reliability of any predicted noise level data for this purpose.

Additionally, concurrent surveys of visitor/park user experiences and aircraft noise levels at key sensitive locations should be undertaken to enable a dose-response relationship to be developed, specific for the Blue Mountains. This would provide an objective reference for ongoing airspace management of the planned Western Sydney Airport.
# TABLE OF CONTENTS

1.0 INTRODUCTION........................................................................................................................................1  
2.0 MONITORING SURVEY ..................................................................................................................................2  
  2.1 Noise monitoring locations......................................................................................................................2  
  2.2 Equipment ................................................................................................................................................2  
  2.3 Methodology............................................................................................................................................3  
3.0 MONITORING RESULTS...............................................................................................................................4  
  3.1 Location 1 – Darling Causeway................................................................................................................5  
    3.1.1 Background sound level........................................................................................................................5  
    3.1.2 Number of aircraft events ....................................................................................................................5  
    3.1.3 Maximum noise levels ..........................................................................................................................5  
    3.1.4 Aircraft overflight duration...................................................................................................................6  
  3.2 Location 2 – Glenbrook............................................................................................................................7  
    3.2.1 Background sound level........................................................................................................................7  
    3.2.2 Number of aircraft events ....................................................................................................................7  
    3.2.3 Maximum noise levels ..........................................................................................................................7  
    3.2.4 Aircraft overflight duration...................................................................................................................8  
4.0 DISCUSSION ..............................................................................................................................................9  

APPENDIX A  GLOSSARY OF TERMINOLOGY  
APPENDIX B  NOISE MONITORING LOCATIONS
1.0 INTRODUCTION

The planned Western Sydney Airport at Badgerys Creek could result in a significant increase in the number of aircraft movements over the Greater Blue Mountains World Heritage Area and Greater Blue Mountains National Park (collectively referred to as the Greater Blue Mountains area herein).

The Blue Mountains City Council (Council) is concerned about the impacts associated with the location and operation of the Airport, including the potential for overflight noise to detrimentally affect the amenity of the Greater Blue Mountains area where quiet environments and natural soundscapes are highly valued.

Through a public consultation process, the Council are providing input into the airspace and flight path design for the Airport. This is being facilitated through the community and stakeholder reference group, Forum on Western Sydney Airport, established as part of the development approval conditions for the operation of the Airport.

A separate report\(^1\) was commissioned by the Council to develop evidence-based guidelines for the management of aircraft noise impacts within the GBMWHA and National Park to be used by the Council throughout the flight path design phase of the Airport. This report included a literature review of national and international practices and policies on the mitigation and management of aircraft overflight noise in natural areas. One of the findings of the literature review was a recommendation to undertake quantitative noise assessments when comparing and assessing alternative operating strategies. Importantly, these assessments should be carried out on the basis of noise metrics that are selected to reflect the type of impact that could occur as a result of aircraft overflight noise in quiet environments where natural soundscapes are highly valued.

This document presents the findings of a study commissioned by the Council to monitor existing aircraft noise levels at two (2) locations within the GMBWHA. The monitoring provides an example of the type of baseline information which may need to be obtained more broadly across the GBMWHA when evaluating alternative operating strategies and potential future impacts associated with the planned Western Sydney Airport.

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\(^1\) Marshall Day Acoustics report reference Rp 001 20170310 Guidelines for Minimising Aircraft Overflight Impacts dated 21 July 2017
2.0 MONITORING SURVEY

This section describes the following aspects of the noise survey:

- the noise monitoring locations
- the noise monitoring equipment
- the measurement and analysis methodology.

2.1 Noise monitoring locations

Noise monitoring was conducted at two (2) locations within the Greater Blue Mountains World Heritage Area (GBMWHA), agreed in conjunction with the Council.

The main selection criterion was to identify locations that are representative of quiet areas in the GBMWHA where aircraft noise intrusion may have the greatest impact on the natural soundscape. These locations included areas affected by current aircraft noise intrusion, associated with Kingsford Smith Airport operations, and areas, where there was potential to be further impacted by future aircraft noise intrusion, associated with the planned Western Sydney Airport.

MDA reviewed existing (with Kingsford Smith Airport) and potential future flight (Western Sydney Airport) paths, and preliminary monitoring locations were identified. These preliminary locations were subsequently reviewed by the Council and the monitoring locations selected. Consideration was also given to the following technical and logistical factors in the selection of the locations:

- Accessible remote telecommunication connectivity (3G coverage)
- Minimal influence from external noise sources (e.g. areas not located within close proximity to major road/transport routes)
- Representative of both the upper and lower mountain areas
- Located in the vicinity of readily accessible vehicle routes.

The locations are identified as follows and as described in Appendix B.

- Location 1 - Darling Causeway in the Upper Mountains area
- Location 2 - Glenbrook in the Lower Mountains area

2.2 Equipment

The survey was conducted between 29 June 2017 and 28 July 2017 at the two (2) locations, using unattended noise monitors. The equipment used during the survey is detailed in Table 2.

Table 2: Noise monitoring equipment

<table>
<thead>
<tr>
<th>Location</th>
<th>Noise Logger Details</th>
<th>Monitoring period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Make</td>
<td>Model</td>
</tr>
<tr>
<td>1 - Darling Causeway</td>
<td>01dB</td>
<td>Cube</td>
</tr>
<tr>
<td>2 - Glenbrook</td>
<td>01dB</td>
<td>DUO</td>
</tr>
</tbody>
</table>
2.3 Methodology

The objective of the survey was to identify and distinguish the noise of aircraft overflights from the underlying ambient noise environment. The survey therefore involved the collection of detailed measurement and audio records which could be analysed for this purpose. Specifically, the following information was obtained:

- Sound pressure levels were continuously sampled in 0.5 second intervals, including measurement of total A-weighted noise levels and frequency band levels for each sample
- Continuous audio recordings for the duration of the survey to enable listening checks where required.

Proprietary software, dBTrait, was used to code the survey data and identify individual overflights. Specifically, a set of criteria were used to automatically screen the measurement data and identify sound level characteristics which are typically associated with an aircraft overflight, such as the progressive rise and fall in sound pressure level as an aircraft moves toward and away from an observation point. These criteria were developed by reviewing audio records to identify periods in which an aircraft overflight could be confirmed, identifying key characteristics of the noise signature that could provide a basis for defining detection criteria, and then applying the detection criteria to the entire noise measurement data sets.

A select number of events which were identified through the application of the automated detection criteria were then checked by reviewing the audio files to confirm whether it was an aircraft event. These checks were then used to define filters for removing any measurement samples with sound characteristics that were similar to an aircraft overflight, but ultimately considered to have been unrelated to aircraft operations.
3.0 MONITORING RESULTS

The following section summarises the aircraft noise measurement data and derived metrics at each monitored location, including:

- The background sound level

  Information is provided as an L_{A90} value (noise level exceeded for 90 % of the measurement period to describe natural the sound environment. The literature review did not identify a specific methodology for representing background noise levels in areas of natural quiet or those affected by aircraft noise intrusion. In lieu of a specific method, and for consistency with NSW policies which consider background noise levels for other noise sources, day, evening and night periods have been determined in accordance with the New South Wales Noise Policy for Industry.

- The number of identified audible aircraft overflights per day

  Information is provided in terms of the upper, lower and average number of events identified in a 24-hour period. These events are further broken down into individual 1-hour periods.

- The average and range of maximum noise levels of individual aircraft overflights

  Maximum noise levels from aircraft overflights are inherently and significantly variable. This variability arises from a range of factors such as variations in aircraft operations (arrival v departure, flight profiles and tracks) and atmospheric conditions that influence sound propagation. Information is provided in a form that accounts for the range of variation of aircraft noise levels.

- The aircraft overflight duration

  Information is provided in terms of the upper, lower and average time that aircraft noise is most likely to be audible above background noise in a 24-hour period. These total periods, are further broken down into the average time that aircraft noise is audible in each individual 1-hour period. Defining the full extent of the duration that an aircraft event will be audible is dependent on a wide range of complex and variable factors, including background sound levels and individual hearing thresholds. For the purpose of defining periods in which aircraft noise levels are most likely to be audible, the aircraft overflight duration is defined as the period for which the noise of an identified aircraft overflight is 10 dB or more above the calculated day, evening and night background noise levels. In most instances, this approach is expected to provide a lower value for the duration that an aircraft overflight is audible. In practice, aircraft overflights are therefore likely to be audible for longer periods than determined by this analysis.
3.1 Location 1 – Darling Causeway

3.1.1 Background sound level

The background sound levels for the day, evening and night periods over the measurement survey are provided in Table 3.

**Table 3: Background sound level – Darling Causeway**

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>Background sound level, dB L_{A90}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>0700 h – 1800 h (Monday to Saturday)</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>0800 h – 1800 h (Sunday and public holidays)</td>
<td></td>
</tr>
<tr>
<td>Evening</td>
<td>1800 h – 2200 h</td>
<td>22</td>
</tr>
<tr>
<td>Night</td>
<td>2200 h – 0700 h (Monday to Saturday)</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>2200 h – 0800 h (Sunday and public holidays)</td>
<td></td>
</tr>
</tbody>
</table>

The results presented in Table 3 indicate very low background sound levels that are considered typical of quiet natural areas. The limited variation in noise levels between the day, evening and night period at this location also contrast with the diurnal variations in noise that are commonly associated with transport noise in urban areas.

3.1.2 Number of aircraft events

The average number of aircraft events in a 24 hours period was 28. This ranged between a low 11 events on Sunday 23 July 2017, and a maximum 68 events on Monday 17 July 2017.

Figure 1 shows the average number as well as the upper and lower number of events per individual 1-hour period over the duration of the monitoring survey. The peak hour is between 11am and 12pm, with an average 3 identified events and an upper value of 9 events.

**Figure 1: Number of Events per Hour of Day – Darling Causeway**

3.1.3 Maximum noise levels

Figure 2 details the number of identified audible aircraft events in different maximum noise level ranges.

The majority (more than 60 %) of measured aircraft events ranged between 35 dB L_{Amax} and 45 dB L_{Amax}. The average maximum noise level of each event was 46 dB L_{Amax} ranging between 35 dB L_{Amax} and 73 dB L_{Amax} per event.
For reference, review of the audio files of the high noise events (above \(60 \text{ dB L}_{\text{Amax}}\)), indicates the presence of an aircraft noise event, though the absolute maximum level measured is from an external source.

**Figure 2: Range of maximum noise levels – Darling Causeway**

3.1.4 Aircraft overflight duration

The average aircraft overflight duration was 2 minutes and ranged between 1.2 and 3.5 minutes. The average total time in a 24 hour period that aircraft overflight noise was most likely to be audible, was approximately 59 minutes, and ranged between 23 and 138 minutes total in a 24 hour period. Figure 3 shows the average time aircraft noise was audible in each 1 hour period.

**Figure 3: Average total aircraft overflight duration per Hour – Darling Causeway**
3.2 Location 2 – Glenbrook

3.2.1 Background sound level

The background sound levels for the day, evening and night periods over the measurement survey are provided in Table 4.

Table 4: Background sound level – Glenbrook

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>Background sound level, dB $L_{A90}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>0700 h – 1800 h (Monday to Saturday)</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>0800 h – 1800 h (Sunday and public holidays)</td>
<td></td>
</tr>
<tr>
<td>Evening</td>
<td>1800 h – 2200 h</td>
<td>19</td>
</tr>
<tr>
<td>Night</td>
<td>2200 h – 0700 h (Monday to Saturday)</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>2200 h – 0800 h (Sunday and public holidays)</td>
<td></td>
</tr>
</tbody>
</table>

The results presented in Table 4 indicate very low background sound levels that are considered typical of quiet natural areas. The lower noise levels measured during the evening and night period are comparable to the lowest levels that the instrumentation is able to measure, indicating actual background sound levels during the evening and night may be lower than indicated.

3.2.2 Number of aircraft events

The average number of aircraft events in a 24 hours period was 79. This ranged between a low 42 events on Friday 28 July 2017, and a maximum 115 events on Tuesday 11 July 2017.

Figure 4 shows the average number as well as the upper and lower number of events per individual 1 hour period over the duration of the monitoring survey. The peak hours of events was between 9am and 3pm.

Figure 4: Number of events per hour of day – Glenbrook

3.2.3 Maximum noise levels

Figure 5 details the number of identified audible aircraft events in different maximum noise level ranges.

The majority (more than 40 %) of measured aircraft events ranged between 40 dB $L_{A\text{max}}$ and 50 dB $L_{A\text{max}}$. The average maximum noise level of each event was 49 dB $L_{A\text{max}}$ ranging between 33 dB $L_{A\text{max}}$ and 58 dB $L_{A\text{max}}$ per event.
3.2.4 Aircraft overflight duration

The average aircraft overflight duration was 110 seconds (1.8 minutes) and ranged between 56 seconds and 240 seconds (4 minutes).

The average total time in a 24 hour period that aircraft overflight noise was most likely to be audible was 146 minutes, and ranged between 74 and 214 minutes total in a 24 hour period.

Figure 6 shows the average aircraft overflight duration in each 1 hour period.

Figure 6: Average aircraft overflight duration per hour – Glenbrook
4.0 DISCUSSION

The findings of the survey demonstrated that the noise of existing aircraft overflights over the Greater Blue Mountains area can be readily distinguished in the noise measurement data and is clearly distinguishable in the corresponding audio records.

Importantly, as a result of aircraft noise at low noise levels being dominated by low frequencies, in combination with the extended duration of audibility in low background noise environments, aircraft overflight noise is relatively prominent, and potentially intrusive, even at relatively low levels when compared to the types of noise levels encountered in urban environments (as opposed to quiet park areas). In particular, prominent and intrusive aircraft overflight noise was found to occur at levels significantly below the 55 dB $L_{A_{max}}$ value referenced in the impact assessment for the planned Western Sydney Airport. The rationale for the approach presented in the impact assessment was based on comparing overflight maximum sound levels with the maximum levels of natural sounds in the environment. However, the findings of this survey are consistent with Commonwealth guidelines which state that aircraft noise levels should not be assessed by comparisons with other ambient noise sources. This is particularly relevant in areas of the Blue Mountains areas where these predominant noise sources are of natural origin (e.g. birds and other wildlife).

The current level of aircraft overflight noise in the Greater Blue Mountains area, predominantly as a result of operations associated with Kingsford Smith Airport, results in large periods of respite between audible overflight events. During peak periods however, sequential aircraft movements can significantly reduce the amount of time between consecutive overflights in which the sound environment is free of aircraft noise. This is a particularly important consideration to be addressed as part of the planned Western Sydney Airport airspace design. Specifically, with the increase of operations, the ‘current’ peak periods of aircraft noise intrusion could become more prevalent, i.e. planned future operations could result in a significant decrease in the time periods in which the soundscape is unaffected by aircraft noise intrusion. Locations within the Greater Blue Mountains area currently subjected to low aircraft noise intrusion, could therefore also have an increase in overflights and hence reduced time between audible events with the planned Western Sydney Airport operations.
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.

**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.

**Frequency**
Sound can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. Sound is generally described over the frequency range from 63Hz to 4000Hz (4kHz). This is roughly equal to the range of frequencies on a piano.

**Hertz (Hz)**
Hertz is the unit of frequency. One hertz is one cycle per second. One thousand hertz is a kilohertz (kHz).

**L_{A90}**
The noise level exceeded for 90% of the measurement period, measured in dB. This is commonly referred to as the background noise level.

**L_{Aeq}**
The 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.
Location 1 – Darling Causeway