MARSHALL DAY Acoustics

WELLINGTON INTERNATIONAL AIRPORT
DMAPS MONITORING REPORT

Rp 001 20220295 | 21 December 2023

84 Symonds Street
PO Box 5811
Victoria Street West
Auckland 1142 New Zealand
T: +64 9 379 7822 F: +64 9 309 3540
www.marshallday.com

Project: **WELLINGTON INTERNATIONAL AIRPORT DMAPS NOISE MONITORING**

Prepared for: **Wellington International Airport Limited**
PO Box 14175
Kilbirnie

Wellington 6241

Attention: **Wellington Airport Planning Manager**

Report No.: **Rp 001 20220295**

Document control

Status:	Rev:	Comments	Date:	Author:	Reviewer:
Draft			18 Dec 2023	L Smith	
Draft	01		19 Dec 2023	L Smith	S Peakall
Issued	02		21 Dec 2023	L Smith	S Peakall

Cover Photo: Robert de Bock

Contents

1.0 INTRODUCTION

This report summarises the results and findings from a three-month noise monitoring study, undertaken by Wellington International Airport Limited (WIAL) to measure aircraft noise levels in four suburbs affected by flight path changes implemented on 1 December 2022 (referred to as DMAPS flight paths). The four suburbs, referred to as the 'northern suburbs', are Ngaio, Broadmeadows, Khandallah and Johnsonville. The DMAPS flight path changes investigated in this report apply to departures taking-off towards the north using runway 34. The changes are described further in Section 2.0 of this report.

Four noise monitors were deployed by WIAL to measure noise levels from September to December 2023. The four noise monitors are located at residential addresses in the locations listed in Table 1 and shown in Figure 1. Prior to this, a single noise monitor was deployed in Homebush Road Khandallah to measure noise levels between 28 October 2022 and 1 June 2023. The results from the Homebush Road monitor are detailed in a Marshall Day memo dated 11 July 2023. Some data from the Homebush Road monitor is included in this report for reference.

Table 1: Northern suburbs monitor locations

Monitor Number	Street	Suburb	Date Deployed
200	Heke Street	Ngaio	27 September 2023
201	Rajkot Terrace	Broadmeadows	5 September 2023
202	Maldive Street	Khandallah	5 September 2023
203	Elliot Street	Johnsonville	31 August 2023
105	Homebush Road	Khandallah	28 October 2022

The noise loggers were linked to WIAL's ANOMS[1] software and public Webtrak website. We have analysed noise and aircraft operations data from the ANOMS software to prepare the results presented in this report. We have assessed the following for each of the four monitors:

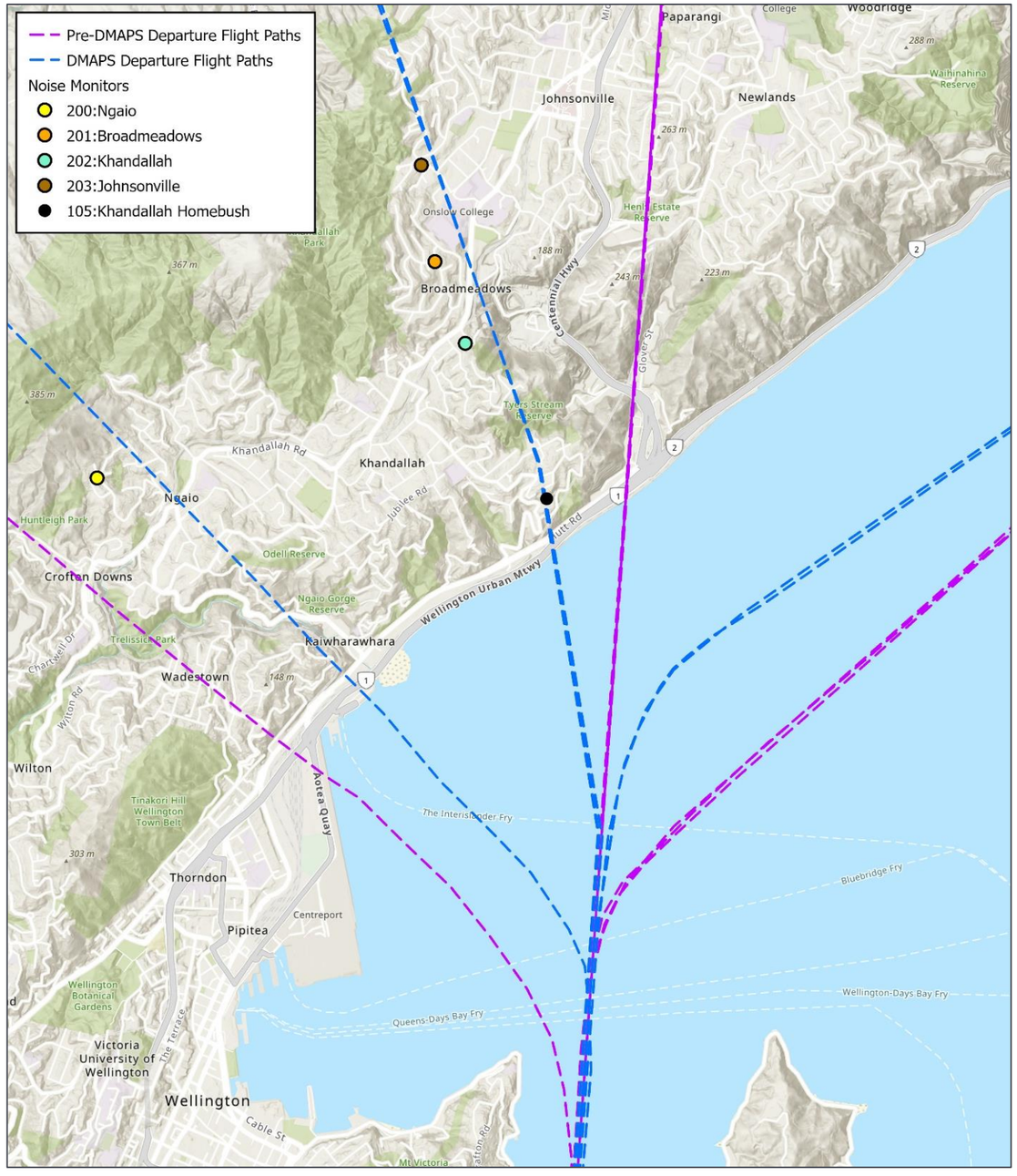
- Quantified the change in number of overflights experienced since the introduction of DMAPS;
- A summary of the aircraft noise environment with DMAPS;
- A statistical summary of jet departure single event maximum noise levels with DMAPS;
- An estimate of the change in single event maximum noise levels for jet departures due to DMAPS.

2.0 FLIGHT PATH CHANGES AFFECTING THE NORTHERN SUBURBS

On 1 December 2022, flight path changes referred to as DMAPS (Divergent Missed Approaches Protection Systems), were implemented at Wellington Airport. The changes relevant to this report involve the introduction of several new departure flight paths for aircraft taking-off on runway 34 (i.e. in a northly direction) and removal of the previous published flight paths for these aircraft.

Previously the published flight paths on runway 34 for jet aircraft heading to domestic and Trans-Tasman destinations tracked directly north over eastern Johnsonville and Newlands areas. The new DMAPS flight paths turn to the north-west over the harbour, and then overfly Khandallah and Broadmeadows. Figure 1 illustrates the change in flight paths and the locations of the four temporary noise monitors. The other flight paths shown in Figure 2 are for turbo-prop aircraft departures. The monitor in Ngaio is well situated for the western turbo-prop flight track however our analysis of the measurement data revealed the number of turbo-prop events has not changed with DMAPS and this monitor mostly recorded domestic jets heading to southern destinations that had diverted off the published flight tracks. Hence this report does not provide a separate analysis of turbo-prop noise levels.

Figure 1: Flight path changes relative to noise monitor locations



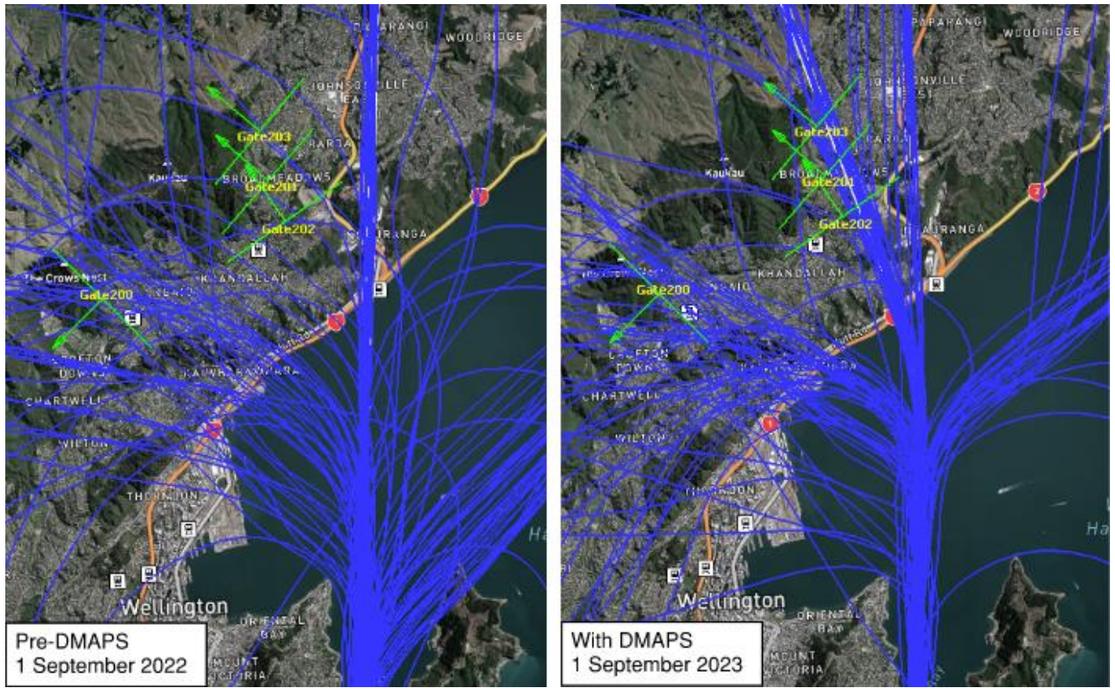
[1] Airport Noise and Operations Monitoring System

3.0 AIRCRAFT MOVEMENTS OVER NORTHERN SUBURBS

Although the published flight paths appear as single lines on the map in Figure 1, in practice aircraft do not fly consistently along these lines. Radar data shows that aircraft fly on a wide spread of flight paths but with a greater concentration near the published route. Sometimes departing aircraft divert from the published flight track when air traffic control permits, to take a more direct route to their destination. Figure 2 shows 24 hours of flight track data from 2022 before DMAPS was implemented compared with a day in 2023 with the DMAPS flight paths.

The noise monitors are located where the yellow gate labels are shown on the map. We have defined the green gates that span 1.5km either side of the monitors for our analysis of overflights presented in this section.

Figure 2: Flown flight tracks for a representative day pre-DMAPS and with DMAPS (northerly wind)



In the case of runway 34 departures at Wellington Airport, the radar data shows that prior to DMAPS the northern suburbs experienced some overflights from aircraft that had diverted off the published flight paths. With DMAPS implemented, more aircraft overfly these areas than previously with a concentration near the published DMAPS flight path.

To quantify this change, we have analysed six months of pre and post DMAPS radar data. We have calculated the average number of jet departures passing through the gate for each monitor shown in Figure 2 for each six-month period. The data from each period has been normalised to reflect the average runway utilisation statistics (60% runway 34 and 40% runway 16) to enable an equivalent comparison.

The results are summarised in Table 2. We understand from WIAL, that public feedback indicates an increase in departures experienced between 6 and 7am is the most noticeable and disruptive change for residents near the new DMAPS flight path. As such, Table 2 also quantifies the change in number of overflights in the 6 – 7 am period.

Table 2: Average number of jet departure overflights per day

	All departure overflights		6 – 7am departure overflights	
Monitor Location	Pre-DMAPS	With DMAPS	Pre-DMAPS	With DMAPS
200 Ngaio	1.4	2.1	<0.0	0.1
201 Broadmeadows	1.5	14.6	0.2	1.7
202 Khandallah	1.6	16.4	0.2	1.9
203 Johnsonville	1.4	13.0	0.3	1.4

The average daily number of events in Table 2 is the average over all days, including days where runway 16 is in use and aircraft do not take-off towards the north. In practice, when runway 16 is in use, there are no departure overflights, and when runway 34 is in use, there are more departure overflights than listed in Table 2. Therefore, the numbers in Table 2 represent the number of departure overflights experienced if they occurred on a daily basis.

The data shows there has been an appreciable increase in departure overflights for northern suburbs under the new DMAPS flight paths.

4.0 AIRCRAFT NOISE METRICS

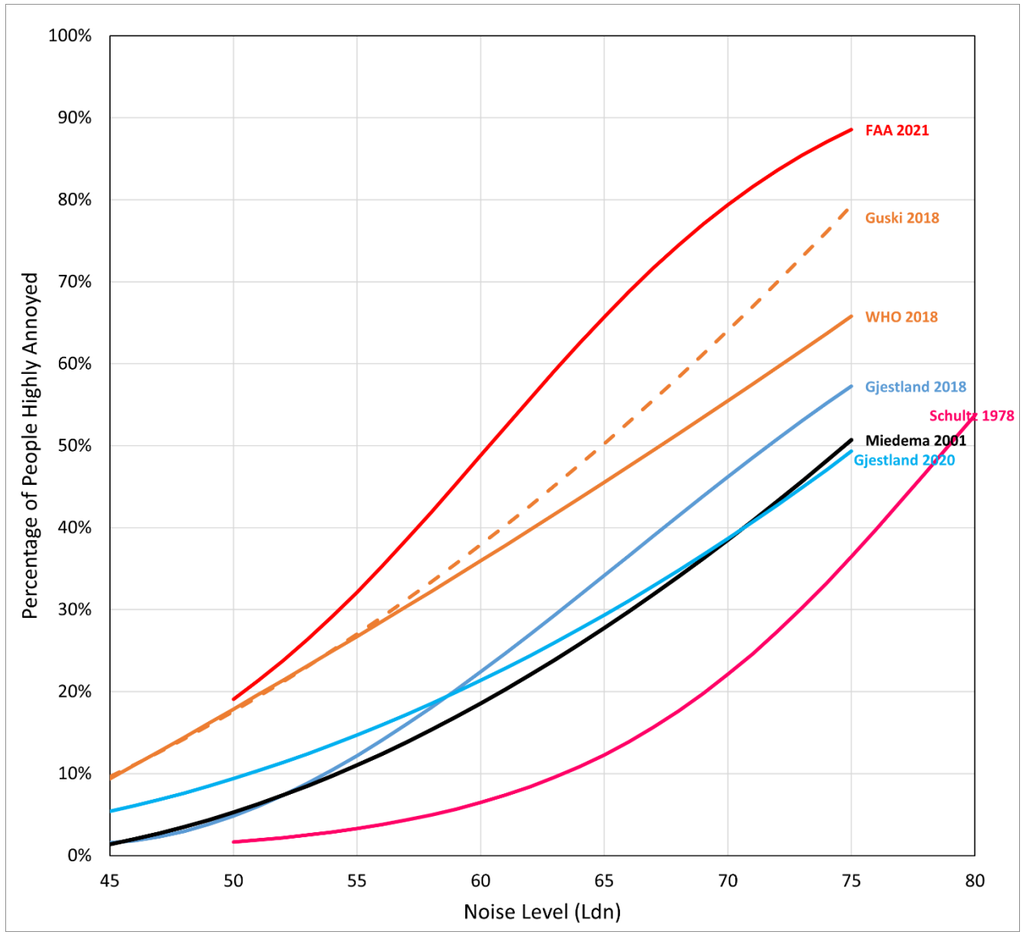
The New Zealand Standard for managing aircraft noise around airports (NZS 6805:1992[2]) defines aircraft noise boundaries using the L_{dn} noise metric (24-hour day night weighted average noise exposure). L_{dn} is a measure of noise exposure and uses the cumulative 'noise energy' received from all aircraft events over 24 hours with a 10 decibel weighting applied to night flights (10pm – 7am).

The smallest period of time the L_{dn} metric can be measured is 24 hours and it is often assessed over longer periods such as days or months to quantify a longer term noise exposure. This is particularly relevant for airport noise as the direction of aircraft movements and hence flight paths vary depending on wind direction. NZS 6805 recommends averaging aircraft noise over 3 months.

L_{dn} and equivalent metrics (L_{den} and ANEF) are used internationally for assessing and managing aircraft noise. These metrics provide a suitable descriptor for the overall effects of aircraft noise exposure. Dose-response relationships commonly link community annoyance with overall aircraft noise exposure using L_{dn} and L_{den} metrics. There have been many annoyance response relationships developed for aircraft noise over the last few decades with various predictions of the percentage of people highly annoyed at different levels of aircraft noise exposure. Figure 3 shows a sample of the available annoyance curves. NZS 6805:1992 recommends as a minimum, that land use controls apply to areas exposed to 55 dB L_{dn} or greater. The annoyance curves in Figure 3 predict that a small to moderate percentage of people will be highly annoyed at this level but the majority of people would not.

[2] New Zealand Standard NZS 6805:1992 Airport noise management and land use planning

Figure 3: A sample of aircraft noise dose response curves



There are other metrics used to quantify and describe aircraft noise. Individual aircraft events can have short term effects that can be assessed using single event noise metrics such as L_{Amax} and L_{AE}. L_{AE} is the total sound energy from a noise event normalised to a one second duration. L_{Amax} is the maximum noise level occurring during the aircraft noise event. For this report we have considered L_{Amax} from individual aircraft events.

Single event noise levels are usually applied to assess sleep disturbance at night and communication interference during the day. In New Zealand, typical district plan noise limits in residential areas are 70 or 75 dB L_{Amax} at night. The Wellington District Plan Outer Residential zone noise limits allow up to 70 dB L_{Amax} at night (10pm – 7am) from general noise sources (excluding transportation). NZS 6805:1992 does not define limits of acceptability for single event noise from aircraft. At some airports in New Zealand, a level of 95 dB L_{AE} is used as a threshold for sleep disturbance effects. For aircraft events, 95 dB L_{AE} is generally equivalent to 85 dB L_{Amax}. For comparison with other transportation, a typical bus drive-by reaches 70 - 75 dB L_{max} at a distance of 6 – 10 m and road trucks are approximately 85 dB L_{Amax} at 13 m.

5.0 MEASURED AIRCRAFT NOISE IN NORTHERN SUBURBS

The ANOMS software can be used to export a range of noise and aircraft operations data. In this section we present several methods that quantify and describe the aircraft noise environment measured at each of the four northern suburbs monitors.

5.1 Average Noise Exposure

Table 3 lists the overall measured L_{dn} for the monitoring period (approximately 60 – 90 days). The table shows both the L_{dn} attributable to aircraft events and the L_{dn} from all other noise between aircraft events.

Table 3: Measured average 24 hour day night noise exposure L_{dn}

Monitor Location	Aircraft Noise (dB L_{dn})	Non-Aircraft Noise (dB L_{dn})
200 Ngaio	41	53
201 Broadmeadows	50	57
202 Khandallah	49	57
203 Johnsonville	47	53

The average aircraft noise exposure is less than the average noise exposure from other sources. This does not mean aircraft noise is inaudible above other background sounds. Noise during individual aircraft events rises above the background and is clearly audible. However, because there are periods between events when there is no aircraft noise, the average exposure is lower than from all other noise sources combined. The aircraft noise ranges from 41 to 50 dB L_{dn} at the monitors. These are generally considered to be reasonable noise levels although Figure 3 shows that some people in the community may be highly annoyed.

5.2 Variation in Daily Aircraft Noise Levels (All Aircraft)

The 60 – 90 day average noise exposure listed in Table 3 is useful to understand the overall impact, however in practice the aircraft noise fluctuates day by day depending on wind direction and the number of movements. When the wind is from the north, the northern suburbs experience departure overflights. When the wind is from the south, there are no departures over the northern suburbs, however arrivals on the straight arrival flight paths over Newlands are audible at the monitor locations. In **Figures 4 to 7**, we have presented the daily aircraft movement and corresponding noise data from the month of October 2023 for each of the four monitors. October was selected as all monitors recorded data for the full month and it is not practicable to show more than one month of data on the charts.

- The yellow line represents the daily L_{dn} from aircraft noise.
- The grey line is the number of aircraft overflights measured at the monitor each day.
- The blue bars are the total number of departures using runway 34 each day.
- The green bars are the total number of arrivals using runway 16 each day.

The graphs are useful to understand the degree of fluctuation in aircraft overflights and L_{dn} from day to day as well as the variation in wind direction. During October runway 34 was used 66% of the time which is a little more than the historical average utilisation of 60%.

Figure 4: Daily Aircraft Noise and Operations - October 2023 RMT200 Ngaio

Figure 5: Daily Aircraft Noise and Operations - October 2023 RMT201 Broadmeadows

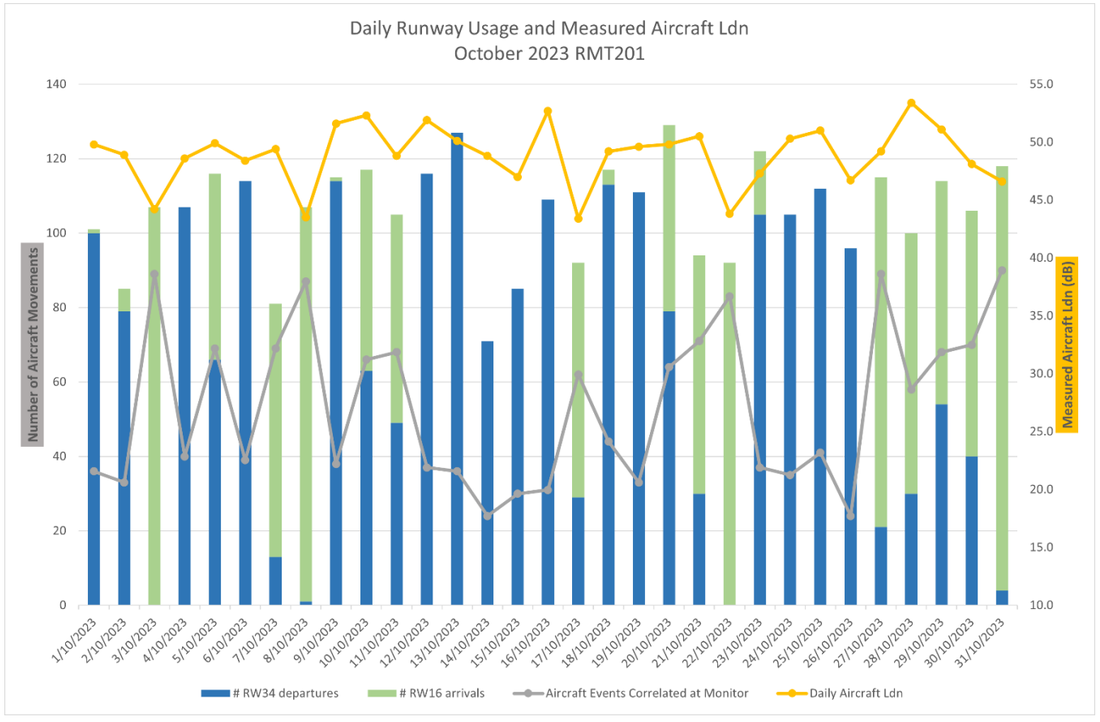
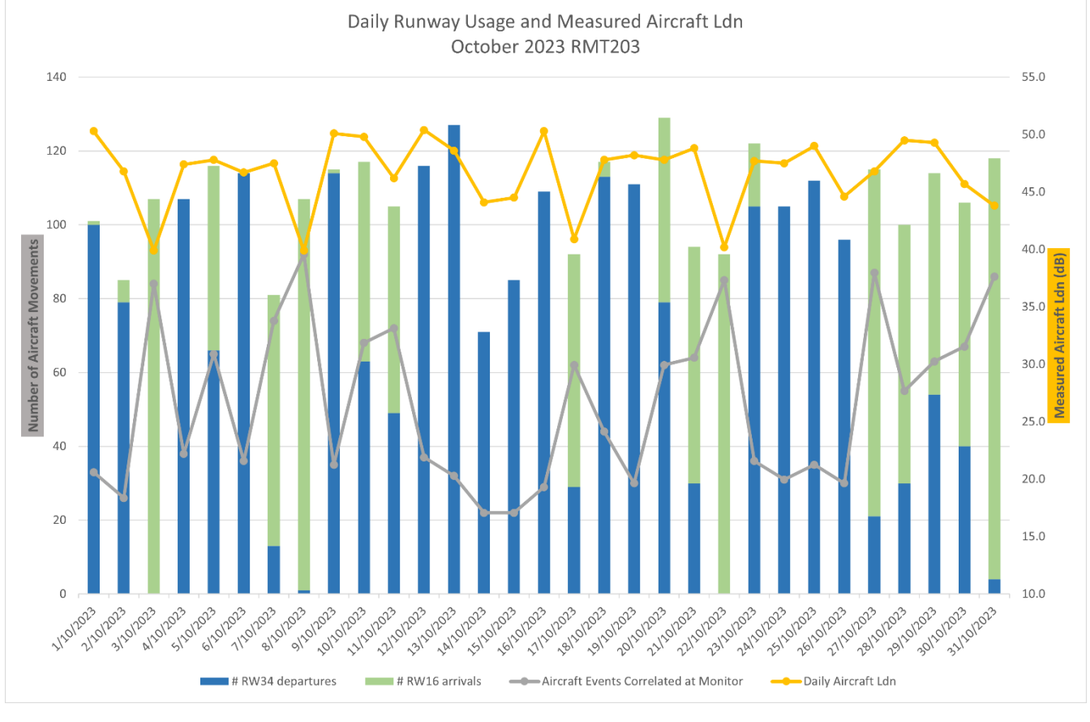


Figure 6: Daily Aircraft Noise and Operations - October 2023 RMT202 Khandallah

Figure 7: Daily Aircraft Noise and Operations - October 2023 RMT203 Johnsonville



5.3 Hourly Noise Levels and Aircraft Events (All Aircraft)

In addition to the daily fluctuations in noise, residents experience fluctuations in aircraft noise at different times of day. In **Figures 8 – 11** we have presented hourly statistics for one representative day when runway 34 was in use (i.e. departure events). For comparison, **Figures 12 – 15** present the hourly statistics for one representative day when runway 16 was in use (i.e. arrivals events).

- The blue line represents the hourly average noise from aircraft events.
- The green line represents the hourly average noise from other noise sources.
- The yellow line shows the number of measured aircraft events per hour.
- The grey points show the L_{Amax} for each of these measured events.

The graphs show that aircraft noise generally occurs between 6am and 10pm on runway 34 days but on runway 16 days there are some arrival events later at night. On the date shown in the graphs (22 October 2023), these consisted of four trans-Tasman arrivals between 11pm and 1am and one medical arrival between 3am and 4am. All five aircraft flew on straight arrival flight paths over Newlands.

On the runway 34 day, there were generally between two and ten measured aircraft events an hour although on occasion this reached 10 - 20 overflights in a single hour. The L_{Amax} levels from departure events generally range between 55 and 80 dB L_{Amax}.

By comparison, the runway 16 day graphs show there were generally more measured aircraft events compared with the runway 34 day (i.e. frequently 10 or more events per hour). Generally, the arrival events were quieter than departure events. For RMT 201 and 203, arrival L_{Amax} levels ranged from 55 to 70 dB and for RMT 202 the arrival L_{Amax} levels ranged from 55 to 80 dB. Arrivals on flight paths over Newlands were not measurable at RMT 200 in Ngaio hence this graph shows only one aircraft event in this location on a runway 16 day.

Although more aircraft events were measured on runway 16 days, the hourly average aircraft noise is slightly lower than on runway 34 days. This trend is also reflected in **Figures 4 – 7,** which generally show the grey line increases where there are green bars (arrival events) and the yellow line (daily L_{dn}) decreases, with occasional exceptions.

Arrival flight paths have not changed with DMAPS, so **Figures 12 – 15** are a reasonable representation of the noise environment on a runway 16 day both currently and pre-DMAPS.

Figure 8: Hourly Measured Noise During a Runway 34 Day - RMT200 Ngaio

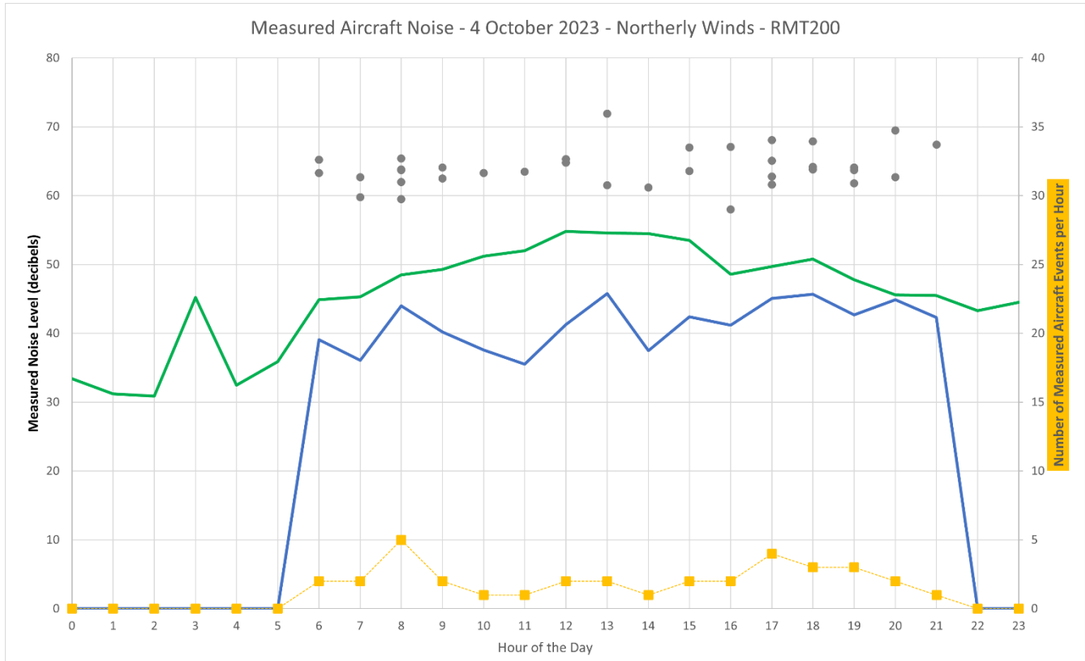


Figure 9: Hourly Measured Noise During a Runway 34 Day - RMT201 Broadmeadows

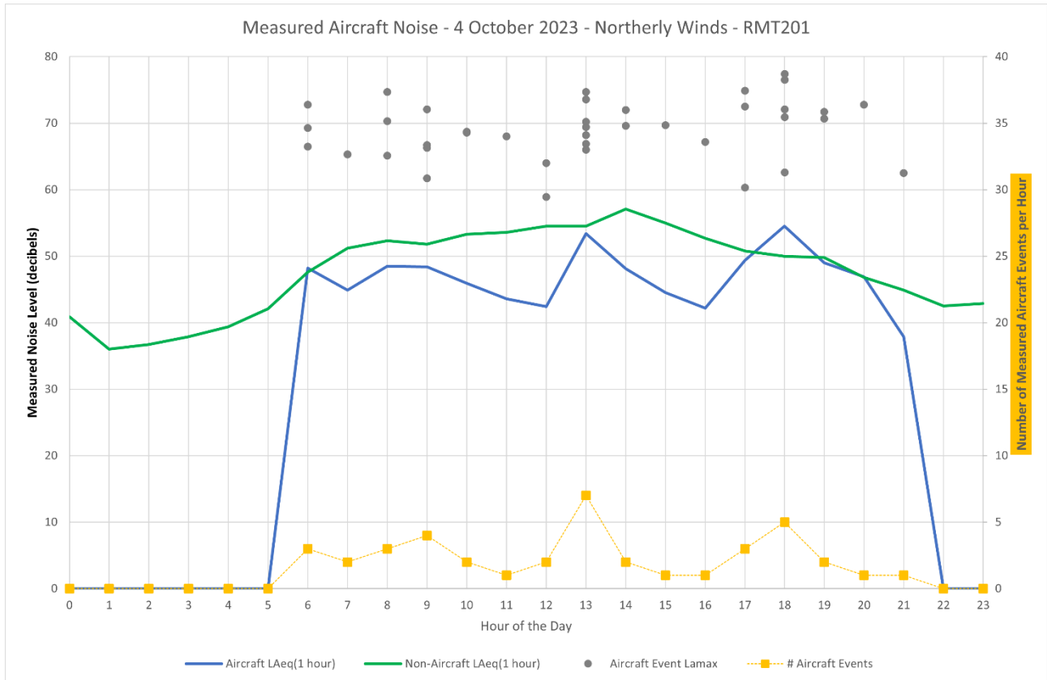


Figure 10: Hourly Measured Noise During a Runway 34 Day - RMT202 Khandallah

Figure 11: Hourly Measured Noise During a Runway 34 Day - RMT203 Johnsonville

Figure 12: Hourly Measured Noise During a Runway 16 Day - RMT200 Ngaio

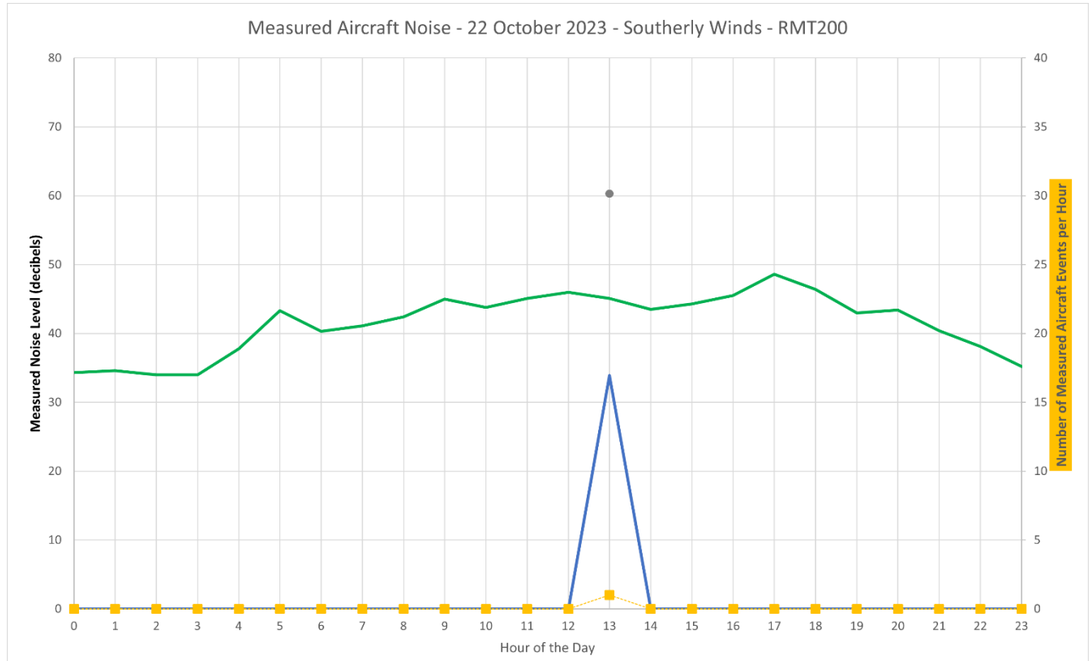


Figure 13: Hourly Measured Noise During a Runway 16 Day - RMT201 Broadmeadows

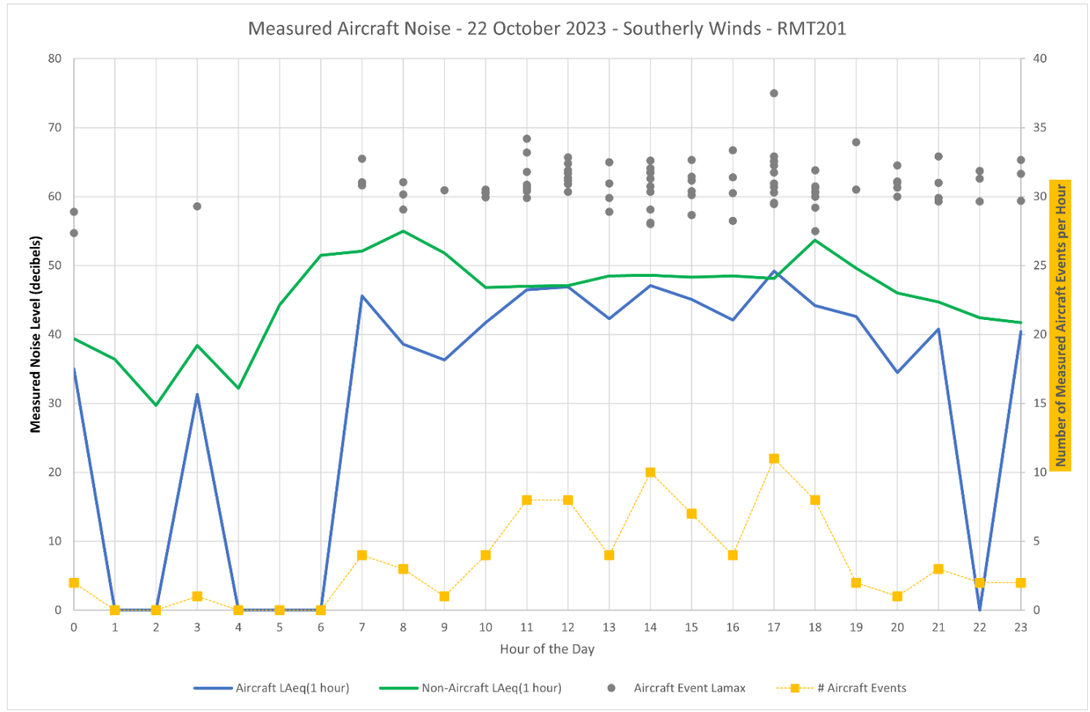


Figure 14: Hourly Measured Noise During a Runway 16 Day - RMT202 Khandallah

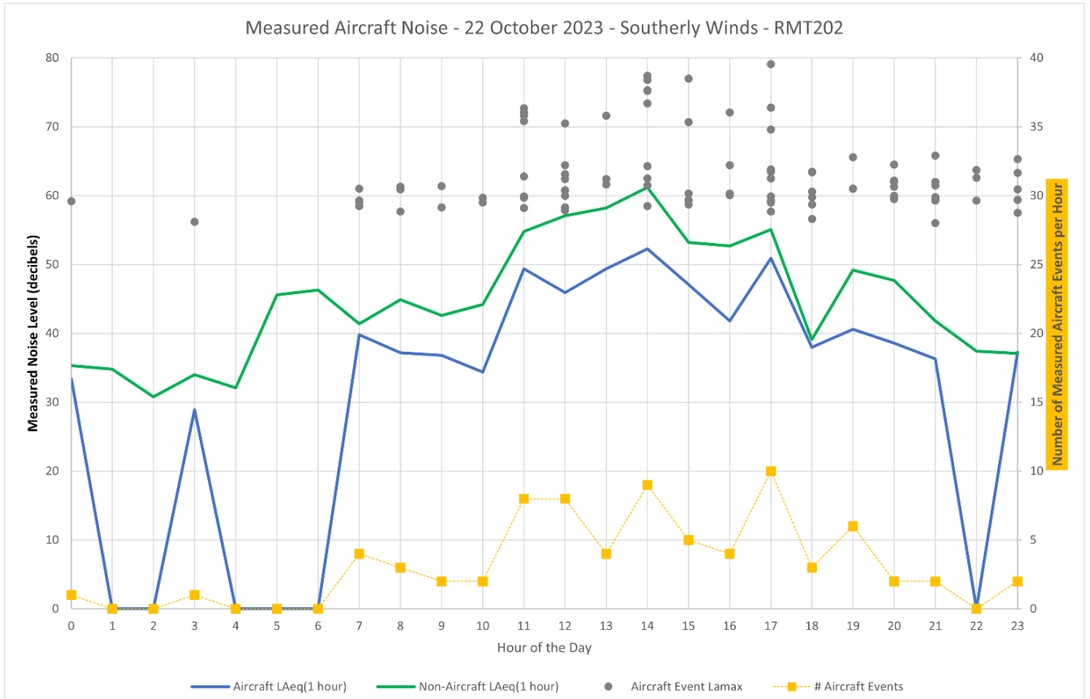
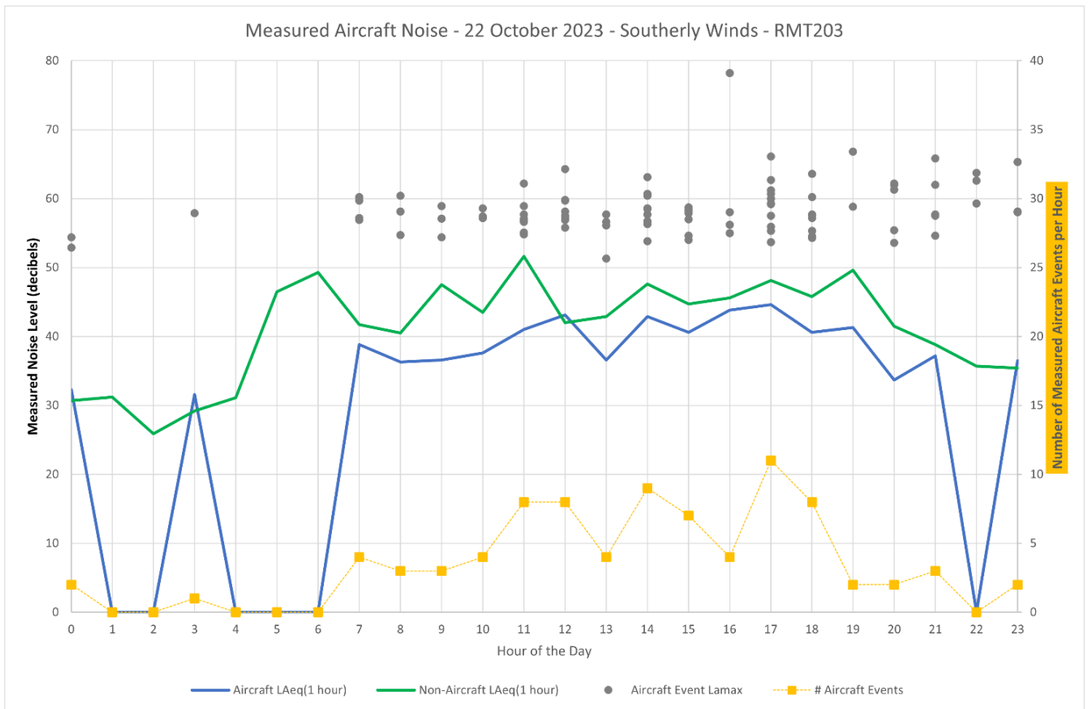


Figure 15: Hourly Measured Noise During a Runway 16 Day - RMT203 Johnsonville



6.0 MEASURED AIRCRAFT NOISE BETWEEN 6AM AND 7AM

The feedback that WIAL has received from some residents near the new DMAPS flight path is that the early morning jet departures between 6am and 7am are particularly disruptive. In **Figures 16 to 19** we have presented daily statistics of all runway 34 departures and runway 16 arrivals between 6am and 7am for the month of October 2023.

- The blue bars are the total number of departures using runway 34 in the 6 – 7am hour.
- The green bars are the total number of arrivals using runway 16 in the 6 – 7am hour.
- The grey line is the number of measured aircraft noise events in the 6 – 7am hour.

The data shows that not all runway 34 departures between 6am and 7am overfly at the monitor locations. At each of the monitors, there were zero to five measured aircraft events each day between 6am and 7am. In **Figures 20 to 23** we have presented the L_{Amax} levels for each of these events which generally ranged between 60 and 80 dB L_{Amax}. Section 7.0 provides more analysis of jet departure noise levels which are the main contributor to noise between 6am and 7am at the monitors.

Figure 16: Early Morning Aircraft Movements - RMT200 Ngaio

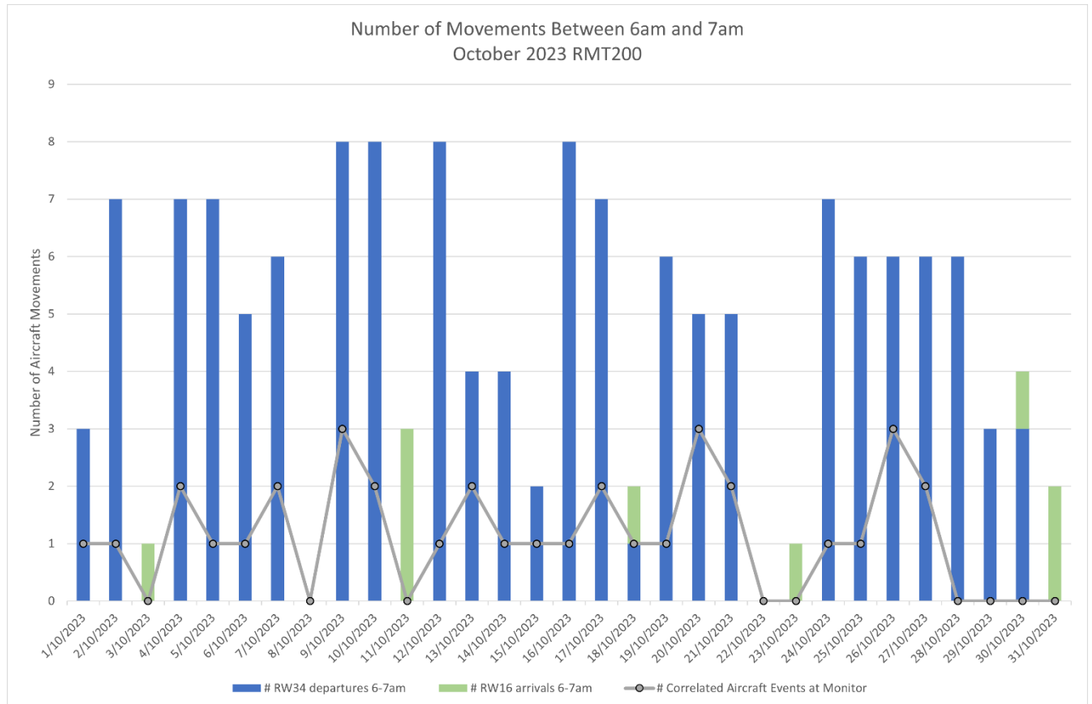


Figure 17: Early Morning Aircraft Movements - RMT201 Broadmeadows

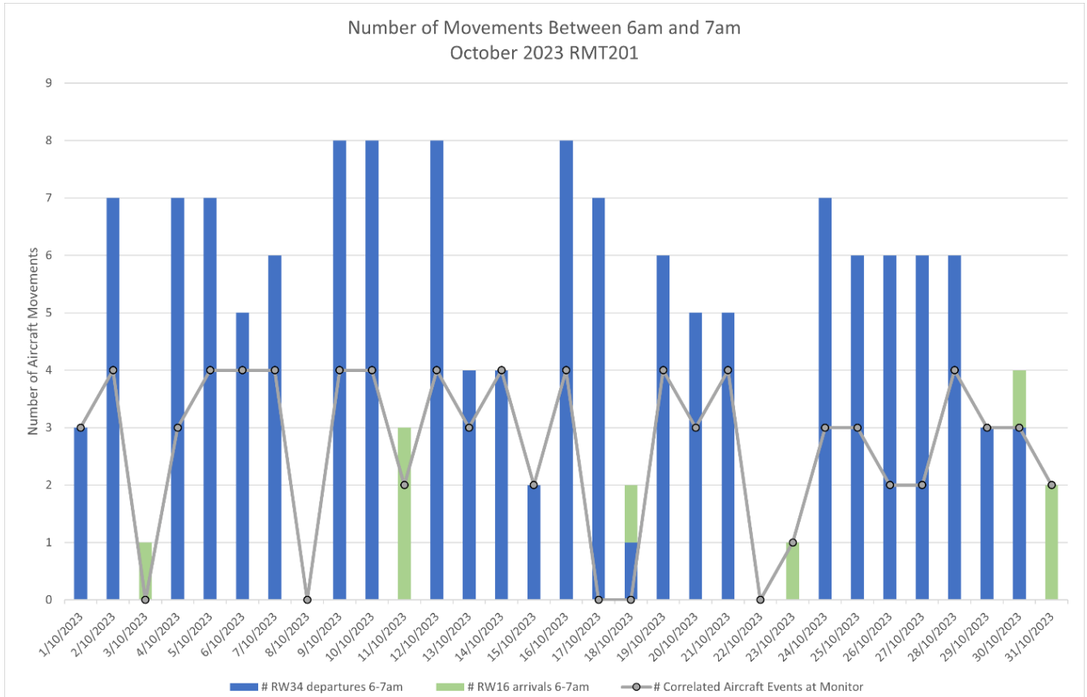


Figure 18: Early Morning Aircraft Movements - RMT202 Khandallah

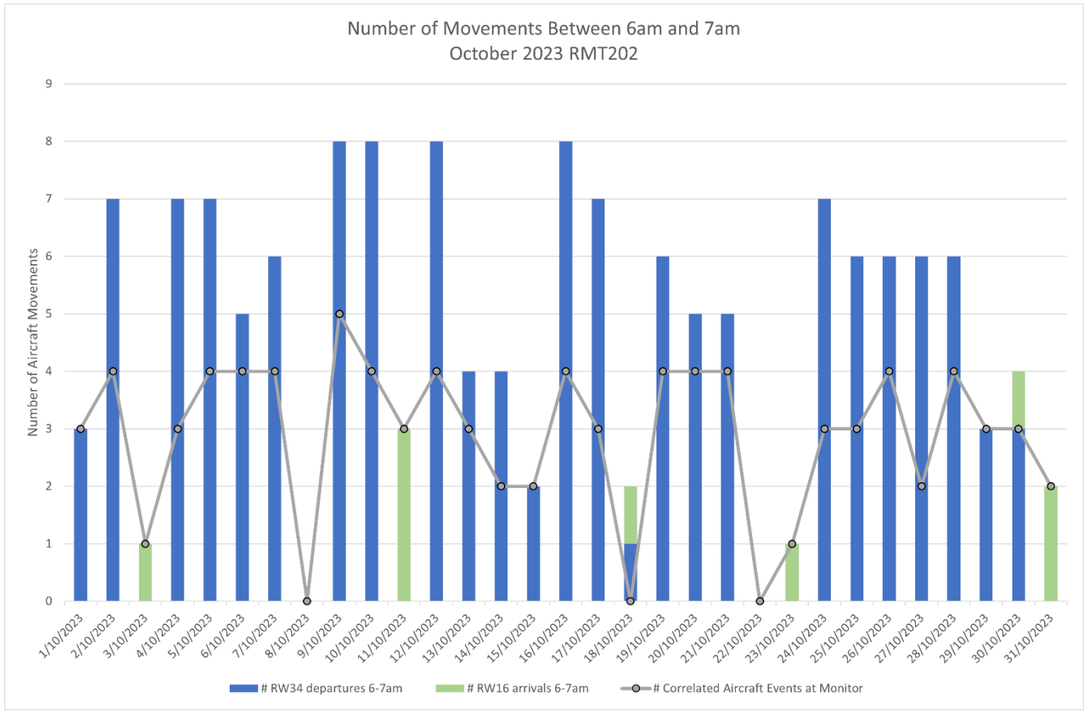


Figure 19: Early Morning Aircraft Movements - RMT203 Johnsonville

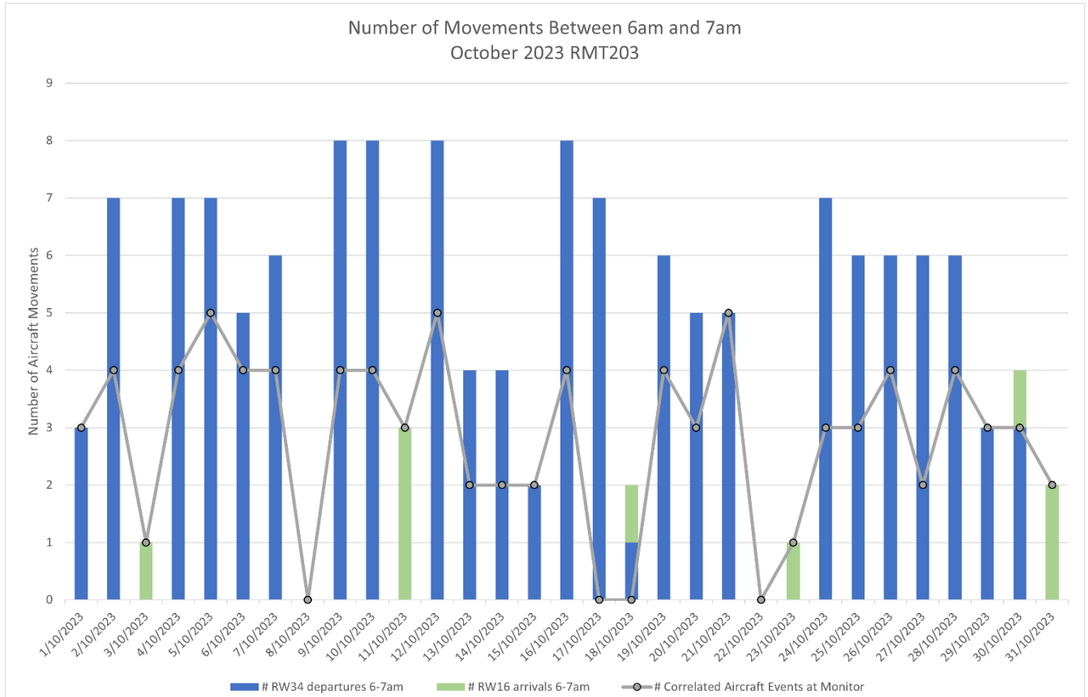


Figure 20: Measured Aircraft L_{Amax} 6am - 7am - RMT200 Ngaio

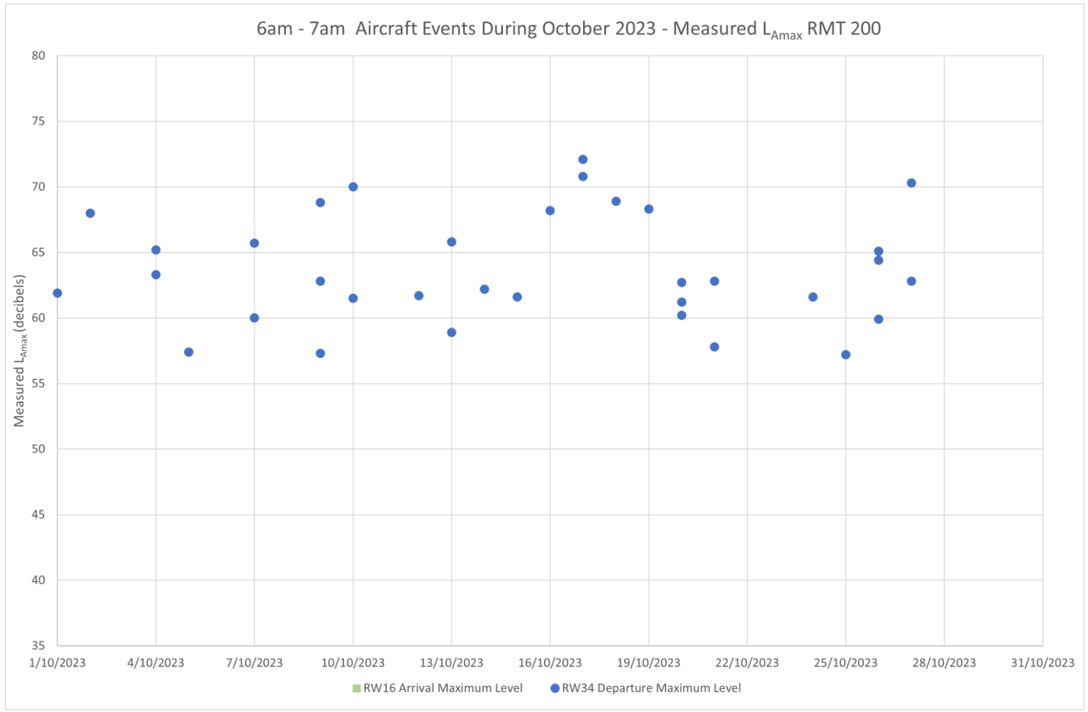


Figure 21: Measured Aircraft L_{Amax} 6am - 7am - RMT201 Broadmeadows

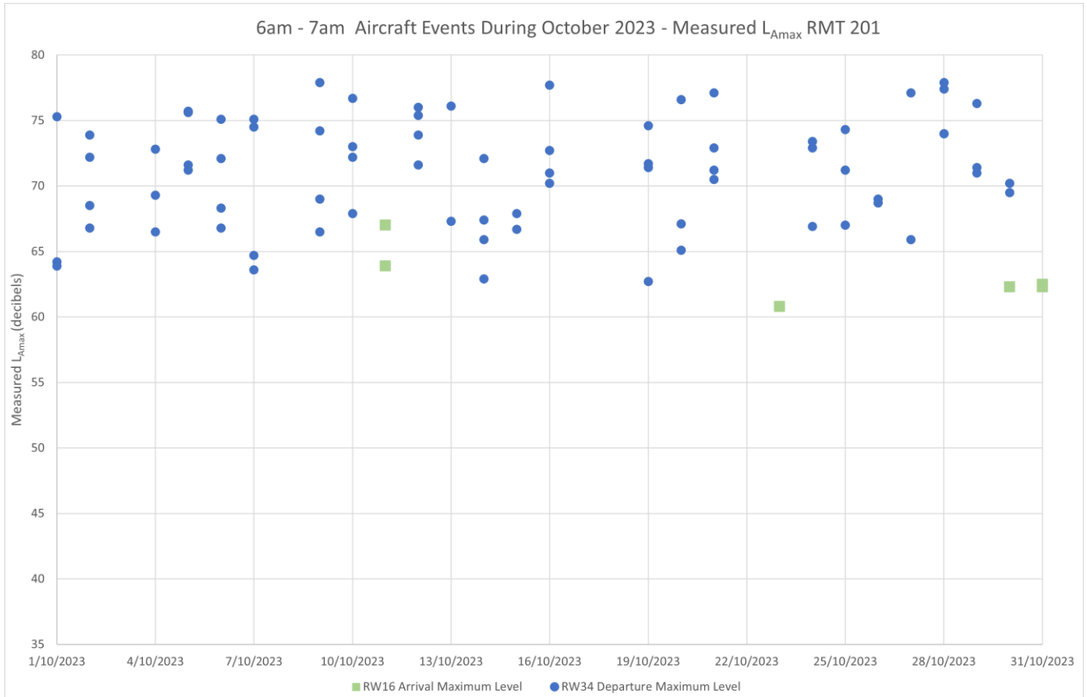


Figure 22: Measured Aircraft L_{Amax} 6am - 7am - RMT202 Khandallah

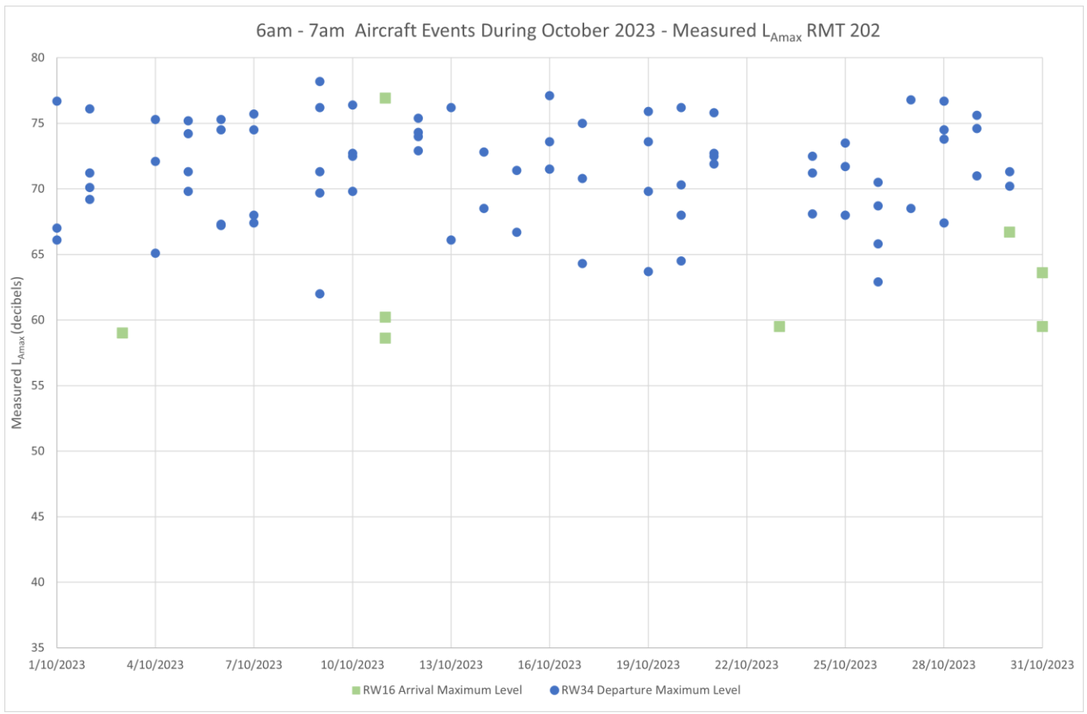
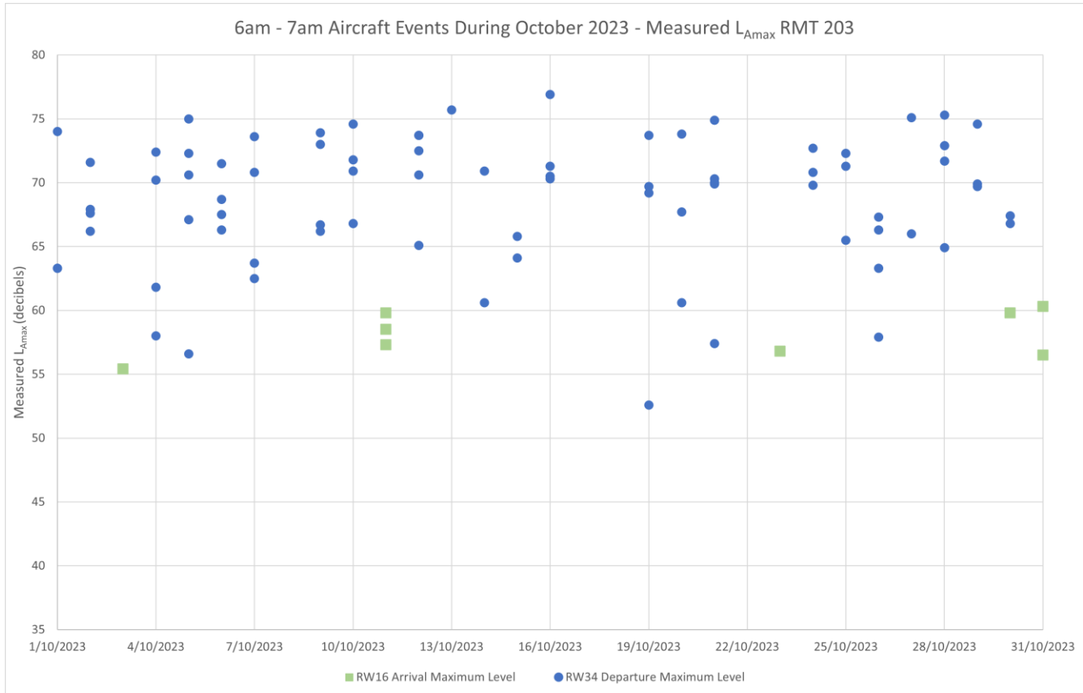


Figure 23: Measured Aircraft L_{Amax} 6am - 7am - RMT203 Johnsonville



7.0 MEASURED JET DEPARTURE EVENT STATISTICS

This section focusses on single event noise levels from jet departures at the northern suburbs monitors. Figures 24 to 27 are histograms of the measured L_{Amax} from runway 34 jet departures at each of the monitors. The average and standard deviation of the samples is shown as well as the 95th percentile, which is the level that only 5% of the events exceeded. Across all the monitors, the average L_{Amax} was no greater than 70 dB and the 95th percentile level was no greater than 76 dB L_{Amax}. Although likely to be noticeable at the time, these noise levels are considered reasonable and similar to noise levels from other environmental noise sources present in residential areas.

At the request of WIAL, we have analysed the measured noise levels by jet aircraft type. Table 4 summarises the average of the measured maximum noise levels (L_{Amax}) for each jet aircraft type at the monitors.

The jet aircraft types are:

A320 (domestic)	Airbus A320ceo on domestic route
A20N (international)	Airbus A320neo on Trans-Tasman route
B738 (international)	Boeing 737-800 on Trans-Tasman route
B38M (international)	Boeing 737 MAX 8 on Pacific route

Table 4: Average measured L_{Amax} for runway 34 jet departures

Aircraft	RMT 200 Ngaio	RMT 201 Broadmeadows	RMT 202 Khandallah	RMT 203 Johnsonville	RMT 105 Homebush Rd
A320	66	70	70	68	71
A20N	64	69	70	67	71
B738	65	75	75	73	76
B38M	-	68	68	66	69

The data in Table 4 shows the quietest aircraft is the B38M and the loudest aircraft is the B738. The B38M is a modern version of the B738. The Airbus jets are one to two decibels louder than the B38M and approximately five decibels quieter than the B738. The most relevant aircraft at RMT 200 in Ngaio is the A320 as the international jets generally do not overfly this area meaning the sample sizes are relatively small.

Figure 24: Jet Departures L_{Amax} - RMT200 Ngaio

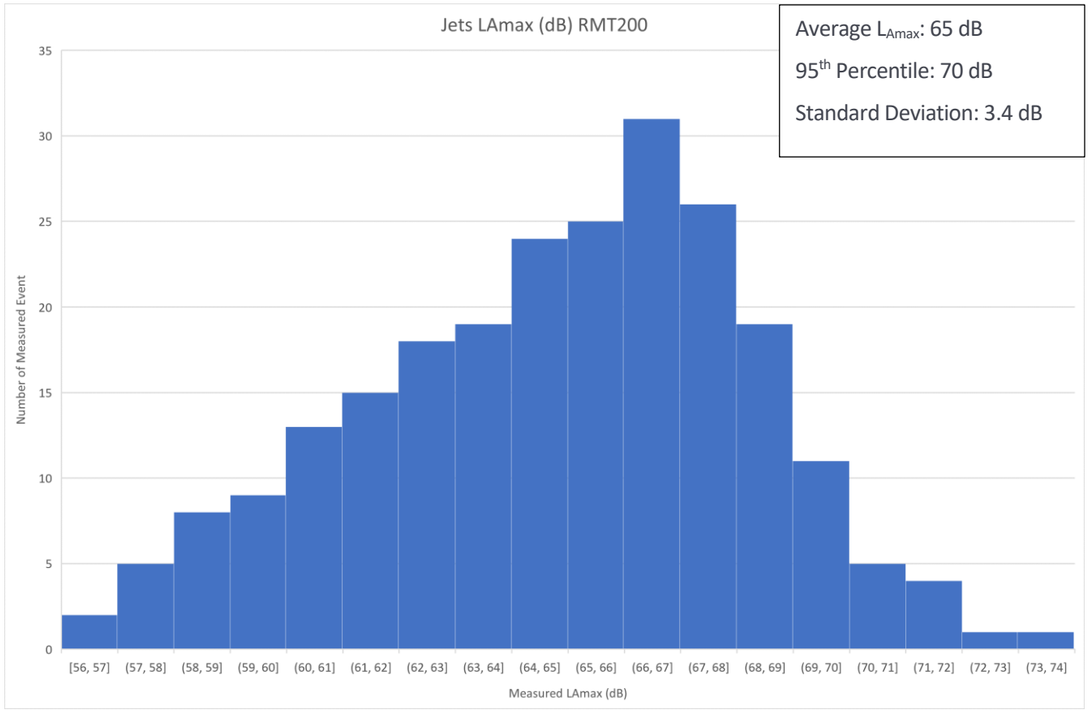


Figure 25: Jet Departures L_{Amax} - RMT201 Broadmeadows

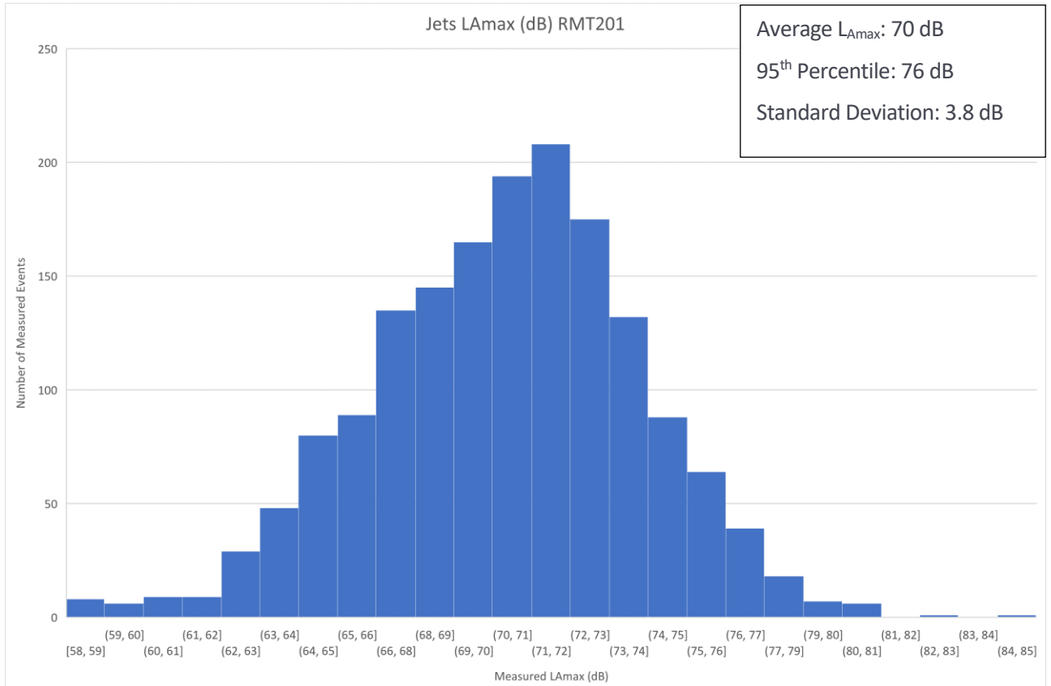


Figure 26: Jet Departures L_{Amax} - RMT202 Khandallah

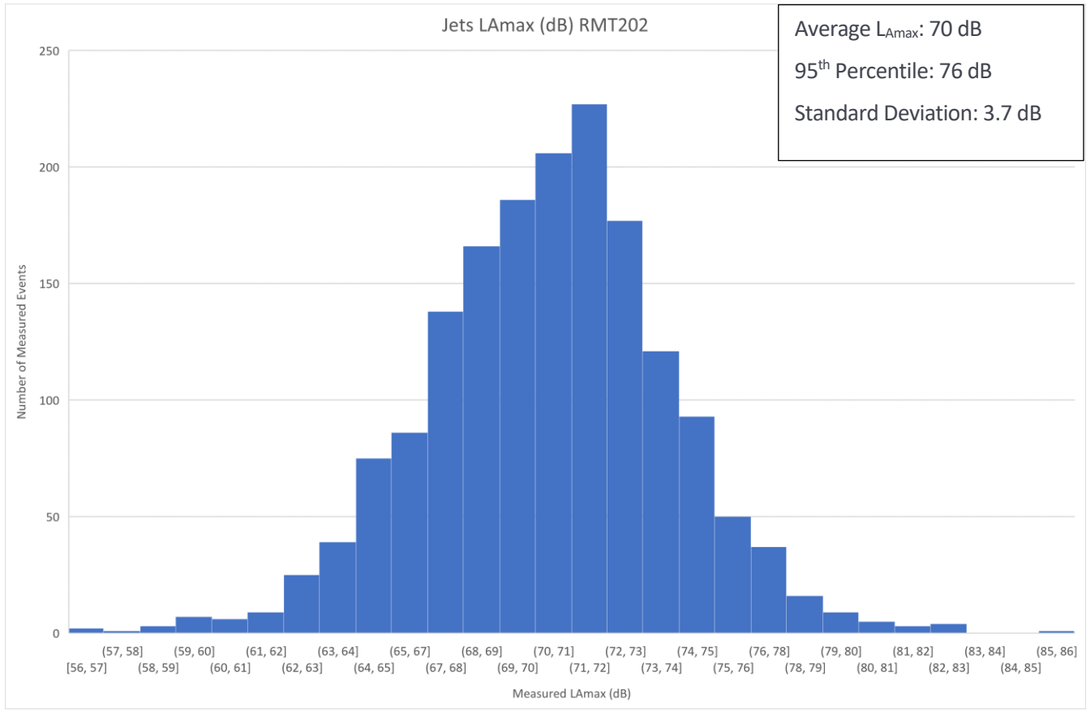
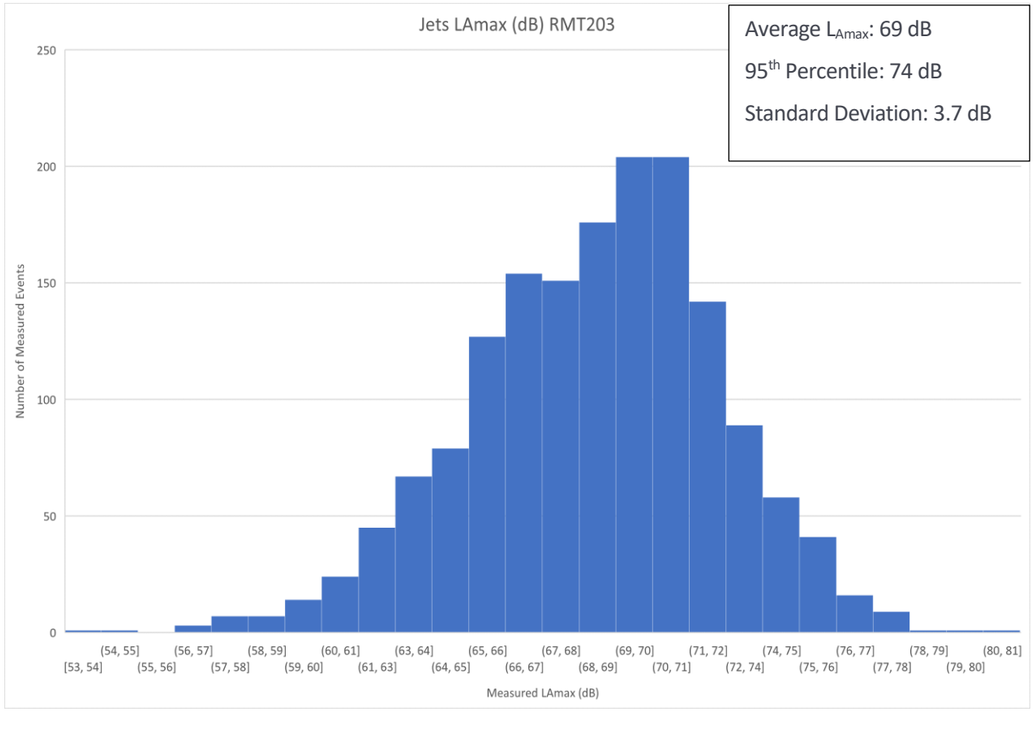


Figure 27: Jet Departures L_{Amax} - RMT203 Johnsonville



7.1 Reference Measurements for Pre-DMAPS Jet Departures

The four noise monitors in the northern suburbs were deployed after the DMAPS flight path changes were implemented so there is no aircraft noise data prior to DMAPS other than the Homebush Road monitor in Khandallah. However, during the time the northern suburbs monitors were operating, some departing jets flew flight paths similar to the pre-DMAPS flight path heading directly north as shown in Figure 28. These aircraft have diverted off the DMAPS flight path before reaching the monitors so they could take a more direct route to Auckland. These flights are a reasonable representation of pre-DMAPS domestic jet departures, and we have used the measured single event levels at the monitors to compare with domestic jet departures using the DMAPS flight path. Table 5 summarises the results. The sample size of measured A320 domestic departures on straight flight paths is 200 – 220 events at each monitor with standard deviations of 2.5 – 3.0 dB.

Figure 28: Pre-DMAPS Flight Path and Cancelled DMAPS flight paths during monitoring period

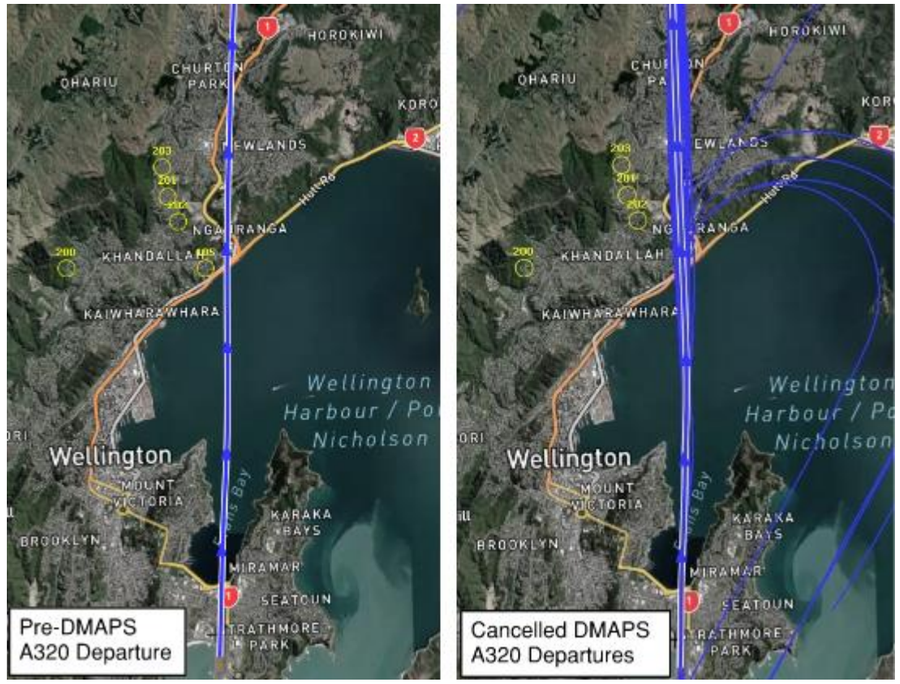


Table 5: Average measured L_{Amax} for A320 domestic departures

Monitor Location	DMAPS Flight Path	Cancelled DMAPS (Straight)
RMT201 Broadmeadows	71 dB	67 dB
RMT202 Khandallah	71 dB	67 dB
RMT203 Johnsonville	69 dB	64 dB

Using the available measurement data summarised in Table 5, we estimate the change in jet departure single event maximum noise levels due to DMAPS is 4 – 5 dB at monitors 201, 202, 203. Although we have only analysed A320 domestic departures, we expect a similar increase in noise level for other jets resulting from the change in flight path. The subjective response to a change in noise level is widely variable from individual to individual and is also different for a change that occurs immediately, compared with a change that occurs slowly over many years.

The following general response to an immediate change in noise is typical:

- An increase in noise level of 9 to 12 dB sounds subjectively about ‘twice as loud’;
- A change in noise level of 5 to 8 dB is regarded as appreciable;
- A change in noise level of 3 to 4 dB is just detectable;
- A change in noise level of 1 to 2 dB is not discernible.

An increase of 4 – 5 dB would subjectively be noticeable but is not considered a significant change.

8.0 CONCLUSION

The main conclusions from our analysis of the monitoring data are as follows:

- The average number of jet departure overflights experienced at the monitors (within 1.5km) has increased appreciably since the implementation of DMAPS.
- Jet departures on pre-DMAPS straight flight paths were approximately 4 – 5 dB quieter at the monitors than jet departures on the DMAPS flight path. An increase of 4 – 5 dB would subjectively be noticeable but is not considered a significant change.
- The average measured maximum noise level for jet departures during the monitoring period was 70 dB L_{Amax} and the 95th percentile was 76 dB L_{Amax}. Although likely to be noticeable at the time, these noise levels are considered reasonable and similar to noise levels from other environmental noise sources present in residential areas.
- The average L_{dn} aircraft noise exposure measured at the monitors ranged from 41 to 50 dB L_{dn} which is considered reasonable for most of the population. However, some people may be highly annoyed.
- The Boeing 737-800 aircraft is approximately 5 decibels louder than the other jet aircraft operating frequently from Wellington Airport. Currently the Boeing 737-800 departs three times a day with one early morning departure between 6 and 7am.

In summary, in the context of general environmental and transportation noise sources, the measured aircraft noise levels summarised above are considered reasonable.

APPENDIX A MEASURED DAILY NOISE LEVELS

Daily Measured Aircraft Noise Levels RMT200 Ngaio

Location	Date	Daily Aircraft Ldn	Daily Aircraft LAeq(16hour)	Non- Aircraft LAeq(16hour)
200	26/09/2023	27.6	36.6	52.4
200	27/09/2023	35.3	38.6	47.3
200	28/09/2023	42.1	43.9	46.1
200	29/09/2023	45.8	45.7	47.6
200	30/09/2023	35.6	36.7	50.8
200	1/10/2023	42.4	44.2	45.5
200	2/10/2023	43.7	43.8	53.7
200	3/10/2023	25.8	36.4	49.9
200	4/10/2023	41.7	42.4	50.8
200	5/10/2023	37.8	40.9	44.6
200	6/10/2023	41.3	41.7	49.7
200	7/10/2023	38.5	42	47.5
200	8/10/2023	24.9	38.7	51
200	9/10/2023	43.6	43.4	47.2
200	10/10/2023	41.5	40.9	46.2
200	11/10/2023	39	43.8	46.4
200	12/10/2023	40.6	42.7	45
200	13/10/2023	43.9	45.4	53
200	14/10/2023	40.2	42.4	54.5
200	15/10/2023	43.5	45.7	56.4
200	16/10/2023	41	42.4	48.4
200	17/10/2023	44.6	44.1	52.8
200	18/10/2023	42.8	43.7	44.5
200	19/10/2023	52.2	53.8	57.3
200	20/10/2023	44.7	47	49
200	21/10/2023	40.5	43.6	47.7
200	22/10/2023	20.1	33.9	44.3
200	23/10/2023	38.7	42.1	49.1
200	24/10/2023	40.6	42.6	48.5
200	25/10/2023	40	42.6	45.2
200	26/10/2023	41.3	42.5	56.1
200	27/10/2023	43.6	46.6	44.4
200	28/10/2023	36	43.8	45.5
200	29/10/2023	37.9	42.1	43.5
200	30/10/2023	37.6	43.7	45.7
200	31/10/2023	30.3	44.1	46.9
200	1/11/2023	40.1	41.7	45.1
200	2/11/2023	41.2	43.1	49.4
200	3/11/2023	43.8	45.2	47.8
200	4/11/2023	39.9	42.6	51.7
200	5/11/2023	38.2	42.6	47.6
200	6/11/2023	21.8	35.6	46.6
200	7/11/2023	17.2	31	47.9
200	8/11/2023	30.4	34.2	49.2
200	9/11/2023	34.7	36.6	43.9
200	10/11/2023	30.9	33	44.8
200	11/11/2023	35.6	39.4	46.4
200	12/11/2023	39.1	41.8	51.2
200	13/11/2023	44.6	44.2	49.4
200	14/11/2023	41.6	44.5	51.3
200	15/11/2023	41.1	43.7	51.6
200	16/11/2023	44.2	45	47.1
200	17/11/2023	42.4	43.6	51.7
200	18/11/2023	34.2	42	44.3
200	19/11/2023	22.8	33.6	43.8
200	20/11/2023	25.6	33.4	47.1
200	21/11/2023	29.8		46
200	22/11/2023	42	42.5	45
200	23/11/2023	43.5	44.7	49
200	24/11/2023	31.8	38.6	51.2
200	25/11/2023	16	29.8	50.6
200	26/11/2023	31.6	39.4	47.1
200	27/11/2023	40.9	42.6	48.3

Daily Measured Aircraft Noise Levels RMT201 Broadmeadows

Location	Date	Daily Aircraft Ldn	Daily Aircraft LAeq(16hour)	Non- Aircraft LAeq(16hour)
201	5/09/2023	50.2	47.5	48.4
201	6/09/2023	48.2	46.7	50.3
201	7/09/2023	48.4	49.4	48.7
201	8/09/2023	51.8	48.3	50.5
201	9/09/2023	49.9	48.9	49.1
201	10/09/2023	48.8	50.3	48.7
201	11/09/2023	48	47.7	51.8
201	12/09/2023	50.7	49.4	50.6
201	13/09/2023	50.8	50.1	50.1
201	14/09/2023	48.2	48.5	53.8
201	15/09/2023	51.5	48.2	50.2
201	16/09/2023	50	47.6	53.1
201	17/09/2023	46.7	49.1	59.2
201	18/09/2023	49.4	49.5	49.9
201	19/09/2023	49.3	47.5	51.3
201	20/09/2023	48.6	48.4	52
201	21/09/2023	48.5	46.8	52.6
201	22/09/2023	49.8	46.9	50.2
201	23/09/2023	46.2	44.7	50.8
201	24/09/2023	45	44.7	50
201	25/09/2023	47.8	47	54.5
201	26/09/2023	47.3	47.9	56
201	27/09/2023	44.9	45.5	50.7
201	28/09/2023	51	49.3	50.7
201	29/09/2023	51.1	51.1	51.6
201	30/09/2023	45	47.3	53.6
201	1/10/2023	49.8	50.1	50
201	2/10/2023	48.9	46.3	54.6
201	3/10/2023	44.2	45.2	53.6
201	4/10/2023	48.6	48.6	52.4
201	5/10/2023	49.9	48	49.2
201	6/10/2023	48.4	47.2	53.2
201	7/10/2023	49.4	46.1	53.1
201	8/10/2023	43.5	43.8	48.7
201	9/10/2023	51.6	50.4	51.1
201	10/10/2023	52.3	51.4	50.3
201	11/10/2023	48.8	48.8	55.4
201	12/10/2023	51.9	50.5	51.1
201	13/10/2023	50.1	48.5	55.6
201	14/10/2023	48.8	45.8	56.1
201	15/10/2023	47	47.8	56.7
201	16/10/2023	52.7	50	52.4
201	17/10/2023	43.4	45	55.6
201	18/10/2023	49.2	50.9	49.7
201	19/10/2023	49.6	47.9	50.4
201	20/10/2023	49.8	49.5	53.3
201	21/10/2023	50.5	47.5	48.6
201	22/10/2023	43.8	44.4	49.9
201	23/10/2023	47.3	48.9	51.1
201	24/10/2023	50.3	48.1	51.5
201	25/10/2023	51	51.5	50.8
201	26/10/2023	46.7	46.3	57.6
201	27/10/2023	49.2	46.6	50.5
201	28/10/2023	53.4	47.6	50.3
201	29/10/2023	51.1	49.1	54
201	30/10/2023	48.1	48.2	49.7
201	31/10/2023	46.6	44.2	49.6
201	1/11/2023	51.3	49.8	50.3
201	2/11/2023	48.9	49.3	47.1
201	3/11/2023	52.2	52.5	56.5
201	4/11/2023	51.7	49.2	48.7
201	5/11/2023	49.6	47.9	51.7
201	6/11/2023	44.3	45.8	52.3
201	7/11/2023	45.1	45.4	59.3
201	8/11/2023	44.6	45.8	50.7
201	9/11/2023	45.1	46.1	52
201	10/11/2023	47.6	47.4	54
201	11/11/2023	51.9	49	52.3
201	12/11/2023	50.4	50	54.7
201	13/11/2023	49.7	48.4	56
201	14/11/2023	49.1	48.3	57.1
201	15/11/2023	52.1	51.9	56.1
201	16/11/2023	50.8	49.5	53.1
201	17/11/2023	47.3	46.8	54.5
201	18/11/2023	44.6	46.6	52.9
201	19/11/2023	44.3	44.8	52.2
201	20/11/2023	46.4	46.3	52.4
201	21/11/2023	49.5	45.5	53.4
201	22/11/2023	48.9	48.8	56.2
201	23/11/2023	51.3	50.4	54.3
201	24/11/2023	47.8	47.9	56.3
201	25/11/2023	47.9	49.3	55.9
201	26/11/2023	46.4	46.5	52.9
201	27/11/2023	52.2	51	55.1

Daily Measured Aircraft Noise Levels RMT202 Khandallah

Location	Date	Daily Aircraft Ldn	Daily Aircraft LAeq(16hour)	Non- Aircraft LAeq(16hour)
202	5/09/2023	49.6	46.4	49.7
202	6/09/2023	49	48.5	52.5
202	7/09/2023	49.7	50.4	55.4
202	8/09/2023	51.4	48	51.4
202	9/09/2023	50.3	49.5	56
202	10/09/2023	49.3	49.7	47.4
202	11/09/2023	48.7	48	54.2
202	12/09/2023	50.6	49.1	51.7
202	13/09/2023	50.4	49.8	49.8
202	14/09/2023	49.1	48	54.1
202	15/09/2023	50.5	46.6	47.9
202	16/09/2023	49.9	47.4	54.4
202	17/09/2023	48.9	50.5	62.3
202	18/09/2023	49.2	48.8	49.8
202	19/09/2023	49.2	47.6	51.1
202	20/09/2023	49.1	49	53.5
202	21/09/2023	49.3	47.2	53.7
202	22/09/2023	50	47.4	51.8
202	23/09/2023	46.7	44.3	50.4
202	24/09/2023	42.5	42.7	47.2
202	25/09/2023	48	48.8	55.8
202	26/09/2023	44.8	45.5	53
202	27/09/2023	43.9	44.5	49.1
202	28/09/2023	50.2	48.6	46.8
202	29/09/2023	51.3	51.5	52
202	30/09/2023	43.5	45.9	53
202	1/10/2023	49.9	49.9	52.4
202	2/10/2023	50.1	48.3	55.7
202	3/10/2023	44.1	45.4	54
202	4/10/2023	49.6	49.2	56.3
202	5/10/2023	50.4	48.9	53.9
202	6/10/2023	50.2	49.4	59.2
202	7/10/2023	49.6	45.5	50.5
202	8/10/2023	45.6	46.8	58.1
202	9/10/2023	53	51.1	56.3
202	10/10/2023	50.9	48.1	48.7
202	11/10/2023	48.8	47.9	48.4
202	12/10/2023	52.1	51.1	55.6
202	13/10/2023	50.7	49.9	57.8
202	14/10/2023	47.2	45.2	57
202	15/10/2023	47.5	48	57.6
202	16/10/2023	51.6	49.6	52.9
202	17/10/2023	46.7	43.9	54.1
202	18/10/2023	49.3	51.2	50.9
202	19/10/2023	50.1	48.4	52.3
202	20/10/2023	50.1	48.8	51
202	21/10/2023	50.5	47.2	49.7
202	22/10/2023	44.7	46.2	53.5
202	23/10/2023	47.5	49.2	57.5
202	24/10/2023	48.8	47.8	51.2
202	25/10/2023	50.9	51.2	51.1
202	26/10/2023	48.4	48.8	58.6
202	27/10/2023	50.4	48.9	55.6
202	28/10/2023	52.7	50.9	57.5
202	29/10/2023	51.1	48.7	52.5
202	30/10/2023	47.8	47.4	50.4
202	31/10/2023	45.4	42.3	56.4
202	1/11/2023	51.2	49.4	53.2
202	2/11/2023	50.1	50.5	56.1
202	3/11/2023	51.4	51	51.1
202	4/11/2023	50.9	49.4	52.1
202	5/11/2023	50.3	47.2	54.7
202	6/11/2023	41.6	43.6	51.4
202	7/11/2023	42.6	42.1	50.9
202	8/11/2023	39.8	40.4	49.8
202	9/11/2023	39.9	41.2	52.1
202	10/11/2023	43.7	41.7	47.7
202	11/11/2023	51.5	48.9	57.5
202	12/11/2023	51.3	52.1	59.3
202	13/11/2023	49	48	54.2
202	14/11/2023	48.8	47.7	53
202	15/11/2023	50.6	50.4	50.3
202	16/11/2023	50.8	49.7	54.6
202	17/11/2023	46.1	46.4	53.5
202	18/11/2023	42.5	44.6	56.2
202	19/11/2023	38.8	36.8	47.5
202	20/11/2023	45.3	46.1	54.4
202	21/11/2023	48.2	46.6	47.1
202	22/11/2023	47.2	46.7	47.2
202	23/11/2023	51.3	50.9	56.2
202	24/11/2023	46	46.8	52.6
202	25/11/2023	45.2	46.5	53
202	26/11/2023	47.8	48.5	56
202	27/11/2023	51.1	50.1	53.5

Table 6: Daily Measured Aircraft Noise Levels RMT203 Johnsonville

Location	Date	Daily Aircraft Ldn	Daily Aircraft LAeq(16hour)	Non- Aircraft LAeq(16hour)
203	1/09/2023	48.9	45.6	46.3
203	2/09/2023	48	44.9	45.3
203	3/09/2023	42.4	42	41
203	4/09/2023	39.9	40.3	43.3
203	5/09/2023	48.4	44.9	42.8
203	6/09/2023	46.9	44.8	46
203	7/09/2023	46.7	47.7	45.6
203	8/09/2023	49.6	45.7	42.1
203	9/09/2023	48.1	46.9	41.5
203	10/09/2023	46.8	48.2	42.4
203	11/09/2023	46.5	45.6	63.8
203	12/09/2023	49.1	47.8	45
203	13/09/2023	49.6	48.9	44.7
203	14/09/2023	47.3	46.4	48.6
203	15/09/2023	49.9	46.1	44.4
203	16/09/2023	48.4	45.6	47.5
203	17/09/2023	45.6	47.7	55.5
203	18/09/2023	47.6	48	51.1
203	19/09/2023	47.8	45.3	44.8
203	20/09/2023	45.8	45	45.4
203	21/09/2023	45.8	43.9	47.2
203	22/09/2023	47.6	44.9	46.1
203	23/09/2023	43.5	41.9	45.3
203	24/09/2023	40.6	40.2	45.2
203	25/09/2023	42.6	41	48.7
203	26/09/2023	43.2	43.4	51.3
203	27/09/2023	41.5	41.6	53.5
203	28/09/2023	48.5	47.3	43.4
203	29/09/2023	49.9	50.3	53.5
203	30/09/2023	40.7	42.6	49.1
203	1/10/2023	50.3	51.2	56.9
203	2/10/2023	46.8	44.2	53.5
203	3/10/2023	39.9	40.4	47.6
203	4/10/2023	47.4	47.1	47.3
203	5/10/2023	47.8	45.4	43.2
203	6/10/2023	46.7	45	47.4
203	7/10/2023	47.5	43.4	46.1
203	8/10/2023	39.9	40.6	43.9
203	9/10/2023	50.1	48.8	47.3
203	10/10/2023	49.8	46.7	44.9
203	11/10/2023	46.2	45.9	43.4
203	12/10/2023	50.4	48.8	44.3
203	13/10/2023	48.6	47.6	53.7
203	14/10/2023	44.1	42.5	52.8
203	15/10/2023	44.5	45.7	53.8
203	16/10/2023	50.3	48.4	59.3
203	17/10/2023	40.9	42.9	51.4
203	18/10/2023	47.8	49.6	48.5
203	19/10/2023	48.2	46.5	46
203	20/10/2023	47.8	47.1	46
203	21/10/2023	48.8	45.7	56.3
203	22/10/2023	40.2	40.7	46.2
203	23/10/2023	47.7	49.4	54.5
203	24/10/2023	47.5	46.4	48.5
203	25/10/2023	49	49.5	47.4
203	26/10/2023	44.6	44.4	54.4
203	27/10/2023	46.8	43.5	44.9
203	28/10/2023	49.5	44.2	41.6
203	29/10/2023	49.3	46.9	43.2
203	30/10/2023	45.7	45.7	43.1
203	31/10/2023	43.8	40.1	42.4
203	1/11/2023	49.9	48	43.8
203	2/11/2023	47	47.1	45.8
203	3/11/2023	49.4	49.3	46
203	4/11/2023	49	47.2	54.3
203	5/11/2023	48.2	46.4	57.7
203	6/11/2023	39.5	41.1	47.6
203	7/11/2023	40.4	39.6	46.5
203	8/11/2023	38.4	39.3	43.5
203	9/11/2023	39.2	40	44.7
203	10/11/2023	42.3	40.9	45.3
203	11/11/2023	49.7	46.8	48
203	12/11/2023	48	47.9	50.1
203	13/11/2023	47.5	45.9	49.8
203	14/11/2023	46.7	44.9	49.4
203	15/11/2023	49.8	49.2	46.3
203	16/11/2023	48.4	46.9	46.9
203	17/11/2023	44.9	44	48.7
203	18/11/2023	42.3	44.5	52.1
203	19/11/2023	36.9	35.8	43.4
203	20/11/2023	43	42.6	45.6
203	21/11/2023	47.1	41.2	43.2
203	22/11/2023	45.7	44.4	46
203	23/11/2023	48.5	47.6	45.8
203	24/11/2023	42.9	42.9	49.5
203	25/11/2023	43.3	43.9	49.5
203	26/11/2023	41.7	41.1	45.1
203	27/11/2023	49.7	48.1	47.1

APPENDIX B GLOSSARY OF TERMINOLOGY

L_{AE}	Exposure Level. An A-weighted measure of the total sound energy over a certain time period, compressed into 1 second. Used to describe the sound energy of a single event, such as a train pass-by or an aircraft flyover.
L_{Aeq}	The equivalent continuous A-weighted sound level. Commonly referred to as the average sound level and is measured in dB.
L_{Amax}	The A-weighted maximum sound level. The highest sound level which occurs during the measurement period. Usually measured with a fast time–weighting i.e. L_{AFmax}
L_{dn}	The day-night sound level calculated from the measured L_{Aeq} over a 24 hour period with a 10 decibel penalty applied to the night-time period (2200-0700 hours)