MARSHALL DAY Acoustics

WELLINGTON INTERNATIONAL AIRPORT
NORTHERN FLIGHT PATH OPTIONS ASSESSMENT

Rp 002 20220295 | 18 September 2024

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** **Northern Flight Path Options Assessment**
Prepared for:	**Wellington International Airport Limited** **PO Box 14175** **Kilbirnie** **Wellington 6241**
Attention:	**Wellington Airport Planning Manager**
Report No.:	**Rp 002 20220295**

Document control

Status:	Rev:	Comments	Date:	Author:	Reviewer:
Draft			24 July 2024	L Smith	
Draft	R01	Updated report	10 Sep 2024	S R King	L Smith
Issued	R02		18 Sep 2024	S R King	L Smith

Cover Photo: Robert de Bock

ISO 9001 Certified System

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1.0 INTRODUCTION

Wellington International Airport Limited (WIAL) has engaged Marshall Day Acoustics to assess the noise impact of three alternative flight path options for northerly jet departures.

Following the introduction of new flight paths by Airways Corporation New Zealand (Airways) in December 2022 under the new Divergent Missed Approach Protection System (DMAPS), there has been public comment on the changes relating to northerly jet departures. WIAL requested Airways to develop alternative options for assessment and public consultation which include:

1. Maintain the status quo.
2. Change the northerly route for jet departures before 7am to fly over less populated areas.
3. Changing the northerly route for jet departures to a similar route used before December 2022 over Newlands Ridge.

WIAL will also consider other options raised through the consultation process.

This report summarises our assessment which predicts and compares the noise impact of the three defined options by quantifying the number of residents affected under each scenario using a range of metrics.

The summary of our findings is that Option 3 (pre-DMAPS) would impact the most people for all the metrics applied in our assessment. Option 2 (new northeast route pre-7am) would have the least impact, affecting approximately half as many people as Option 1 (status quo). The status quo affects approximately 19 – 35% fewer people than the pre-DMAPS option and 23 – 59% more people than the new northeast route option.

If Option 2 was implemented, it would affect an area of Wellington that currently and historically has experienced low levels of aircraft noise. We assessed the impact on residents in Horokiwi and Korokoro which are the two suburbs most affected by Option 2. In summary we found that the change in noise in Horokiwi and Korokoro would be a noticeable compared to the current environment and some residents may be woken between 6am and 7am due to aircraft overflights. However overall, we consider that the predicted aircraft noise levels would not be unreasonable or excessive.

2.0 OPTIONS ASSESSMENT FOR NORTHERN FLIGHT PATHS

Airways is New Zealand's air traffic navigation service provider and is responsible for designing and publishing flight procedures for New Zealand airports. On 1 December 2022, Airways implemented flight path changes referred to as DMAPS, at Wellington Airport. DMAPS was implemented to make flights safer and more efficient.

Prior to DMAPS, the published flight paths for jet aircraft taking-off on runway 34 tracked directly north over eastern Johnsonville and Newlands areas.

The DMAPS flight paths for jets introduced in December 2022, turn to the north-west over the harbour, and then overfly Khandallah and Broadmeadows.

In 2024, WIAL asked Airways to consider alternatives for jet flight paths departing to the north (i.e. departures on runway 34). Airways has proposed three options for northerly jet departures that are operationally feasible. These are described below and illustrated in Figure 1.

Standard Instrument Departure or SID is a published departure flight procedure. Usually there are multiple SIDs for a given runway that are assigned depending on the aircraft type and destination. In this report, we use the term SID interchangeably with published flight path as this study relates to departure flight paths only.

The description of the three options below relates to the published flight paths which are single lines on the map, whereas in practice aircraft fly a more dispersed spread of flight paths. In Section 3.0, we describe the difference between published flight paths and actual flown flight paths and how this is accounted for in our assessment.

2.1 Option 1 – Status quo

This option is currently in operation and involves the DMAPS northern jet SIDs which turn slightly northwest over the harbour before overflying Khandallah and Broadmeadows.

2.2 Option 2 – Early morning departures on northeast flight path

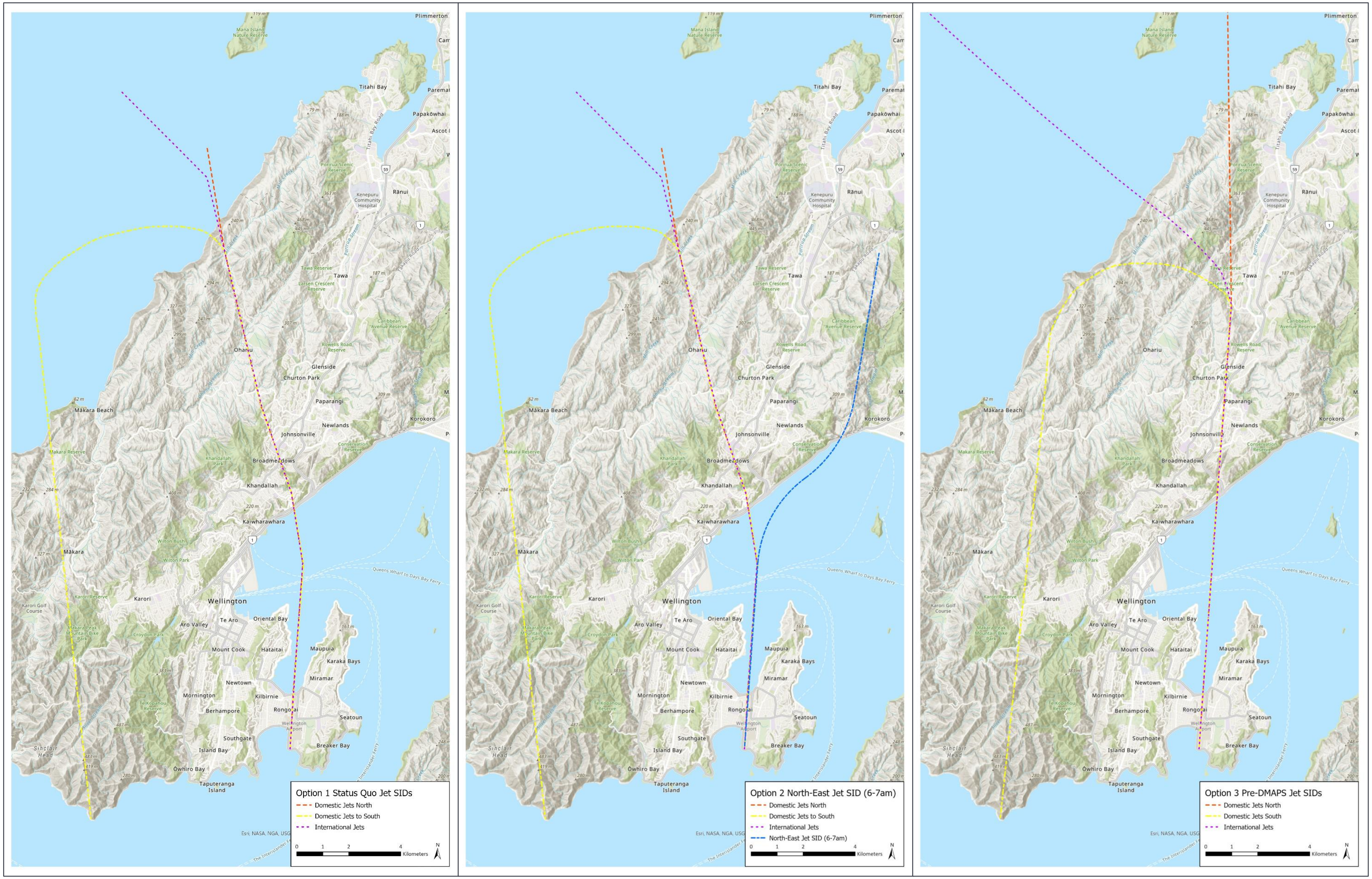
For this option, a new SID would be introduced for jet departures between 6am and 7am that overflies less populated areas to the northeast of the airport rather than overflying populated urban areas. For all other times of the day, this option would use the same DMAPS flight paths introduced in December 2022 (i.e. the status quo).

2.3 Option 3 – Return to pre-DMAPS flight paths

This option would change the northerly route for jet departures to a similar route used before December 2022 over Newlands Ridge. The previous SIDs head directly north overflying Newlands, eastern Johnsonville and Churton Park.

The flight tracks for the three options are shown overleaf in Figure 1.

Figure 1: Runway 34 departure flight tracks for the three options



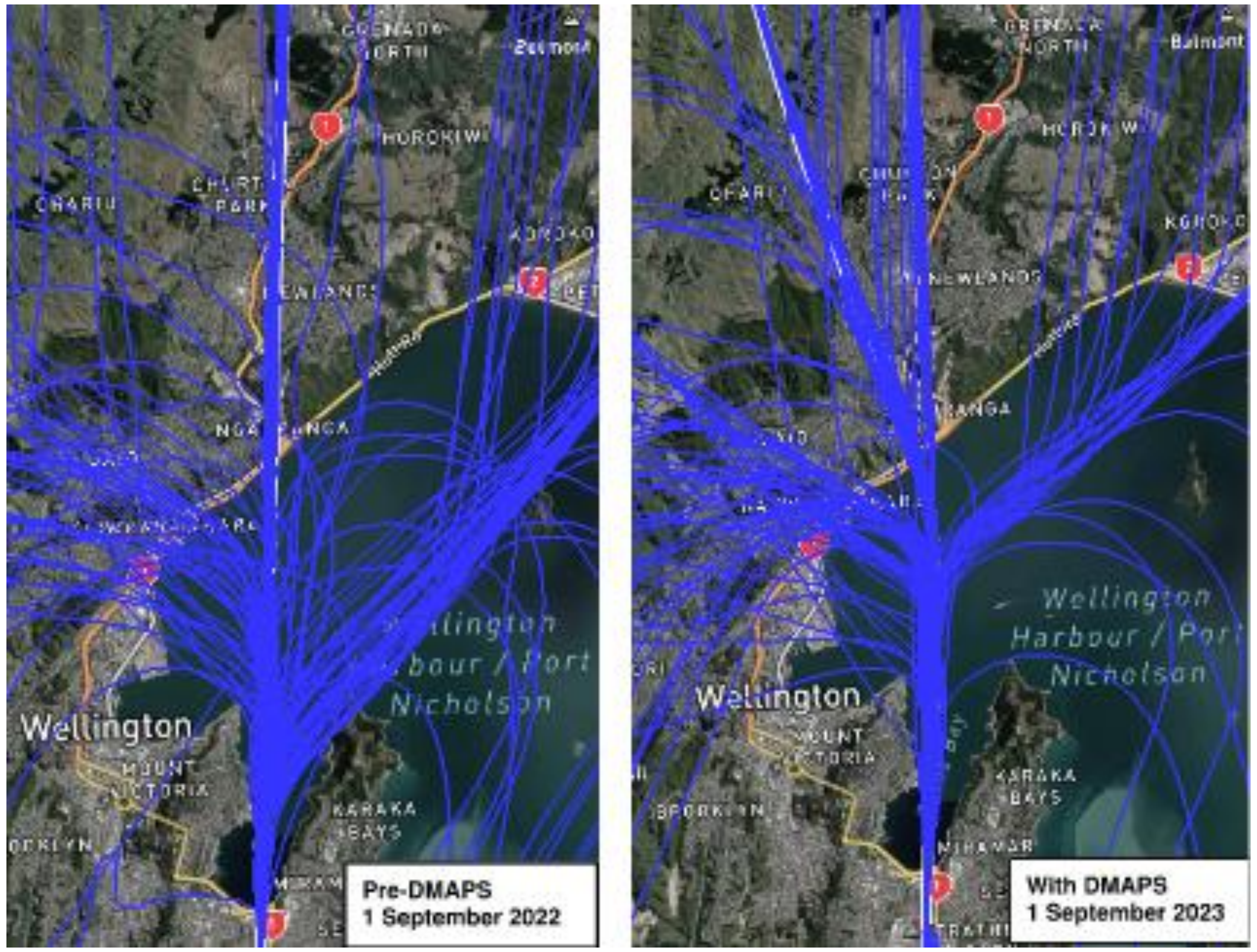
3.0 PUBLISHED FLIGHT PATHS AND FLOWN FLIGHT PATHS

The published flight paths are shown as single lines on the map in Figure 1, however 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 path when air traffic control permits, so they can take a more direct route to their destination.

To show this, we have two examples of actual flight track data shown in Figure 2 (24 hours each). These examples show a runway 34 day (northerly wind) before DMAPS was implemented, and one afterwards. The maps include jet and turbo-prop departures which use different SIDs.

For our assessment we have undertaken aircraft noise modelling to predict noise levels received by residents under each of the three options. Rather than modelling aircraft accurately following the published flight paths, we have accounted for the dispersion of flight paths in the model. In addition, we have used the radar maps to estimate the proportion of departures diverting off the published procedures and modelled this too. This means the real-life variability is approximated in the modelling.

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



4.0 AIRCRAFT NOISE METRICS

4.1 Day night level (L_{dn})

The New Zealand Standard for managing aircraft noise around airports (NZS 6805:1992[1]) 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 but 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 depends on wind direction which means that flight paths also vary depending on the wind. 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. Annoyance is discussed further in the following section.

4.2 Number of people highly annoyed

The most common method of quantifying the effects of aircraft noise is to apply a dose-response relationship. This predicts the percentage of people likely to be highly annoyed by a given level of aircraft noise exposure (based on L_{dn} or equivalent metric). There have been many dose-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. Figure 3 overleaf shows a sample of these "Percentage of people highly annoyed" (%HA) curves. For our options analysis, we have used the 2018 World Health Organisation (WHO 2018) annoyance curve.

The purpose of our options analysis is to assess the relative scale of effects between the three options. The number of people highly annoyed provides an appropriate single figure objective measure of the affected population under each option for comparison.

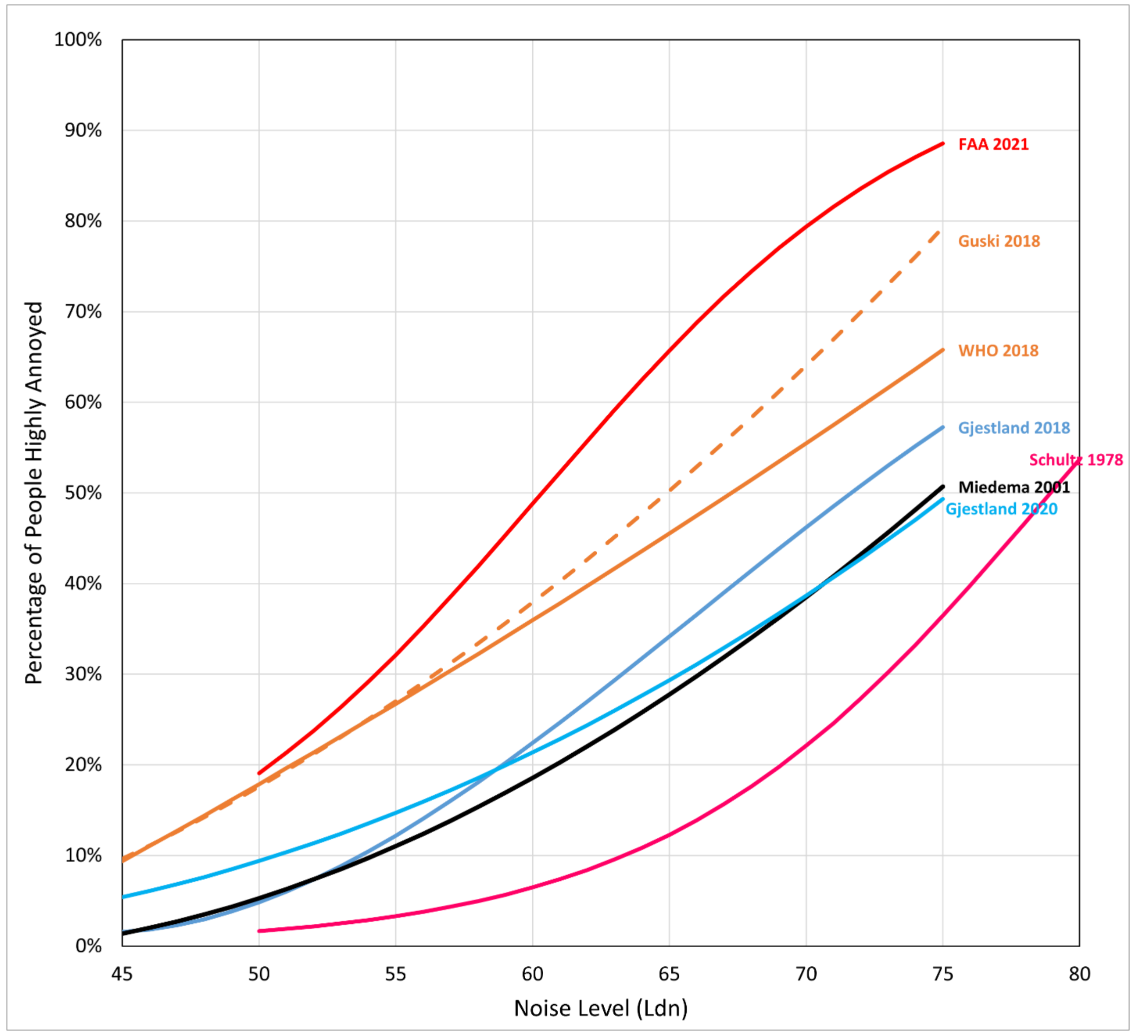
We have calculated the number of people highly annoyed based on the 24-hour L_{dn} noise exposure for each option assuming northerly winds and the current level of air traffic. Although the annoyance curve is generally associated with the 12-month average aircraft noise exposure, we consider it is appropriate to apply the curve to the 24-hour noise exposure to compare the relative annoyance impacts of the three options.

We have calculated the number of people highly annoyed based on the following formula using L_{dn} noise contours in one decibel increments (from 45 to 75 dB L_{dn}).

$$No.People\ HA = \sum \text{No. dwellings} \times \text{average occupancy} \times \%\text{HA}$$

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

Figure 3: A sample of aircraft noise dose response curves



4.3 Number above metric (N60 and N65)

Individual aircraft events can have short term effects that are different to the overall long term noise exposure. Individual events can be assessed using single event noise metrics such as L_{Amax} which is the maximum noise level occurring during the aircraft noise event.

In Australia, a metric which quantifies the number of aircraft events above a certain L_{Amax} level is used to assess airport noise. This recognises that the impact of one loud event per day is not the same as many loud events. The metric was developed to help residents more readily understand what they will experience compared with an energy average metric such as L_{dn}. The Australian framework uses N70 and N65 contours which are the number of events above 70 and 65 dB L_{Amax} respectively. N60 contours are also used for the night-time period between 11pm and 6am.

For this study we have calculated N65 contours for aircraft movements over a 24-hour period for the three options. N65 contours extend further than N70 contours, and since the neighbourhoods of concern are more than 5km away from the airport, we consider that N65 contours are most suitable for this analysis. For the early morning period (6am to 7am) we have calculated N60 contours as the impact during this period relates to sleep disturbance therefore the night-time metric is most appropriate.

5.0 ASSESSMENT METHODOLOGY

To compare the relative noise impact of the three northern flight path options, we have quantified the number of residents affected under each option using several methods. We have assessed aircraft noise experienced over a 24-hour period and the one-hour early morning period between 6am and 7am. Our assessment is based on the current level of aircraft operations[2] rather than a future projection.

5.1 24-hour noise exposure

We have calculated L_{dn} noise contours for a 24-hour period of aircraft movements assuming northerly wind conditions for each of the three options (i.e. aircraft departing towards the north on runway 34 for 24 hours – this occurs on average 60% of the year).

These noise contours have been used to calculate the number of people highly annoyed for each option using the 2018 WHO annoyance response curve discussed in Section 4.2. We have used L_{dn} contours down to 45 dB L_{dn} for this analysis.

We have also calculated N65 contours (Number of events above 65 dB L_{Amax}) over 24 hours for each of the three options. These contours have been used to quantify the number residents affected by disruptive aircraft noise events under each option.

5.2 Early morning one hour noise exposure (6am to 7am)

Commercial passenger flights commence from 6am at Wellington Airport. Complaints relating to the DMAPS flight path changes, identify that early morning jet departures are particularly disruptive.

Option 2 seeks to address this issue by directing jet departures between 6am and 7am over less populated areas. Option 1 would maintain the status quo with early morning flights over a populated urban area. Option 3 would direct these flights over a different populated urban area.

To compare the noise impact of the three options specifically for this early morning period, we have calculated the one-hour average noise exposure ($L_{Aeq(1h)}$) from aircraft operations between 6am and 7am under northerly wind conditions (i.e. departures towards the north on runway 34). These contours have been used to quantify the number of residents exposed to 45 dB $L_{Aeq(1h)}$ or more.

We have also calculated N60 contours (Number of events above 60 dB L_{Amax}) over the one-hour period. These contours have been used to quantify the number of residents that would experience potentially sleep disturbing aircraft noise events under each option.

5.3 Residential dataset for analysis

To quantify the number of residents affected by each option, we first prepared a map of residential properties in the areas of interest. We used Geographic Information Systems (GIS) software and data including district plan zoning data, unit titles and building footprints to develop the dataset of land parcels containing a dwelling. We have defined a dwelling as a property title with a building located in a zone with residential use[3]. Buildings such as apartments, which have multiple titles, are included as multiple dwellings in our dataset. We have assumed an average of 2.6 residents per dwelling[4].

Figure 4 overleaf shows the extent of the residential dataset used for our analysis. In the neighbourhoods near the airport the noise levels experienced from the three options doesn't differ, so we have excluded this area from our analysis. This excluded area is within approximately 3.5 km of the airport and is shown in Figure 4 as "Local Airport Area".

[2] We used the actual aircraft movements from the busiest 90 days during the 2024 Financial Year (FY24). This is the same data used to calculate the FY24 compliance contour. The busiest 90 days were 02/01/2024 to 31/03/2024.

[3] The district plan zones included are listed in Appendix B.

[4] Based on occupancy data from 2018 Census for Wellington Region.

Figure 4: Extent of Wellington Region considered for assessment

5.4 Modelling inputs

We used the airport modelling software *AEDT* [5] to calculate noise contours for this study.

The aircraft movement data used for the modelling was the same data used to calculate Wellington Airport's 2024 Financial Year (FY24) compliance contours and represents actual aircraft movements between 2 January and 31 March 2024.

The aircraft movement data includes the following details for every movement:

– Operation (arrival or departure)
– Aircraft type
– Destination or departure airport
– Time of flight (to determine night-time noise)

We have prepared flight tracks in the model based on information from Airways on the published and proposed SIDs and our analysis of actual flown flight paths from radar data available in WIAL's noise monitoring system ANOMS[6] (as discussed in Section 3.0).

5.5 Model calibration

In 2023 WIAL undertook noise monitoring in Broadmeadows, Khandallah, Johnsonville and Ngaio. MDA analysed the measurement data and prepared a summary report dated 21 December 2023. The measurement results indicated that the actual noise levels for certain jet aircraft are slightly higher than the noise model predicts. Therefore, prior to carrying out modelling for this study, we have undertaken a calibration exercise to adjust the modelling inputs, so the outputs better represent the measured noise levels.

We have calibrated inputs for the A320, A320neo, A321neo and B738 aircraft by adjusting one or more of the following parameters:

- aircraft engine code;
- departure profile;
- stage length.

The outcome is that the calibrated modelled noise levels are within 1 dB of the measured levels from the 2023 monitoring study[7] which is an acceptable tolerance. Without calibration the discrepancy was up to 5 dB for some aircraft.

[5] Aviation Environmental Design Tool, version 3e. Created by the U.S. Federal Aviation Administration.

[6] This is the noise and operations monitoring system used by WIAL. It contains flight information including actual flight paths flown, type of aircraft, and noise levels measured by noise monitoring stations.

[7] The calibration exercise focused on L_{Amax} noise levels.

6.0 RESULTS

6.1 24-hour assessment

People highly annoyed

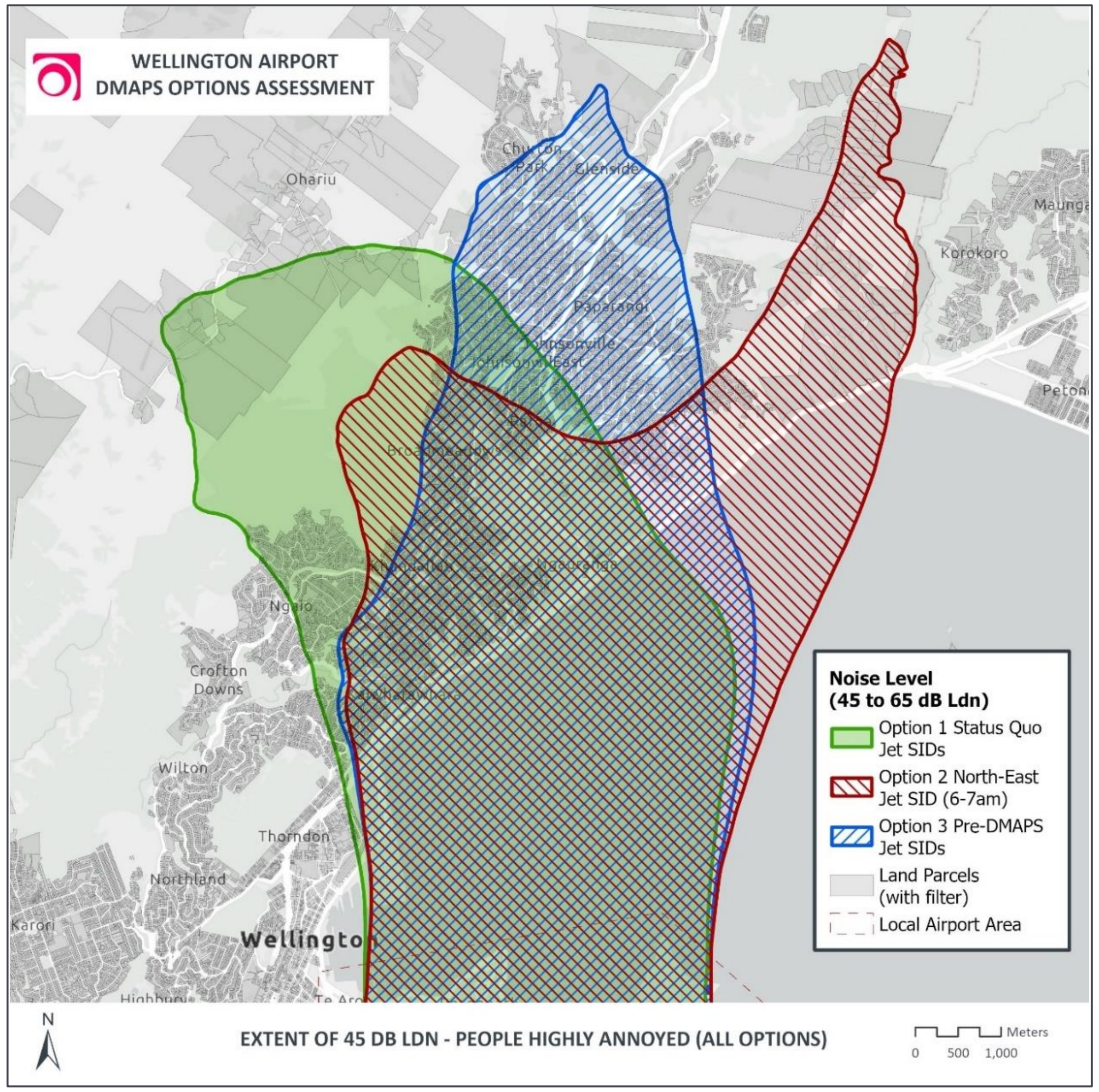
Figure 5 shows the extent of the calculated 45 dB L_{dn} contours for each option. There is substantial overlap (the brown region) between all three options which covers most of Kaiwharawhara, Khandallah and Broadmeadows. Appendix C1 shows these three contours separately.

Table 1 shows the calculated number of people highly annoyed for each option. Using this measure, Option 3 would have the greatest impact and Option 2 would have the least impact.

Table 1: Number of people highly annoyed (using WHO 2018)

	Option 1 Status Quo	Option 2 Northeast SID (6-7am)	Option 3 Pre-DMAPS
People Highly Annoyed	3,823	2,056	4,724

Figure 5: Extent of 45 dB L_{dn} contours for a northerly day



People affected by N65 events

We calculated the number of people affected by aircraft noise events of 65 dB L_{Amax} or greater for each of the options. This is summarised with two brackets: 1 to 9 events over 24 hours (very low number of events), and 10 to 19 events over 24 hours (low number of events).

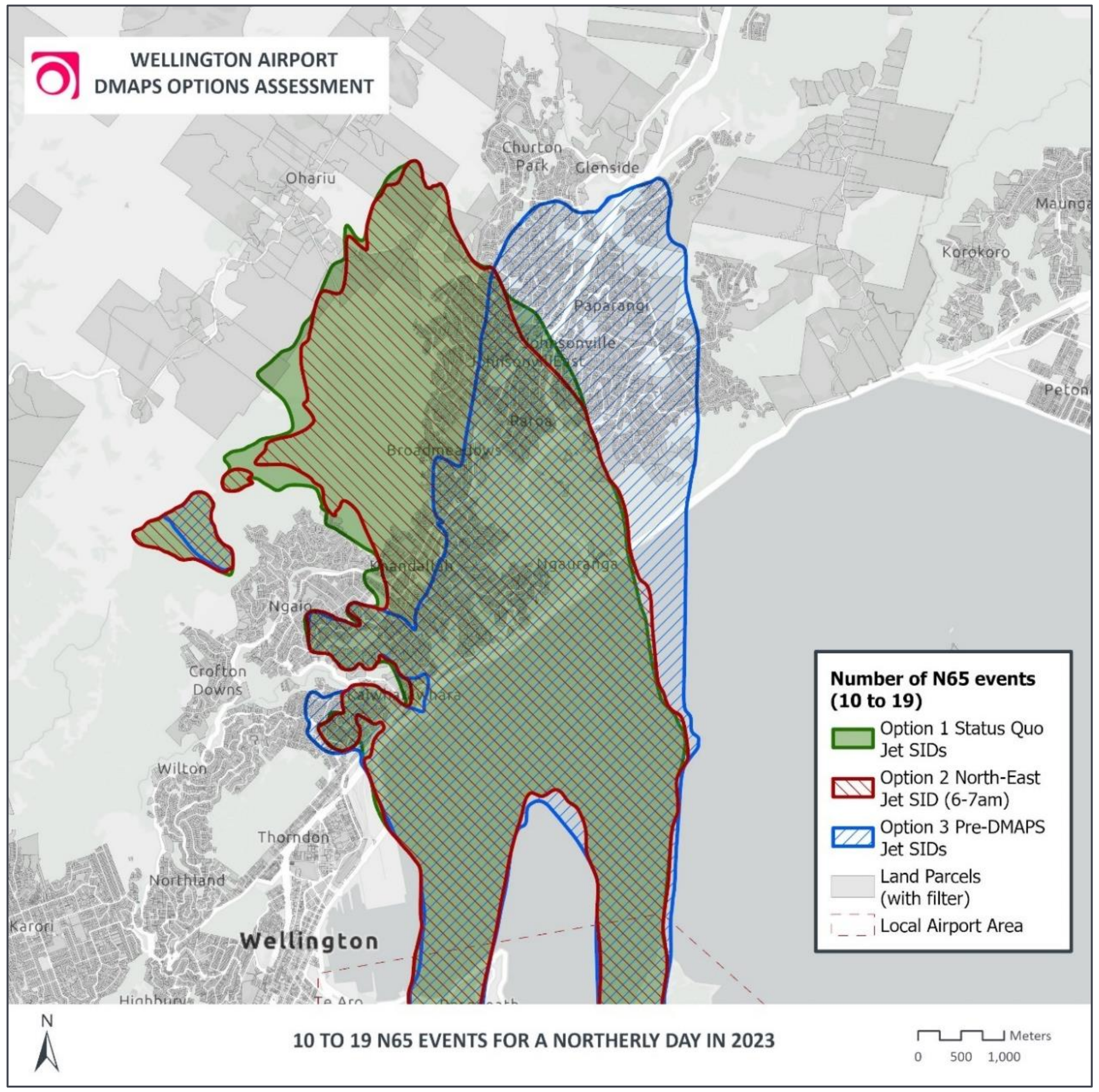
Table 2 summarises the results and Figure 6 shows the 10 – 19 event N65 contours for each option. The N65 contours with both brackets shown are also shown separately in Appendix C2.

Using the N65 measure, Option 3 would have the greatest impact. Overall Option 1 would have the least impact, however we note that Option 2 would affect fewer residents in the 10 – 19 events bracket.

Table 2: Number of people affected by aircraft events above 65 dB L_{Amax} (N65)

Number of events	Option 1 Status quo	Option 2 Northeast SID (6-7am)	Option 3 Pre-DMAPS
1 to 9	58,204	60,749	65,931
10 to 19	22,316	20,756	29,570
Total	**80,519**	**81,505**	**95,501**

Figure 6: N65 contours (10 to 19 events) for a northerly day



6.2 Early morning assessment - 6am to 7am

People affected by early morning noise levels above 45 dB $L_{Aeq\ (1\ hour)}$

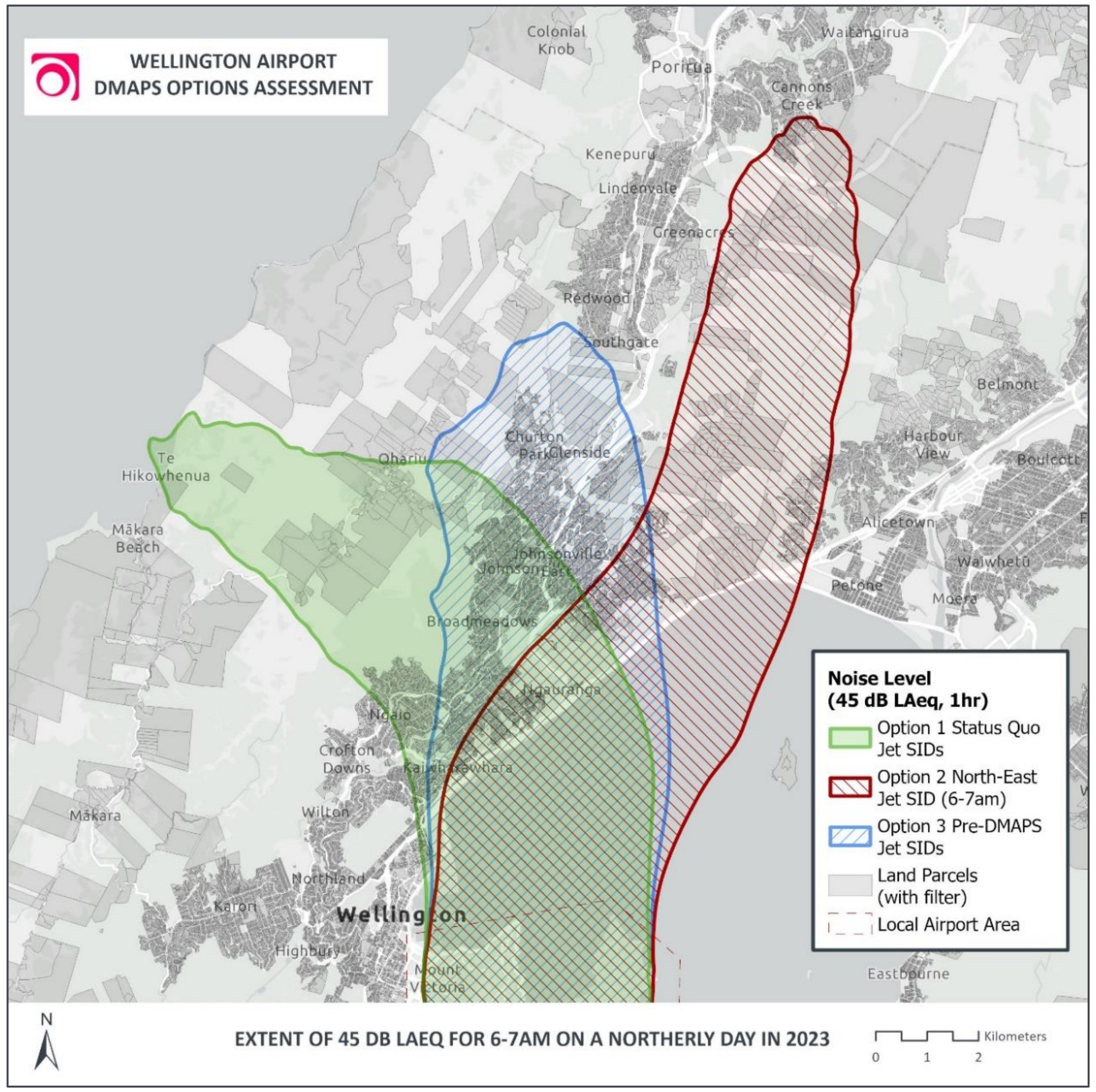
Figure 7 shows the extent of the calculated 45 dB $L_{Aeq(1h)}$ contours for each of the options. We used these contours to count the number of people affected by early morning aircraft noise. Appendix C3 shows these contours separately and Table 3 summarises the results in three decibel bands.

Using this measure, Option 3 would have the greatest impact, and Option 2 would have the least impact by a substantial margin.

Table 3: Number of people affected by early morning noise levels above 45 dB $L_{Aeq\ (1\ hour)}$

Noise level ($L_{Aeq\ (1\ hour)}$)	Option 1 Status quo	Option 2 Northeast SID (6-7am)	Option 3 Pre-DMAPS
45 - 47	14,472	9,669	16,515
48 - 50	8,645	3,086	20,498
51 - 53	7,842	3	4,826
Total	**30,958**	**12,758**	**41,839**

Figure 7: Extent of 45 $L_{Aeq,\ 1\ hour}$ for 6am-7am for a northerly day



People affected by early morning N60 events

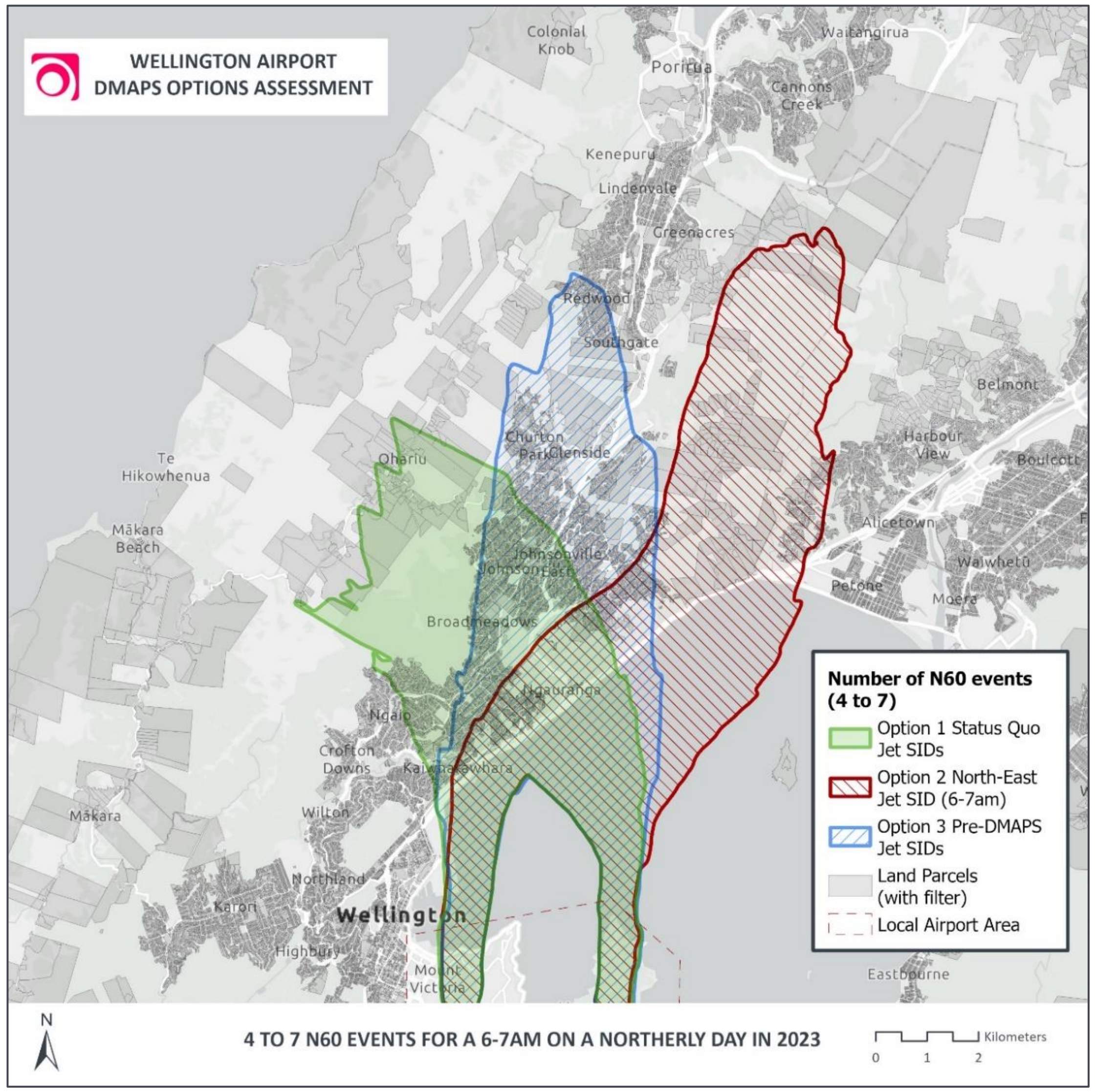
Table 4 shows the number of people affected by aircraft events of 60 dB L_{Amax} or greater between 6am and 7am for each of the options. Figure 8 shows the extent of the 4 to 7 event bracket for each options. The N60 contours with both brackets shown are shown separately in Appendix C4.

Using this measure, Option 3 would have the greatest impact and Option 2 would have the least impact overall.

Table 4: Number of people affected by aircraft events above 60 dB L_{Amax} (6am – 7am)

Number of events	Option 1 Status quo	Option 2 Northeast SID (6-7am)	Option 3 Pre-DMAPS
1 to 3	14,916	23,098	15,714
4 to 7	27,568	9,542	41,189
Total	**42,484**	**32,640**	**56,904**

Figure 8: N60 contours (4 to 7 events) for 6am-7am for a northerly day



6.3 Assessment summary

Table 5 provides a summary of how Option 2 and Option 3 compare against the status quo (Option 1) for all four of the applied metrics.

In general, our analysis shows that Option 2 would affect substantially fewer people than Option 1 (23% to 59% fewer) in all metrics except N65 events (which is almost identical to Option 1). Option 3 would affect substantially more people (19% to 35%) than Option 1 for all of the applied metrics.

Table 5: Option 2 and Option 3 percentage change in affected population compared with Option 1

	Option 1 Status Quo	Option 2 Northeast early morning flights	Option 3 Pre-DMAPS
24-hour period			
People Highly Annoyed	-	-46%	+24%
N65 events	-	+1%	+19%
6am to 7am			
45+ $L_{Aeq(1h)}$	-	-59%	+35%
N60 events	-	-23%	+34%

7.0 IMPACT OF OPTION 2 ON HOROKIWI AND KOROKORO

If Option 2 was implemented (early morning departures on northeast flight path), it would affect an area of Wellington that currently and historically has experienced low levels of aircraft noise.

To assess the effect of Option 2 on Horokiwi and Korokoro residents, we have considered the following which are discussed in sections 7.1 to 7.5:

1. What is the current noise environment in this area
2. What is the current level of aircraft noise experienced in this area
3. What would Option 2 mean in terms of change in noise for residents in this area
4. How many residents in this area would be impacted
5. How loud would overflights be in this area compared with Khandallah

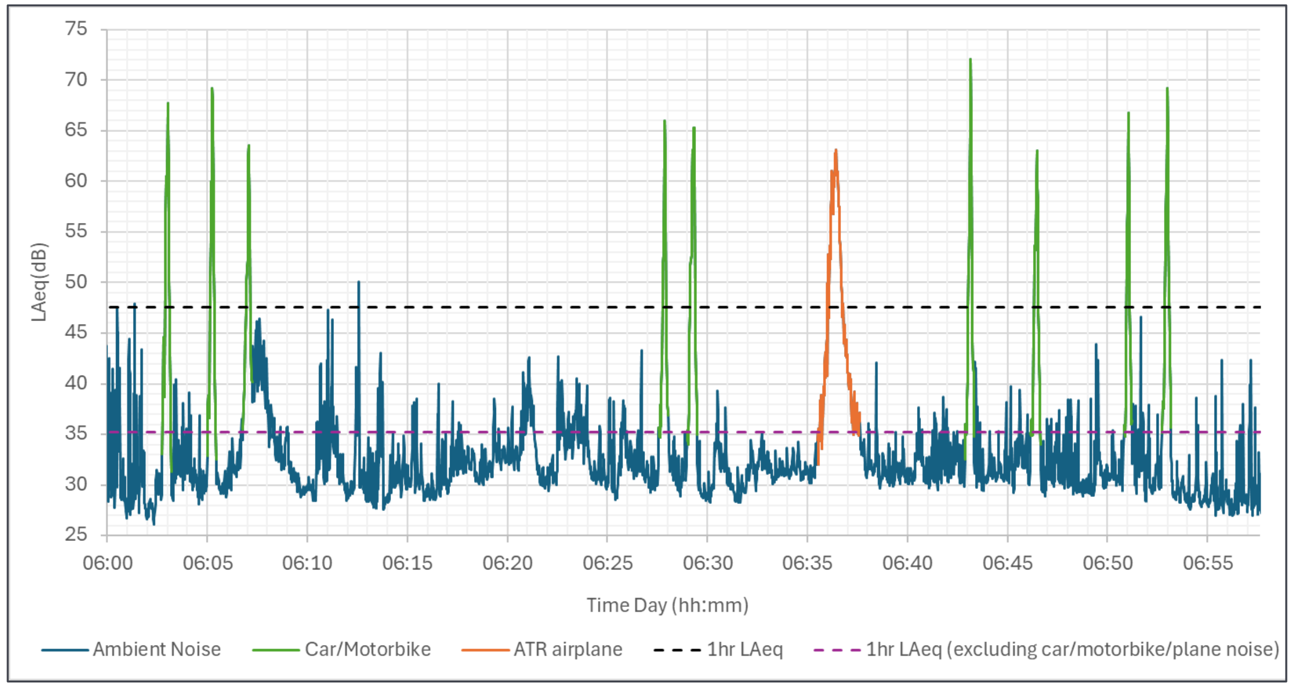
7.1 Measurements of the existing noise environment

To quantify the existing noise environment we carried out a noise survey between 6am and 7am on 05 July 2024 near 189 Horokiwi Road. Noise levels were measured every second for one hour and the resulting time trace is shown in Figure 9. The average noise level during this hour was 48 dB $L_{Aeq\,(1\,hour)}$which is shown as the black dashed line in Figure 9.

The main continuous noise during this time was from traffic on State Highway 2, with occasional noise from the nearby Horokiwi quarry. The noise logger was approximately 4 m from the roadside therefore occasional local traffic registered as discrete loud events. During the measurement period, there were eight cars and one motorbike (the loudest event at 6.43am). Distant aircraft were audible and one ATR aircraft overflew the noise logger.

In total there were 10 loud events, which were all above 60 dB L_{Amax}. These events are marked in green or orange on the figure. The measured maximum level from the ATR (turboprop) overflight was 63 dB L_{Amax}. If we remove these 10 events from the sample, the residual sound was 35 dB $L_{Aeq\,(1\,hour)}$, shown as the purple dashed line.

Figure 9: Early morning noise survey (6 to 7am) in Horokiwi

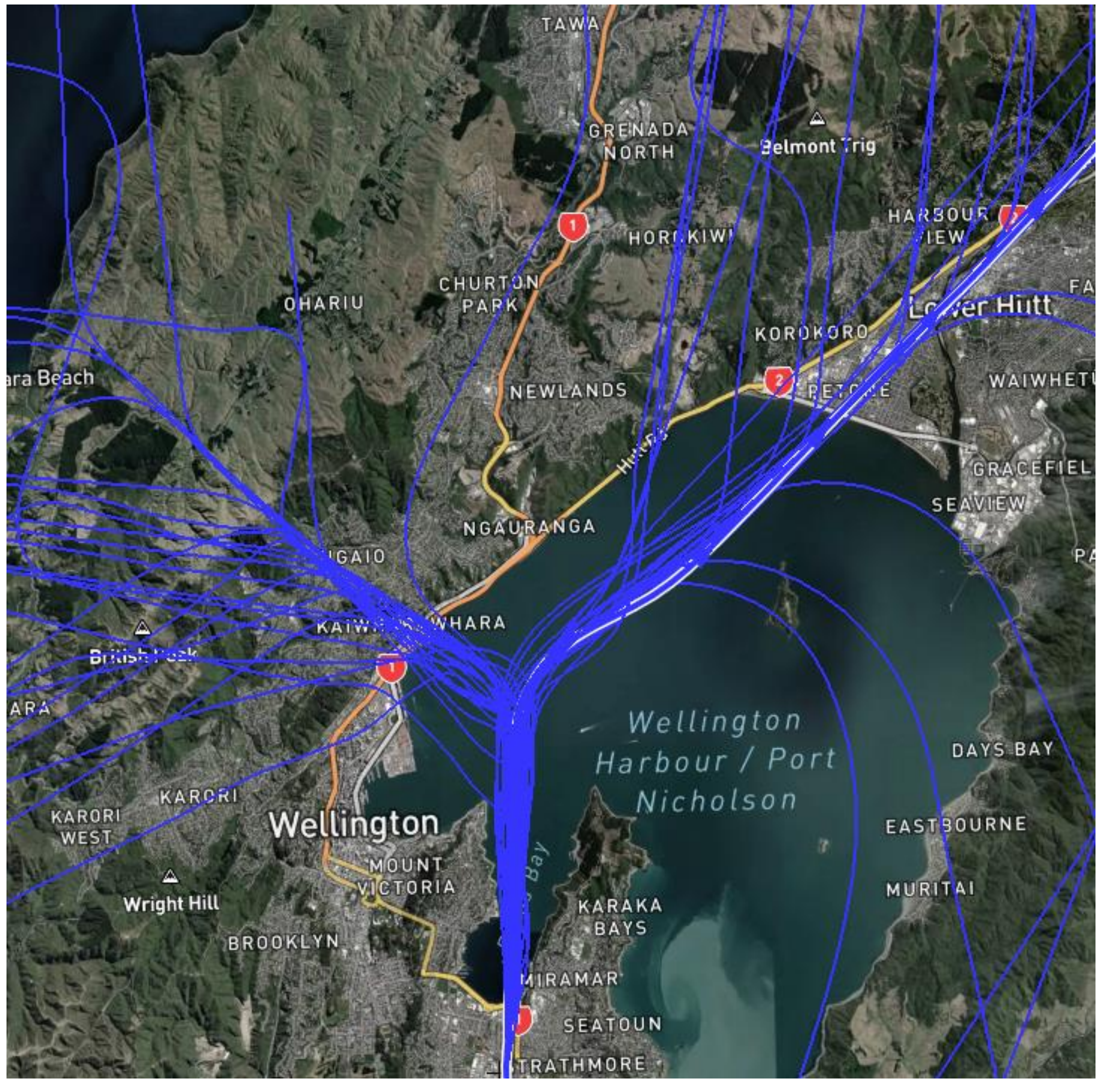


7.2 Current aircraft noise in Horokiwi and Korokoro

Currently turbo-prop aircraft heading north overfly the Horokiwi and Korokoro areas although the number of overflights8 is relatively low. Jet aircraft generally do not currently overfly these areas.

Between 6am and 7am there is a regular turbo-prop flight to Hamilton that overflies the area when the wind is from the north. We have analysed movement records for January to July 2024 and found this overflight typically occurs one day out of three. We measured a maximum level of 63 dB L_{Amax} from one of these flights in Horokiwi.

Figure 10: Turbo-prop flight paths on a day with northerly winds



7.3 Change in noise due to Option 2

Option 2 would change the noise environment in Horokiwi and Korokoro between 6am and 7am on days with northerly winds. Outside of these times, there would be no change. We have analysed runway utilisation records between 6am and 7am since 2021 and found that during this hour, runway 34 is used 60 – 70% of the time which is two out of three days on average.

We have predicted the change in noise between 6am and 7am based on current aircraft operations at Wellington Airport.

Currently Horokiwi and Korokoro experience one early morning turbo-prop overflight every third day on average. Option 2 would introduce an additional four jet overflights on two days out of three. Table 6 lists the number of departures between 6am and 7am that would use the new flight path based on 2024 movements.

Table 6: Aircraft departures over Horokiwi/Korokoro 6am – 7am in northerly winds

Aircraft/Destination	Current	Option 2
Domestic turbo-prop	1	1
Domestic jet	0	2
Trans-Tasman jet	0	2
Total	1	5

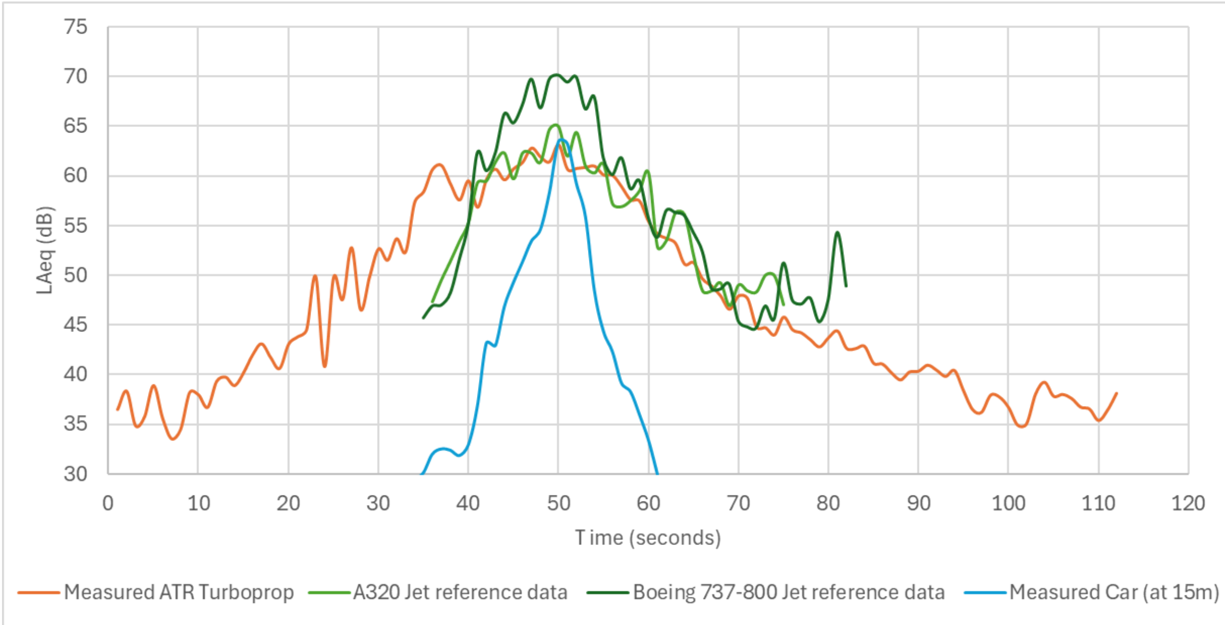
The existing noise environment survey showed there are similarly high noise events in the area between 6am and 7am. During the survey there were 10 events which were mostly traffic and one turbo-prop overflight. Option 2 would mean an additional four noisy events during this hour.

Figure 11 compares the noise levels from the existing noise events in the area (traffic pass-by and turbo-prop overflight), with the proposed jet overflights. For the traffic pass-by, we have adjusted the levels to represent houses at 15 m from the roadside (which is typical of Horokiwi). For the jet overflights, we have used measured data from the 2023 DMAPS monitoring study and adjusted the levels to represent overflights in Horokiwi.

There are two types of jets shown in the figure, a Boeing 737-800 and an Airbus A320. The 2023 monitoring study found that the Boeing is louder than the Airbus variants. Currently, one Boeing 737-800 departs between 6am and 7am and the other three departures are Airbus variants. The graph shows that the maximum noise levels from the Airbus overflights would be similar to current events (traffic and turbo-prop overflights). The Boeing overflight would be noticeably louder.

The graph shows that a traffic pass-by is a shorter duration event than an aircraft overflight. Also, we note many rural houses are further than 15 m from the road, therefore a traffic pass-by may not be subjectively comparable in all cases.

Figure 11: Comparison of different noise events – turboprop and jet aircraft, and a car pass-by



[8] An overflight is an event where an aircraft passes over or near a particular area

Another way to quantify the change in noise is to consider the change in average noise exposure between 6am and 7am. The measured existing noise environment was 48 dB $L_{Aeq(1\ hour)}$, and 35 dB $L_{Aeq(1\ hour)}$ excluding traffic and aircraft overflights. The addition of four jet overflights is predicted to increase this to 50 dB $L_{Aeq(1\ hour)}$.

In summary, there would be a noticeable change for residents in Horokiwi and Korokoro on mornings when the wind is from the north (two days out of three on average). In particular, the Boeing 737-800 overflight would subjectively sound twice as loud as the current turbo-prop overflights.

Section 7.4 quantifies the number of residents in Horokiwi and Korokoro that would be impacted by Option 2.

7.4 Number of residents affected in Horokiwi and Korokoro

Figure 12 shows the Option 2 flight path for jet departures between 6am and 7am relative to Horokiwi and Korokoro. We have calculated the number of residents in these two suburbs that would be affected by Option 2, and this is summarised in Table 7 (for all other Wellington suburbs see Appendix D and Appendix E).

Figure 12: Option 2 flight path relative to Horokiwi and Korokoro suburbs

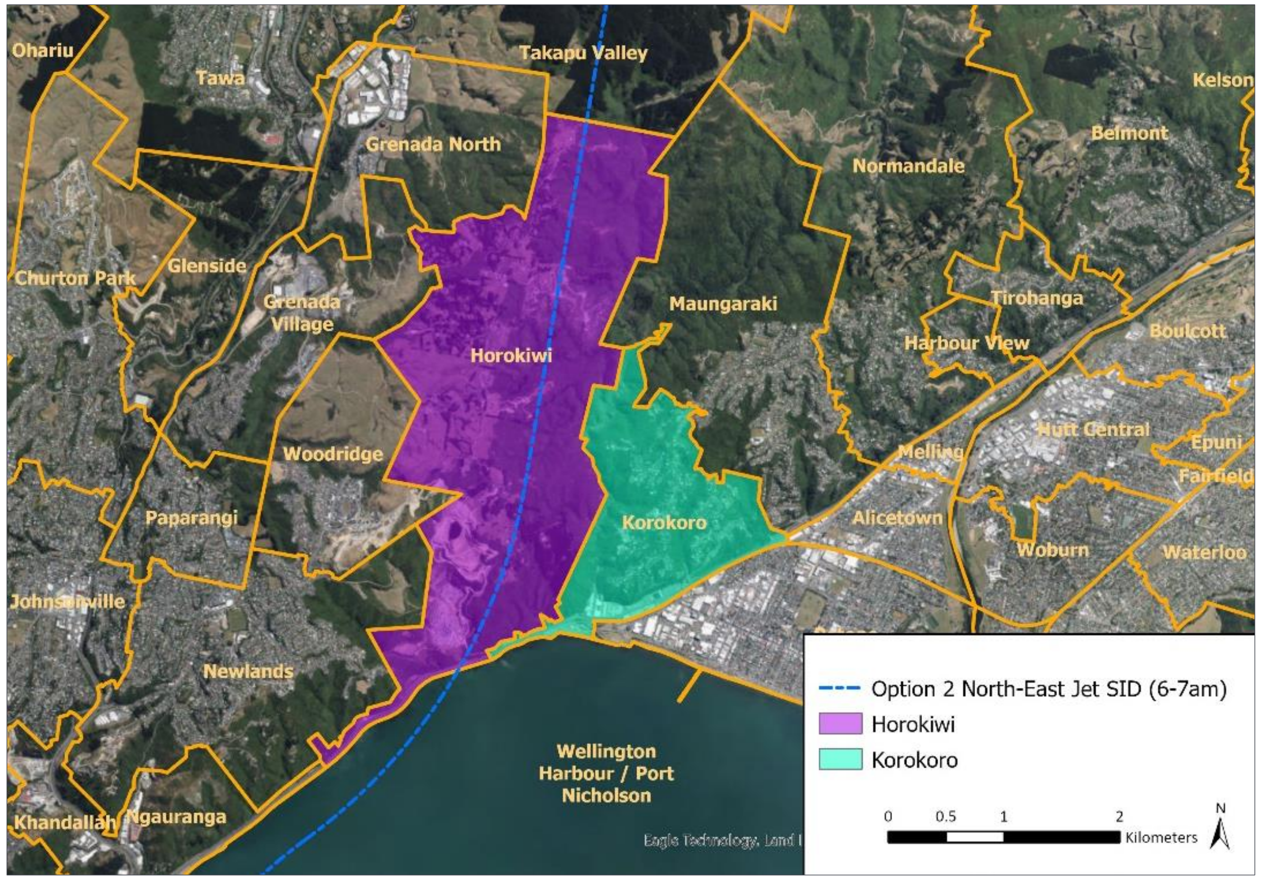


Table 7: Number of people in Horokiwi and Korokoro affected by Option 2

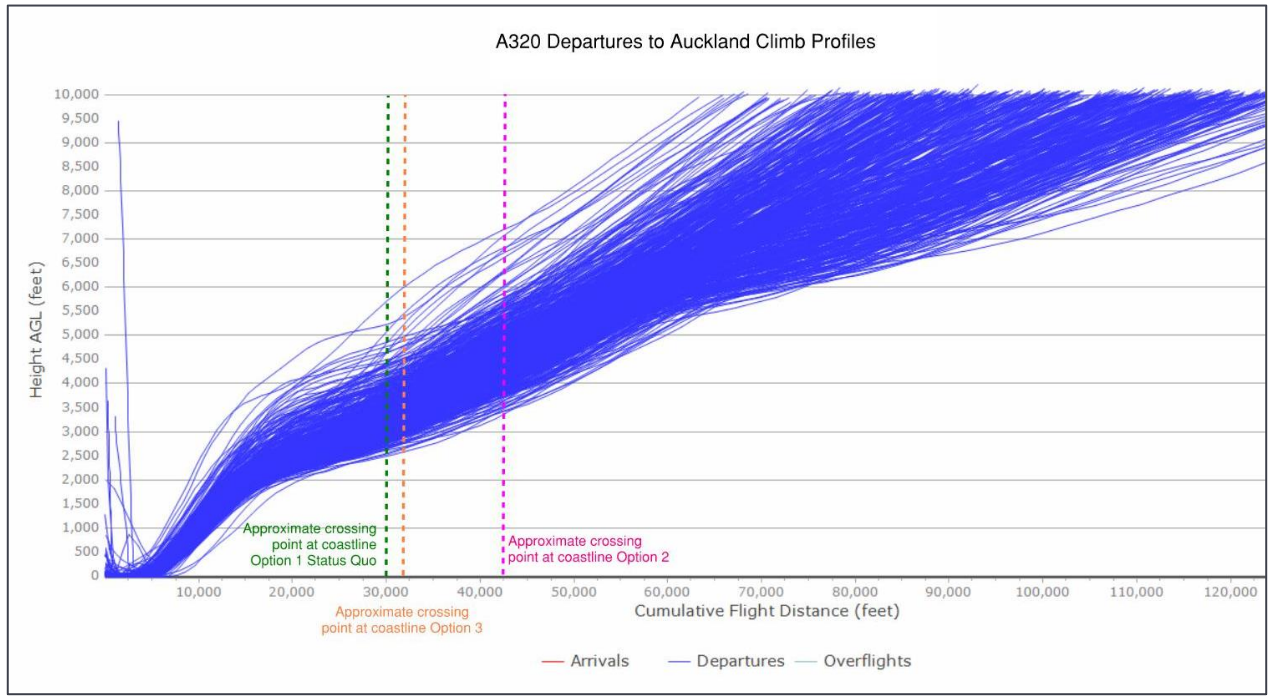
	Noise level above 45 dB $L_{Aeq\ (1\ hour)}$	Aircraft events above 60 dB L_{Amax} (N60)		
		1 to 3 events	4 to 7 events	Total
Horokiwi	239	0	239	239
Korokoro	1,048	291	1,204	1,495

7.5 Comparison of single event noise levels for Option 2 compared with Option 1

In this section we compare the single event noise levels for jet overflights for Option 1 (status quo) and Option 2. Individual aircraft events can be assessed using single event noise metrics such as L_{Amax} which is the maximum noise level occurring during an overflight. Louder individual events between 6am and 7am are more likely to wake residents.

The Option 2 flight path for jets between 6am and 7am, overflies the harbour for longer than Options 1 or 3, meaning that aircraft are higher and quieter when overflying residents. Figure 13 below shows a sample of jet departure climb profiles relative to residents for the three options. There is a large variation in climb rate which depends on several factors including aircraft weight and wind conditions. In Khandallah, jet aircraft altitudes range from 2,500 to 5,500 ft (green line) and in Horokiwi we estimate jet aircraft altitudes would range from 3,500 to 7,500 ft (purple line).

Figure 13: Sample of altitude profiles for A320 departures to Auckland



To predict how much quieter aircraft would be in Horokiwi compared with Khandallah due to the increased altitude, we have considered modelling predictions for an average climb profile. The noise model predicts that maximum noise levels would be 3 - 5 dB lower in Horokiwi than in Khandallah due to aircraft being higher.

We have also considered measurement data from the 2023 monitoring study by comparing the average measured L_{Amax} in Khandallah with the average measured L_{Amax} in Johnsonville where aircraft are higher. The measurement data suggests that maximum noise levels would be 5 decibels lower in Horokiwi than in Khandallah due to aircraft being higher.

Table 8 compares the predicted single event noise levels[9] for jet overflights in these two suburbs.

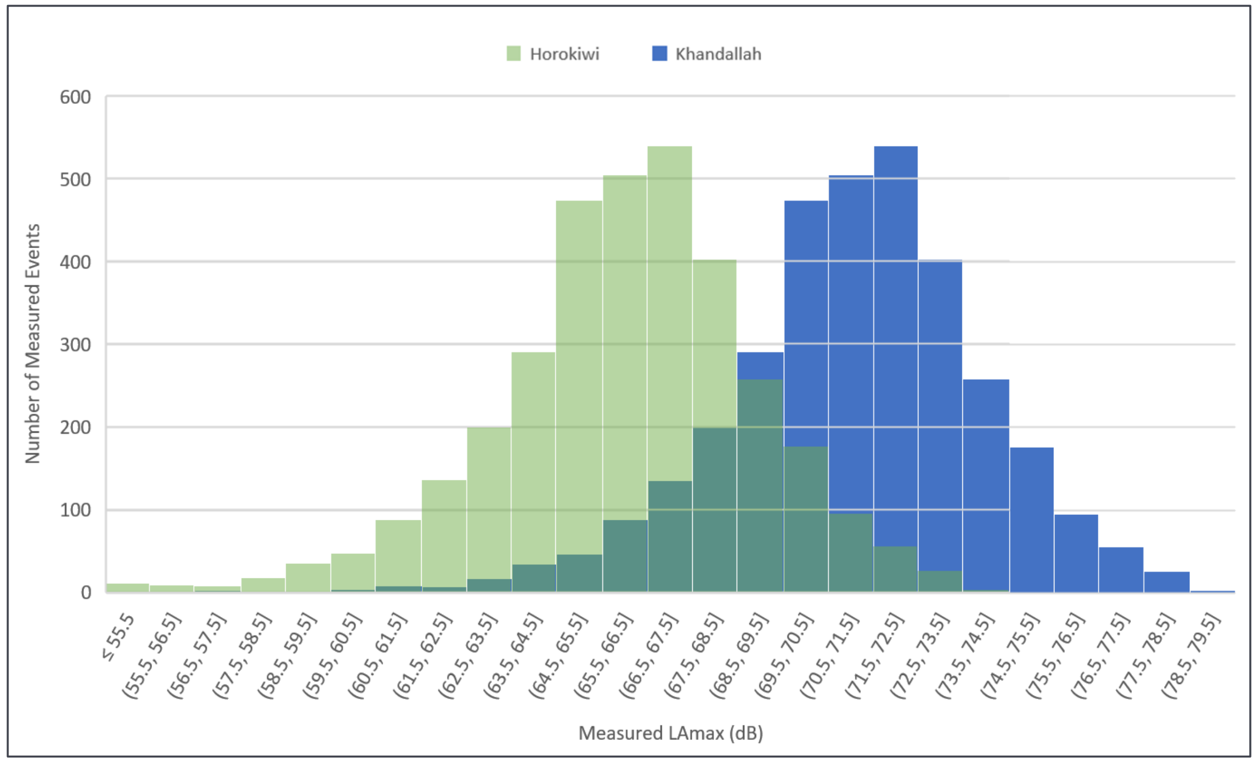
Table 8: Comparison of predicted overflight noise levels in Horokiwi and Khandallah

Aircraft Overflight	Khandallah (dB L_{Amax})	Horokiwi (dB L_{Amax})
Domestic A320	71	66
Trans-Tasman A21N	73	68
Trans-Tasman B738	76	71

For general environmental noise sources, maximum levels of 70 – 75 dB L_{Amax} are considered reasonable during night-time hours in residential areas. For aircraft events, there is a large range of metrics and thresholds applied for different purposes throughout the world.

Although the average single event noise levels in Horokiwi would be noticeably lower than in Khandallah, in practice some overflights in Horokiwi will be as loud as overflights in Khandallah due to the variation in climb profiles and other factors. Figure 14 demonstrates how the distribution of L_{Amax} levels received in the two suburbs would overlap.

Figure 14: Likely distribution of jet overflight single event noise levels in Horokiwi compared with Khandallah



7.6 Summary of impact on Horokiwi and Korokoro

In summary, we predict that under Option 2, the single event noise levels in Horokiwi and Korokoro would be a noticeable change to the current environment and some residents may be woken between 6am and 7am due to aircraft overflights. However overall, we consider that the predicted aircraft noise levels would not be unreasonable or excessive.

[9] The average L_{Amax} based on the average measured L_{Amax} at Homebush Rd Khandallah for each aircraft set out in the 2023 monitoring report

APPENDIX A GLOSSARY OF TERMINOLOGY

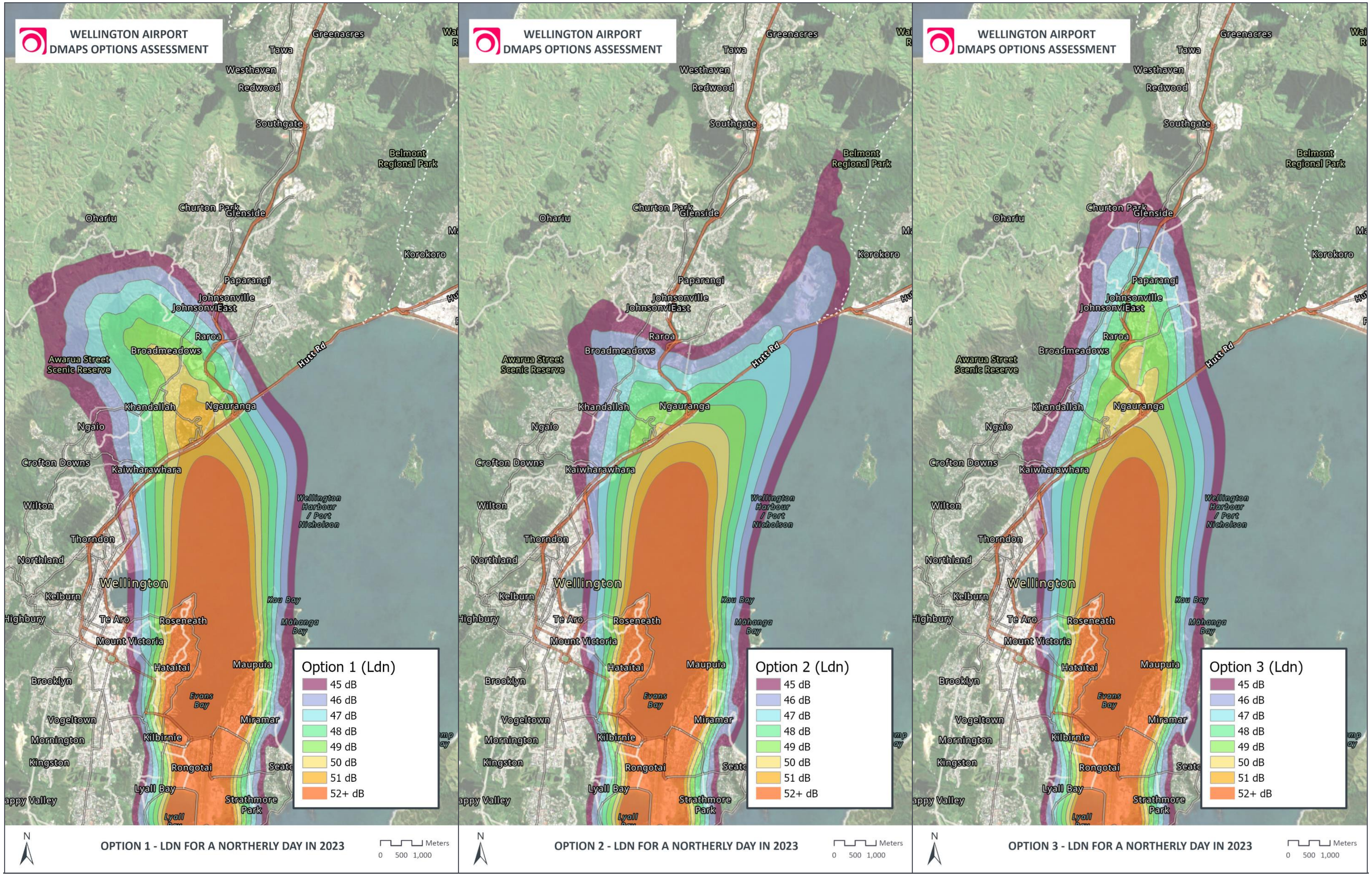
L_{AE}	Exposure Level. An A-weighted measure of the total sound energy over a certain time period, compressed into 1 second. Used to describe the sound energy of a single event, such as a train pass-by or an aircraft flyover.
L_{Aeq}	The equivalent continuous A-weighted sound level. Commonly referred 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)

APPENDIX B LIST OF DISTRICT PLAN ZONES INCLUDED IN HOUSE COUNTS

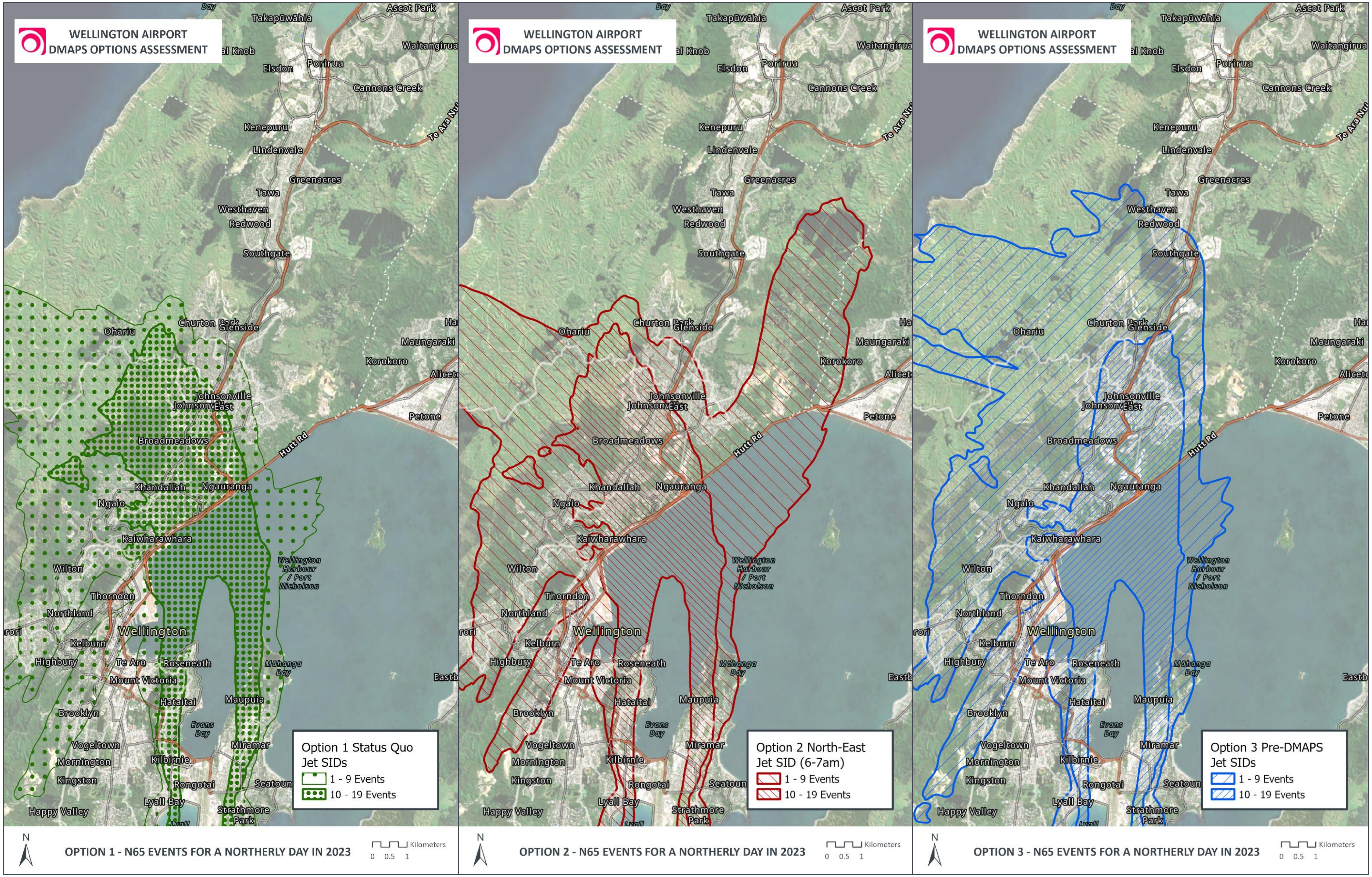
Hutt City Council	Porirua City Council	Wellington City Council
Community Health	City Centre Zone	City Centre Zone
Community Iwi	Future Urban Zone	General Residential Zone
General Residential	General Residential Zone	General Rural Zone
General Rural	General Rural Zone	Large Lot Residential Zone
Hill Residential	Hospital Zone	Medium Density Residential Zone
Historic Residential	Māori Purpose Zone (Hongoeka)	Metropolitan Centre Zone
Medium Density Residential	Medium Density Residential Zone	Mixed Use Zone
Rural Residential	Mixed Use Zone	Neighbourhood Centre Zone
Special Residential	Neighbourhood Centre Zone	Special Purpose Corrections Zone
Suburban Mixed Use	Rural Lifestyle Zone	Special Purpose Future Urban Zone
	Settlement Zone	Special Purpose Hospital Zone
	Special Purpose Zone (BRANZ)	Special Purpose Tertiary Education Zone

APPENDIX C FIGURES

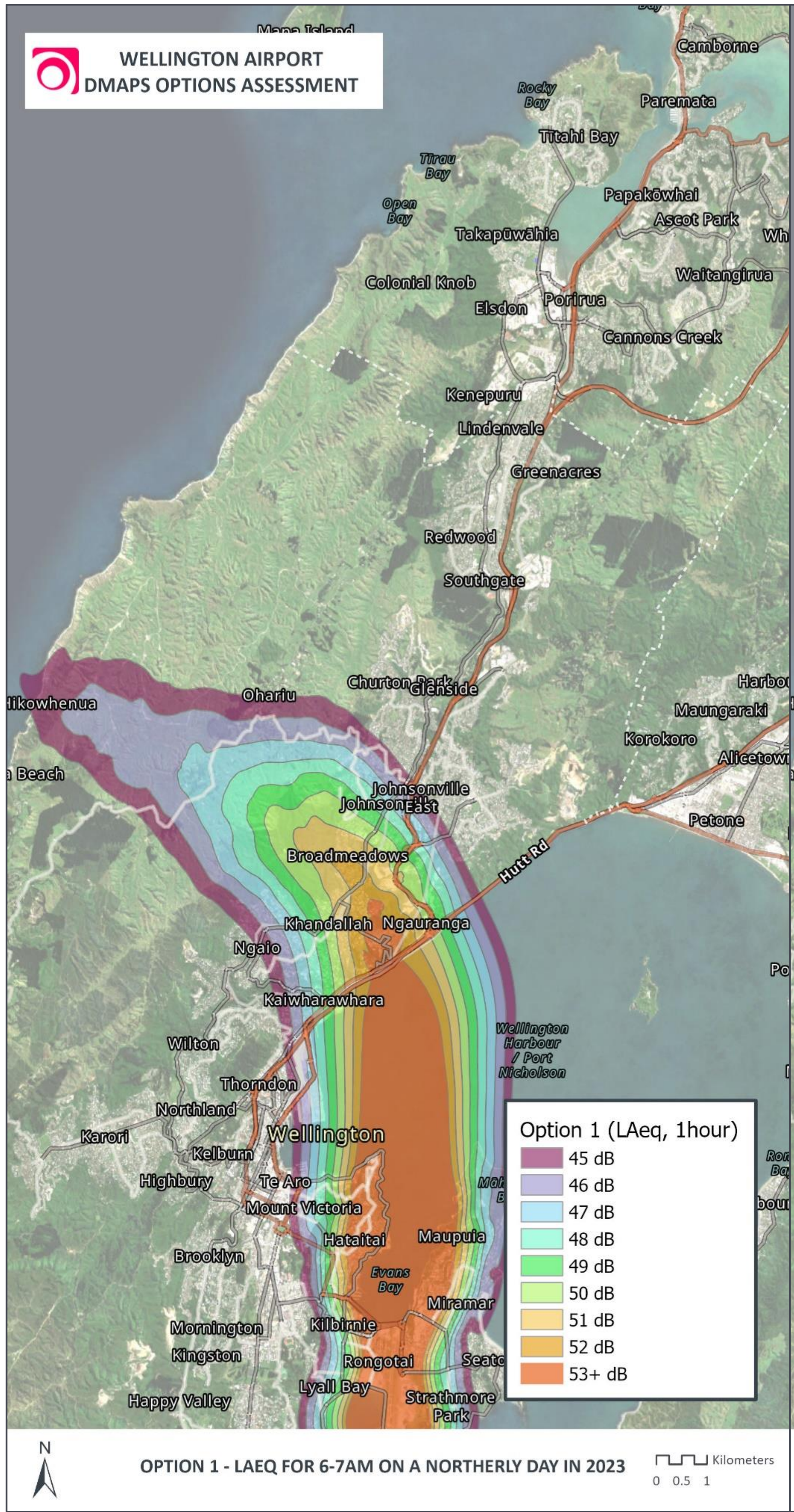
C1 L_{DN} FOR NORTHERLY DAY (OPTION 1, 2 AND 3)



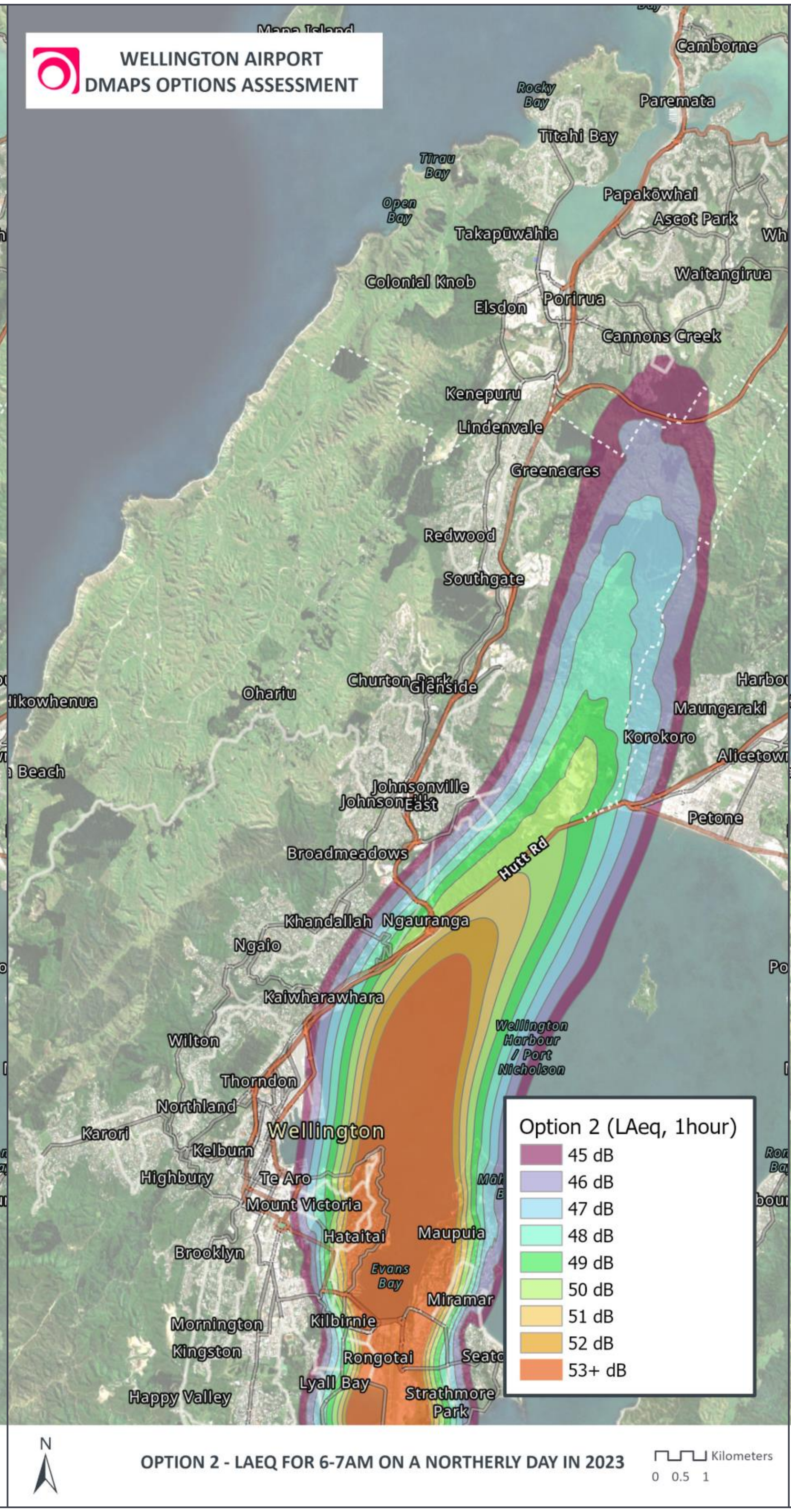
C2 N65 FOR NORTHERLY DAY (OPTION 1, 2 AND 3)



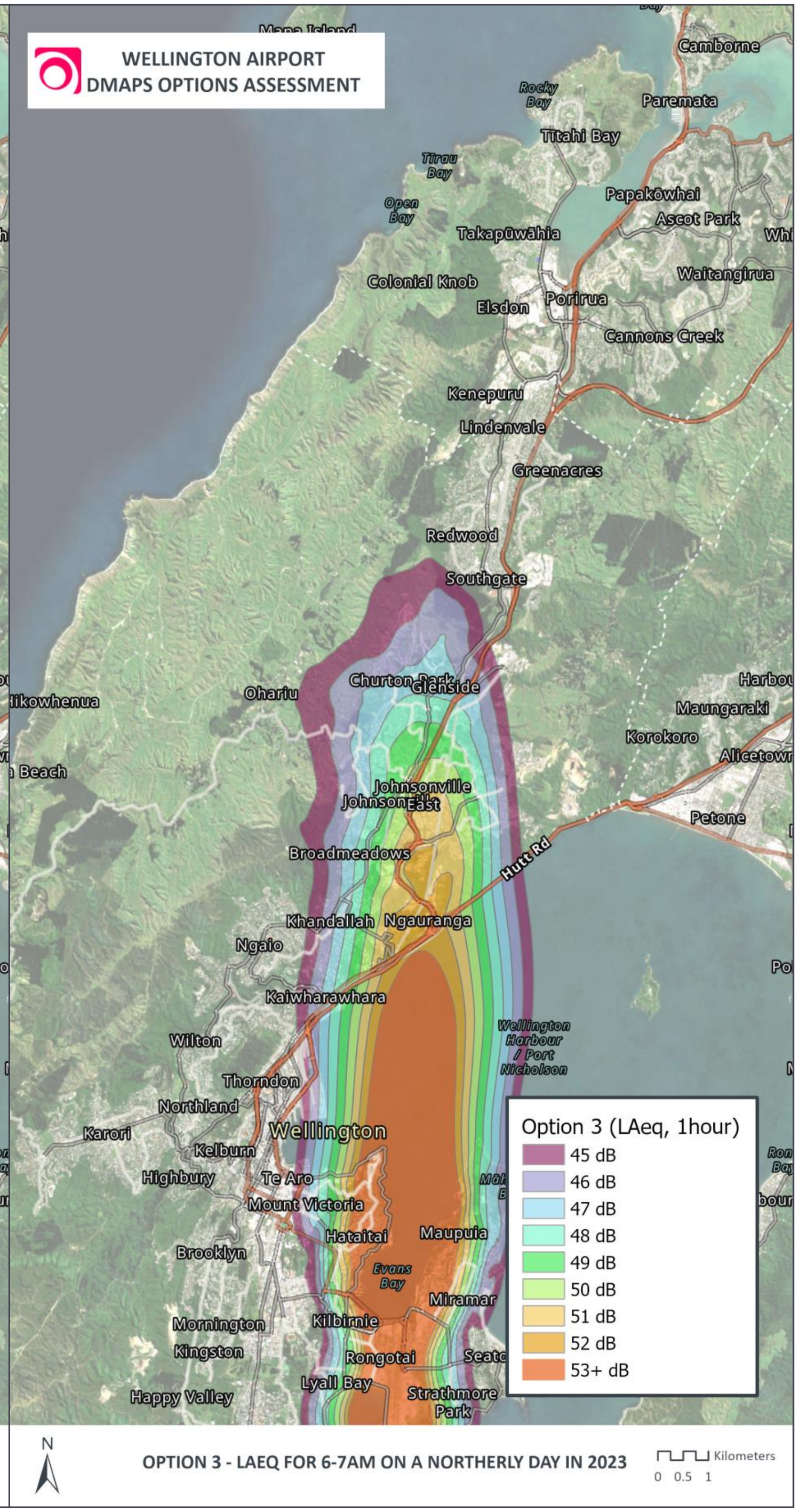
C3 $L_{AEQ\,(1\,HOUR)}$ FOR 6AM-7AM ON A NORTHERLY DAY (OPTION 1, 2 AND 3)



OPTION 1 - LAEQ FOR 6-7AM ON A NORTHERLY DAY IN 2023

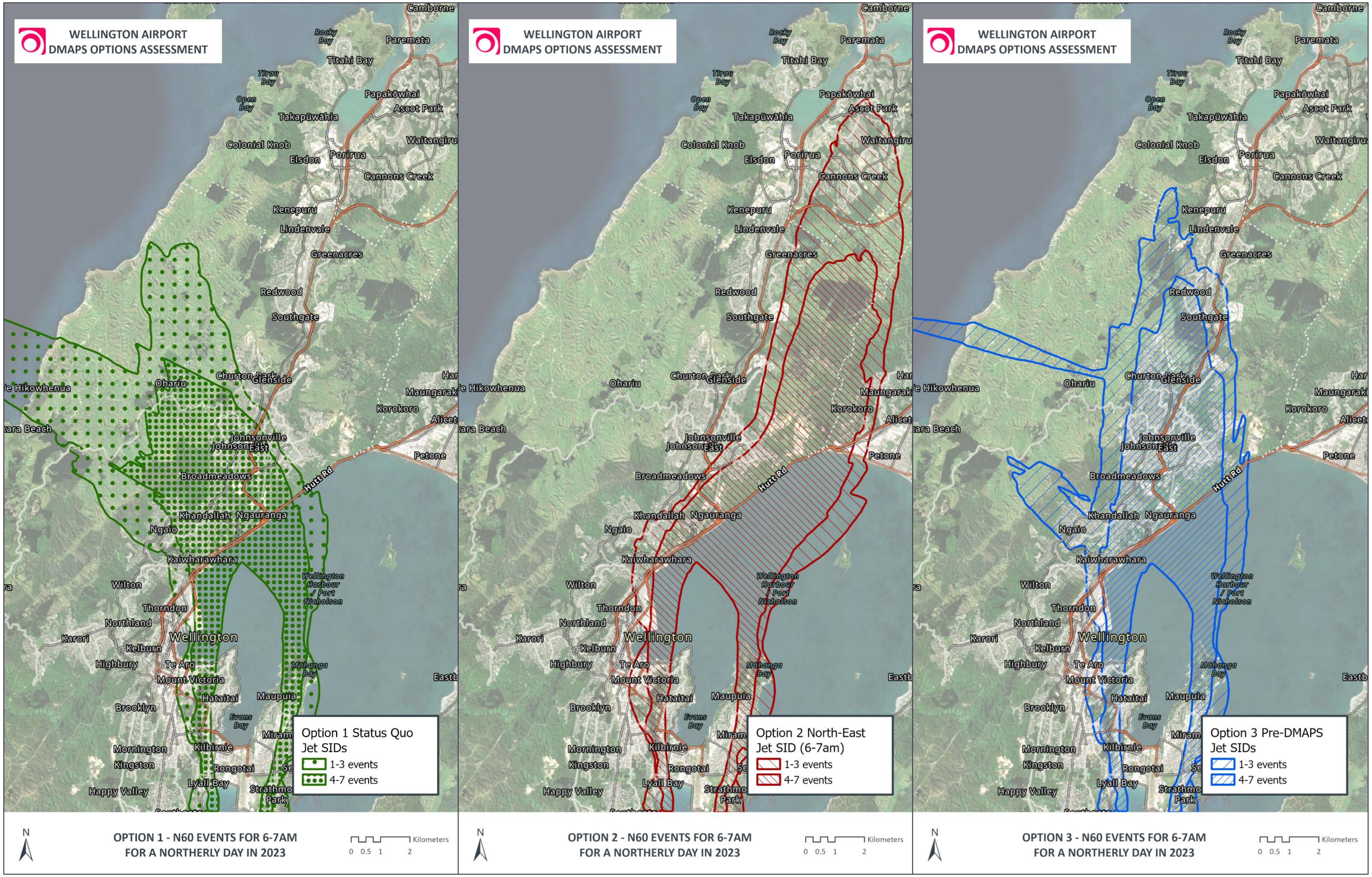


OPTION 2 - LAEQ FOR 6-7AM ON A NORTHERLY DAY IN 2023



OPTION 3 - LAEQ FOR 6-7AM ON A NORTHERLY DAY IN 2023

C4 N60 FOR 6AM-7AM ON A NORTHERLY DAY (OPTION 1, 2 AND 3)



APPENDIX D NUMBER OF PEOPLE AFFECTED BY 45+ DB $L_{AEQ,\,1\,HOUR}$ PER SUBURB (6AM – 7AM)

	Option 1 Status quo	Option 2 Northeast SID (6-7am)	Option 3 Pre-DMAPS
Broadmeadows	1,612	0	1,612
Cannons Creek	0	1,180	0
Churton Park	153	0	6,430
Glenside	0	0	390
Grenada Village	0	0	1,256
Horokiwi	0	239	0
Johnsonville	10,863	0	11,942
Kaiwharawhara	572	473	572
Khandallah	8,783	3,063	7,896
Korokoro	0	1,048	0
Maungaraki	0	281	0
Newlands	1,238	4,987	6,932
Ngaio	4,269	0	13
Ngauranga	109	107	109
Ohariu	229	0	42
Paparangi	0	0	2,631
Pipitea	1,209	0	588
Takapu Valley	0	101	0
Tawa	0	0	8
Thorndon	603	0	0
Wadestown	1,318	13	512
Woodridge	0	1,266	907
Total:	**30,958**	**12,758**	**41,839**

APPENDIX E NUMBER OF PEOPLE AFFECTED BY N60 AIRCRAFT EVENTS PER SUBURB (6AM – 7AM)

	Option 1 - Status quo			Option 2 - Northeast SID (6-7am)			Option 3 - Pre-DMAPS		
	1 to 3	4 to 7	total	1 to 3	4 to 7	total	1 to 3	4 to 7	total
Aotea	0	0	**0**	1823	0	**1823**	0	0	**0**
Ascot Park	0	0	**0**	1027	0	**1027**	0	0	**0**
Broadmeadows	0	1612	**1612**	0	0	**0**	211	1401	**1612**
Cannons Creek	0	0	**0**	5169	0	**5169**	0	0	**0**
Churton Park	3123	385	**3507**	0	0	**0**	0	6430	**6430**
Crofton Downs	426	0	**426**	0	0	**0**	70	0	**70**
Glenside	0	0	**0**	0	0	**0**	23	395	**419**
Grenada North	0	0	**0**	244	0	**244**	42	0	**42**
Grenada Village	0	0	**0**	101	0	**101**	143	1368	**1511**
Horokiwi	0	0	**0**	0	239	**239**	5	0	**5**
Johnsonville	265	11677	**11942**	23	0	**23**	666	11276	**11942**
Kaiwharawhara	0	572	**572**	120	452	**572**	18	554	**572**
Kenepuru	0	0	**0**	0	0	**0**	3	0	**3**
Khandallah	0	8783	**8783**	3221	2891	**6113**	1934	6523	**8458**
Korokoro	0	0	**0**	291	1204	**1495**	0	0	**0**
Mākara	5	0	**5**	0	0	**0**	0	0	**0**
Mākara Beach	3	0	**3**	0	0	**0**	0	0	**0**
Maungaraki	0	0	**0**	1001	346	**1347**	0	0	**0**
Newlands	2179	1477	**3656**	2636	3812	**6448**	359	6929	**7288**
Ngaio	3580	2384	**5964**	107	0	**107**	5114	0	**5114**
Ngauranga	0	109	**109**	0	107	**107**	0	109	**109**
Ohariu	205	177	**382**	0	0	**0**	107	3	**109**
Papakōwhai	0	0	**0**	44	0	**44**	0	0	**0**
Paparangi	590	65	**655**	320	0	**320**	0	2631	**2631**
Petone	0	0	**0**	83	0	**83**	0	0	**0**
Pipitea	1230	16	**1245**	1214	0	**1214**	1225	13	**1238**
Rānui	0	0	**0**	1355	0	**1355**	0	0	**0**
Takapu Valley	0	0	**0**	140	10	**151**	0	0	**0**
Tawa	0	0	**0**	47	0	**47**	3679	2220	**5899**
Thorndon	1651	0	**1651**	564	0	**564**	764	0	**764**
Wadestown	1659	312	**1971**	975	0	**975**	980	182	**1162**
Waitangirua	0	0	**0**	1570	0	**1570**	0	0	**0**
Woodridge	0	0	**0**	1022	481	**1503**	372	1154	**1526**
Total:	**14916**	**27568**	**42484**	**23098**	**9542**	**32640**	**15714**	**41189**	**56904**