G

APPENDIX G

Acoustic Assessment

(to be provided 26.2.20)

MARSHALL DAY Acoustics

WELLINGTON AIRPORT EAST SIDE AREA ASSESSMENT OF NOISE EFFECTS

Rp 003 r04 20181298 | 26 February 2020

MARSHALL DAY Acoustics

84 Symonds Street
PO Box 5811 Wellesley Street
Auckland 1141 New Zealand
T: +64 9 379 7822 F: +64 9 309 3540
www.marshallday.com

Project: **WELLINGTON AIRPORT EAST SIDE AREA ASSESSMENT OF NOISE EFFECTS**

Prepared for: **Wellington International Airport Ltd**
PO Box 14175
Kilbirnie
Wellington 6241

Attention: **Mr Mike Brown**

Report No.: **Rp 003 r04 20181298**

Document Control

Status:	Rev:	Comments	Date:	Author:	Reviewer:
Draft			12 Sep 2019	L Smith	
Draft	01		24 Sep 2019	L Smith	S Peakall
	02		2 Oct 2019	L Smith	S Peakall
Issued	03		15 Jan 2020	L Smith	S Peakall
Issued	04		26 Feb 2020	L Smith	S Peakall

Cover Photo: Simon Eugster and Sergey Kustov

MARSHALL DAY Acoustics

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

Wellington International Airport Ltd (WIAL) seeks to designate land over the southern part of the existing golf course site,[1] to the east of the Airport, for airport purposes, to enable the extension of the Airport as proposed in the 2040 Airport Masterplan.

The Airport's draft 2040 Masterplan which informs the Notice of Requirement (NoR) includes an expansion of the terminal, airside and landside operational areas. The NoR involves redevelopment of part of the existing golf course site into taxiways, aprons and associated airport activities.

Marshall Day Acoustics (MDA) has been engaged to undertake an assessment of noise effects for the NoR for the East Side Area (ESA) designation. This report includes a description of the existing noise environment, predicted noise levels for the proposed airport activities in the ESA, an assessment of noise effects and recommendations for noise related conditions.

The residential properties most affected by noise from the proposed ESA designation are those on Raukawa Street, Bunker Way and Kekerenga Street. These Strathmore Park properties currently overlook the golf course land area. This assessment pays particular regard to the effects of noise on these properties (ESA receivers).

The initial noise effects from the proposal would occur during the construction phase. Construction noise would be managed to comply with the limits set out in NZS 6803:1999 where practicable. This Standard sets specific limits to manage the effects of construction noise and recognises the specific character of such noise and that such noise is temporary. This report recommends that a specific construction noise assessment be undertaken once further information is available about the construction methodology. It is expected that conditions will be attached to the designation to require such noise to adhere to suitable limits and that construction activities will be managed according to a fit for purpose management plan.

The ongoing noise effects on ESA receivers would arise from airport related activities on the proposed new taxiways, aircraft stands and road within the designated area. These effects would occur over time as the ESA is developed. We predict the following noise effects for the ESA receivers:

- As the ESA is developed and the airport grows, a progressive increase in aircraft operations noise will occur and it is predicted that by the year 2050 this will comprise an increase of 1 dB L_{dn} (imperceptible) compared with the levels currently allowed under the current District Plan provisions. A designation condition to allow for this increase is proposed.
- This increase in aircraft operations noise will likely result in an increase of 5 - 6 dB L_{dn} (noticeable) by 2050 compared with current aircraft noise levels.
- A just perceptible increase (4 dB) in noise from Auxiliary Power Units (APU) operating at the new stands within the Designated Area compared with APU noise from the current Airport site. The resulting noise levels would be moderately high for a residential area but not uncommon for residents living near transport infrastructure. The effect from this noise source would be appropriately mitigated by applying duration and night-time operating restrictions. A designation condition to this effect is proposed.
- The day-time noise limit on Sundays for land based activities would be aligned with the Monday to Saturday limit in the District Plan that currently applies to land based airport activities. This is a theoretical 10 dB increase in permitted levels on Sundays (7am – 10pm). However, in practice this is considered reasonable and would not have a noticeable effect on receivers given existing ambient noise levels on Sundays. A designation condition to this effect is proposed.

[1] Zoned Golf Course Area in the Airport and Golf Course Recreation Precinct in the Wellington City District Plan

- Wide body aircraft taxiing on the ESA taxiways (up to 12 events per day) would cause a significant increase (10 dB L_{AE}) in aircraft single event noise compared with current loudest single event noise which is from aircraft departures. The predicted single event levels (95 dB L_{AE} and 83 dB L_{Amax}) on ESA receivers are moderately high but not uncommon for residents living near an airport. Night-time restrictions would apply to taxiing activities to avoid sleep disturbance. A designation condition to this effect is proposed.
- For the year 2050, cumulative airport noise levels (from all noise sources at the Airport) of 62 – 63 dB L_{dn} are predicted for ESA receivers. These are moderately high levels that are generally undesirable for residential activity but not uncommon for properties adjacent to an airport. This is about the same level of noise that can be generated by airport activities in terms of the current District Plan limits. However, this represents an appreciable (7 dB) increase on ESA receivers compared to the current measured cumulative noise levels.

Our assessment considers the change in noise for some 30 years in the future as a result of gradual growth in airport operations. It is typical to apply a 30 year planning horizon for noise at New Zealand's major airports. The predicted change, compared with current noise, would not occur immediately the ESA becomes operational. We have not prepared predictions for a scenario immediately following the ESA becoming operational, however we estimate a 1 – 2 dB increase initially due to the new taxiways then further increases would occur gradually over many years.

The following measures are proposed to manage the effects of noise arising from the use of the ESA:

Night-time Effects

- No taxiing under engine power will be permitted on ESA taxiways at night (10pm – 7am).
- APUs will be required to meet land based activity noise limits at night (45 dB L_{Aeq} at residential properties 10pm – 7am) which effectively excludes them from running at night.
- Ground support equipment and road traffic will be managed to comply with a night-time limit of 45 dB L_{Aeq} at residential properties (10pm – 7am).

Daytime and Overall

- Noise from aircraft operations will be limited to 65dB L_{dn} at a new proposed Compliance Line within the Designated Area.
- Plug-in Ground Power Units (GPU) will need to be available for use within the ESA and allowable APU runtime will be restricted.
- Continuous noise monitoring will be undertaken near ESA receivers to monitor compliance with the proposed noise limits.
- No engine testing will be allowed in the ESA.

We consider that the recommended operational restrictions on the new taxiways and aircraft stands represent the best practicable option to manage and mitigate the noise effects of the activities that are to occur within the ESA designation. In summary we consider that noise effects would be appropriately controlled and reasonable in the existing Wellington Airport context.

2.0 INTRODUCTION

Wellington International Airport Ltd (WIAL) seeks to designate land on part of the existing golf course site,[2] to the east of the Airport, for airport purposes to enable the extension of the Airport as proposed in the 2040 Masterplan.

The Airport's 2040 Masterplan, which informs the Notice of Requirement (NoR), includes an expansion of the terminal and airside and landside operational areas. The NoR involves redevelopment of part of the existing golf course site into taxiways, aprons and associated airport activities.

Marshall Day Acoustics (MDA) has been engaged to undertake an assessment of noise effects for the NoR for the East Side Area (ESA) designation. This report includes a description of the existing noise environment, predicted noise levels for the proposed airport activities in the ESA, an assessment of noise effects and recommendations for conditions.

3.0 NOTICE OF REQUIREMENT – EAST SIDE AREA

Figure 1 shows the extent of the proposed designation.

Figure 1: Proposed Extent of East Side Area Designation

Designating the ESA would enable a change in land use from golf course to airport purposes. Currently, airport activities take place in the Airport Area Precinct in the District Plan, and it is proposed to expand the Airport into the adjacent ESA. The proposed Airport development would involve a terminal expansion with new apron and aircraft stands within the existing Airport Area, but

[2] Zoned Golf Course Area in the Airport and Golf Course Recreation Precinct in the Wellington City District Plan

parts of the apron and new taxiways need to be located in the ESA. Appendix C includes the concept airport layout extended into part of the golf course from the 2040 Masterplan.

Activities permitted within the ESA will include:

- Aircraft operations and associated activities, including all ground-based infrastructure, plant and machinery necessary to assist aircraft operations;
- Taxiways, aprons and other aircraft movement areas;
- Navigation and safety aids, monitoring stations, lighting and telecommunications facilities;
- Car parking, roads, accessways, pedestrian ways, stormwater and wastewater infrastructure, utility activities and security fencing;
- All demolition (if required), construction and earthworks activities, including associated structures;
- Landscaping, planting, tracks and trails;
- Ancillary activities, buildings and structures related to the above; and
- Servicing, testing and maintenance activities related to the above

4.0 AIRCRAFT NOISE MANAGEMENT IN NEW ZEALAND

4.1 NZS 6805:1992

NZS 6805:1992 *"Airport Noise Management and Land Use Planning"* (the Standard) is the basis for the management of airport noise effects at the majority of airports in New Zealand. The Standard was published in 1992 with a view to providing a consistent approach to noise planning around New Zealand airports. Since publication, the principles of the Standard have been applied to more than 15 New Zealand airports.

The approach to airport noise management that the Standard provides for is to *"implement practical land use planning controls and airport management techniques to protect and conserve the health of people living near airports without unduly restricting the operation of airports."*

The Standard uses the "Noise Boundary" concept as a mechanism for local authorities to:

- *"establish compatible land use planning"* around an airport; and
- *"set noise limits for the management of aircraft noise at airports"*.

Typically, the noise boundary concept involves fixing an Outer Control Boundary (OCB) and a smaller Air Noise Boundary (ANB) around the airport. The OCB is based on a day/night noise exposure level of 55 dB L_{dn} and the ANB is based on 65 dB L_{dn}.

L_{dn} is the day/night weighted average noise exposure level which is the sum of the sound energy from all aircraft noise events averaged over 24 hours with a weighting applied to night-time events. For airport noise boundaries the Standard recommends using the average L_{dn} over a three month period[3]. The L_{dn} night weighting means that aircraft noise events between 10pm and 7am are weighted by an additional 10 decibels to account for the heightened sensitivity to noise at night. International research has found that the L_{dn} metric correlates well with community annoyance to aircraft and other transportation noise.

[3] NZS 6805 recommends averaging over a three month period or agreed alternative period. L_{dn} can be averaged over any period of 24 hour blocks.

Typically noise from aircraft operations (arrivals, departures and taxiing) is considered when setting the boundaries; and other airport activities such as maintenance and engine testing are controlled in other ways.

The noise boundaries are calculated to allow for reasonable future growth of an airport based on a realistic forecast of aircraft types and number of movements. NZS 6805:1992 recommends a minimum 10 year growth period, but due to the length of the planning process to implement noise contours, many New Zealand airports have adopted 20 – 30 year growth periods on which to base the noise boundaries.

The Standard recommends that noise from aircraft operations be restricted to 65 dB L_{dn} at the ANB and land use restrictions apply to noise sensitive activities inside the ANB and OCB. The airport operators are responsible for managing noise from aircraft operations to comply with the limit. The Standard recommends that territorial authorities implement the following land use restrictions:

> Inside the ANB (>65 dB L_{dn}):
>
> New noise sensitive uses (including residential) should be prohibited;
>
> Existing residential buildings and subsequent alterations should have appropriate sound insulation;
>
> Between the ANB and the OCB (55 - 65 dB L_{dn}):
>
> New noise sensitive uses (including residential) should be prohibited unless a District Plan permits such use subject to appropriate sound insulation; and
>
> Alterations or additions to existing noise sensitive uses (including residential) should include appropriate sound insulation.

For the calculation of noise boundaries, the Standard refers to the Federal Aviation Administration (FAA) Integrated Noise Model (INM). The INM is an internationally accepted tool for predicting aircraft noise levels around airports and calculating contours for the purpose of setting noise boundaries. The INM has been replaced by the Aviation Environmental Design Tool (AEDT). While the AEDT is now required in the United States for FAA CFR[4] Part 150 studies, in Australia, the statutory framework is currently transitioning from INM to AEDT. In New Zealand there is no national statutory requirements and for Wellington, the District Plan does not define the software to be used. MDA is transitioning from INM to AEDT for the airport assessments we carry out. During this transition period we consider that applying either the INM or AEDT model is appropriate. Our review of the AEDT shows that predicted noise levels are almost identical to the INM for the same operational scenarios.

Generally, the noise boundaries are based on the day-night sound exposure level (L_{dn}). The Standard does not recommend a noise limit for individual aircraft events however it does recommend that night-time single event noise levels are considered when setting the location of the ANB. This is because for smaller airports the ANB may not be large enough to protect against high single event levels at night causing sleep disturbance. The Standard does not provide limits of acceptability for sleep disturbance, so guidelines from other sources such as the World Health Organisation (WHO) are usually applied.

5.0 BACKGROUND TO AIRCRAFT NOISE MANAGEMENT AT WELLINGTON AIRPORT

Wellington Airport has a unique noise management framework compared to other New Zealand airports, which is largely due to its geographical location and residential surroundings. As for all New Zealand airports, the NZS 6805:1992 recommendations had to be adapted to suit the local situation.

[4] Federal Aviation Administration Code of Federal Regulations

The main differences that set Wellington Airport's noise management framework apart from airports like Auckland and Christchurch, is that Wellington operates with a partial night-time curfew, and the District Plan only controls land use inside the Air Noise Boundary. There is no Outer Control Boundary shown in the District Plan for Wellington Airport.

5.1 Aircraft Noise Controls

Aircraft noise at Wellington Airport is currently controlled by rules in Chapter 11A of the Operative Wellington City District Plan (the District Plan). These rules have been operative since 2000. The rules are summarised in Section 7.0.

As set out above, the noise controls for Wellington Airport are based on the NZS 6805:1992 approach, although there is just an ANB and no OCB at Wellington. In summary, noise from aircraft operations (arrivals, departures and taxiing) is controlled by a 65 dB L_{dn} noise limit at the ANB which is defined on Map 35 of the planning maps (refer Section 7.1).

In addition to the L_{dn} limit which includes a night weighting, operations at Wellington Airport are restricted by a partial night-time curfew as follows:

- Domestic operations must not occur during the hours from midnight to 6am.
- International operations must not occur during the hours of midnight to 6am for departures and 1am to 6am for arrivals.

Some exceptions apply that enable the operating hours to be extended in certain situations (refer complete rules in Section 7.1).

Noise from aircraft operations is measured continuously by noise loggers at three locations near the Air Noise Boundary.

5.2 Land Use Controls

NZS 6805:1992 recommends that residential activity should be prohibited inside the ANB. Wellington Airport has historically had a large number of houses in close proximity to the runway and therefore a large number of houses are inside the ANB. As such residential activity is not prohibited by the District Plan within the ANB, but new and altered noise sensitive activities are required to be acoustically insulated.

The land use restrictions for activities sensitive to aircraft noise inside the ANB were strengthened through District Plan Changes 72 and 73 following the outcome of the LUMIN Study (refer Section 5.3) which found that stronger controls were appropriate to curb residential intensification in this high noise environment. The changes, which became operative in November 2014, include strengthening the acoustic insulation requirements for new and altered noise sensitive activities within the ANB. Nonetheless, new noise sensitive development continues to be permitted inside the ANB in the residential zone.

5.3 Land Use Management and Insulation for Airport Noise Study (LUMINS)

The Land Use Management and Insulation for Airport Noise Study ("LUMINS") was carried out by the Wellington Airport Air Noise Management Committee and was completed in 2009. The purpose of LUMINS was to determine the future management of land use and acoustic insulation for the properties within the ANB.

The study involved an in-depth assessment of the effects of aircraft noise on residents. This led to consideration of mitigation options such as acoustic insulation for existing houses and more stringent land use controls for new noise sensitive activities within the ANB. Recommendations from the study have been implemented through changes to the District Plan to restrict intensification of noise sensitive activities inside the ANB. Furthermore, an acoustic mitigation programme "Quieter Homes"

has been implemented to retro-fit acoustic insulation and ventilation to existing dwellings inside the ANB.

Our assessment of the ESA NoR does not seek to re-examine the LUMINS outcomes. Instead, it is focussed on the change in noise effects resulting from the proposed extension of the Airport into part of the golf course area compared with current and permitted airport noise emissions.

6.0 SCOPE OF THE ASSESSMENT OF NOISE EFFECTS FOR PROPOSED ESA DESIGNATION

Although this NoR relates specifically to activities in the ESA, in practice activities in the ESA would be linked to activities in the existing Airport Area, as the ESA would be used to provide additional taxiway and apron space to support the existing operation. In general, we have looked to work with the existing noise management framework for Wellington Airport which, as described in Section 5.0, is unique and was adapted from NZS 6805:1992 for the local situation.

In assessing the likely noise effects of the proposed activities in the ESA on residents, we have considered the effects from proposed aircraft operations noise against the aircraft operations noise already permitted by the District Plan. In addition, we have assessed the effects from proposed aircraft operations noise against noise levels currently experienced from airport operations.

Currently the District Plan provides for airport noise effects from the Airport Area received in the surrounding communities including the residential areas adjacent to the ESA. We have quantified the existing planning environment for airport noise provided for by the District Plan.

Next, we have quantified the current actual noise generated by airport activities (including aircraft operations, engine testing, land based activities and ground power and auxiliary units).

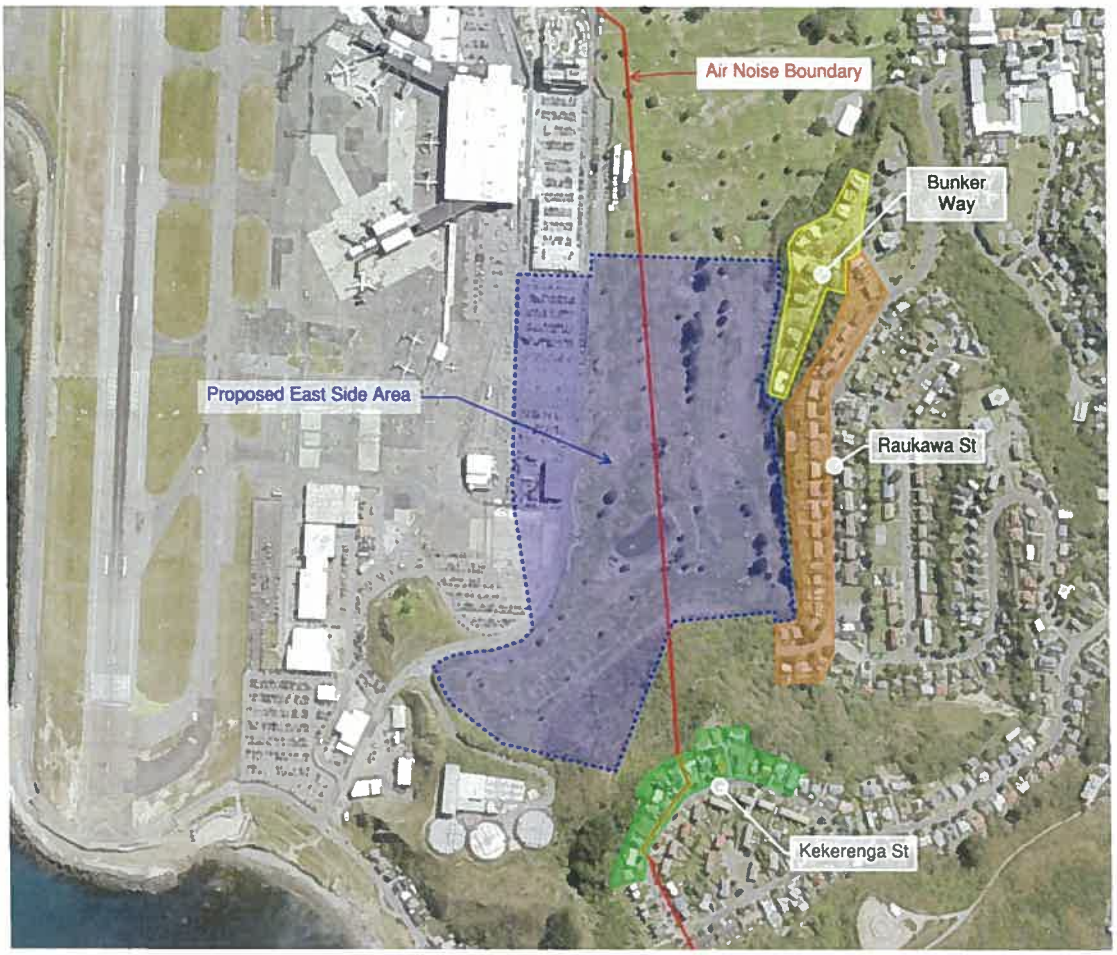
Then, we have predicted the noise emissions from proposed airport activities based on the 2040 Masterplan concept layout which includes the ESA to understand the future noise conditions.

A forecast of aircraft activity for the year 2050 has been used to predict future noise levels from aircraft operations. The year 2050 scenario has been compared with the current noise levels and the permitted noise levels to quantify the likely change in noise for sensitive receivers.

The noise effects of airport activities being extended on to part of the golf course would be received at residential properties in the vicinity of the golf course. For other residents around the airport and in the ANB there would be no appreciable change in noise effects relating directly to activities undertaken within the newly designated area.

The closest noise sensitive receivers affected by the designation are houses in the Outer Residential Zone along Bunker Way, Raukawa Street and Kekerenga Street which currently overlook the golf course. Most of these houses are outside the District Plan ANB. Figure 2 shows the locations of these houses relative to the proposed designation land. Our assessment shows that these properties are most affected by noise from activities within the ESA as they generally have direct line of sight to the area. In our assessment we refer to these properties as "ESA receivers". Houses one or more rows back would be less affected, as noise from activities in the ESA would be screened by the front row of houses. The effects of noise on these properties have still been predicted and assessed, but in less detail than the ESA receivers.

Figure 2: ESA Receivers



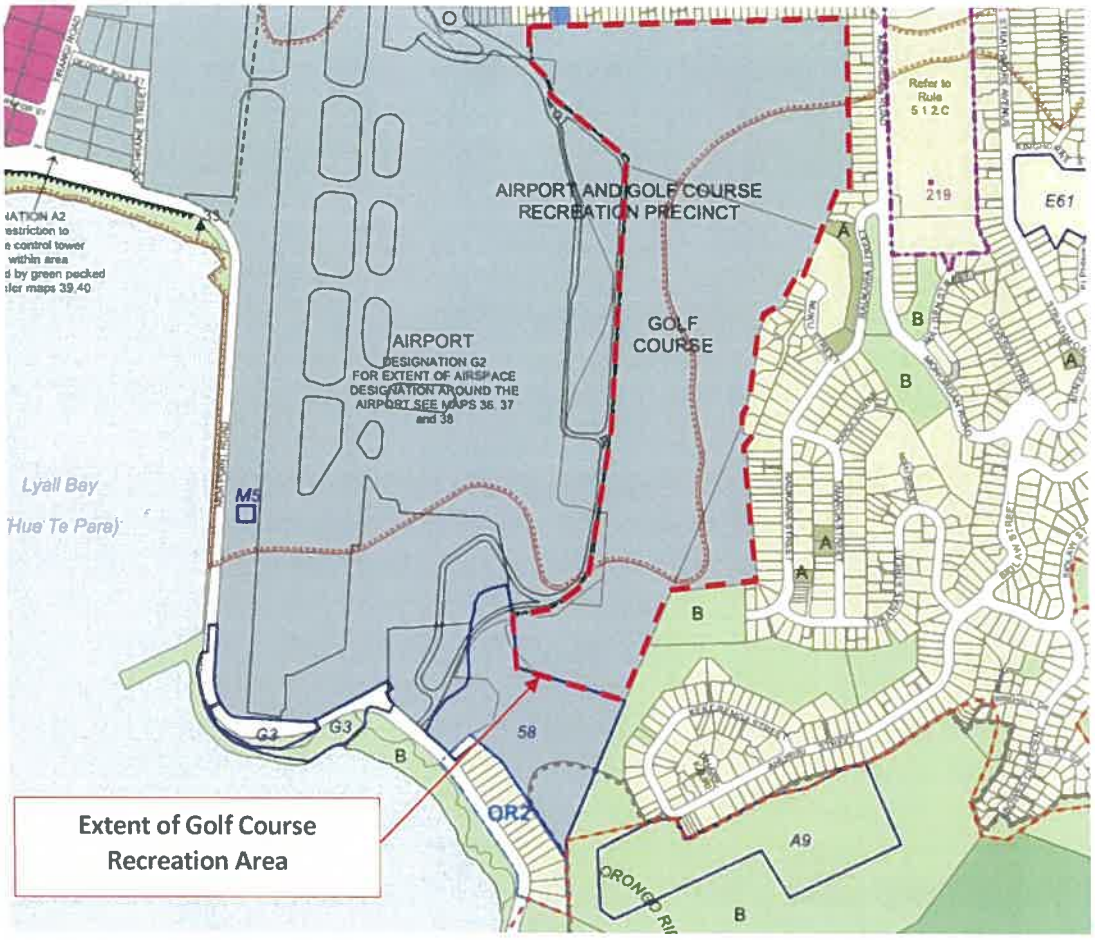
Based on the outcome of our assessment, we have considered what noise controls and mitigation measures are appropriate to control the noise effects from proposed activities within the ESA designation. Our recommendations include operational constraints on some activities and at particular times of the day, and some relaxation of the current noise limits that are set out within the District Plan. The residual noise effects from the proposal have been quantified and assessed.

7.0 EXISTING DISTRICT PLAN PROVISIONS

The Airport and the Golf Course are in the Airport and Golf Course Recreation Precinct in the Wellington City District Plan (District Plan) as shown in Figure 3 below. The Precinct is separated into the Airport Area and the Golf Course Recreation Area with rules set out in Chapters 11A and 11B of the District Plan respectively.

A small 136m^2 area of Outer Residential Zone land is also included in the ESA (refer Figure 1). Despite the land use zoning, this area is currently used for golf purposes. It is proposed that this area will form part of the proposed landscape buffer and will not be occupied. There are no noise related ramifications arising from the proposed use of this parcel of land, and we do not consider it further.

Figure 3: Extent of Golf Course Recreation Area



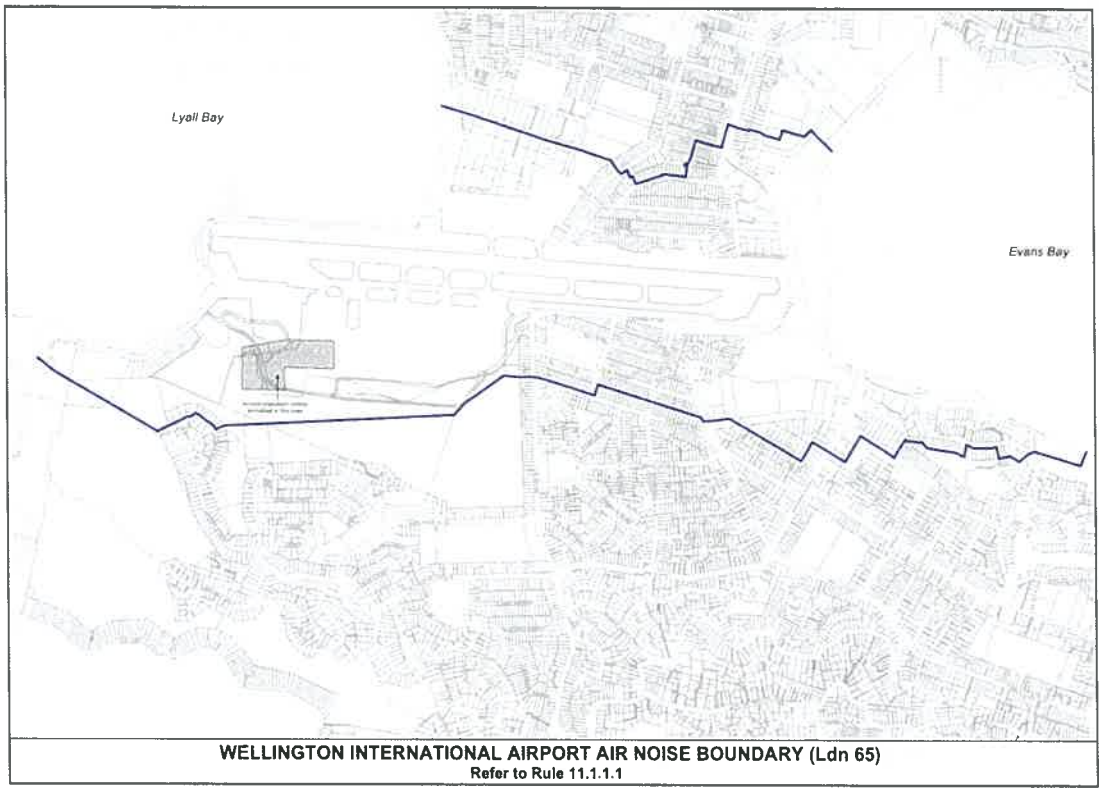
7.1 Airport Area

Activities within the Airport Area (of the Airport and Golf Course Recreation Precinct) are subject to a suite of District Plan noise controls which distinguish between different noise sources as follows:

- Aircraft Operations (taxiing, take-off, landing, engine run-up)
- Engine Testing
- Land Based Activities
- Ground Power and Auxiliary Power Units

Rule 11.1.1.1.1 limits noise from aircraft operations to 65 dB L_{dn} at the Air Noise Boundary shown on Map 35 (Figure 4). The day-night weighted noise exposure (L_{dn}) from aircraft operations is averaged over 90 days. Rules 11.1.1.1.2 to 11.1.1.1.6 set out a range of exclusions from the noise limit and further operational controls.

Figure 4: District Plan Map 35 – Wellington Airport Air Noise Boundary



Noise from the testing of aircraft engines on-wing is controlled by rule 11.1.1.1.7. Engine testing is not a significant contributor to the existing noise environment at Wellington Airport as there is no maintenance facility onsite.

Noise from land based activities is controlled by the following rule:

Rule 11.1.1.1.8

Noise emission levels, from any activity within the Airport area other than aircraft operations, engine testing and the operations of APU's (as provided for in rule 11.1.1.1.9) when measured at any residential site shall not exceed the following limits:

Monday to Saturday 7am to 10pm	*55 dB $L_{AEQ\ (15\ MIN)}$*
At all other times	*45 dB $L_{AEQ\ (15\ MIN)}$*
All days 10pm to 7am	*75 dB L_{AFmax}*

Noise from ground power and auxiliary power units (GPUs/APUs) is controlled by the following rule:

Rule 11.1.1.1.9

a) GPUs must comply with the noise limits in rule 11.1.1.1.8

b) APUs must comply with the noise limits in rule 11.1.1.1.8, with the exception of:

- *Aircraft under tow*
- *The first 90 minutes after the aircraft has stopped on the gate*
- *60 minutes prior to scheduled departure*
- *The use of APUs to provide for engine testing pursuant to rule 11.1.1.1.7.*

7.2 Golf Course Recreation Area

Chapter 11B of the District Plan contains noise limits for activities in the Golf Course Recreation Area. The rule that applies to noise received in the surrounding Outer Residential Zone is as follows:

> ***Rule 11.5.1.1.2***
>
> *Any activity occurring within the Golf Course recreation area when measured from any land or premises outside the precinct shall comply with the noise limits stated in Appendix 1.*
>
> ***Appendix 1 Noise***
>
> *Residential (Outer)*
>
> *Noise emission levels when measured in any residential site in the Outer Residential Area must not exceed:*

Monday to Saturday 7am to 7pm	*50 dB $L_{AEQ\,(15\,MIN)}$*
Monday to Saturday 7pm to 10pm	*45 dB $L_{AEQ\,(15\,MIN)}$*
At all other times	*40 dB $L_{AEQ\,(15\,MIN)}$*
All days 10pm to 7am	*65 dB L_{AFmax}*

> *Where it is impractical to measure outside a dwelling then measurements shall be made inside (with windows closed). Where indoor measurements are made the noise limits stated above shall be reduced by 15 dB.*

7.3 Construction Noise

The District Plan does not specify noise limits for construction activities associated with the Airport. The definition of "noise emission level' in Chapter 3.10 of the District Plan explicitly excludes work on the Airport from construction noise limits. Despite this, we consider it is appropriate to assess and manage construction noise effects from the proposed ESA development.

New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"* is the most recent and widely applied construction noise management standard in New Zealand. It is recommended that the noise limits from NZS 6803:1999 are complied with as far as practicable however, for some construction tasks compliance may not be practicable. This is common particularly for large infrastructure projects. The conventional approach in this situation is to prepare a construction noise management plan which identifies activities that might exceed the limits and sets out appropriate measures to manage and mitigate the noise effects from these activities. We recommend this approach for the ESA designation. We have recommended suitable conditions in this regard.

8.0 EXISTING NOISE ENVIRONMENT

The ESA receivers (identified in Section 6.0) are currently exposed to noise from both golf course and airport activities, which is permitted in the District Plan. Noise from airport activities is the most significant influencer of the noise environment for these receivers both with higher permitted noise limits and higher noise emissions in practice. Noise from the golf course is negligible, therefore our description of the existing noise environment focusses on airport activities.

8.1 Existing Noise from Aircraft Operations

Aircraft operations are defined in the District Plan as *'the engine run-up, taxiing, take-off or landing at an airport of an aircraft".*

We have quantified the existing noise environment from aircraft operations in two ways:

- The existing environment for aircraft operations which is defined by the noise levels anticipated and permitted by the District Plan provisions ("plan permitted noise levels")

- Calculated current aircraft operations noise levels based on operations in FY19[5] ("current noise levels").

Figure C1 in Appendix C shows the L_{dn} noise contours in 5 decibel increments (55, 60 and 65) for the operating scenario used to develop the existing District Plan ANB. The 65 dB L_{dn} contour was the basis for the ANB which is included in the District Plan. The 55 and 60 dB L_{dn} noise contours demonstrate what the noise levels would be beyond the ANB when noise generated by airport activities reaches 65 dB L_{dn} at the ANB. As indicated earlier, these contours are not included within the airport noise management regime of the airport, nor in the District Plan.

These noise contours were originally calculated using a much earlier version of the INM model, assuming flat ground and therefore any effects of terrain screening are not shown in the contours. Manual adjustments were made to the ANB to account for terrain screening effects and to align with property boundaries. This is why the ANB does not align exactly with the 65 dB L_{dn} contour shown in Figure C1.

The noise contours in Figure C1 (Appendix C) quantify the level of noise anticipated and permitted by the existing District Plan provisions. In our assessment we refer to these as the "plan permitted contours" and "plan permitted noise levels". Figure 5 below shows plan permitted contours in one decibel increments in the vicinity of residential receivers around the ESA. The plan permitted noise levels from aircraft operations at the receivers overlooking the ESA range from 58 to 63 dB L_{dn}.

[5] The 2019 Financial Year (1 April 2018 to 31 March 2019)

Figure 5: Noise Contours the ANB were Based On ("Plan Permitted Contours")

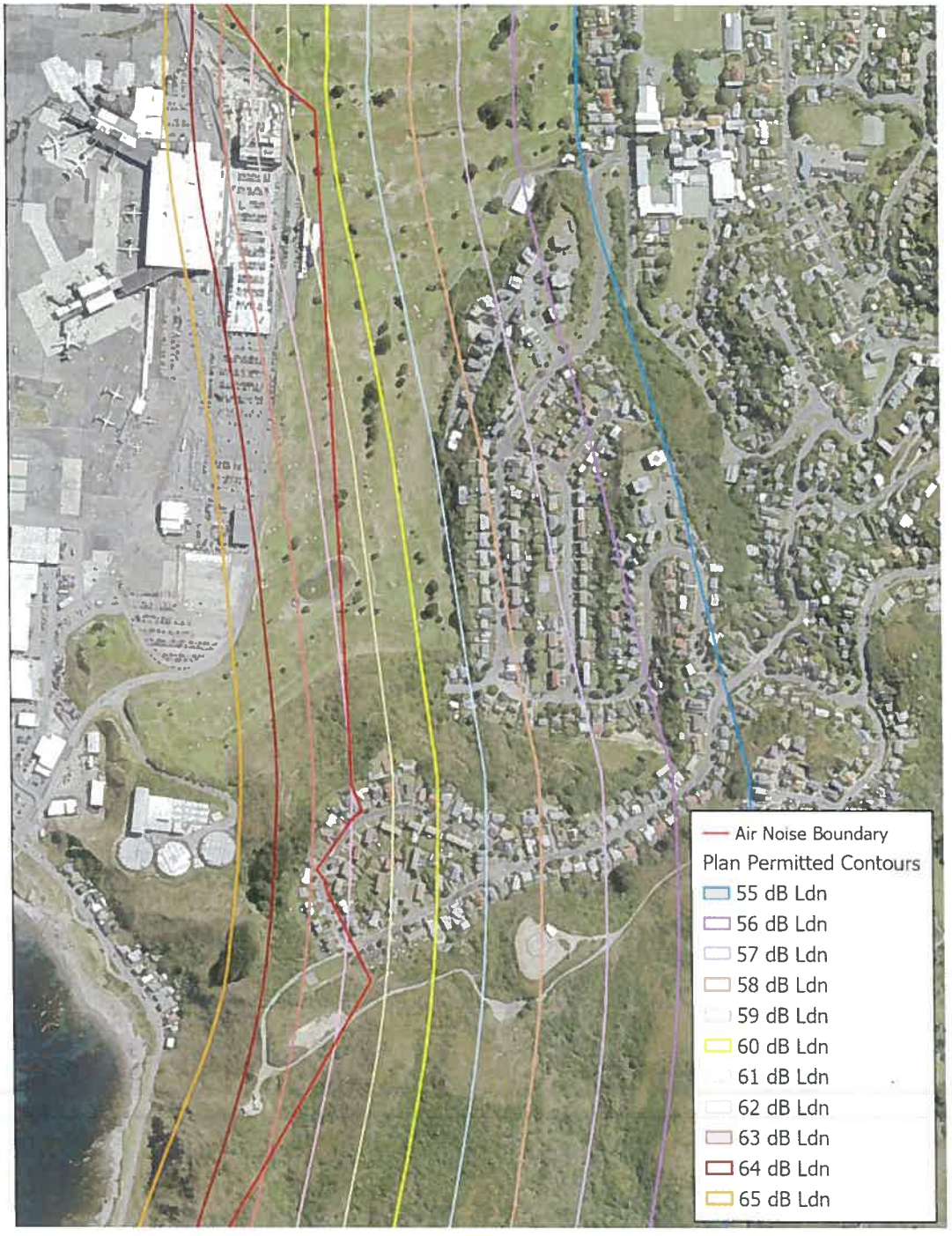
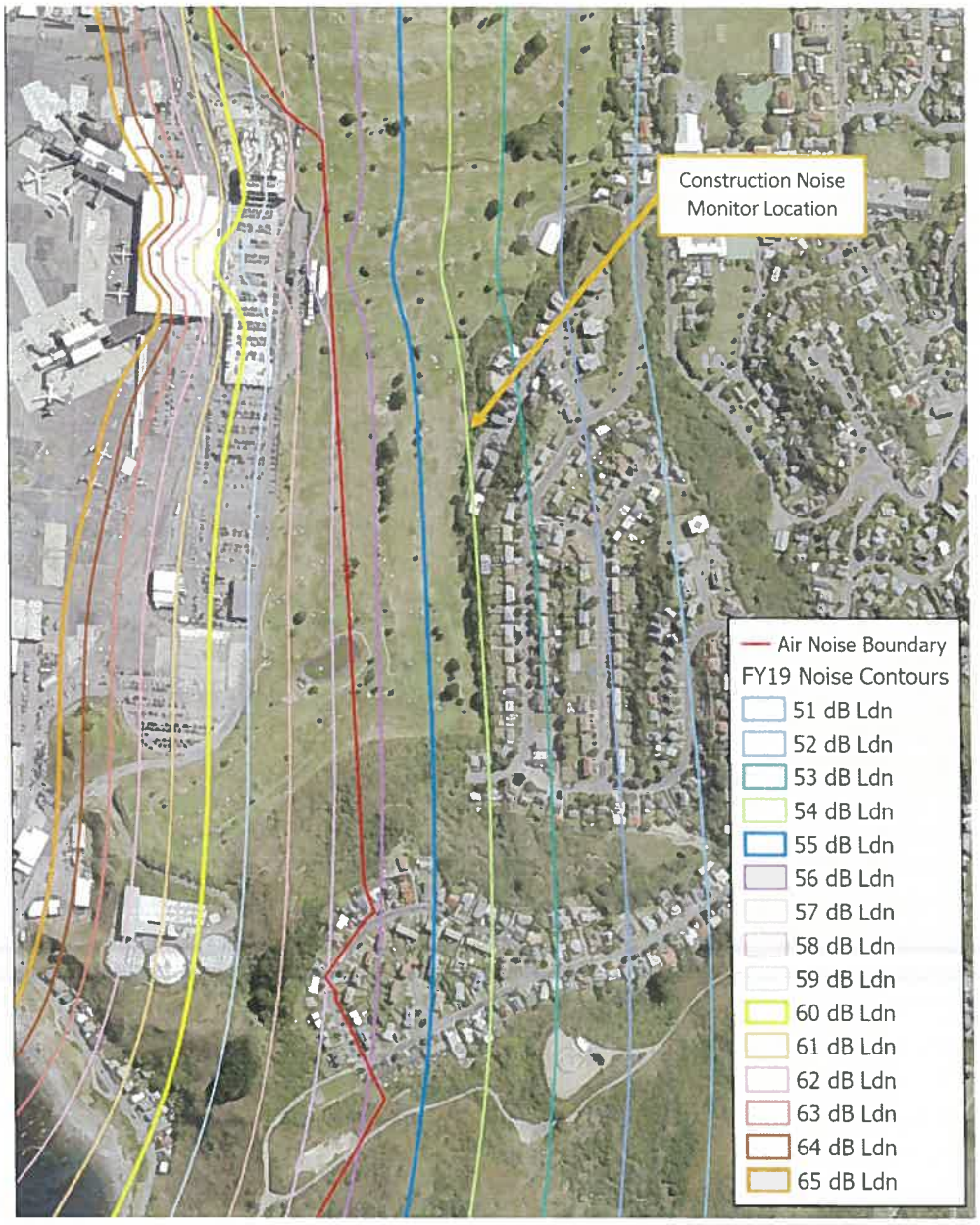


Figure C2 in Appendix C shows the calculated current noise levels from actual aircraft operations during the busiest 3 months in FY19. The calculation methodology is described in Appendix B. The noise contours were calculated assuming flat ground due to limitations of the noise model. Therefore, any effects of terrain screening are not shown in the contours. As noted above, the ANB from District Plan Map 35, also shown in Figure C2, includes adjustments for terrain screening. Despite this difference, Figure C2 shows that current aircraft operations noise levels comfortably comply with the ANB. Current levels at the ANB are approximately 5 decibels below the 65 dB L_{dn}

limit. This recognises that the ANB was put in place to provide for long term growth in aircraft operations at the airport.

Figure 6 below shows the FY19 contours in one decibel increments in the vicinity of residential receivers around the ESA. The current aircraft operations noise levels at the receivers overlooking the ESA range from 53 to 57 dB L_{dn}. Therefore, current levels for ESA receivers are approximately 5 dB below the plan permitted levels. Figure 6 also shows the location of a construction noise monitor which is discussed in Section 8.5.

Figure 6: Current Aircraft Operations Noise Contours (FY19 Operations)



8.2 Existing Noise from Engine Testing

Engine testing is the running of engines on an aircraft while it is stationary for the purpose of carrying out mandatory checks following maintenance work. There is no aircraft maintenance base located at Wellington Airport therefore engine testing only takes place in unplanned break-down situations and is not a prominent feature of the noise environment around the Airport.

The District Plan rule allows engine testing to occur as and when required between 6am and 8pm and essential unscheduled testing until 11pm. However, between 11pm and 6am, noise and duration limits apply to engine testing as well as limitations on frequency (a maximum number of 18 events in 12 months is allowed).

WIAL maintains records of engine testing between 11pm and 6am and in the last 10 years there have been no engine testing events during this period. The noise limits effectively exclude engine testing of most passenger aircraft during this night-time period and therefore aircraft undergoing repairs overnight are tested in the morning after 6am.

8.3 Existing Noise from Land Based Activities

The District Plan controls noise from airport activities that are not aircraft operations, engine testing or APUs in rule 11.1.1.1.8. Land based activities include building services plant, car park activities and activities associated with servicing aircraft on the stands (i.e. baggage and cargo handling, refuelling, water, catering and toilet servicing, airbridge and push back).

The following limits currently apply:

> *Noise emission levels, from any activity within the Airport area, other than aircraft operations, engine testing and the operations of APU's, when measured at any residential site shall not exceed the following limits:*
>
> | | |
> |---|---|
> | *Monday – Saturday 7am to 10pm* | *55 dB $L_{AEQ\,(15\,MIN)}$* |
> | *At all other times* | *45 dB $L_{AEQ\,(15\,MIN)}$* |
> | | *75 dB L_{AFmax}* |

Noise from land based activities at the Airport is not monitored in the same way as aircraft operations therefore it is more difficult to quantify actual current noise levels. If monitoring was carried out, it would be difficult to separate land based activity noise from other airport and local noise sources. For ESA receivers, the noise environment is influenced by other airport noise sources such as aircraft operations more than land based activities. Therefore, rather than attempt to quantify existing land based noise we have relied on the allowable noise limits to define the potential existing land based activities noise levels.

8.4 Existing Noise from Ground Power Units and Auxiliary Power Units

A Ground Power Unit (GPU) provides electricity to an aircraft parked at a stand in order to run the aircraft's essential systems like lighting, air-conditioning etc. An aircraft would otherwise generate its own electricity by running its Auxiliary Power Unit (APU) or main engines. A GPU needs to be manually connected to the aircraft after it parks at a stand. Plug-in type GPUs are connected to a mains power supply and do not emit much noise. Standalone GPUs produce electricity with a diesel generator and can be a contributing noise source at an airport.

Rule 11.1.1.1.9(a) requires that GPUs comply with the land based activities noise limits in rule 11.1.1.1.8. WIAL operates a mix of plug-in and generator type GPUs at different stands. Currently the closest aircraft stands to the ESA receivers are approximately 400 m away. Existing noise from GPUs is estimated to comply with the land based activity noise limits at the ESA receivers.

An aircraft Auxiliary Power Unit (APU) is a small turbine engine usually located in the rear of an aircraft's fuselage. The APU burns aviation fuel to generate electricity to power the aircraft's systems when the main engines are not running or when not connected to a GPU.

Rule 11.1.1.1.9(b) of the District Plan requires that APUs comply with the land based activities noise limits except for:

- aircraft under tow
- the first 90 minutes after an aircraft stops on a gate

- 60 minutes prior to scheduled departure
- the use of APUs to provide for engine testing pursuant to rule 11.1.1.1.7

To calculate the likely current noise emissions from APUs at Wellington Airport we have reviewed a range of manufacturer's data for older and more modern aircraft types. ICAO Annex 16[6] defines a limit for ramp noise for jet aircraft of 90 dBA at a 20 m perimeter around the aircraft. Ramp noise includes the APU running which is likely to be the main noise source. Our review of manufacturers data for older and modern aircraft types shows that ramp noise at 20 m ranges between 80 and 85 dB.

The closest existing aircraft stands to the ESA receivers are at the south end of the terminal building, but these stands are for turbo-prop aircraft rather than jets, and we are informed by WIAL that turbo-prop aircraft do not run APUs while parked at a stand. The closest stands used by jets are 480 m from ESA receivers.

We have prepared a computer noise model[7] to calculate noise contours for APUs operating simultaneously on two of the closest existing jet stands. The source level in the model is 85 dB at 20m with spectral data from APU measurements we have previously undertaken. The calculated contours are included in Figure C6 Appendix C. The calculated level at the most affected properties is 58 dB L_{Aeq} and quieter APU models (80 dB at 20 m) would be 53 dB L_{Aeq} at these properties.

Currently the District Plan allows APUs to run for 90 minutes after an aircraft stops on a gate and 60 minutes before scheduled departure time. We are informed that in general, jet aircraft spend 30 – 45 minutes at a stand unloading and reloading (30 – 45 minute turnaround time) and APUs are often run for these durations.

8.5 Existing Cumulative Noise

The District Plan separates out different types of airport noise and applies appropriate limits depending on the nature of each noise source type. The community experiences the combined noise from all sources, so it is important to consider the cumulative effect from all noise sources on receivers. However, it can be difficult to quantify the cumulative noise, as different sources are assessed using different metrics and time frames. The different types of noise and the metrics used are:

- Aircraft Operations (L_{dn} over 90 days)
- Land Based Activities ($L_{Aeq(15\ min)}$ day and night)
- On-Wing Engine Testing (sporadic and only night-time limits apply)
- APUs ($L_{Aeq(15\ min)}$ day and night when not exempt)

We have quantified the cumulative noise from aircraft operations, land based activities and APUs by converting all of these sources into the L_{dn} metric. The existing land based activity noise limits are 55 dB L_{Aeq} during the day and 45 dB L_{Aeq} at night, which is approximately equivalent to 55 dB L_{dn}. For APUs we have assumed the levels calculated in Figure C6 (Appendix C) for 7.5 hours during the day (i.e. 50% of the time) plus 2 hours at night (10pm to 7am). For the ESA receivers, noise from APUs ranges from 56 to 59 dB L_{dn}.

[6] International Civil Aviation Organisation (ICAO) aircraft certification noise standards are contained in Annex 16 to the Convention on International Civil Aviation

[7] Using SoundPLAN software

Table 1: Permitted Cumulative Noise Levels

	Levels Permitted by District Plan (dB L_{dn})			
Receiver	Aircraft Operations	Land Based Activities	APUs[8]	Cumulative
Raukawa St	58	55	57	62
Bunker Way	58	55	59	62
Kekerenga St	59 – 63	55	56	62 - 64

To quantify the existing cumulative noise, we have used measurement data available from a recent construction project at the Airport. WIAL recently carried out noise monitoring of construction activities at the location indicated in Figure 6 adjacent to Bunker Way dwellings. We understand from WIAL that construction generally did not take place on Saturdays and Sundays (daytime), which means that the data from this noise logger is useful to this assessment in that it can be used to provide an understanding of the typical existing total noise levels received at houses overlooking the golf course.

Table 2 summarises the measured noise data from 17 Saturdays and 18 Sundays between July 2018 and May 2019[9]. Sunday night-time data is not shown as we understand that construction often took place on Sunday nights.

Table 2: Measured Total Noise Levels at Bunker Way (all noise sources)

	Saturdays		Sundays
	Daytime $L_{Aeq(15\ hour)}$	Night-time $L_{Aeq(9\ hour)}$	Daytime $L_{Aeq(15\ hour)}$
Minimum	51 dB	44 dB	52 dB
Maximum	59 dB	50 dB	58 dB
Average	55 dB	46 dB	56 dB

The measurements show that total noise levels at Bunker Way on Saturdays and Sundays typically range from 51 – 59 dB $L_{Aeq(15\ hour)}$. We expect the main contributor to the measured noise would be aircraft operations, predicted to be around 53 dB L_{Aeq} however other unidentified noise sources are also contributing to the total level.

The measurements demonstrate that this location does not enjoy a quieter noise environment on Sundays. Sunday noise levels are the same as Saturdays which is expected for an area adjacent to an international airport.

The data from Saturdays provides further understanding of the ambient noise environment from all noise sources. The average daytime level is 55 dB $L_{Aeq(15\ hour)}$ and the average night-time level is 46 dB $L_{Aeq(9\ hour)}$. This is an average 24 hour L_{dn} of 55 dB. We consider that this is representative of the existing cumulative airport noise at ESA receivers near Bunker Way. Comparing this with the

[8] Based on APUs running continuously all day and two hours at night

[9] We have excluded data for days with strong winds as wind noise on the microphone affects the results.

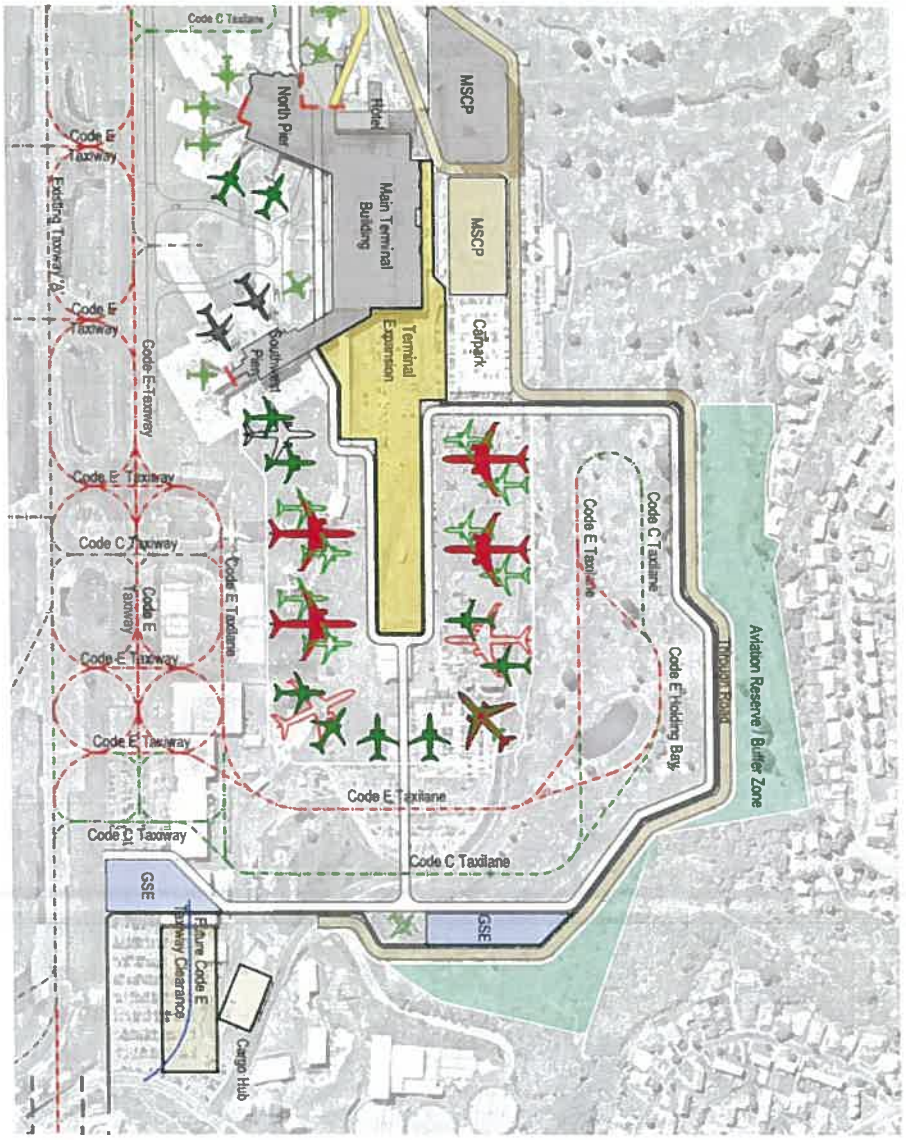
permitted cumulative levels in Table 1 we see that existing cumulative noise is 7 dB below the permitted cumulative level of airport noise.

9.0 PROPOSED NOISE EMISSIONS

9.1 Predicted Noise from Aircraft Operations

Aircraft operations are defined in the District Plan as '*the engine run-up, taxiing, take-off or landing at an airport of an aircraft*". Take-off, landing and taxiing currently takes place within the Airport Area. The only aircraft operations proposed in the ESA is taxiing and engine start up. Figure 7 shows the proposed Concept Code C[10] and Code E[11] aircraft taxiways in the ESA.

Figure 7: Proposed Taxiways in East Side Area



Source: 2040 Masterplan (May 2019)

[10] Code C is the ICAO aircraft classification used in airport geometric design which generally relates to aircraft wingspan and landing gear width. Code C aircraft at Wellington are typically Airbus A320, Boeing 737-800

[11] Code E is the ICAO aircraft classification used in airport geometric design which generally relates to aircraft wingspan and landing gear width. Code E aircraft anticipated for Wellington include Airbus A359, Boeing 777-200, Boeing 787-900

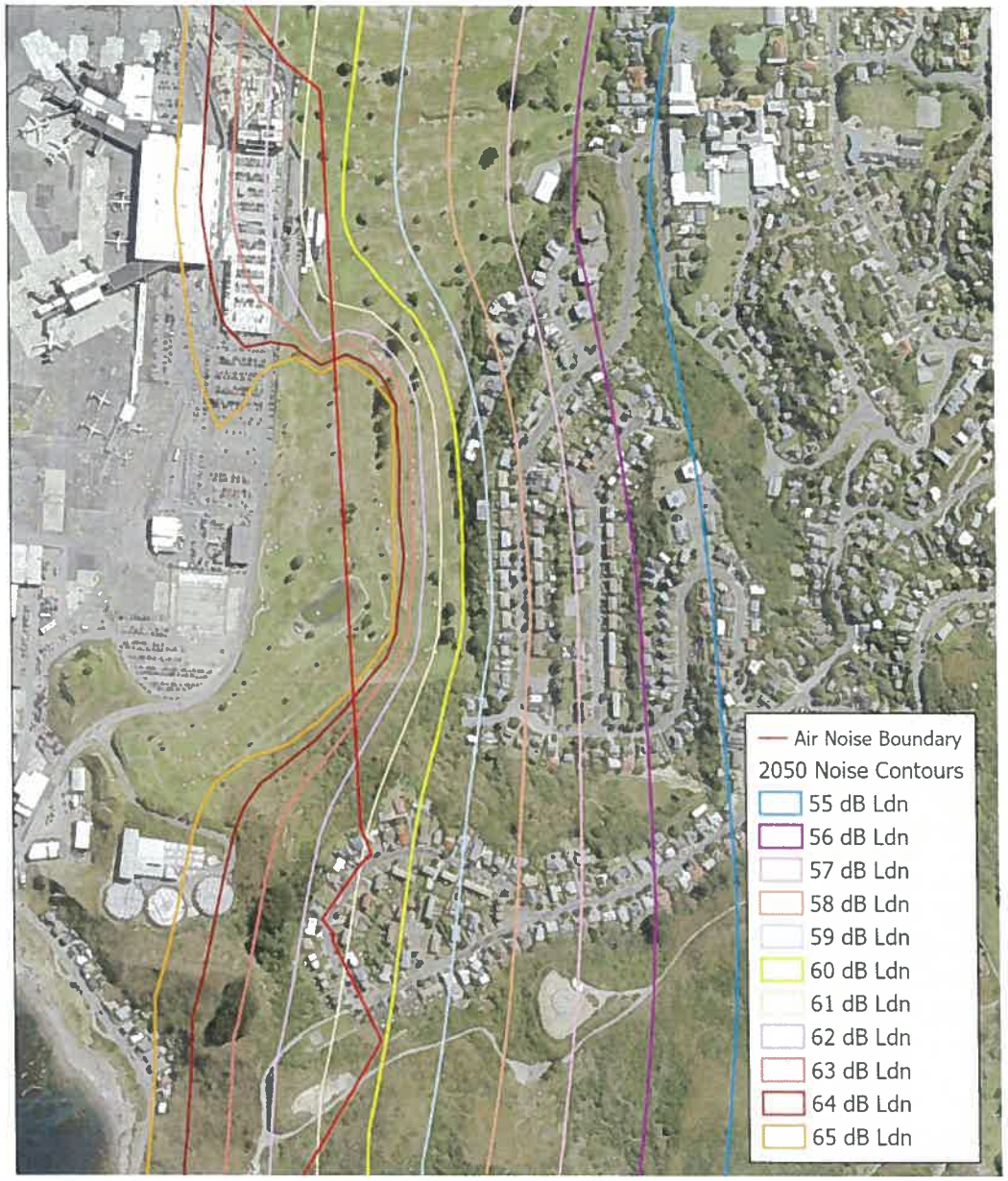
To quantify the noise from aircraft operations once the ESA designation has been implemented and is operational, we have calculated noise contours. These are based on a future forecast of aircraft operations which underpin the 2040 Masterplan. WIAL engaged InterVISTAS to prepare future passenger and aircraft movement forecasts.

The aircraft movements included in the 2050 (95th percentile) forecast allows for approximately 16 million passengers per annum. We understand that the life of the Masterplan is to the year 2040 however we have considered noise effects beyond this horizon using the InterVISTAS 2050 forecasts. A thirty year planning horizon is typical for noise contours at New Zealand's major airports. Utilisation of the 95th percentile 2050 forecast is suitably conservative insofar as noise assessment is concerned as this is effectively "worst case". Details of the calculation methodology are contained in Appendix B.

As a noise management measure, WIAL proposes to exclude aircraft from taxiing under their own power in the ESA at night (between 10pm and 7am). This would avoid sleep disturbance effects for residents in Raukawa Street in particular and reduce the overall noise exposure for these residents. Therefore, the predicted 2050 noise contours include no account for aircraft taxiing under their own power in the ESA at night.

Figure C3 in Appendix C shows the predicted 2050 noise contours. The 2050 65 dB L_{dn} contour extends beyond the existing District Plan ANB within the ESA due to noise from aircraft operating on the proposed taxiways during daytime. The 2050 contours in one decibel increments in the vicinity of the ESA are shown in Figure 8. In summary, noise from aircraft on the proposed ESA taxiways would increase the average L_{dn} noise exposure for ESA receivers. Our assessment in Section 10.1 considers the scale and resulting effects of this increase.

Figure 8: 2050 Aircraft Operations Noise Contours



The L_{dn} noise contours describe the overall noise exposure from aircraft noise events averaged over 3 months in accordance with NZ Standard NZS 6805 and the District Plan. Residents would also notice a change in individual noise events due to aircraft taxiing closer to their homes than they currently do. We have predicted the single event levels from aircraft on the proposed taxiways received at the closest houses on Raukawa Street based on measurements of aircraft taxiing.

The single event levels from a wide body aircraft[12] on the eastern-most taxiway are predicted to be approximately 95 dB L_{AE} and 83 dB L_{Amax} at the Raukawa Street houses[13]. For taxiing narrow body aircraft, noise levels would be approximately 84 dB L_{AE} and 75 dB L_{Amax}. The 2050 operating scenario includes 12 wide body and 12 narrow body jet aircraft movements per day (7am – 10pm) on the taxiways within the ESA.

[12] Based on Boeing 777-200

[13] Based on measurements at 47 m

For comparison the single event levels of jet aircraft taking off or landing on the runway received at these houses are predicted to be approximately 83 – 89 dB L_{AE}. This means that single event noise levels from narrow body aircraft on the new taxiways would be similar to current take-offs on the runway. Wide body aircraft taxiing in the ESA would sound subjectively twice as loud as current take-offs on the runway. Section 10.1 considers the effects of these single event levels on residents.

9.2 Predicted Noise from Engine Testing

It is not proposed to provide for engine testing in the ESA designation.

9.3 Predicted Noise from Land Based Activities

Land based activities include activities associated with servicing aircraft on the stands (i.e. APUs, GPUs, baggage and cargo handling, refuelling, water, catering and toilet servicing, airbridge and push back). The 2040 Airport Masterplan also includes the realignment of part of Stewart Duff Drive. We consider it appropriate for noise from this road to be assessed as a land based activity.

In the following sections we have predicted the likely noise emissions from land based activities in the ESA to assess whether emissions would comply with the recommended noise limits set out below. A discussion on the effects of the recommended noise limits is provided in Section 10.2.

> *Noise emission levels, from any activity within the designation boundary, other than aircraft operations, engine testing and the operations of APUs, when measured at any residential site shall not exceed the following limits:*
>
> | | |
> |---|---|
> | *7am to 10pm* | *55 dB $L_{AEQ\,(15\,MIN)}$* |
> | *At all other times* | *45 dB $L_{AEQ\,(15\,MIN)}$* |
> | | *75 dB L_{AFmax}* |

9.3.1 Predicted Noise from Ground Support Equipment (GSE)

New apron and aircraft stands are proposed to be located largely within the existing Airport Area. Ground support equipment (GSE) such as baggage and cargo handling, refuelling, water, catering and toilet servicing would operate around aircraft parked on the new stands. We have prepared a computer noise model[14] to calculate noise contours for GSE operating simultaneously on three of the proposed new stands which we have assumed is a realistic operating scenario based on the future forecast. The source levels are based on conventional combustion engine GSE with an average sound power of 102 dB L_w. The calculated contours are included in Appendix C.

The contours show that predicted noise from GSE operating at the new stands would comply with the proposed daytime limit of 55 dB L_{Aeq} at relevant receivers but not the night-time limit of 45 dB L_{Aeq}. Some GSE activity could potentially comply at night particularly if electric GSE are used and this could be managed once specific equipment noise levels are established.

Noise from GPUs and APUs is addressed in Section 9.4.

9.3.2 Predicted Noise from Traffic on Realigned Road

The realigned road on the eastern side of the ESA designation would be approximately 45 m from the closest relevant receiver. At this stage we do not know what volume of traffic would use the road. Instead we have calculated the volume of heavy vehicles that could potentially use the road within the land based activity noise limits.

Between 7am and 10pm the proposed limit is 55 dB $L_{Aeq(15\,min)}$, and this decreases to 45 dB $L_{Aeq(15\,mins)}$ at night (10pm – 7am). We have prepared a computer noise model to calculate noise contours for

[14] Using SoundPLAN software

truck movements for the daytime and night-time assessment periods as summarised in Table 3. The resulting contours can be found in Figures C9 and C10 in Appendix C.

Table 3:Number of Truck Movements Predicted to Comply with Land Based Activity Noise Limits

	Number of Truck Movements		
	15 Minutes[15]	Hourly	Daily/Nightly
Daytime (7am – 10pm)	-	45	680
Night-time (10pm – 7am)	1	4	41

We predict the single event noise levels during a truck pass-by would be 74 dB L_{AE} and 72 dB L_{Amax} at the closest ESA receivers. Therefore, the L_{Amax} level is predicted to comply with the proposed limit of 75 dB L_{Amax} at night.

9.3.3 Predicted Combined GSE and Road Noise

The land based activity noise limits apply to the combined noise from all relevant activities. The noise model has been used to calculate combined daytime noise contours for GSE at the new stands and trucks on the road. The contours, in Figure C11 in Appendix C, show that the combined noise can comply with the proposed daytime limit of 55 dB L_{Aeq} at relevant receivers.

To comply with 45 dB L_{Aeq} at night, trucks accessing the proposed cargo hub and GSE activity would need to be carefully managed. If electric GSE are used, then it may be possible to operate these around the new stands and comply with the night-time noise limit.

9.4 Predicted Noise from Ground Power Units and Auxiliary Power Units

We understand that all new aircraft stands adjacent the ESA would include plug-in type GPUs therefore generator type GPUs would not operate in the ESA. Therefore, GPU noise emissions would be negligible.

To predict noise emissions from APUs in the ESA, we have reviewed a range of manufacturer's data for older and more modern aircraft types. ICAO Annex 16[16] defines a limit for ramp noise for jet aircraft of 90 dBA at a 20 m perimeter around the aircraft. Ramp noise includes the APU running which is likely to be the main noise source. Our review of manufacturers data for older and modern aircraft types shows that ramp noise at 20 m ranges between 80 and 85 dB.

The Airport's 2040 Masterplan shows that for the new aircraft stands near the ESA, aircraft APUs could be as close as 230 m from the ESA receivers.

We have prepared a computer noise model[17] to calculate noise contours for APUs operating simultaneously on two of the proposed new stands. As APUs are only used for a short time before leaving and after arriving at a stand, we have assumed that two APUs operating simultaneously is a realistic scenario. The source level in the model is 85 dB at 20m with spectral data from APU measurements we have previously undertaken. The calculated contours are included in Figure C7 Appendix C. The predicted level at the most affected properties is 62 dB L_{Aeq} and quieter APU models (80 dB at 20 m) would be 57 dB L_{Aeq} at these properties. This is an increase of 4 dB compared

[15] A 15 minute assessment period only applies at night when averaging is not provided for in NZS 6802:2008

[16] International Civil Aviation Organisation (ICAO) aircraft certification noise standards are contained in Annex 16 to the Convention on International Civil Aviation

[17] Using SoundPLAN software

with the estimated current APU noise levels (as noted in Section 8.4). Section 0 discusses the effects of APU noise on ESA receivers and our recommended controls.

9.5 Predicted Construction Noise

Construction noise would be predicted and assessed against NZS 6803:1999 when final details relating to construction are known and the Earthworks and Construction Management Plan is prepared (refer to proposed construction noise condition). This Management Plan would be submitted as part of an Outline Plan for Works and a condition in this respect is recommended. At the time an outline plan for works is submitted, it is expected that an accurate assessment of the likely construction noise would be undertaken, based on a detailed construction methodology. Where practicable it is expected that the project would comply with the noise limits in NZS 6803:1999. If there were likely to be any exceedances of these limits it is usual for the Construction Noise Management Plan to identify when and where these might occur and include fit for purpose mitigation measures to properly manage the effects of these exceedances. It is recommended that as part of the outline plan process that the Council should have the opportunity to make comment on the Construction Management Plan prior to commencing works.

10.0 ASSESSMENT OF NOISE EFFECTS

This section considers the noise effects from the various airport noise sources. Part of the effects assessment addresses the change in noise levels resulting from the proposal. 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.

However, the following general response to an immediate change in noise is typical:

- An increase in noise level of 9 to 10 dB sounds subjectively about 'twice as loud';
- A change in noise of 7 to 8 dB is regarded as 'appreciable';
- A change in noise level of 5 to 6 dB is regarded as 'noticeable';
- A change in noise level of 3 to 4 dB is 'just discernible';
- A change in noise level of 1 to 2 dB is 'not discernible'.

10.1 Noise Effects from Aircraft Operations

10.1.1 Change in L_{dn} Average Noise Exposure

We have assessed the change in aircraft operations noise level in the vicinity of the designated area by comparing the 2050 noise contours with:

a) The plan permitted noise contours (the model used to develop the ANB)

b) Current noise contours (FY19) which show the current level of noise exposure experienced by ESA receivers.

This assessment considers the change in noise for some 30 years in the future as a result of gradual growth in airport operations. The predicted change, compared with current noise, would not occur immediately the ESA becomes operational. We have not prepared predictions for a scenario immediately following the ESA becoming operational however we estimate a 1 – 2 dB increase initially due to the new taxiways then further increase would occur gradually over many years.

Figures C4 and C5 in Appendix C show coloured maps that identify the above changes in noise level at properties surrounding the ESA. The assessment extends out generally as far as the 55 dB L_{dn} contours in the vicinity of the ESA. For clarity, some large lots that are industrial or community use rather than residential have not been coloured on the maps.

Figure C4 shows the predicted increase in aircraft operations noise at individual properties by comparing the plan permitted noise exposure levels to the year 2050. Most properties are coloured

pale green which means the 2050 levels are the same or lower than the plan permitted levels. For 16 properties (shaded pale yellow), the 2050 levels are predicted to be 1 dB higher than the plan permitted levels. For the ESA receivers, the change in noise compared with the plan permitted contours is due to a combination of different aircraft types and the additional noise from aircraft taxiing in the ESA during the day, which was not an anticipated part of the District Plan model. Subjectively a change of 1 dB is imperceptible and therefore we consider the change in L_{dn} noise level compared with the levels already provided for by the District Plan is reasonable.

Figure C5 shows the predicted increase in aircraft operations noise at individual properties by comparing current noise exposure levels (FY19) to the year 2050. The predicted increase ranges from 4 – 6 dB L_{dn}. Subjectively an increase of 4 decibels is 'just discernible' and a 5 – 6 dB increase is a 'noticeable' change. An increase of 5 dB is expected as current aircraft operations noise levels are currently around 5 dB below the 65 dB L_{dn} limit at the ANB. The 1 dB greater increase for some ESA receivers is due to additional noise from aircraft taxiing in the ESA which is not part of current operations.

In summary, the predicted change in L_{dn} noise levels compared with current levels for ESA receivers, is a just discernible to noticeable increase. For ESA receivers, L_{dn} noise levels would increase by 1 -2 decibels when operations began in the ESA then the rest of the increase would occur gradually over approximately 30 years.

Figures C4 and C5 show that the ESA receivers most affected by the proposed airport expansion, are the front row of houses on Ruakawa Street and Bunker Way. Aircraft operations noise received at houses on Kekerenga St is largely most affected by runway noise already provided for by the District Plan, and noise from the ESA taxiways is not predicted to contribute significantly to the noise exposure level at these houses.

10.1.2 Annoyance Due to Aircraft Operations Noise

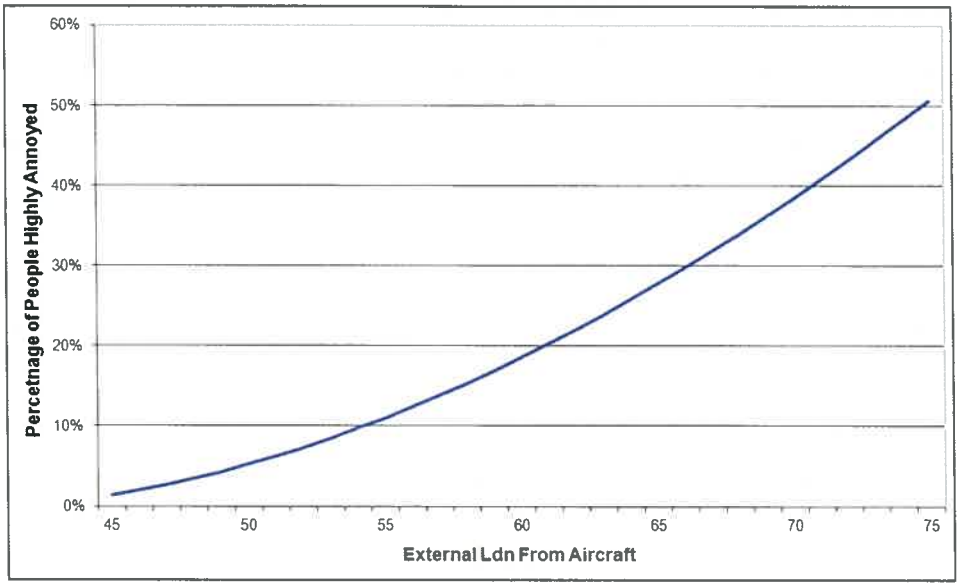
Annoyance due to aircraft noise is influenced by many factors including, but not limited, to:

- How loud the noise is;
- How long the noise lasts for;
- How many times the noise occurs in a day/month/year;
- The time of the noise event (i.e. daytime vs. night-time);
- The frequency (or pitch) of the noise;
- Whether there is a change to the noise source;
- The receiver's attitude to the noise source and the noise producer.

No single noise metric can take into account all of the factors that influence annoyance. A large number of studies have been carried out in an attempt to determine the general relationship between aircraft noise levels and community annoyance. The most comprehensive amalgamation of the various airport noise studies was carried out by Miedema and Oudshoorn in 2001[18]. The Miedema and Oudshoorn relationship is shown in Figure 9.

[18] Miedema and Oudshoorn (2001); "Annoyance from Transportation Noise: Relationships with Exposure Metrics DNL and DENL and Their Confidence Intervals"

Figure 9: Dose Response Curve for Community Annoyance Response to Aircraft Noise



This relationship can be used to estimate the number of people likely to be highly annoyed at various levels of aircraft noise. At an exposure level of 55 dB L_{dn} 11% of residents are likely to be highly annoyed. At 60 and 65 dB L_{dn} 19% and 28% respectively of residents are likely to be highly annoyed.

Acoustic insulation of houses is one method of reducing the annoyance effects on residents however aircraft noise in outdoor living areas would still contribute to annoyance. Therefore, acoustic insulation is not a complete solution.

NZS 6805:1992 recommends that between 55 and 65 dB L_{dn} new houses and additions to existing houses are prohibited or if permitted are fitted with appropriate acoustic insulation. Between 65 and 70 dB L_{dn} NZS 6805:1992 recommends that new houses are prohibited and steps are taken to provide existing houses with acoustic insulation.

For residents inside the ANB, Wellington Airport Noise Treatment Ltd offers an acoustic mitigation program (Quieter Homes) which provides acoustic treatment to residents affected by aircraft noise levels greater than 65 dB L_{dn}. The Quieter Homes indoor design target for habitable rooms is 45 dB L_{dn}. The criteria for the program were developed through the Land Use Management and Insulation for Airport Noise Study (refer Section 5.3). The Quieter Homes offers do not extend beyond the ANB (65 dB L_{dn}).

For ESA receivers, the future noise from aircraft operations is predicted to reach 58 – 61 dB L_{dn} which is outside the eligibility criteria for Quieter Homes. We expect that internal noise levels for ESA receivers would be approximately 45 dB L_{dn} with windows ajar for ventilation therefore these properties would generally achieve the Quieter Homes objective without acoustic treatment.

10.1.3 Single Event Levels from Taxiing Aircraft

In addition to assessing overall noise exposure with the L_{dn} metric, we have considered the effects on receivers during individual noise events such as aircraft taxiing under their own power in the ESA.

The 2050 noise predictions include an average of 12 wide body and 12 narrow body jet aircraft movements per day on the taxiways within the ESA.

The single event levels from a wide body aircraft on the eastern-most taxiway are predicted to be approximately 95 dB L_{AE} and 83 dB L_{Amax} at the Raukawa Street houses. These events would disrupt communication outdoors. Indoors with windows open these levels would be clearly audible and likely to disrupt communication. With windows closed the indoor noise levels would be audible and may disrupt quieter activities.

These levels are 10 decibels higher (subjectively twice as loud) than current jet departures which are the loudest aircraft events these receivers currently experience. This is a significant increase in single event levels but although these levels are undesirable in a conventional setting, they are not excessive or uncommon for residents living near an airport. These elevated noise events are predicted to occur only 12 times a day between 7am and 10pm in the 2050 operating scenario. By comparison the 2050 scenario includes 110 jet departures per day.

For taxiing narrow body aircraft in the ESA, noise levels would be approximately 84 dB L_{AE} and 75 dB L_{Amax} at the Raukawa Street houses. These levels are similar to current single event levels experienced by these receivers from jet departures.

10.2 Noise Effects from Land Based Activities

We recommend land based activities in the ESA are controlled by the following limits at residential receivers:

7am to 10pm	*55 dB $L_{AEQ\ (15\ MIN)}$*
At all other times	*45 dB $L_{AEQ\ (15\ MIN)}$*
	75 dB L_{AFmax}

Currently the limits for land based activities in the Airport Area apply 45 dB $L_{Aeq(15\ min)}$ all day and night on Sundays. We consider this is an overly restrictive and unrealistic limit for Sundays during the day and recommend that 55 dB L_{Aeq} is applied during the day for the following reasons.

The guidelines for setting general environmental noise limits in NZS 6802:2008 recommend a daytime limit of 55 dB $L_{Aeq(15\ min)}$ is appropriate for residential receivers. The standard does not identify Sundays as particularly sensitive or requiring lower limits. We consider a daytime limit of 45 dB L_{Aeq} in a general urban environment is unrealistic and unnecessary. For an urban environment near an international airport this is even more so. The approach of Sunday noise limits being consistent with other days has been adopted by almost all other District Plans in New Zealand.

For an international airport, reduced noise limits on Sundays is not practicable. Wellington Airport operates 7 days a week and land based activities cannot practicably be curtailed on Sundays. Recent measurements show that current total noise levels from all sources during the day on Sundays is around 56 dB L_{Aeq} (refer Table 2). Most of this noise is expected to be from aircraft operations which demonstrates that a lower daytime limit for land based activities on Sundays would provide little benefit to receivers.

In summary we consider that a daytime limit of 45 dB L_{Aeq} on land based activities on Sundays is neither appropriate nor warranted. A limit of 45 dB L_{Aeq} at night (10pm – 7am) is however appropriate for sleep protection. We consider that the proposed limit for the ESA of 55 dB L_{Aeq} during the day on Sundays is appropriate and the effects on receivers would be reasonable.

10.2.1 Recommended Mitigation of Land Based Activity Noise

Our predictions show that land based activities in the ESA would comply with the recommended limits during the day and at night some activities would need to be managed in order to comply (e.g. employing electric ground support equipment).

We recommend that the Airport Noise Management Plan is the appropriate mechanism for managing land based activities to comply with the proposed noise limits in conjunction with designation conditions. Operational procedures should be developed once the demand for night-time GSE operations on the eastern stands and the type of equipment are known.

10.3 Noise Effects from GPUs and APUs

As discussed in Section 9.4, generator type GPUs would not operate in the ESA and noise from plug-in GPUs would be negligible.

For ESA receivers, APU noise levels are predicted to range from 57 – 62 dB while APUs are operating on the eastern stands. This is a 'just perceptible' 4 dB increase on current predicted APU noise levels. The predicted 62 dB L_{Aeq} for the noisier APUs is elevated for a residential environment but not unusual for residential sites near an airport. The following section discusses our recommended mitigation of APU noise effects on ESA receivers.

10.3.1 Recommended Mitigation of APU Noise

We understand it is necessary for APUs to be run for a short time while aircraft are not connected to a GPU either side of departing and arriving at a stand. It is appropriate that airlines should use GPUs for as long as possible when on a stand meaning that APUs are only run for as short a time as necessary reducing fuel burn, noise and emissions.

Aircraft manufacturers continue to innovate ways to reduce ramp noise from aircraft systems while parked on stands. The industry (ICAO) sets minimum ramp noise standards[19] that are reduced as the technology improves. In this way, and by reducing the run time, APU noise is mitigated at the source as much as practicable. It is not practicable to attenuate APU noise by screening or other means at the stands.

To balance the need for APUs to operate for short times at the proposed new eastern stands against managing the noise effects on ESA receivers we recommend that noise from APUs in the ESA complies with the land based activities noise limits except for:

- Aircraft under tow (7am – 10pm)
- 20 minutes after block on time at a stand (7am - 10pm)
- 10 minutes prior to block off time at a stand (7am - 10pm)

These controls would effectively exclude APUs running on the eastern stands between 10pm and 7am. They would also provide certainty to the ESA receivers that they would not be unnecessarily subjected to noise from APUs on the new stands.

Although the noise level received with an APU running would be up to 6 dB higher than the land based activity limit, the duration restrictions would control the overall daily exposure to APU noise for ESA receivers. Based on the 2050 operating scenario we calculate that APUs on the eastern stands could potentially run for an average of 24 minutes per hour during the day (or 364 minutes 7am – 10pm)[20]. This is equivalent to 57 dB $L_{Aeq(15\ hour)}$ and 55 dB L_{dn}.

Considering the predicted APU noise levels in the context of the total noise environment and the recommended mitigation measures, we consider that the effects from APU noise on the ESA receivers would be appropriately managed.

10.4 Cumulative Noise Effects from ESA Site

For residents living adjacent to an airport, the total noise exposure is the combination of all airport noise sources. It is important to consider what the cumulative effect from all noise sources is on receivers. However, it can be difficult to quantify the cumulative noise as different sources are assessed using different metrics and time frames.

[19] ICAO Annex 16 Chapter 9 (90 dBA at 20m)

[20] Based on 24 taxi movements per day in the ESA

The different types of noise we recommend be controlled by way of conditions for the ESA are:

- Aircraft Operations (L_{dn} over 90 days)
- Land Based Activities ($L_{Aeq(15\ min)}$ day and night)
- APUs

We have quantified the cumulative noise from aircraft operations (2050), land based activities and APUs by converting all of these sources into the L_{dn} metric. Table 4 summarises the results.

APUs would need to either comply with the land based activity limits or the duration restrictions. Either way, the equivalent L_{dn} noise exposure would be approximately 55 dB L_{dn}.

The proposed land based activity noise limits are 55 dB L_{Aeq} during the day and 45 dB L_{Aeq} at night which is approximately equivalent to 55 dB L_{dn}.

Table 4: Predicted Cumulative Noise Levels (2050) After Mitigation

	Predicted 2050 Noise Levels (dB L_{dn})			
Receiver	Aircraft Operations*	Land Based Activities	APUs[21]	Cumulative
Raukawa St	59	55	55	62
Bunker Way	59	55	55	62
Kekerenga St	59 – 62	55	55	62 - 63

* Combined aircraft operations noise from Airport Area and ESA

The cumulative noise based on the year 2050 mitigated scenario is predicted to reach 62 – 63 dB L_{dn} at ESA receivers. This is an elevated and undesirable noise level for residential areas but is not unusual for residential properties adjacent to transport infrastructure such as roads and airports. Noise from aircraft operations is the main source contributing to the cumulative noise and this would increase gradually over approximately 30 years.

Comparing the predicted cumulative levels with the permitted cumulative levels (refer Section 8.5) there is no increase in cumulative noise at any of the ESA receiver locations.

The measured current total noise level at Bunker Way was 55 dB L_{dn} (refer Section 8.5). Therefore a 7 dB increase is predicted on current cumulative noise levels. This is subjectively an appreciable increase. Initially when the ESA becomes operational there would be a small (just perceptible) increase in total cumulative noise exposure but much of the 7dB increase would occur gradually over many years as airport operations grew.

10.5 Cumulative Noise from Airport Area and ESA Site

In addition to the cumulative effect from different types of airport noise in the ESA, it is important to consider the impact of noise from activities in the Airport Area combined with noise from activities in the ESA. To avoid allowing twice the noise at receivers through separate provisions in each area, we recommend the conditions for the ESA designation apply limits that properly account for the combined noise from the existing Airport Area and the ESA. This is practicable and appropriate for aircraft operations and land based activities. It would also avoid the need to monitor compliance of these activities in each Airport site separately which would be difficult to achieve in practice. The proposed noise controls in Section 11.0 apply this approach.

[21] Either by complying with land based activity limits, or the duration limits

However, it is not practicable to apply the recommended APU controls for the ESA to the combined noise from APUs in the Airport Area and the ESA as the existing Airport Area rules are more permissive. In theory, with the existing Airport Area APU provisions, the cumulative airport noise from both sites could be 2 dB higher than the levels in Table 4.

11.0 RECOMMENDED NOISE CONTROLS

It is recommended that the designation conditions generally reflect the limits imposed by the existing District Plan Airport Area noise rules but with seven changes to enable the Masterplan and manage the noise effects:

1. Undertake construction noise assessment and prepare construction noise management plan;
2. Allow an exceedance of the ANB within the ESA to allow for localised taxiing noise;
3. Align the daytime noise limits for land based airport activities on Sunday with those for Monday to Saturday;
4. Tighten the allowance for APUs within the ESA to be exempt from noise limits;
5. Exclude taxiing under power within the ESA between 10pm and 7am;
6. Require continuous monitoring of airport noise at the interface between the ESA and the residential zone;
7. Exclude engine testing from the ESA.

The following sections describe these recommendations in more detail.

11.1 Undertake Construction Noise Assessment and Prepare Management Plan

Construction noise should be managed to comply with the limits set out in NZS 6803:1999 where practicable. This Standard sets specific limits to manage the effects of construction noise and recognises the specific character of such noise and that such noise is temporary. We recommend that a specific construction noise assessment be undertaken once further information is available about the construction methodology and construction activities are managed according to a fit for purpose management plan. Suitable conditions should be placed on the designation to achieve this outcome.

11.2 Allow localised exceedance of ANB

Section 9.1 presents the predicted aircraft operations noise contours for the year 2050 with the extension of airport activities onto the ESA. The predictions show that noise from 2050 aircraft operations will exceed the ANB within the ESA. The exceedance is localised around the taxiways within the area.

The effect of the exceedance is mostly contained within the ESA however taxiing noise will contribute to the total operational noise levels at the ESA receivers on Raukawa Street and Bunker Way. This is apparent in the bulge in the shape of the contours over these properties (refer Section 9.1). The outcome for these receivers is that aircraft operations noise at 2050 would be 1 dB higher than the levels permitted by the District Plan. This is because noise from aircraft on the runway is the main contributor to operational noise, rather than taxiing. A one decibel change is imperceptible.

The effect of taxiing activity within the ESA designation necessitates a change to the compliance point of the 65 dB L_{dn} contour at this location. Figure 10 below shows how this differs from the existing ANB in the vicinity of the ESA. This means that compliance with the 65 dB L_{dn} limit would be assessed at the red dashed Compliance Line where it is shown, and elsewhere compliance would be assessed at the existing ANB. A suitable condition to this effect is recommended.

Figure 10: Proposed 65 dB L_{dn} Compliance Line within the ESA designation

11.3 Relax day time noise limit for land based activities on Sundays

The District Plan Airport Area noise limit for land based activities is 55 dB $L_{Aeq(15\ min)}$ (Monday – Saturday 7am – 10pm). At all other times including all day on Sundays, a more restrictive limit of 45 dB $L_{Aeq(15\ min)}$.applies.

As set out in Section 9.3 we consider that a daytime limit of 45 dB L_{Aeq} on land based activities on Sundays is neither appropriate nor warranted and at odds with existing ambient noise levels on Sundays at the Airport. A limit of 45 dB L_{Aeq} at night (10pm – 7am) is however appropriate for sleep protection. We recommend that noise limits for land based activities in the ESA designation are as follows:

> *Combined noise emission levels, from any activity within the Airport Area and East Side Area other than aircraft operations, engine testing and the operations of APUs when measured at any residential site shall not exceed the following limits:*
>
> | | |
> |---|---|
> | *7am to 10pm* | *55 dB $L_{AEQ\ (15\ MIN)}$* |
> | *At all other times* | *45 dB $L_{AEQ\ (15\ MIN)}$* |
> | | *75 dB L_{AFmax}* |

11.4 Tighten controls for APUs

In Section 10.3.1 we recommend that the current District Plan operating window for APUs is reduced in the ESA designation area to mitigate the noise effects from APUs running at the new eastern stands. We recommend that plug-in or battery powered GPUs are provided on all new eastern aircraft stands. Then APUs in the ESA should be required to meet the land based activity noise limits except for:

- Aircraft under tow (7am – 10pm)
- A maximum of 20 minutes after block on time at a stand (7am – 10pm)
- A maximum of 10 minutes prior to block off time at a stand (7am – 10pm)

These controls would effectively exclude APUs being run on the eastern stands between 10pm and 7am and minimise the amount of runtime during the day.

11.5 Exclude aircraft taxiing under power in the ESA at night (10pm – 7am)

WIAL proposes to exclude aircraft taxiing under their own power in the ESA between 10pm and 7am to mitigate the noise effects of this activity. As such we recommend that the designation conditions clearly set out this exclusion but still enable aircraft to be towed on the ESA taxiways at night.

11.6 Monitoring requirement

We recommend that prior to the ESA becoming operational, a permanent noise monitor is installed near the most affected ESA receivers in Bunker Way or Raukawa Street. The monitor would provide data to assess compliance of airport activities including aircraft operations with the proposed noise limits.

The aircraft operations compliance point would be at the proposed 65 dB L_{dn} Compliance Line inside the ESA, however it is not practicable or relevant to measure at this line. It is more relevant to measure noise at the closest receivers and assess compliance from this data.

It is likely to be difficult to distinguish between measured noise from aircraft operations and noise from land based activities but the monitor would at least show the cumulative noise levels which could be used to generally assess compliance. The predicted cumulative level (2050) at the closest Bunker Way and Raukawa Street properties is 62 dB L_{dn}. At night, when aircraft operations have stopped, the monitor would also provide useful data on night-time noise levels from other airport noise sources.

The monitor would also provide reassurance to the ESA receivers that airport noise was continually being monitored and managed to comply with the noise limits.

11.7 Exclude Engine Testing from the East Side Area

Engine testing is not proposed in the ESA designation and should be explicitly excluded.

12.0 SUMMARY OF NOISE EFFECTS

The residential properties most affected by noise from the proposed ESA designation are those on Raukawa Street, Bunker Way and Kekerenga Road that overlook the golf course. These properties have been identified as ESA receivers where noise effects have been assessed.

The initial noise effects from the proposal would occur during the construction phase. This report recommends that a specific construction noise assessment be undertaken once further information is available about the construction methodology. It is expected that conditions will be set in place to require such noise to adhere to suitable limits and that construction activities will be managed according to a fit for purpose management plan.

The ongoing noise effects on ESA receivers would arise from airport related activities on the proposed new taxiways, aircraft stands and road. These effects would occur over time as the ESA is developed. We predict the following noise effects for the ESA receivers:

- As the ESA is developed, a progressive, increase in aircraft operations noise will occur and it is predicted that by the year 2050 this will comprise an increase of 1 dB L_{dn} (imperceptible) compared with the levels currently allowed under the current planning provisions.
- This increase in aircraft operations noise will likely result in an increase of 5 - 6 dB L_{dn} (noticeable) by 2050 compared with currently experienced levels.
- A just perceptible increase (4 dB) in noise from APUs operating at the new stands compared with APU noise from the current Airport site. The resulting levels would be moderately high for a residential area but not uncommon for residents living near transport infrastructure. The effect from this noise source would be appropriately mitigated by applying duration and night-time operating restrictions.
- The day time noise limit on Sundays for land based activities would be aligned with the Monday to Saturday limit. In theory this results in a 10 dB increase in permitted levels on Sundays (7am – 10pm). However, in practice this is considered reasonable as it aligns with current noise levels on Sundays and would not have a noticeable effect on receivers given the effect of other existing noise sources at the Airport.
- Over time wide body aircraft taxiing on the ESA taxiways (up to 12 events per day) would be a significant increase (10 dB L_{AE}) in aircraft single event noise compared with current single event noise from aircraft departures. Night-time restrictions would apply to these activities to avoid sleep disturbance. The predicted single event levels (95 dB L_{AE} and 83 dB L_{Amax}) are moderately high but not uncommon for residents living near an airport.
- For the year 2050, cumulative airport noise levels (from all noise sources) of 62 – 63 dB L_{dn} are predicted. These are moderately high levels that are generally undesirable for residential activity but not uncommon for properties adjacent to an airport. This is an appreciable (7 dB) increase compared to the current measured cumulative noise but no increase compared to cumulative airport noise already permitted by the District Plan at these properties.

The following measures are proposed to manage the noise effects:

Night-time Effects

- No taxiing under engine power will be allowed on ESA taxiways at night (10pm – 7am).
- APUs will be required to meet land based activity noise limits at night (45 dB L_{Aeq}) on the eastern aircraft stands (10pm – 7am) which effectively excludes them from running at night.
- Ground support equipment on eastern aircraft stands and road traffic will be managed to comply with night-time limit of 45 dB L_{Aeq}.

Daytime and Overall

- Noise from aircraft operations will be limited to 65dB L_{dn} at the proposed Compliance Line within the ESA.
- Plug-in GPUs to be available at new eastern aircraft stands and allowable APU runtime restricted.
- Continuous noise monitoring will be undertaken near ESA receivers to monitor compliance with the proposed noise limits.
- No engine testing will be allowed in the ESA.

We consider that the recommended operational restrictions on the new taxiways and aircraft stands represent the best practicable option to manage and mitigate the noise effects of the East Side Area designation.

In summary we consider that noise effects would be appropriately controlled and reasonable in the existing Wellington Airport context.

APPENDIX A GLOSSARY OF TECHNICAL TERMS

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.
SPL or L_P	Sound Pressure Level A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 µPa RMS) and expressed in decibels.
SWL or L_W	Sound Power Level A logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
dB	Decibel The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 µPa i.e. dB = 20 x log(P/Pr)
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
$L_{Aeq\,(t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
L_{dn}	The day night noise level which is calculated from the 24 hour L_{Aeq} with a 10 dB penalty applied to the night-time (2200-0700 hours) L_{Aeq}.
SEL or L_{AE}	Sound Exposure Level The sound level of one second duration which has the same amount of energy as the actual noise event measured. Usually used to measure the sound energy of a particular event, such as a train pass-by or an aircraft flyover
NZS 6801:2008	New Zealand Standard NZS 6801:2008 *"Acoustics – Measurement of environmental sound"*
NZS 6802:2008	New Zealand Standard NZS 6802:2008 *"Acoustics – Environmental Noise"*
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"*
NZS 6805:1992	New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"*

APPENDIX B AIRCRAFT NOISE CALCULATION METHODOLOGY

Predictions of aircraft noise around Wellington Airport have been calculated using the Integrated Noise Model (INM) software. The INM was developed by the United States Federal Aviation Administration and is used internationally for aircraft noise modelling. NZS 6805 recommends using the INM for calculating airport noise boundaries. Marshall Day Acoustics has used the INM for over 25 years to calculate aircraft noise contours for the majority of New Zealand Airports. The INM has been replaced by the Aviation Environmental Design Tool (AEDT). While the AEDT is now required in the United States for FAA CFR[22] Part 150 studies, in Australia, the statutory framework is currently transitioning from INM to AEDT. In New Zealand there is no national statutory requirements and for Wellington, the District Plan does not define the software to be used. MDA is transitioning from INM to AEDT for the airport assessments we carry out. During this transition period we consider that applying either the INM or AEDT model is appropriate. Our review of the AEDT shows that predicted noise levels are almost identical to the INM for the same operational scenarios.

The original airport noise contours used to develop the District Plan ANB were generated in an early version of the INM. Since this time, there have been a number of upgrades to the software. The latest version used for calculating future and current noise contours is INM v7.0d.

Much of the land surrounding Wellington Airport is hilly and this has an effect on how aircraft noise propagates to different areas in the community. Some areas are elevated and therefore closer to aircraft in flight and other areas are screened from the runway by hills. When the ANB was developed the noise model was not capable of allowing for screening by terrain. Therefore the noise contours were calculated based on flat land then an estimated screening adjustment was made manually to produce the ANB.

The more recent versions of INM can allow for terrain effects, however unfortunately the INM does not facilitate terrain data of a high enough resolution to accurately model the steep terrain around Wellington. Therefore in this analysis we have assumed flat land when calculating noise contours. By not taking into account terrain screening, our predictions may overstate noise levels in some areas. When comparing noise levels of different operating scenarios, it is less important to allow for screening provided the various scenarios are calculated using the same assumptions (in this case, flat ground).

Runway Usage

Historically an average of 60% Runway 34 and 40% Runway 16 has been applied to aircraft operations at Wellington Airport. The Airport's noise and operations monitoring system (ANOMS) data has been analysed to determine the average runway usage from 2010 to 2018. The average 12 month and three month averages over this time were 61% Runway 34 and 39% Runway 16. However during the busiest 3 months each year (October – December) the runway use is generally biased towards Runway 34 even further with an average use of 64% Runway 34 and 36% Runway 16. In FY17 the bias reached 70% Runway 34.

The District Plan and 2050 contours have been calculated based on the average use of 60% Runway 34 and 40% Runway 16. The current (FY 19) contours have been calculated using the actual runway usage during the busy three months which was 55% Runway 34 and 45% Runway 16.

Forecast

The outer envelope L_{dn} contours have been plotted for two forecast scenarios for the year 2050 prepared by InterVISTAS in October 2018. One scenario is the Business as Usual Optimistic (95th percentile) forecast. The second scenario is the Extended Runway Optimistic (95th percentile) forecast. Both forecast approximately 16 Million Passengers Per Annum.

[22] Federal Aviation Administration Code of Federal Regulations

Table 5: Year 2050 Aircraft Movement Forecasts

Aircraft	Business as Usual Annual Movements	Extended Runway Annual Movements
777	1670	1560
787	6600	6200
738/MAX8	470	0
739/MAX9	9070	7560
A220	9120	9150
A320	13720	14470
A321	35930	33320
A330	900	1830
A350	0	940
ATR72	41030	40280
C208	8890	8930
CV5	290	300
PC12	5890	5930
Total	**133580**	**130470**

Both forecasts have been factored up for the noise model by 5% to represent the busy 90 day period which historically has been 5% busier than the annual average.

Distribution of Aircraft at Night (10pm – 7am)

The distribution of aircraft movements to night-time has been applied to each route category as listed in Table 5. These figures are based on a synthetic schedule prepared by aviation experts Airbiz and the historical distribution of night-time activity.

Table 6: Night-time Aircraft Movement Assumptions

Route Category	Percentage of Movements at Night (10pm-7am)	
	Arrivals	Departures
Domestic Regional	2%	2%
Domestic Trunk	5%	5%
International Short Haul	40%	30%
International Long Haul & 5th Freedom	0%	0%
General Aviation	14%	7%

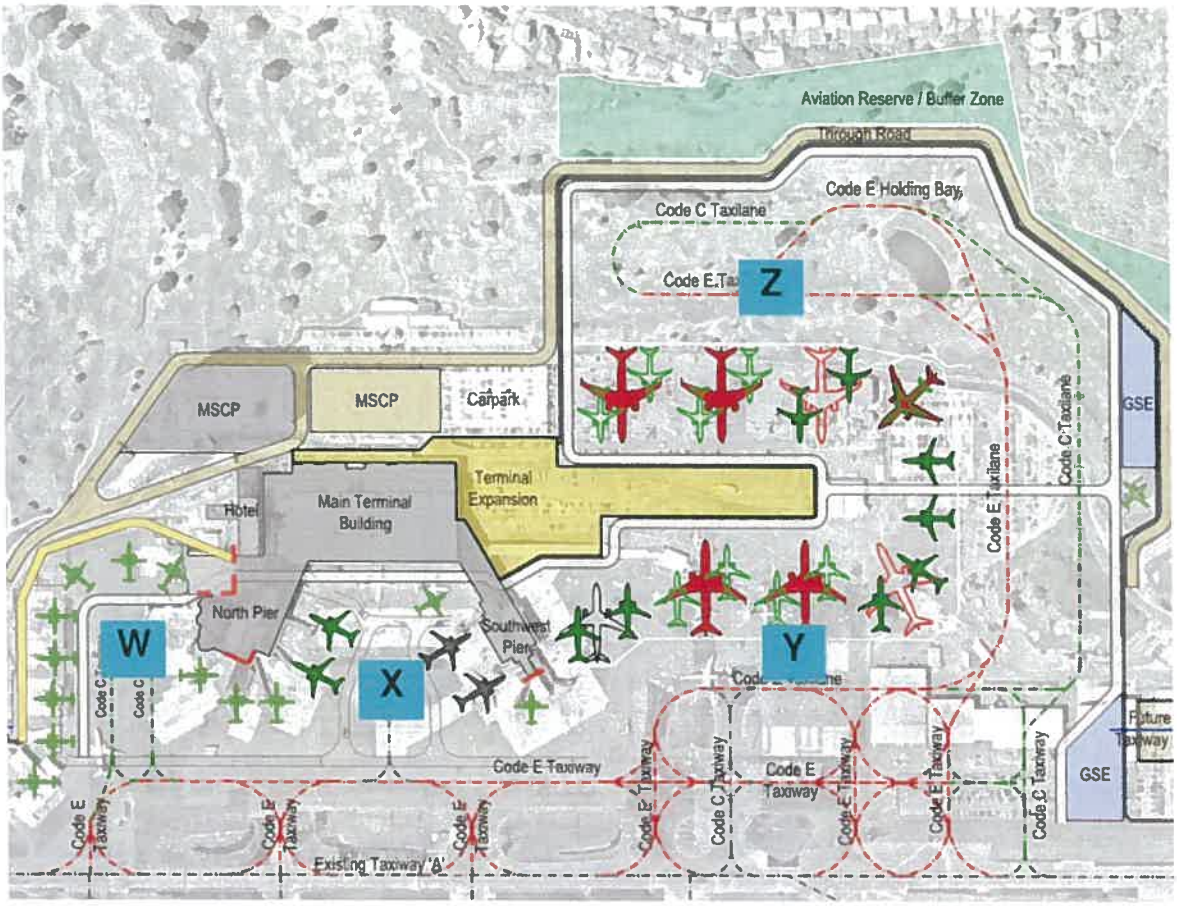
Taxiing

Taxiing aircraft have been included in the calculation of the 2050 and current L_{dn} noise contours. Taxiing was not included in the District Plan noise contours. Despite this taxiing is included in the definition of aircraft operations and is required to comply with the noise limit at the ANB.

For current (FY19) noise contours, taxiing by turbo-prop and jet aircraft are modelled using taxi tracks along the taxiway parallel with the runway.

For the 2050 noise model, the location of taxiways and aircraft stands are based on the 2040 Masterplan concept layout. The taxi tracks in the noise model have been simplified to terminate at four general stand areas W, X, Y and Z as shown in Figure 11.

Figure 11: Consolidated Stand Locations used in Noise Model for Taxi Tracks



The taxiing profiles include a short time (1 minute) with aircraft engines idling during parking or push back from the stand. Four standard aircraft types are used to represent taxiing of turbo-prop, A220, narrow body jets and wide body jets as follows:

Table 7: Distribution of Aircraft Taxiing Across Stand Locations

Aircraft Category	Representative Aircraft for Taxiing	Taxi to Stand Location	Percentage of Taxi Movements
Turbo-Prop	ATR72	W	100%
A220	EMB195	W	50%
		X	50%
Narrow Body Jet	A320-232	X	20%
		Y	40%
		Z	40%
Wide Body Jet	777-200	Y	50%
		Z	50%

Flight Tracks

For the purpose of assessing noise from the proposed East Side Area, jet aircraft have been modelled on straight flight tracks aligned with the extended runway centreline. Turbo-props have been modelled on straight and turning flight tracks based on information available at the time. Aircraft diverging from straight flight tracks in practice does not affect the residential receivers adjacent to the golf course and therefore applying straight flight tracks is reasonable for this assessment.

Aircraft Substitutions and Model Calibration

The InterVISTAS forecast includes modern aircraft types that are not included as standard aircraft in the INM therefore the following aircraft substitutions have been made.

Table 8: Aircraft Substitutions in Noise Model

InterVISTAS Aircraft	INM Aircraft Substitution	Reason for Match
777-200	777-200	INM standard aircraft
A350	777-200 (take-off) A330-343 (landing)	FAA advice
A330	A330-343	INM standard aircraft
738/MAX8	737-800	INM standard aircraft for 738
739/MAX9	737-800	Best available match
A320	A320-232	Best match with local data
A321	A320-232	Best match with local data
ATR72	ATR72 (DO328)	INM standard substitution
A220	EMB195 (Embraer 190-200)	Best available match
PC12	1900D (Beech 1900)	Best available match
C208	CNA208	INM standard aircraft
CV5	CVR580	INM standard aircraft

Terrain Screening

No adjustments for terrain screening have been included at this stage.

APPENDIX C FIGURES

Draft (partial) Masterplan Concept Layout

C1 Aircraft Operations Noise Plan Permitted Contours

C2 Current Aircraft Operations Noise FY19 Actual Operations

C3 Predicted Aircraft Operations Noise 2050

C4 Change in Noise Level 2050 vs Plan Permitted

C5 Change in Noise Level 2050 vs Current (FY19)

C6 Predicted Noise Contours – APUs Current

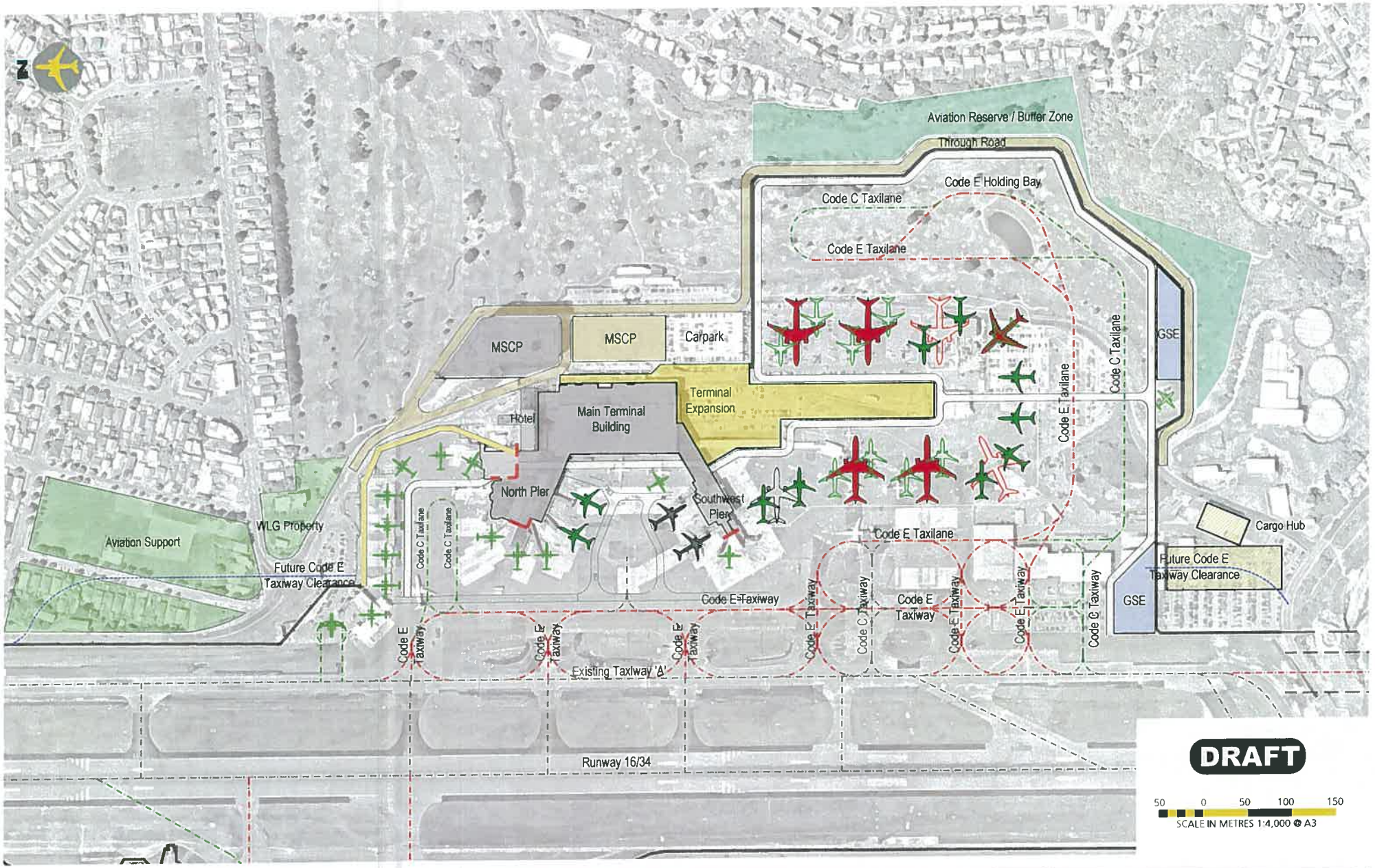
C7 Predicted Noise Contours – APUs ESA

C8 Predicted Noise Contours - Ground Equipment Only (Daytime)

C9 Predicted Noise Contours - Trucks Only Daytime

C10 Predicted Noise Contours - Trucks Only Night-time

C11 Predicted Noise Contours - Ground Equipment and Trucks Daytime



AIRBIZ

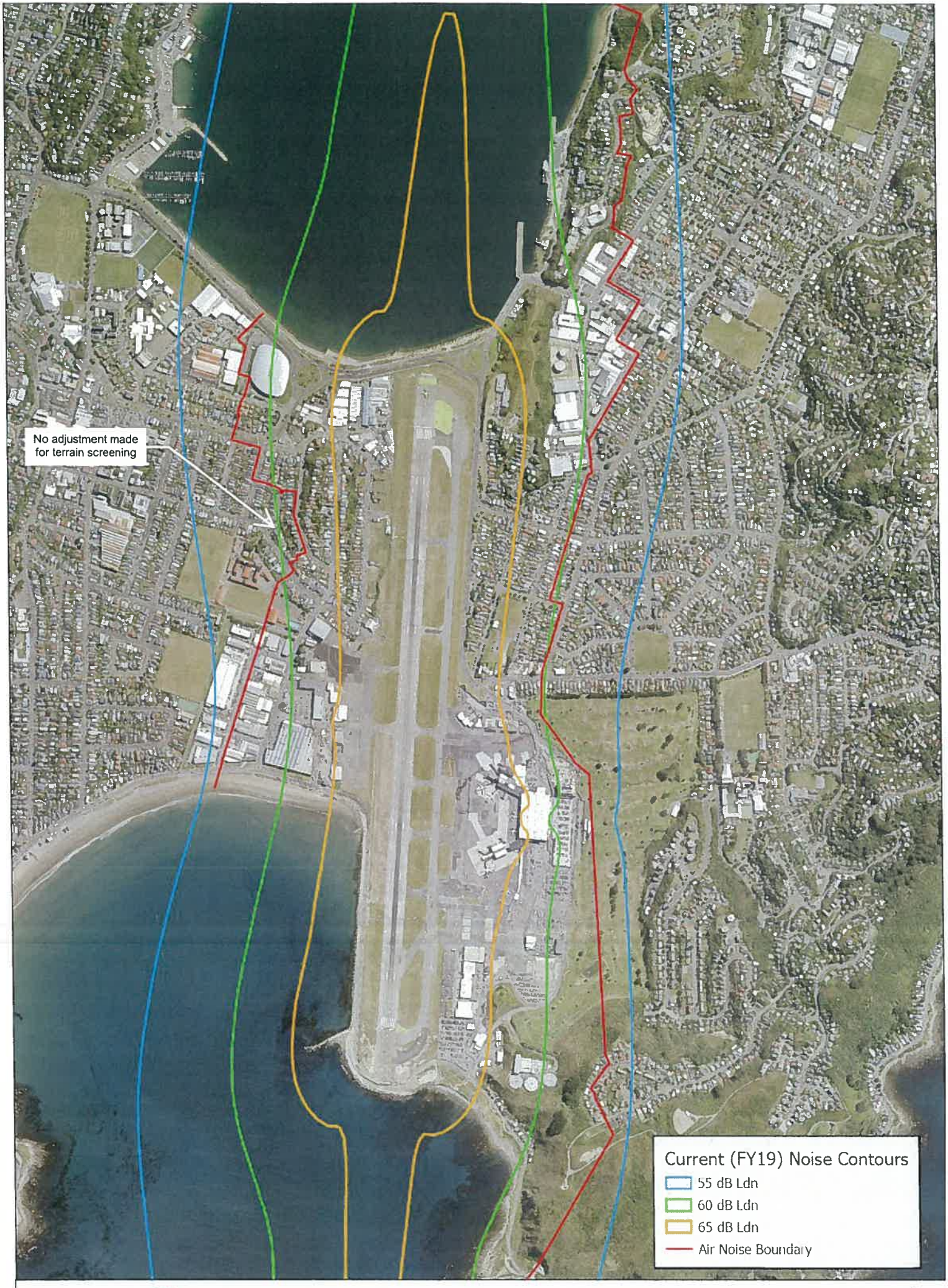
WELLINGTON AIRPORT
Draft Master Plan - 12M Passengers

12576 A240S

MARSHALL DAY Acoustics

Date: 28/09/2015

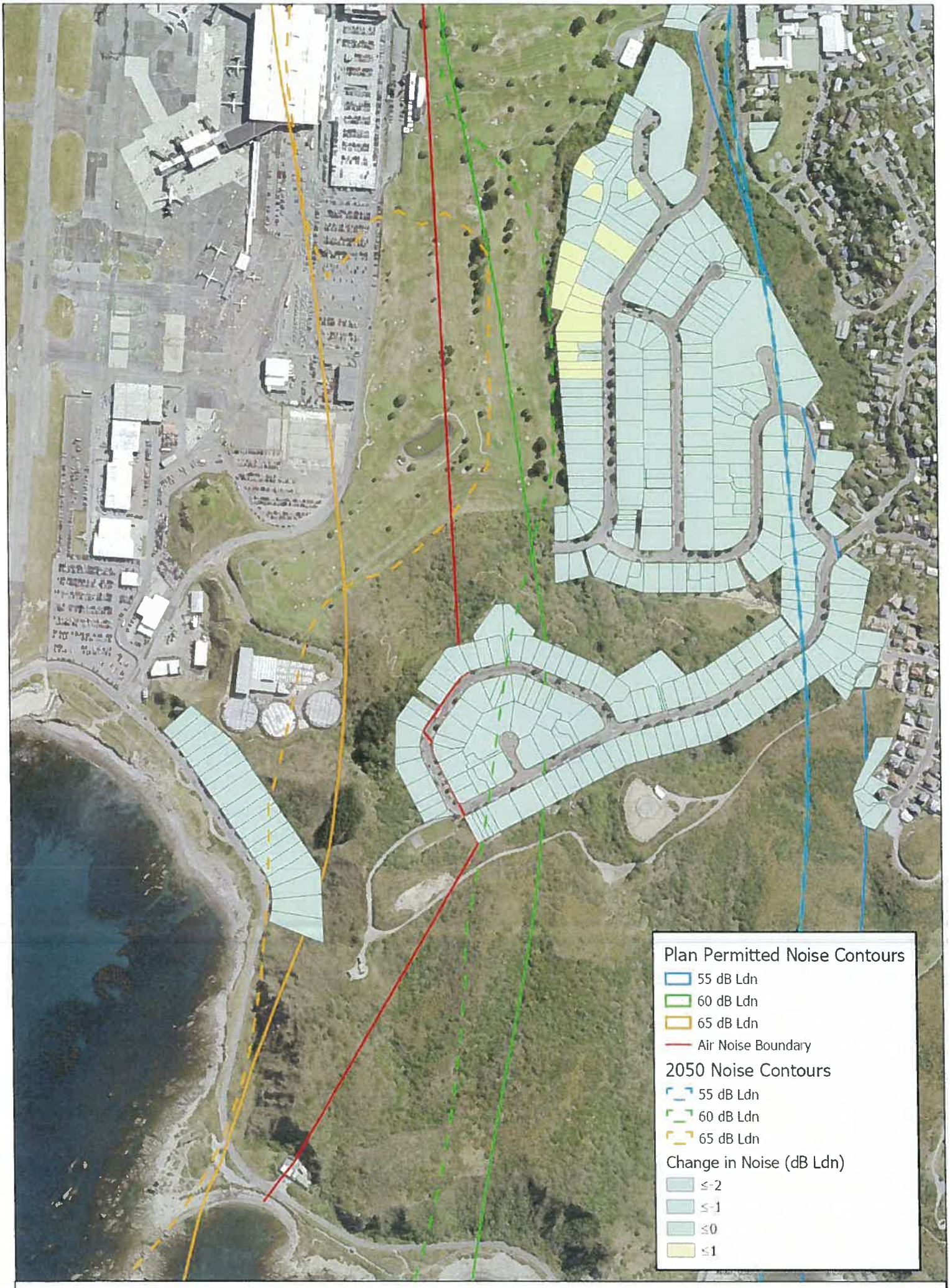
Figure C1 Aircraft Operations Noise
Future Operating Scenario the ANB is Based On



MARSHALL DAY Acoustics

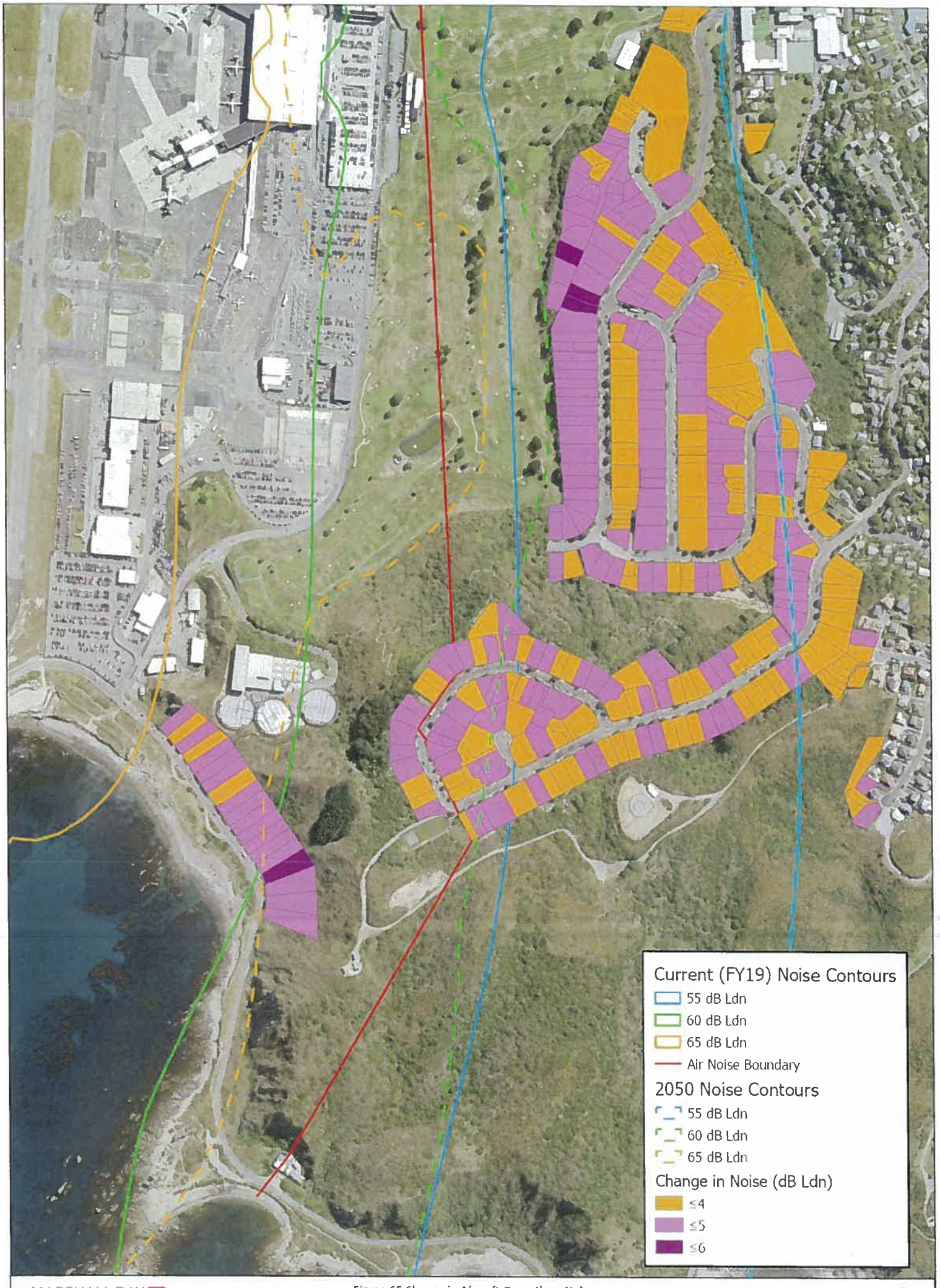
Figure C2 Aircraft Operations Noise
Current (FY19)

Figure C3 Aircraft Operations Noise
Year 2050



MARSHALL DAY Acoustics

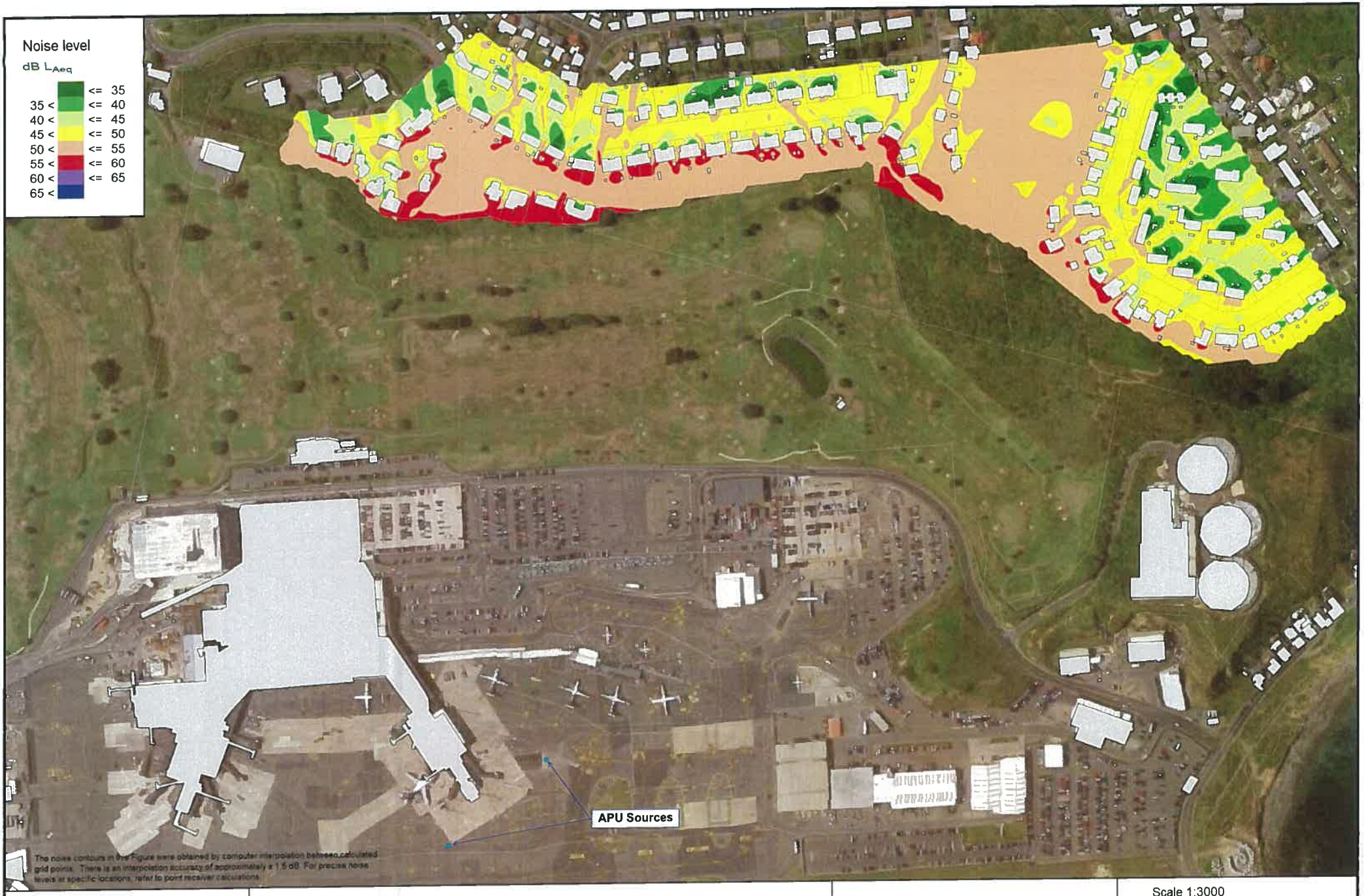
Figure C4 Change in Aircraft Operations Noise
2050 vs Plan Permitted Contours



MARSHALL DAY Acoustics

Date: 25/09/2019

Figure C5 Change in Aircraft Operations Noise
2050 vs Current (FY19) Contours

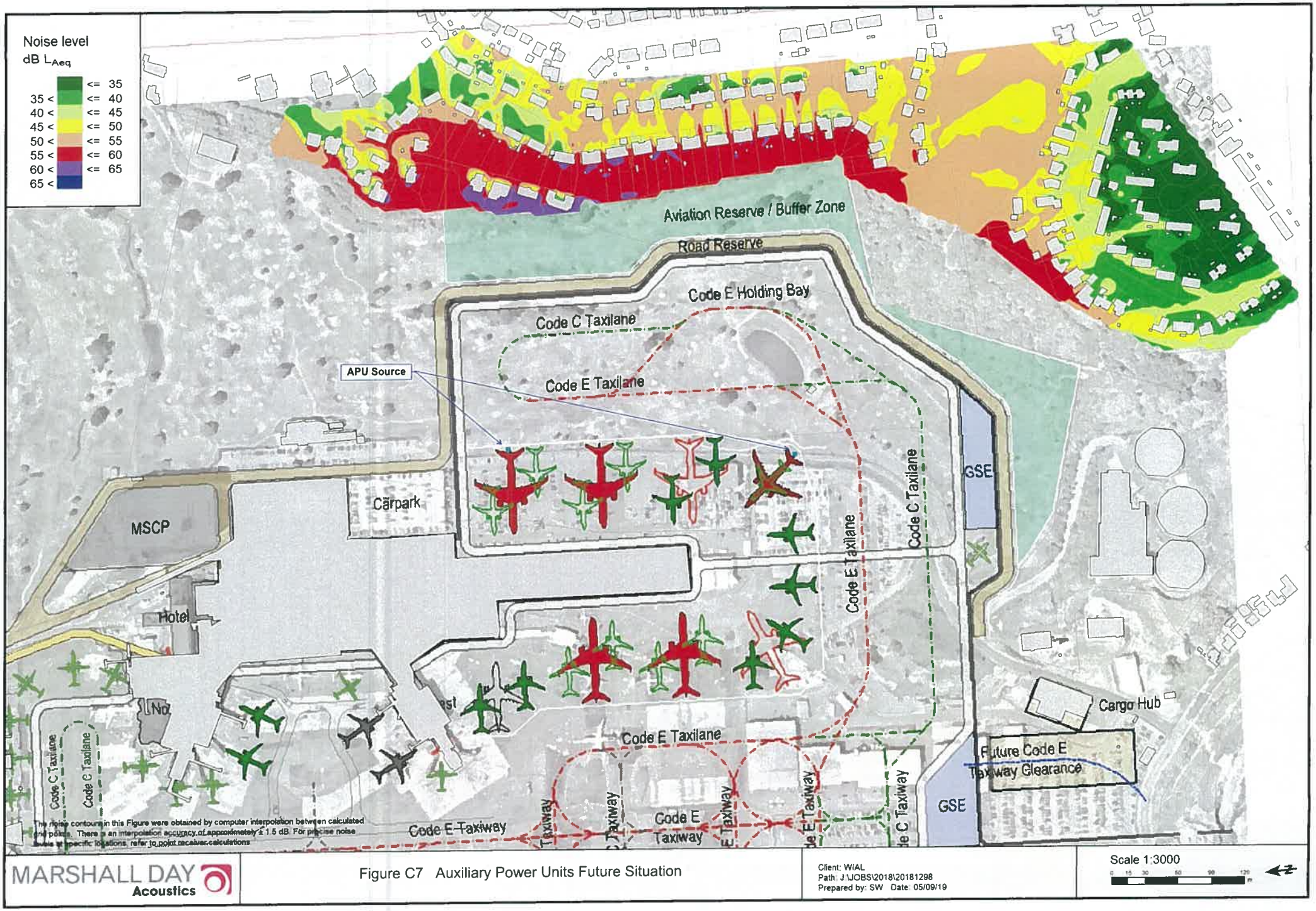


MARSHALL DAY Acoustics

Figure C6 Auxiliary Power Units Current Situation

Client: WIAL
Path: J:\JOBS\2018\20181298
Prepared by: SW Date: 27/09/19

Scale 1:3000

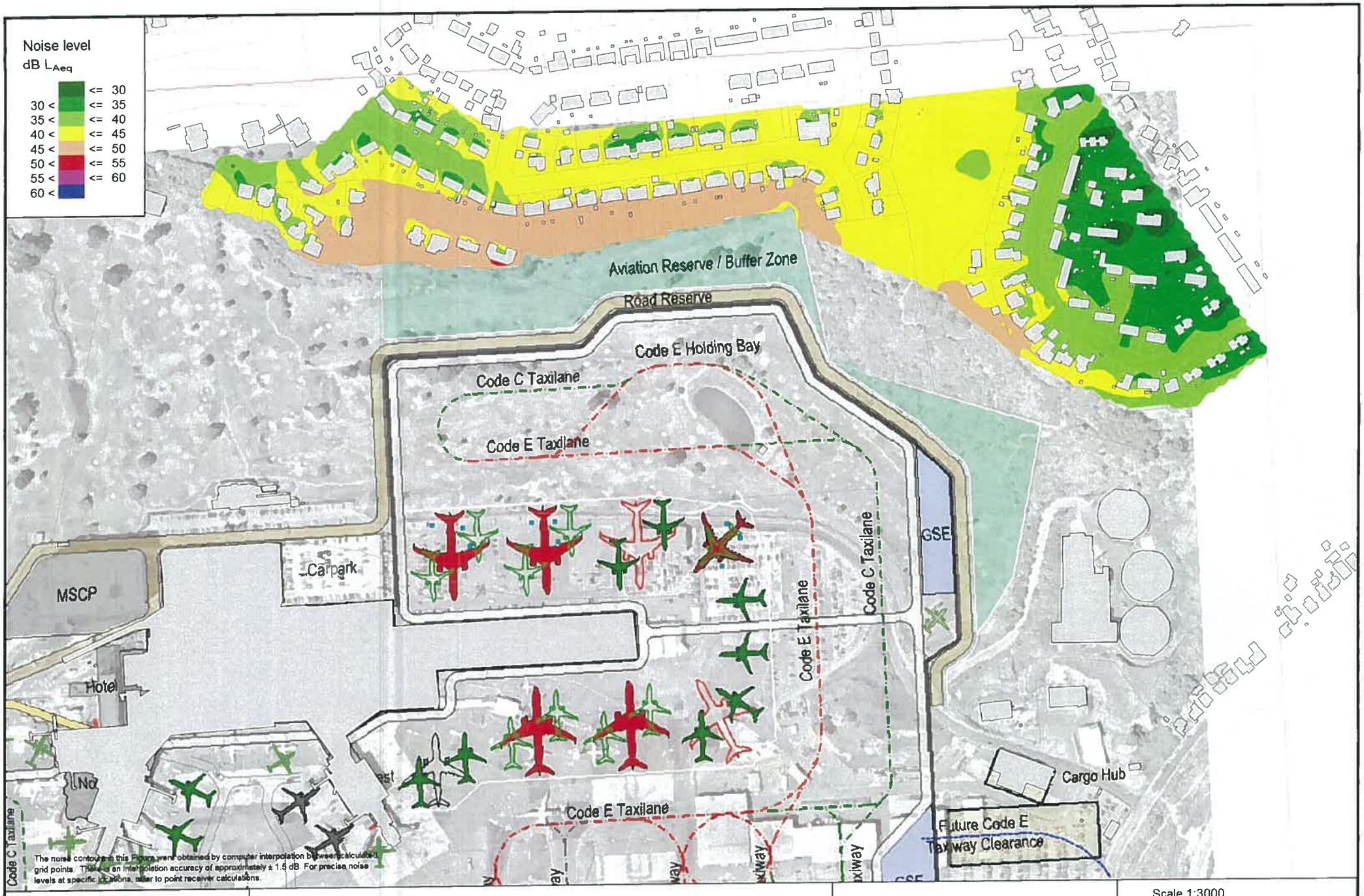


MARSHALL DAY Acoustics

Figure C7 Auxiliary Power Units Future Situation

Client: WIAL
Path: J:\JOBS\2018\20181298
Prepared by: SW Date: 05/09/19

Scale 1:3000

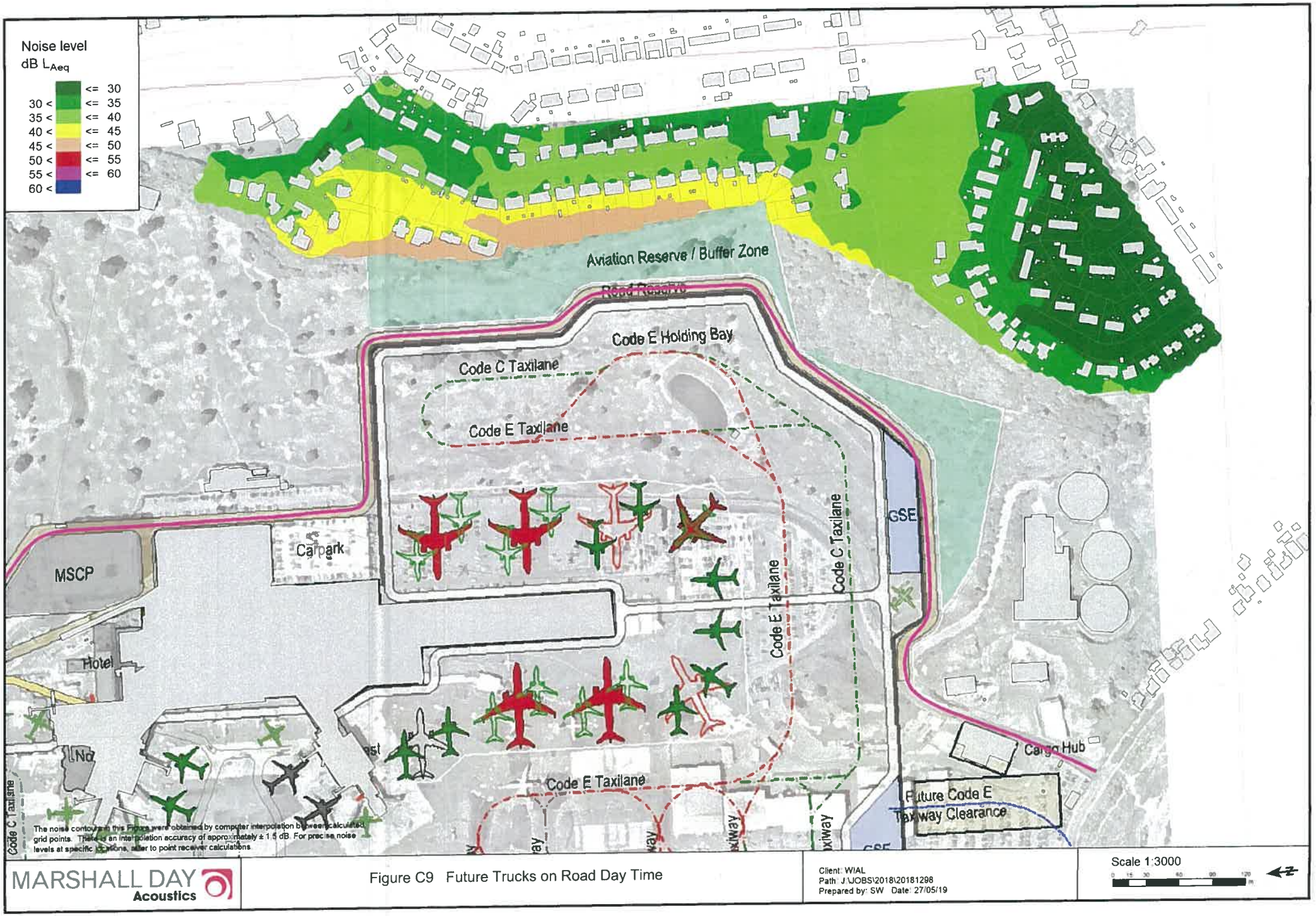


MARSHALL DAY Acoustics

Figure C8 Future Ground Support Equipment Day Time

Client: WIAL
Path: J:\JOBS\2018\20181298
Prepared by: SW Date: 27/05/19

Scale 1:3000

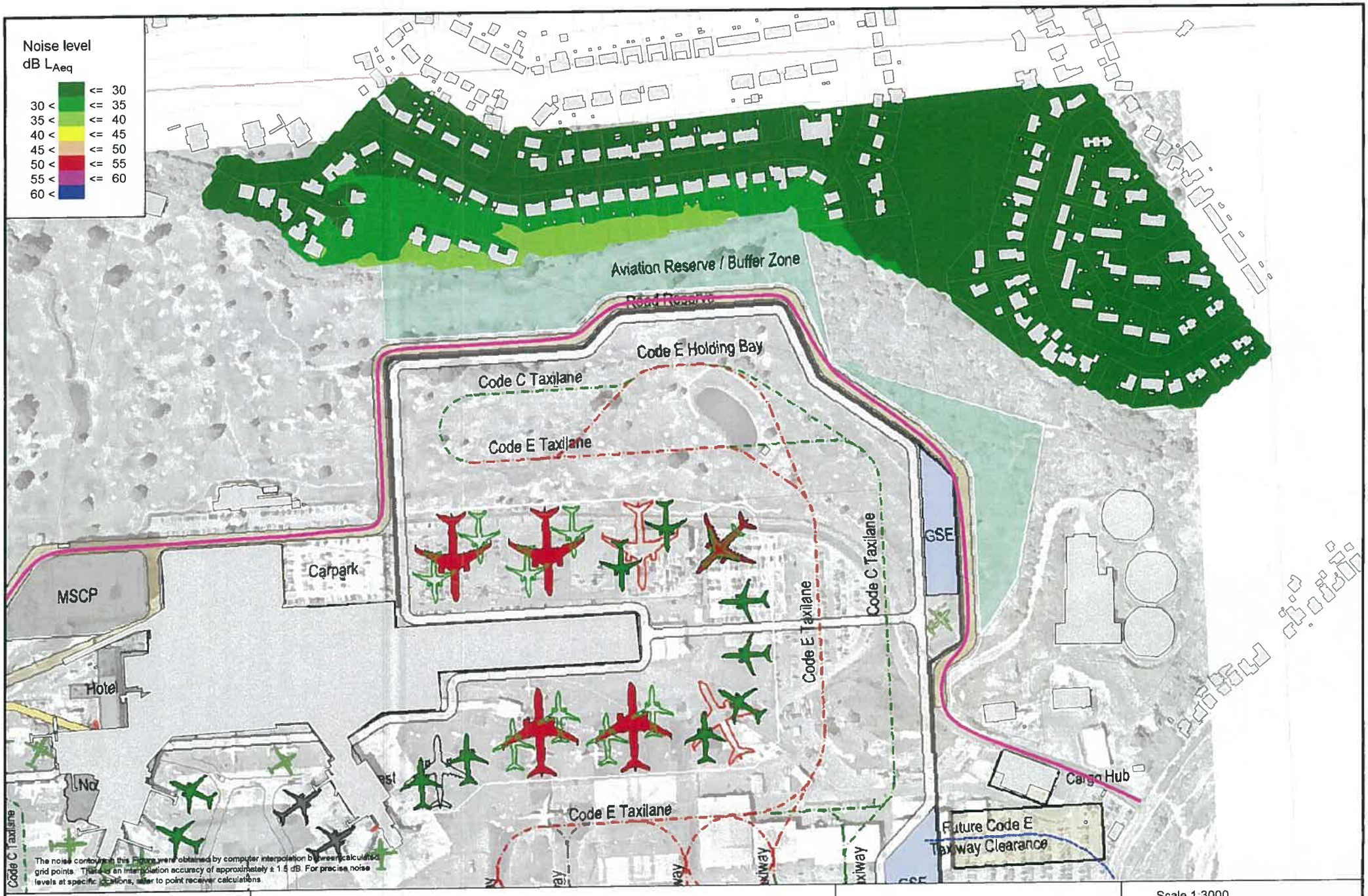


MARSHALL DAY Acoustics

Figure C9 Future Trucks on Road Day Time

Client: WIAL
Path: J:\JOBS\2018\20181298
Prepared by: SW Date: 27/05/19

Scale 1:3000

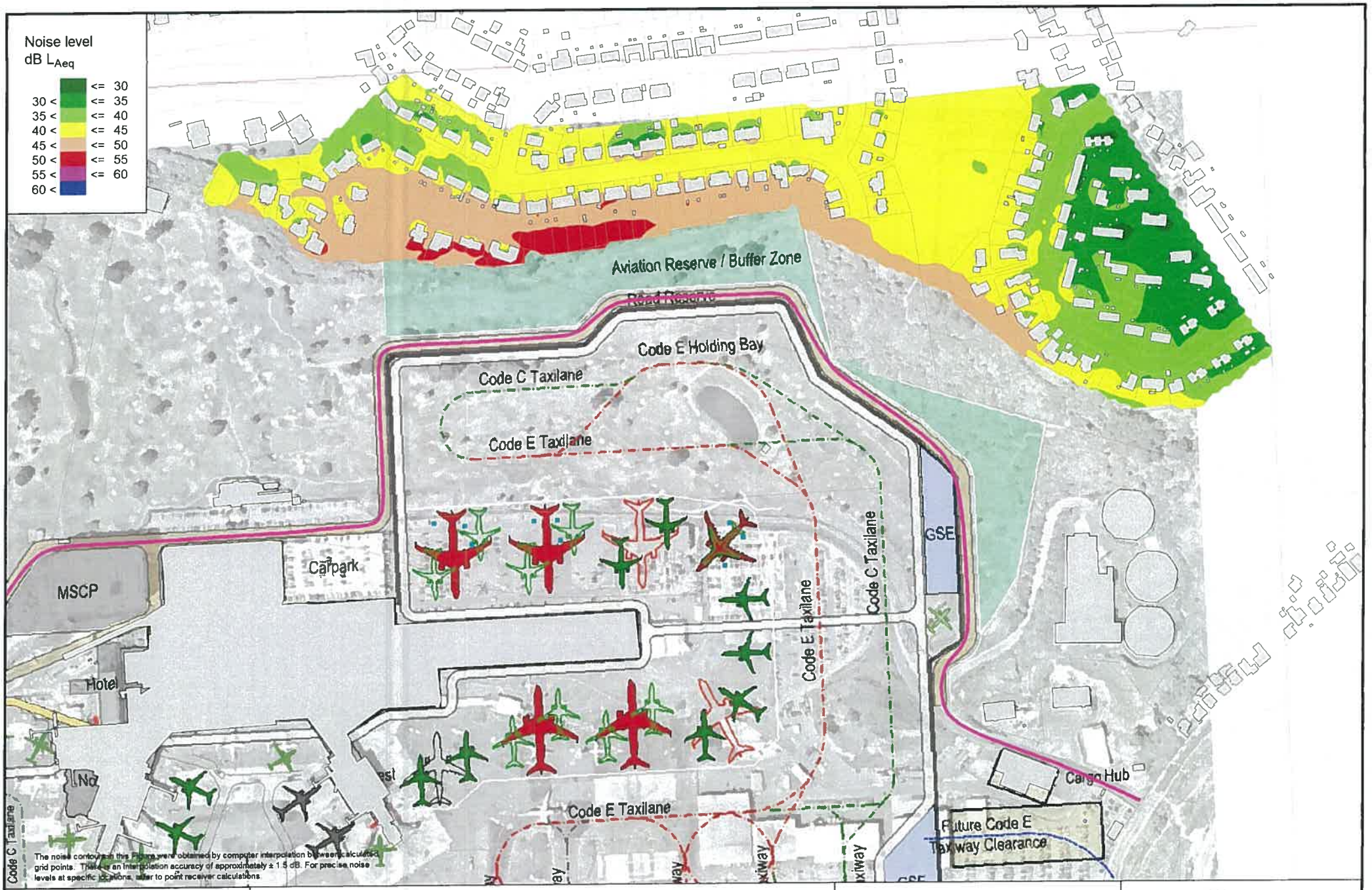


MARSHALL DAY Acoustics

Figure C10 Future Trucks on Road Night Time

Client: WIAL
Path: J:\JOBS\2018\20181298
Prepared by: SW Date: 27/05/19

Scale 1:3000



MARSHALL DAY Acoustics

Figure C11 Future Ground Support Equipment and Trucks on Road Day Time

Client: WIAL
Path: J:\JOBS\2018\20181298
Prepared by: SW Date: 27/05/19

Scale 1:3000