Bickerdike
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EDDC Development Management and Environmental Health Joint Airport Noise Study

Updated Noise Impact Assessment, Exeter International Airport

Parts 1 & 2

FINAL

Report to

East Devon District Council
Knowle
SIDMOUTH
Devon
EX10 8HL

A9894-R03-PH
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1.0 INTRODUCTION

In October 2000, Bickerdike Allen Partners were commissioned by East Devon District Council (EDDC) to carry out an independent noise impact appraisal of Exeter International Airport with specific reference to proposed residential developments in the vicinity. That report is available via EDDC Environmental Health. Exeter International Airport is an established strategic transport facility, important to the South West and anticipated to continue to develop. The noise report concluded that residential development south of the old A30 was likely to be regularly affected by noise from the airport which could not be adequately mitigated. Effectively, for this and other reasons, the line of the old A30 was established as the southern boundary for development in the Cranbrook vicinity.

Now in 2015 the development of the Cranbrook New Community in East Devon near to Exeter International Airport is well underway. As of the 1st October there were over 1,100 occupied homes and a further 2,400 with the benefit of planning permission. The new East Devon Local Plan to 2031 anticipates Cranbrook expanding to accommodate circa 8,000 homes equating to a population of around 20,000 people. The expansion of Cranbrook is to be guided by a masterplanning exercise (the Cranbrook Plan) and already there are live applications for over 4,500 additional homes. It is an over-riding aim that Cranbrook develops as a healthy, sustainable and vibrant community whilst also safeguarding the operation of Exeter International Airport.

A planning application has been submitted for a large expansion area south of the old A30, much closer to the airport than identified to date. In order to properly assess this application and other expansion sites, EDDC have identified a pressing need to obtain an updated noise report.

Bickerdike Allen Partners (BAP) have been instructed by EDDC to update the previous noise impact appraisal. This involves both noise modelling and noise monitoring with reporting in two parts for which the reports follow.

Peter Henson

Partner

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1.0 INTRODUCTION

In October 2000 Bickerdike Allen Partners were commissioned by East Devon District Council (EDDC) to carry out an independent noise impact appraisal of Exeter Airport with specific reference to proposed residential developments in the vicinity. That report is available via EDDC Environmental Health[1]. Exeter International Airport is an established strategic transport facility, important to the South West and anticipated to continue to develop. The noise report concluded that residential development south of the old A30 was likely to be regularly affected by noise from the airport which could not be adequately mitigated. Effectively, for this and other reasons, the line of the old A30 was established as the southern boundary for development in the Cranbrook vicinity.

Now in 2015 the development of the new East Devon community near to Exeter International Airport (Cranbrook) and the wider development of the Growth Point area is well underway. At the time of writing circa 1,100 homes have been built and occupied at Cranbrook. The emerging Local Plan anticipates the expansion of Cranbrook to circa 8,000 homes by 2031 which will be guided by a masterplanning exercise (the Cranbrook Plan). In addition to the 3,500 homes that already have the benefit of planning permission there are live applications for a further 4,620. . Current predictions are for a population of around 20,000 people. It is an over-riding aim that these important developments provide healthy, sustainable and vibrant communities.

A planning application has been submitted for a large expansion area south of the old A30 for 1,550 homes and other uses including a school.. In order to properly assess this application and other expansion sites, EDDC have identified a pressing need to obtain an updated noise report.

Bickerdike Allen Partners (BAP) have been instructed by EDDC to update the previous noise impact appraisal. This involves both noise modelling and noise monitoring with reporting in two parts, this being Part 1.

Section 2.0 of this report gives an overview of the proposed and approved developments in the Cranbrook Plan area, and Section 3.0 describes Exeter International Airport.

Section 4.0 describes the recent and ongoing noise surveys, both unattended and attended undertaken as part of this study.

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[1] BAP Report A5441/R2A July 2001 – East Devon District Local Plan Proposed Residential Developments Around Exeter Airport.

In Section 5.0 the potential for mitigation to control aircraft noise impacts are reported and, in Section 6.0, the scope and appropriate criteria for noise assessment to be submitted with future planning applications are discussed.

Section 7.0 gives an outline consideration to any other local noise sources which may impact on the noise climate of the area in combination with airport noise.

A glossary of acoustic terminology used is included in Appendix 1.

2.0 CRANBROOK PLAN AREA DEVELOPMENTS

The Cranbrook Plan area is shown on Figure 1 with the current planning applications and permissions. Exeter International Airport is located in the bottom left of the figure, and parts of the airport site are within the plan area. The closest potential development to the airport site, located just to the north of it, is outlined in red. This application (Ref: 15/0046/MOUNT 1550) is located to the south of the old A30 (now the B3174).

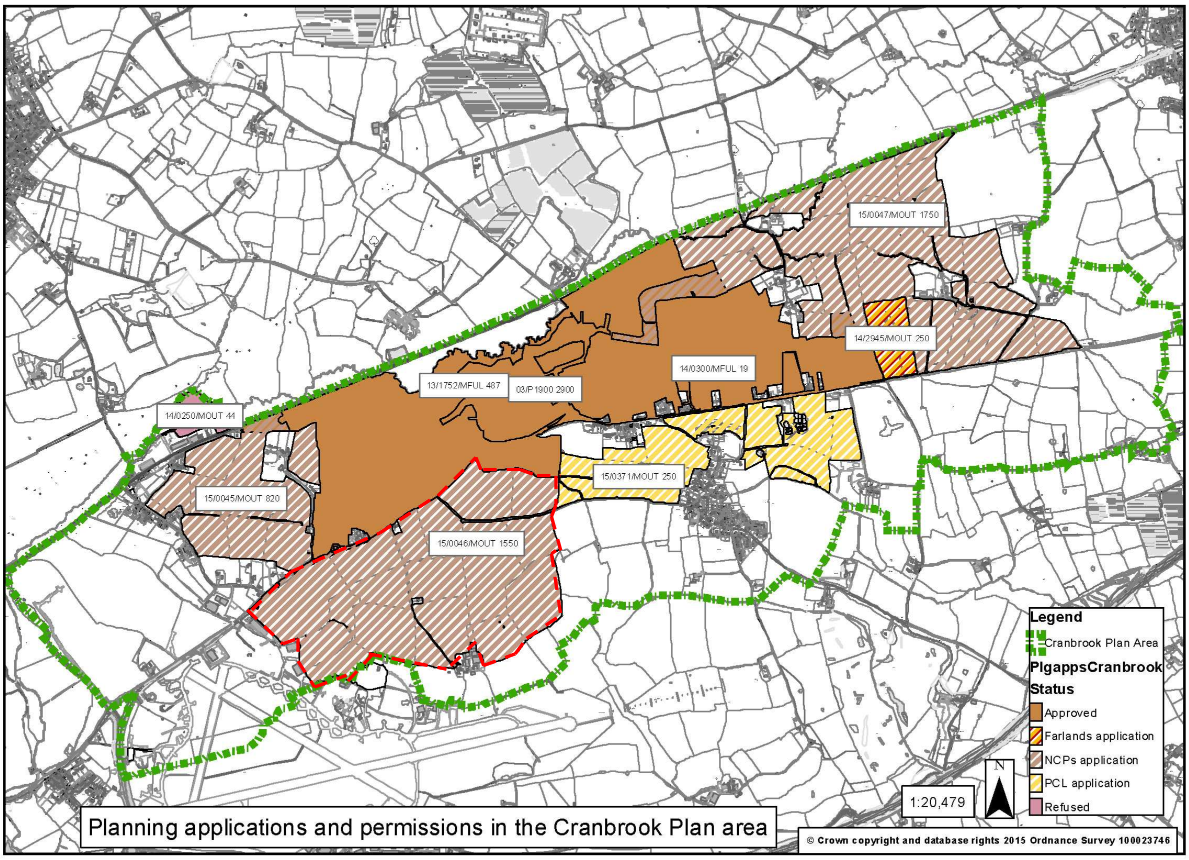

Figure 1: Planning application and permissions in the Cranbrook Plan area

3.0 EXETER INTERNATIONAL AIRPORT

3.1 Physical Details

Exeter International Airport is located approximately 4 miles to the east of Exeter. The airport has a single runway 2076m in length aligned broadly east west. The main apron and most of the airport buildings are located to the south of the centre of the runway. To the north of the runway closer to the proposed Cranbrook development site are a number of hangars, the fire training ground, and the engine ground run area. SkyPark, a strategic employment site, is located immediately to the west of this. Ultimately this will accommodate 1.4m sq.ft. of new commercial floorspace.

The aerodrome chart, which shows the airport layout, taken from *The UK Integrated Aeronautical Information Package (IAIP)*[2] is reproduced as Figure 2.

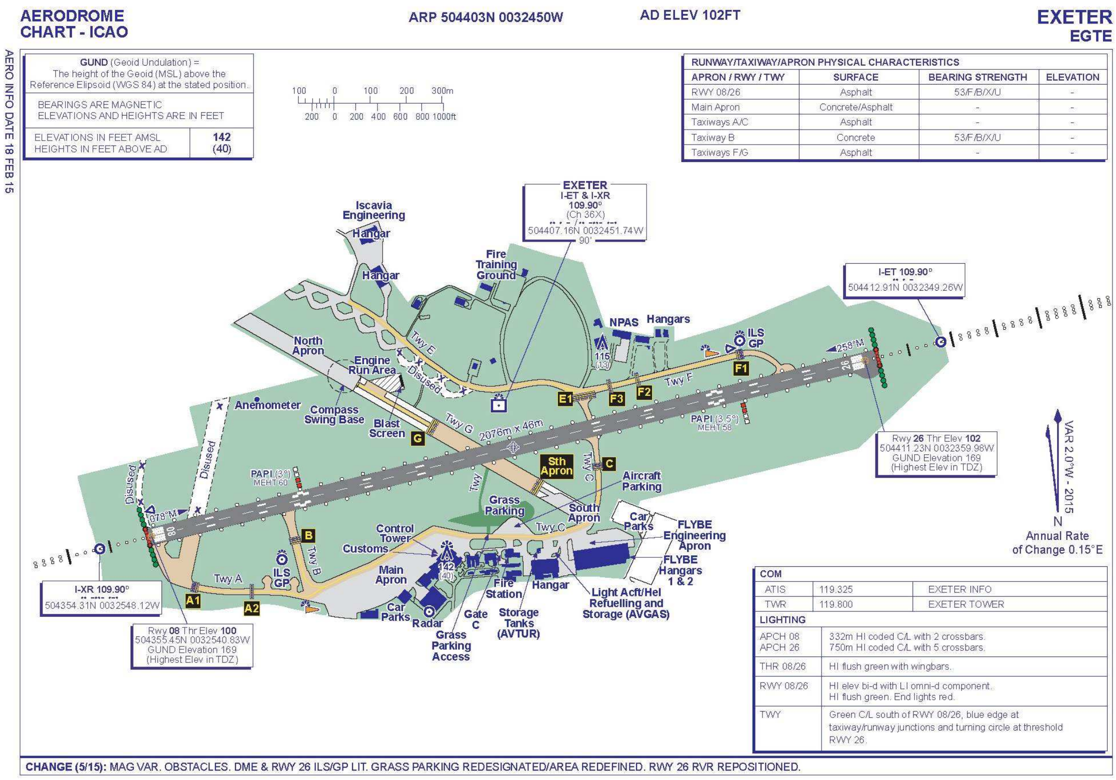

Figure 2: Aerodrome chart – ICAO – Exeter International Airport

2 http://www.nats-uk.ead-it.com/public/index.php%3Foption=com_content&task=blogcategory&id=65&Itemid=114.html

3.2 Operations

The current operating hours of the airport, taken as when the tower is operating, during the summer period are on weekdays from 0600 to 0100 on the following day, on Saturdays from 0530 to 2000, and on Sundays from 0700 to 2359. Activity is concentrated during the daytime, with reduced activity at the weekend, and some activity at night. Currently, there is on average around 4 flights per night during the period of 23.00 to 07.00 hours.

The airport has a number of controls on operation that affect where and when aircraft noise will occur. These include a preference for the use of Runway 26 when the surface wind is calm or light and variable. When Runway 26 is in use, landing aircraft arrive from the east of the airport and aircraft taking off depart to the west.

The airport also has a set of noise abatement procedures as detailed in the IAIP and repeated below. For both arriving and departing aircraft the effect of these procedures is that arriving and departing aircraft will follow the extended centreline of the runway when close to the airport.

EGTE AD 2.21 NOISE ABATEMENT PROCEDURES

Aircraft using the aerodrome will be required to conform to the following procedures notwithstanding that these procedures may be departed from to the extent necessary for avoiding immediate danger.

(a) Every operator of aircraft using the aerodrome shall ensure at all times that aircraft are operated in a manner calculated to cause the least disturbance practicable in areas surrounding the airport, particularly the City of Exeter.

(b) Unless otherwise required in the appropriate instrument approach procedure or otherwise instructed by ATC, inbound aircraft shall maintain as high an altitude as practicable and shall maintain at least 1000 ft aal, until commencing descent on final approach. An aircraft approaching without assistance from radar shall follow a descent path no lower than the normal approach path indicated by the PAPIs.

(c) Unless otherwise instructed by ATC, all turbo-jet aircraft and all public transport aircraft whose MTWA exceeds 5700 kg shall after take-off from:

(i) Runway 26 climb on runway heading at the maximum rate compatible with safety to 1000 ft aal and then turn as soon as possible to avoid the City of Exeter.

(ii) Runway 08 climb at the maximum rate compatible with safety to 1500 ft aal before turning.

(d) For visual approaches, or following a visual circuit, to Runway 26 the following limitations apply:

(i) Jet aircraft shall not join the final approach at a height of less then 1500 ft aal;

(ii) Propeller driven aircraft whose MTWA exceeds 5700 kg shall not join the final approach at a height of less than 1000 ft aal.

Aircraft flying a visual approach should intercept the final approach track at a level not less than that equivalent to a 3.5° glide path at the intercept range. Final approach should be flown at not less than a nominal 3.5° glide path.

(e) Auxiliary Power Units (APU).

APUs may only be operated for a maximum of one hour, or started thirty minutes prior to departure and not without the permission of the aerodrome operator. Aircraft with rear ventral airstairs must shut down APUs immediately after arriving on stand. Ground Power Units (GPU) will be supplied where required.

(f) Light aircraft should avoid overflying the villages of Clyst Honiton, Broadclyst, Whimple, West Hill and Farringdon whenever possible or as otherwise directed by ATC.

(g) Continuous Descent Approaches

(i) Jet and turbo-prop aircraft are expected to apply continuous descent, low power, low drag approach techniques whenever possible.

(ii) Subject to ATC instructions, inbound aircraft are to maintain as high an altitude as practical and adopt a low power, low drag, continuous descent approach profile. ATC will provide estimated track distance to touchdown to allow pilots to descend at a rate they judge best suited to achieve continuous descent without using more power or drag than necessary. The object will be to join the glidepath at the appropriate height for the distance without level flight.

(iii) ATC will provide range checks. Pilots who require additional track mileage to facilitate a successful CDA should inform ATC as soon as possible.

Civil Aviation Authority (CAA) statistics[3] show that in 2014 the airport handled almost 33,000 movements, where a movement is an arrival or a departure. Of these over 13,000 were air transport movements, those carrying passengers or cargo. In total, these carried over 760,000 passengers. The Airport Masterplan published in 2009 anticipates growth to 3.25m passengers per annum over the period to 2030.

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[3] http://www.caa.co.uk/default.aspx?catid=80&pagetype=88&sglid=3&fld=2014Annual

3.3 Sources of Noise

Sources of aircraft noise at the airport fall into two basic categories, airborne aircraft noise and ground noise.

Airborne aircraft noise relates to when aircraft are performing flying operations, and includes their use of the runway. It therefore comprises:

- aircraft take-offs from the commencement of their take off run
- arriving landing and using reverse thrust as required to increase braking until they have slowed to taxiing speed after touching down on the runway
- noise from aircraft in flight, such as those undertaking circuits, often for training purposes.

Airport ground noise consists of noise from aircraft when they are on the ground, with the exception of when they are using the runway. It therefore comprises:

- aircraft taxiing, for example when travelling between the runway and the stands
- aircraft manoeuvring on the apron
- aircraft using their auxiliary power units, where fitted, when on the apron
- aircraft undertaking engine tests, for example after routine maintenance.

In addition to the noise from aircraft at the airport there is also noise from non-aircraft sources, such as produced by general activity by airport vehicles and building services noise, but this is generally of a much lower magnitude.

The main other noise source around the airport site is road traffic noise, in particular from the A30 to the south of the airport.

4.0 2015 NOISE SURVEYS

4.1 Noise Survey Description

The recent noise survey has comprised both unattended and attended measurements at positions on the north side of the airport site shown on Figure 3. Given the location of these positions, aircraft noise makes a significant contribution to the local noise climate at each one.

The unattended monitoring commenced on 9th July 2015 and is still continuing. It has involved the deployment of a single monitor at NMP1 adjacent to the Distance Measuring Equipment (DME) on the airfield. The equipment has comprised a 01dB Smart Noise Monitoring Terminal which has been remotely monitored and the measured results have been downloaded on a regular basis. These are to be reported once the monitoring is completed.

The attended measurements were undertaken with the assistance of a member of the EDDC Environmental Health Department who, over a number of days in July and August 2015, carried out measurements at four locations, NMP2 to NMP5, see Figure 3. A Norsonic Type 1 model 140 sound level meter was used and was checked for correct calibration calibrated at the start and end of each visit. No significant drift was observed.

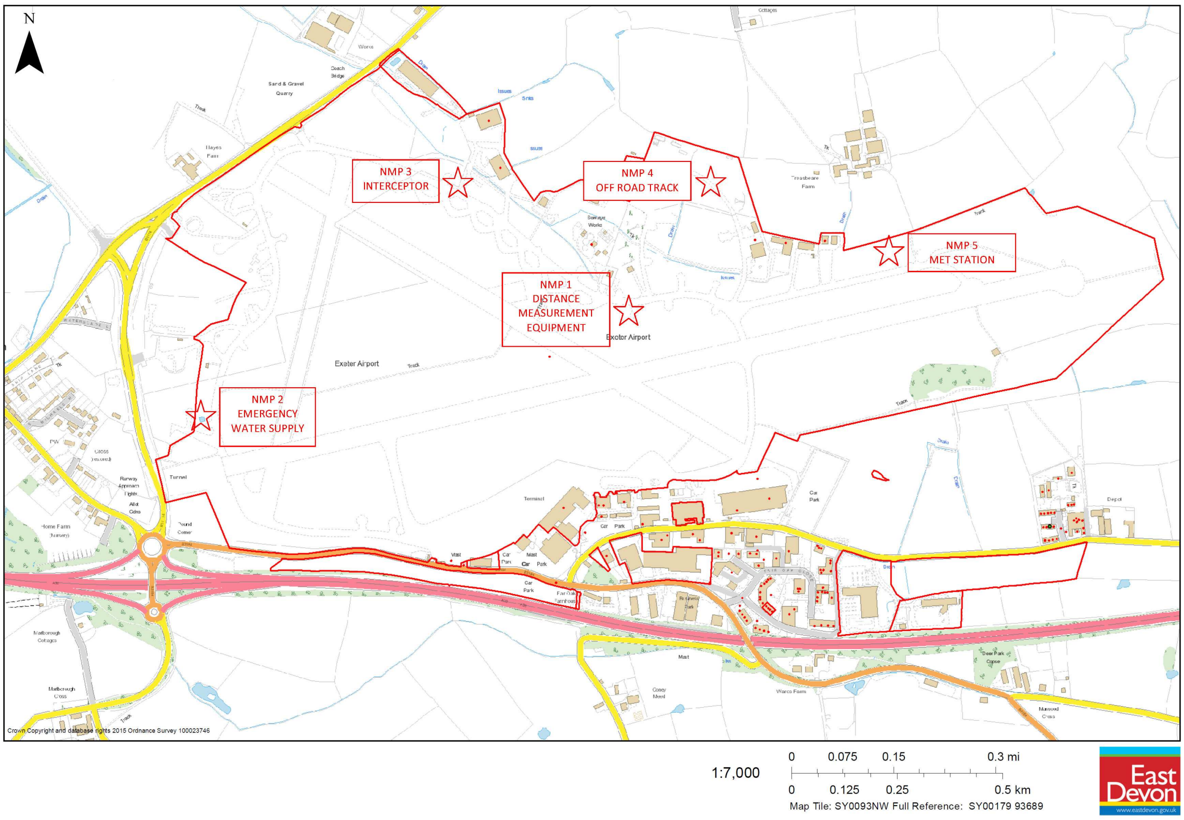

Figure 3: Noise measurement locations

4.2 Attended Survey Results

The attended survey involved visiting the site on seven separate occasions during which noise measurements were conducted at one or more measurement positions (NMP's). A total of twelve separate measurement sets were obtained by this method, each of which was typically 1 to 3 hours in length. The results are presented in graphical format in Appendix 2. This includes an explanation of how they have been processed to determine the contributions to the total noise from the various noise sources in operation. The graphs are colour coded to denote the dominant key source of noise at a particular time. The results of this analysis are summarised below in Table 1 which presents the average noise produced by a key noise source over the measurement period. The maximum noise level produced over the period by the key noise source is shown in parentheses

Noise Measurement Position	Date	Start Time	End Time	Measured Noise Levels, $L_{Aeq,T}$ ($L_{Amax,F}$) dB				
				Airborne Aircraft	Ground Aircraft	Other Airport	Non-Airport	Overall
NMP2	10/07/15	09:46	11:31	73 (88)	69 (83)	-	58 (67)	64
NMP3	10/07/15	11:49	13:15	63 (81)	71 (92)	59 (67)	52 (76)	65
	27/07/15	10:25	12:13	74 (96)	78 (100)	57 (65)	55 (77)	77
NMP4	23/07/15	10:41	12:43	60 (81)	55 (76)	-	47 (58)	56
	27/07/15	14:07	16:00	60 (77)	56 (69)	-	50 (68)	54
	30/07/15	12:15	15:25	56 (78)	53 (76)	42 (45)	42 (65)	51
	31/07/15	12:18	15:30	67 (90)	59 (73)	-	48 (63)	61
	04/08/15	17:10	20:29	64 (85)	56 (72)	-	51 (65)	56
NMP5	09/07/15	13:53	15:05	74 (94)	65 (82)	55 (64)	52 (60)	66
	23/07/15	13:00	15:19	70 (93)	68 (87)	55 (58)	54 (75)	67
	30/07/15	10:00	11:57	64 (86)	56 (75)	51 (58)	41 (67)	59
	31/07/15	10:00	11:59	71 (93)	55 (77)	50 (54)	48 (57)	67

Table 1: Attended Survey Results – Contribution from Noise Sources

Considering first NMP2 and NMP5, these are located at the emergency water supply near the western end of the runway, and near the met station towards the eastern end of the runway Due to their close proximity to the runway, the measured noise levels are highly affected by activity on the runway, giving rise to airborne aircraft noise typically around 70 - 75 dB L_{Aeq} during the measurement periods with highest maxima of around 95 dB $L_{Amax,F}$. In addition, high noise levels, around 65 to 70 dB L_{Aeq} were recorded over the measurement period at these positions from aircraft taxiing to the runway end before departing, classed as aircraft ground noise. Maxima in the range 80 to 85 dB were produced by these taxiing operations.

Positions NMP3 at the interceptor and NMP4 at the off road track are significantly further from the runway and so less affected by airborne aircraft noise. In the case of NMP3, it is however affected by any activity at the engine ground run area. This occurred during the second visit, increasing the measured noise levels significantly as compared to the first visit. Maxima up to 100 dB were recorded at NMP3 during ground running.

The quietest noise levels were measured at NMP4. This is relatively distant from the runway, taxiways, and engine ground run area in comparison to the other positions. The increased distance from the A30 compared to the other locations also led to lower noise levels from non-airport sources. Average noise levels showed some variation across the five visits to this location but were typically around 55 dB $L_{Aeq,T}$.

Details of the maximum measured noise levels from the attended survey and their sources are given in Table 2.

Noise Measurement Position	Date	Start Time	End Time	Measured Noise Levels, dB	
				L_{Amax}	Source
NMP2	10/07/15	09:46	11:31	88	Light aircraft Departure Runway26
NMP3	10/07/15	11:49	13:15	92	Light aircraft on adjacent taxiway
	27/07/15	10:25	12:13	100	Engine testing
NMP4	23/07/15	10:41	12:43	81	Jet Departure Runway 26
	27/07/15	14:07	16:00	77	Jet Departure Runway 26
	30/07/15	12:15	15:25	78	Helicopter Departure Runway 26
	31/07/15	12:18	15:30	90	Military Flypast
	04/08/15	17:10	20:29	85	Jet Arrival Runway 26
NMP5	09/07/15	13:53	15:05	94	Jet Departure Runway 26
	23/07/15	13:00	15:19	93	Jet Departure Runway 26
	30/07/15	10:00	11:57	86	Propeller Departure Runway 26
	31/07/15	10:00	11:59	93	Military aircraft Touch and Go

Table 2: Attended noise survey results – Maximum Noise Levels

The maximum noise levels at NMPs 2, 4 and 5 were typically produced by airborne aircraft operations. The exception to this was at NMP3, which was very close to the taxiway and engine running site used by light aircraft.

5.0 AIRCRAFT NOISE MITIGATION POTENTIAL

5.1 General

As noted in Section 3.3 above there are two main noise sources, aircraft performing flying operations (airborne noise) and aircraft operating on the ground (ground noise). Given the differing locations of these sources the potential for their mitigation varies and so is considered separately below, firstly in regard to on-site measures and then off-site measures.

5.2 On-Site Mitigation

As the source of noise being considered is an airport, on-site mitigation has been taken to be measures that can be undertaken by the airport, either on the airport site, or those that will affect the noise of the aircraft operating into and out of the airport.

The best form of noise mitigation is to control the noise at source. With regard to airborne aircraft noise, the options are primarily to control the aircraft types, their numbers, and the times at which they operate. Whilst each of these has the potential to be highly effective as a noise control measure, they also have the potential to significantly constrain the airport and affect its commercial success.

Less onerous options for airborne aircraft noise control include optimisation of the departure procedures used and the routes flown. These have some potential for benefits although it is understood that aircraft already do not overfly the Cranbrook Plan Area.

When aircraft are on the ground, similar mitigation can be implemented with regard to the types and numbers of aircraft, and the hours of operation. The locations for particular activities can also be reviewed, in particular the location of the engine ground run area, which can benefit certain locations around the airport perimeter although others may suffer as a result.

Ground noise can also be controlled to some extent by screening, for example the engine ground run area could be improved by the installation of an engine test pen although this does have a significant cost. The presence of airport buildings can also have beneficial effects so future developments of the airport could consider potential noise benefits when new buildings are proposed.

One source of ground noise that it may be possible to significantly reduce is the operation of auxiliary power units (APUs). These are small turbine engines fitted to many larger aircraft which provide power to aircraft systems whilst it is parked on the apron. In some cases this power can be supplied by either a mobile ground power generator, or by a fixed electrical ground power installation which is silent.

5.3 Off-Site Noise Mitigation

Off-site mitigation is taken to be measures that could be employed as part of a development affected by noise from the airport. It is necessary to consider two main receptors, those within buildings and those in external amenity areas.

For those within buildings, in addition to the measures discussed below for amenity areas, there is the option to incorporate noise mitigation into the building construction. This is generally equally effective at mitigating noise from both airborne aircraft activities and ground activities. The level of noise intrusion will depend on the acoustic performance of all the elements of the building envelope, but is generally determined by the lowest performing components, which are usually the ventilation and glazing.

The glazing performance is determined by its area and the glass and frame specifications. In theory these can be improved to provide high levels of performance although there are consequential implications on the cost of the building.

The ventilation performance can be improved to relatively high levels but if the ventilation strategy is for natural ventilation the options are more limited, particularly if it is taken that rates of ventilation above the background level required must be achieved at the same time as meeting internal noise levels. In practice, for noise sensitive buildings located close to significant noise sources, acoustic ventilators are commonly deployed, either passive types or mechanical types, to enable occupants to keep windows closed without compromising background ventilation requirements. It normally remains the case that purge ventilation is achieved by opening windows, although some mechanical ventilators have high speeds to seek to achieve this effect.

The noise levels in amenity areas such as gardens can be mitigated to some extent through planning the layout of the development, the location of individual buildings or blocks and through localised screening such as the provision of fencing. For communal areas this approach is less effective, given their larger size, and so their location within a development (away from a noise source) may be the primary form of mitigation. Earth bunding can also be of benefit, particularly if there would otherwise by a need to move material off site.

Of the sources of aircraft noise, ground noise is more effectively attenuated by these forms of mitigation as the source is close to the ground. For airborne aircraft noise screening is less effective and layout may be the primary mitigation.

The phasing of any development should also take into account the screening potential offered by the construction of the earliest phases in an order that best protects the noise environment for later phases.

6.0 NOISE ASSESSMENT SCOPE AND CRITERIA

6.1 Scope of Noise Assessments

A noise assessment for a development in the Cranbrook Plan Area needs to separately consider the magnitude and impacts expected as a result of noise from the sources given in

Table 3. The assessment should be undertaken for the current situation and a future scenario, at all proposed noise sensitive developments of the types given in Table 4.

Noise Source	Notes
Airborne Aircraft	Consider average noise effects during day and night as well as noise from individual movements where relevant, such as at night for dwellings.
Ground Activities	Consider noise effects from engine testing activity as well as from general aircraft taxiing and apron activity
General Airport Activity	For example, from vehicular movements and stationary plant.
Road Traffic	From local and trunk roads, in particular the A30
Industrial Activity	From use of any freight or industrial units
Construction	Effects on local environment and on earlier development phases

Table 3: Noise sources to consider

Type of development	Notes
Residential	-
Hotels	-
Educational / Community	Daytime only
Medical	-
Offices	Daytime only
Commercial / Retail	-
Entertainment	-
Industrial	Generally not noise sensitive
Sport / Recreational / Amenity	Daytime only

Table 4: Development types to consider

6.2 Criteria for Noise Assessments

Noise assessments need to take into account both National, and Local and Regional planning policies. With regard to National policies consideration will need to be given to:

- National Planning Policy Framework (NPPF) 2012

  This sets out the Government's planning policies and provides expectations in regard to planning and noise.

- Noise Policy Statement for England (NPSE) 2010

  This sets out the Government's over-arching noise policy within England. The policy is applicable and relevant within the planning system with its aims and objectives cited by the NPPF.

- Planning Practice Guidance – Noise (PPG-N) 2014

  Although not policy, PPG-N provides guidance on the consideration of noise within the planning system and further guidance on the application of the NPSE when making planning decisions.

- Aviation Policy Framework (APF) 2013

  This sets out the Government's over-arching aviation policy. It provides guidance on the management of noise from airports, the Government expectations and policies in relation to aircraft noise mitigation. The APF states that its policies are consistent with those of the NPSE.

The NPSE introduces the concepts of NOEL (No Observed Effect Level), LOAEL (Lowest Observed Adverse Effect Level) and SOAEL (Significant Observed Adverse Effect Level). The definition of each is as follows:-

a) NOEL – No observed effect level. This is the level below which no effect can be detected.

b) LOAEL – Lowest observed adverse effect level. This is the level above which adverse effects on health and quality of life can be detected.

c) SOAEL – Significant observed adverse effect level. This is the level above which significant adverse effects on health and quality of life occur.

Further guidance on how planning authorities should take account of the acoustic environment and the mitigation strategies which should be applied in relation to the above terms is provided in the PPG-N. The advice is that noise above the SOAEL should be avoided using appropriate mitigation while taking into account the guiding principles of sustainable development.

Where noise is between LOAEL and SOAEL, the advice is to take all reasonable steps to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development. Noise in this category is described as an observed adverse effect which is noticeable and intrusive.

The developing Local policies are contained in the New East Devon Local Plan which is currently at revised draft stage. This includes a specific strategy, No.17, relating to development at or near Exeter International Airport which is repeated below.

Strategy 17 - Future Development at or near Exeter International Airport: ® 6.79

The Local Plan recognises the importance of airport expansion and encourages supporting infrastructure to provide for its direct airport related growth.

It is recognised that many operational uses do not require planning permission and these developments, where compatible with safe and efficient airport operation and where they do not have adverse impacts on land within operational boundaries, will be supported. The Habitats Regulations require the Appropriate Assessment of any project where the likelihood of significant effects on European wildlife sites cannot be ruled out.

Developments that are near to or could be affected by noise from the airport will not be allowed unless evidence is provided that current or future users or occupiers of new dwellings, schools, open spaces or other sensitive uses will not be significantly adversely affected, taking proposed mitigations into account, by airport related noise.

Strategy 17 is therefore consistent with the NPSE, and the concept of SOAEL, as it seeks that new noise sensitive development will not be significantly adversely affected by noise. Although the NPSE introduces the concepts of LOAEL and SOAEL it does not assign any numerical values to them. Values must therefore be taken from other sources, and in this regard the APF is considered valuable.

In Table 5 numerical values are proposed for the LOAEL and SOAEL from different noise sources occurring during the daytime. It is proposed that these values are used to consider to what extent any proposed residential or other noise sensitive developments in the vicinity of the airport might be affected by local noise sources and to determine the need for and extent of noise mitigation.

Noise Source	Proposed Daytime Value	
	LOAEL	SOAEL
Airborne Aircraft	54 dB $L_{Aeq,16h}$	63 dB $L_{Aeq,16h}$
Ground Activities	50 dB $L_{Aeq,16h}$	60 dB $L_{Aeq,16h}$
Road Traffic	55 dB $L_{Aeq,16h}$	63 dB $L_{Aeq,16h}$
Industrial Noise	Equal to background	+ 10dB above background

Table 5: General Noise criteria - Daytime

For night-time activity (from 23.00 to 07.00 hours), the following general criteria are proposed in Table 6 below which accord with recommended limit values set out in the World Health Organisation Night Noise Guidelines[4]. A different set of specific criteria may also apply to individual noise sources/events and the topic of noise criteria will be considered further in Part 2 of this assessment.

Noise Source	Proposed Night-time Value	
	LOAEL	SOAEL
Airborne Aircraft	40 dB $L_{Aeq,16h}$	55 dB $L_{Aeq,16h}$
Ground Activities	40 dB $L_{Aeq,16h}$	55 dB $L_{Aeq,16h}$
Road Traffic	40 dB $L_{Aeq,16h}$	55 dB $L_{Aeq,16h}$
Industrial Noise	Equal to background	+ 10dB above background

Table 6: General Noise criteria – Night-time

7.0 OTHER SOURCES OF NOISE IN THE VICINITY

Aside from Exeter International Airport the main noise source affecting parts of the Cranbrook Plan Area is road traffic, in particular from the A30 which runs to the south of the area. BAP are not aware of any other current significant sources of noise, such as from industrial activity, although it is acknowledged plans are under consideration for development immediately to the north of the airport site in this regard.

[4] Night Noise Guidelines for Europe, World Health Organisation, 2009

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APPENDIX 1

GLOSSARY OF ACOUSTIC TERMINOLOGY

The Decibel, dB

The unit used to describe the magnitude of sound is the decibel (dB) and the quantity measured is the sound pressure level. The decibel scale is logarithmic and it describes equal values to proportional changes in sound pressure, which is a characteristic of the ear. Use of a logarithmic scale has the added advantage that it compresses the very wide range of sound pressures to which the ear may typically be exposed to a more manageable range of numbers. The threshold of hearing occurs at approximately 0 dB (which corresponds to a reference sound pressure of 2 x 10^{-5} Pascals) and the threshold of pain is around 120 dB.

The sound energy radiated by a source can also be expressed in decibels. The sound power is a measure of the total sound energy radiated by a source per second, in watts. The sound power level, L_w is expressed in decibels, referenced to 10^{-12} watts.

Frequency, Hz

Frequency is analogous to musical pitch. It depends upon the rate of vibration of the air molecules that transmit the sound and is measure as the number of cycles per second or Hertz (Hz). The human ear is sensitive to sound in the range 20 Hz to 20,000 Hz (20 kHz). For acoustic engineering purposes, the frequency range is normally divided up into discrete bands. The most commonly used bands are octave bands, in which the upper limiting frequency for any band is twice the lower limiting frequency, and one-third octave bands, in which each octave band is divided into three. The bands are described by their centre frequency value and the ranges which are typically used for building acoustics purposes are 63 Hz to 4 kHz (octave bands) and 100 Hz to 3150 Hz (one-third octave bands).

A-weighting

The sensitivity of the ear is frequency dependent. Sound level meters are fitted with a weighting network which approximates to this response and allows sound levels to be expressed as an overall single figure value, in dB(A).

Environmental Noise Descriptors

Where noise levels vary with time, it is necessary to express the results of a measurement over a period of time in statistical terms. Some commonly used descriptors follow.

Statistical Term	Description
$L_{Aeq,T}$	The most widely applicable unit is the equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$). It is an energy average and is defined as the level of a notional sound which (over a defined period of time, *T*) would deliver the same A-weighted sound energy as the actual fluctuating sound.
L_{AE}	Where the overall sound level over a given period is made up of individual sound events, the $L_{Aeq,T}$ can be predicted by measuring the sound of the individual events using the sound exposure level, LAE (or SEL or LAX). It is defined as the level that, if maintained constant for a period of one second, would deliver the same A-weighted sound energy as the actual sound event.
L_{A01}	The level exceeded for 1% of the time is sometimes used to represent typical sound maxima.
L_{A10}	The level exceeded for 10% of the time is often used to describe road traffic noise.
L_{A90}	The level exceeded for 90% of the time is normally used to describe background noise.
$L_{Amax,F}$	The maximum sound level that occurs during a period of time, measured using a FAST time weighting.

Table 1: Commonly Used Environmental Noise Descriptors

Sound Transmission in the Open Air

Most sources of sound can be characterised as a single point in space. The sound energy radiated is proportional to the surface area of a sphere centred on the point. The area of a sphere is proportional to the square of the radius, so the sound energy is inversely proportional to the square of the radius. This is the inverse square law. In decibel terms, every time the distance from a point source is doubled, the sound pressure level is reduced by 6 dB.

Road traffic noise is a notable exception to this rule, as it approximates to a line source, which is represented by the line of the road. The sound energy radiated is inversely proportional to the area of a cylinder centred on the line. In decibel terms, every time the distance from a line source is doubled, the sound pressure level is reduced by 3 dB.

Factors Affecting Sound Transmission in the Open Air

Reflection

When sound waves encounter a hard surface, such as concrete, brickwork, glass, timber or plasterboard, it is reflected from it. As a result, the sound pressure level measured immediately in front of a building façade is approximately 3 dB higher than it would be in the absence of the façade.

Screening and Diffraction

If a solid screen is introduced between a source and receiver, interrupting the sound path, a reduction in sound level is experienced. This reduction is limited, however, by diffraction of the sound energy at the edges of the screen. Screens can provide valuable noise attenuation, however. For example, a timber boarded fence built next to a motorway can reduce noise levels on the land beyond, typically by around 10 dB(A). The best results are obtained when a screen is situated close to the source or close to the receiver.

Meteorological Effects

Temperature and wind gradients affect noise transmission, especially over large distances. The wind effects range from increasing the level by typically 2 dB downwind, to reducing it by typically 10 dB upwind – or even more in extreme conditions. Temperature and wind gradients are variable and difficult to predict.

APPENDIX 2

ATTENDED SURVEY – DETAILED RESULTS

Attended Survey Methodology

The attended survey involved visiting the airport on seven occasions; 9th, 10th, 23rd, 27th, 30th and 31st July, and 4th August. On each occasion measurements were taken at one of more of four Noise Measurement Positions on the north side of the airport site.

A Norsonic Type 1 model 140 sound level meter was used and was checked for correct calibration calibrated at the start and end of each visit. No significant drift was observed. For each measurement, the meter was set to record a continuous sequence of one second duration measurements. To allow subsequent analysis of these, a log was made of the sources of noise as the measurements progressed. An example of this log is given at the end of this appendix.

Attended Survey Results

The time histories of the measured noise levels are detailed in the attached Figures A2.1 to A2.12. These have been marked up using a range of colours to represent the dominant noise sources that were occurring at particular times, taken from the logs.

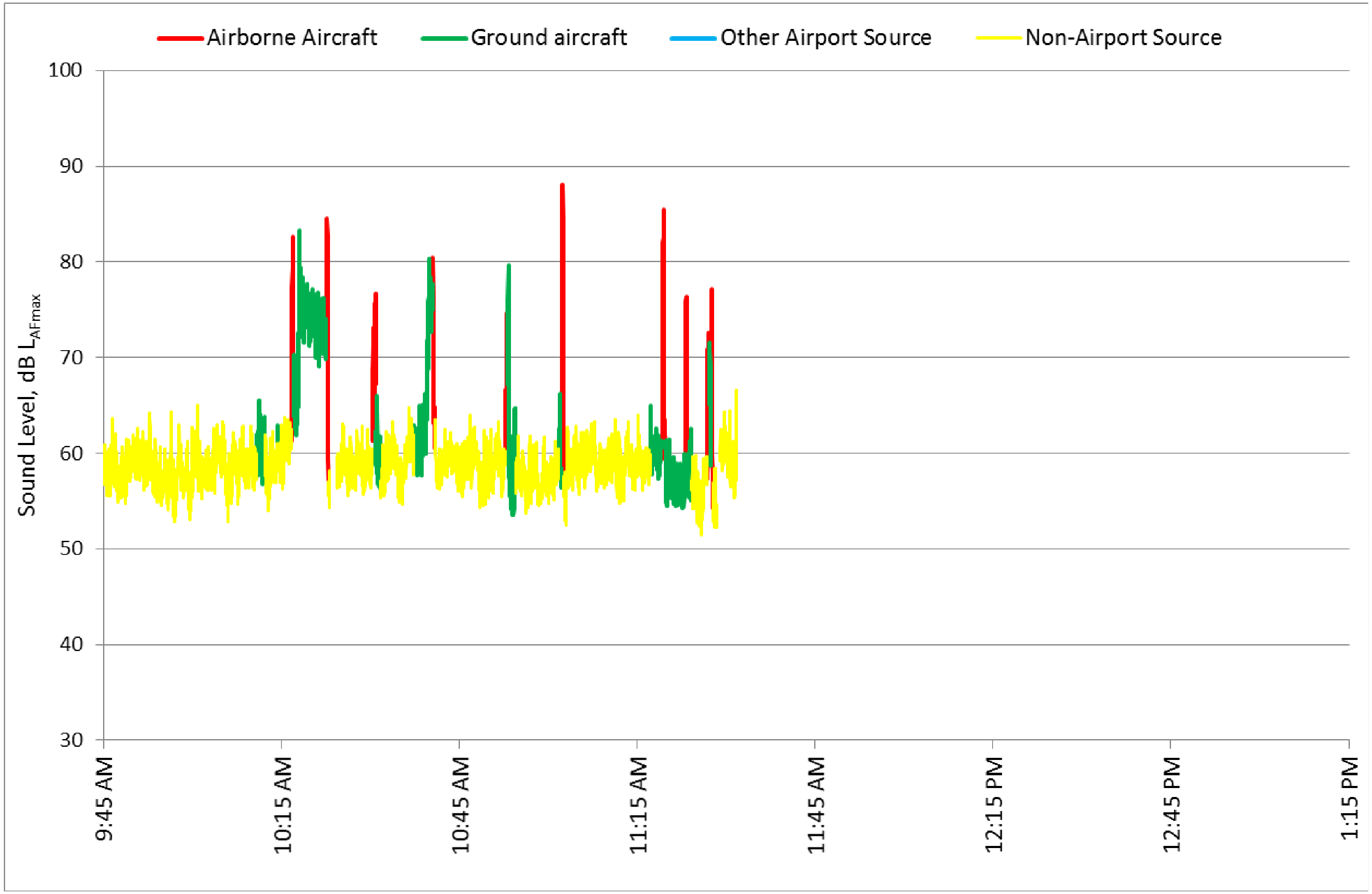

Figure A2. 1: Time History at NMP2, 10th July 2015

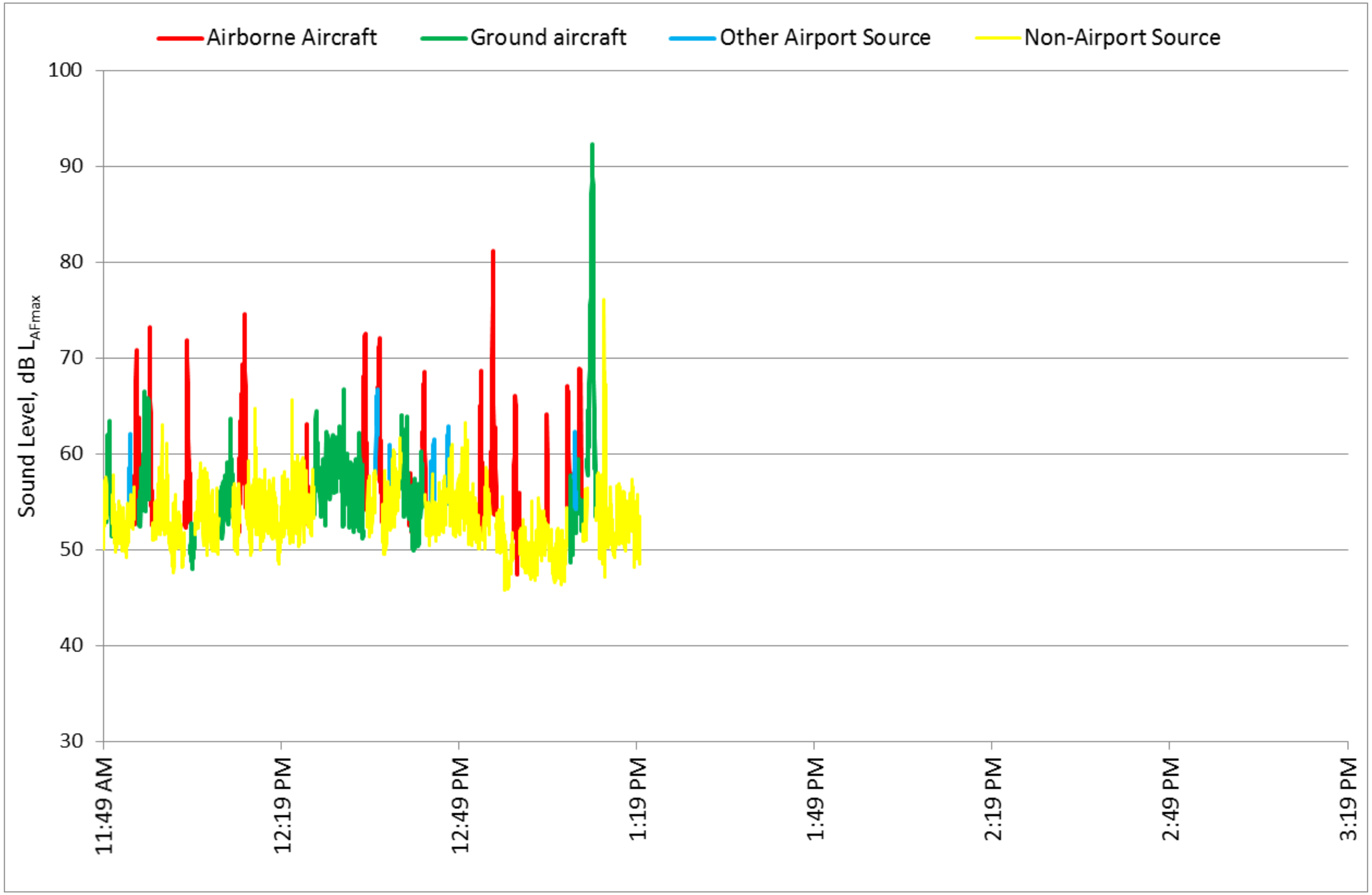

Figure A2. 2: Time History at NMP3, 10th July 2015

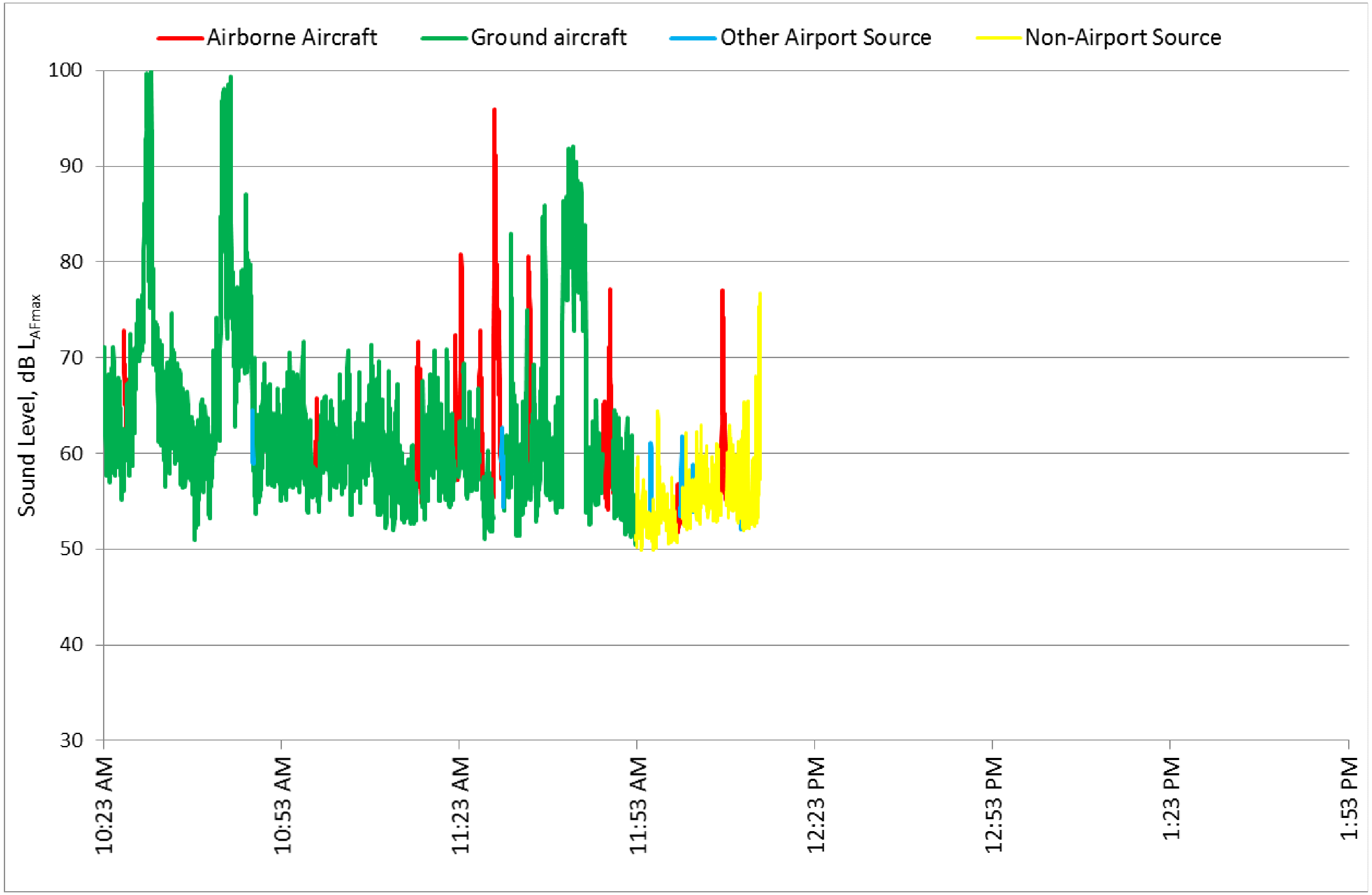

Figure A2. 3: Time History at NMP3, 27th July 2015

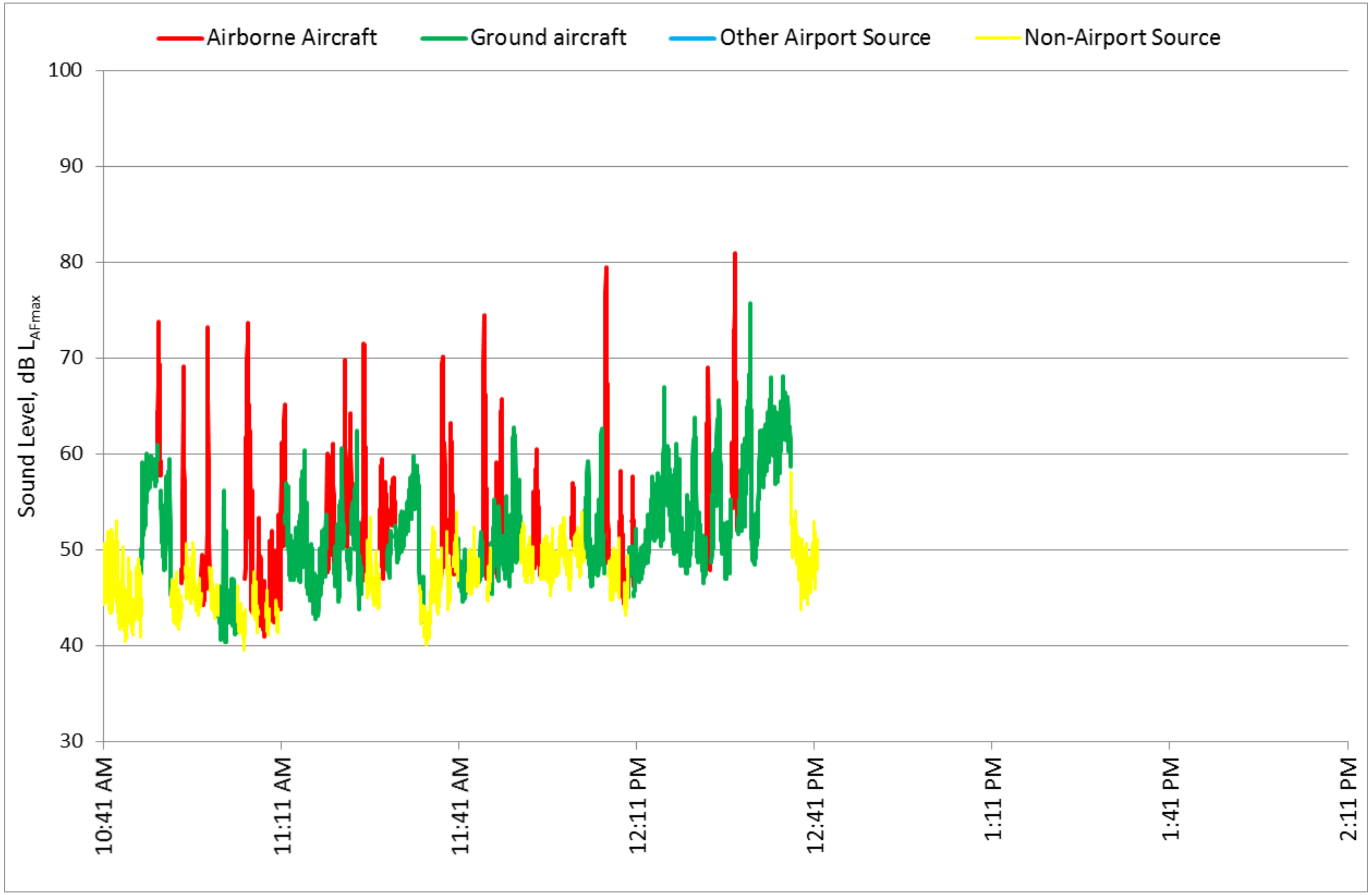

Figure A2. 4: Time History at NMP4, 23rd July 2015

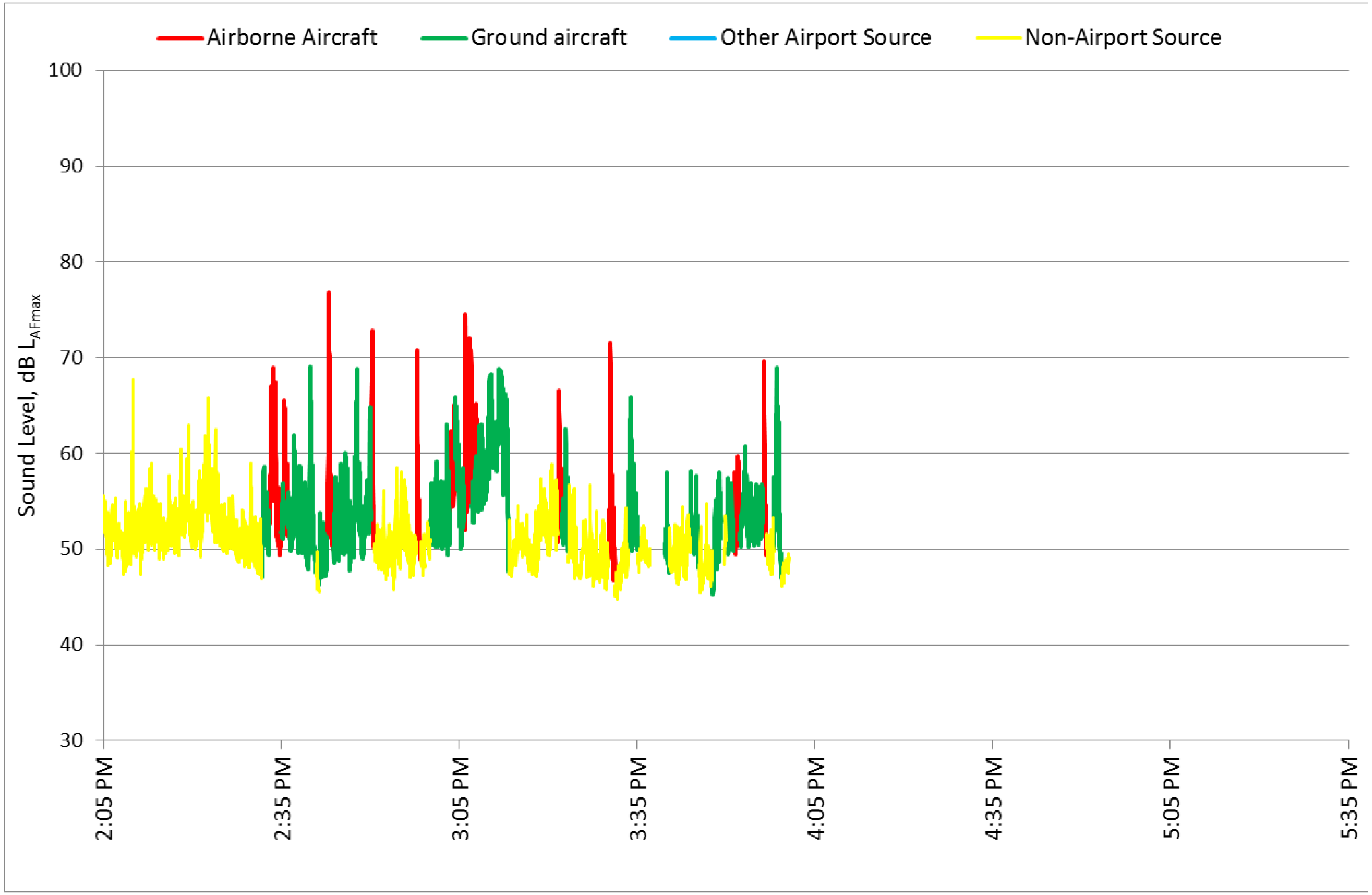

Figure A2. 5: Time History at NMP4, 27th July 2015

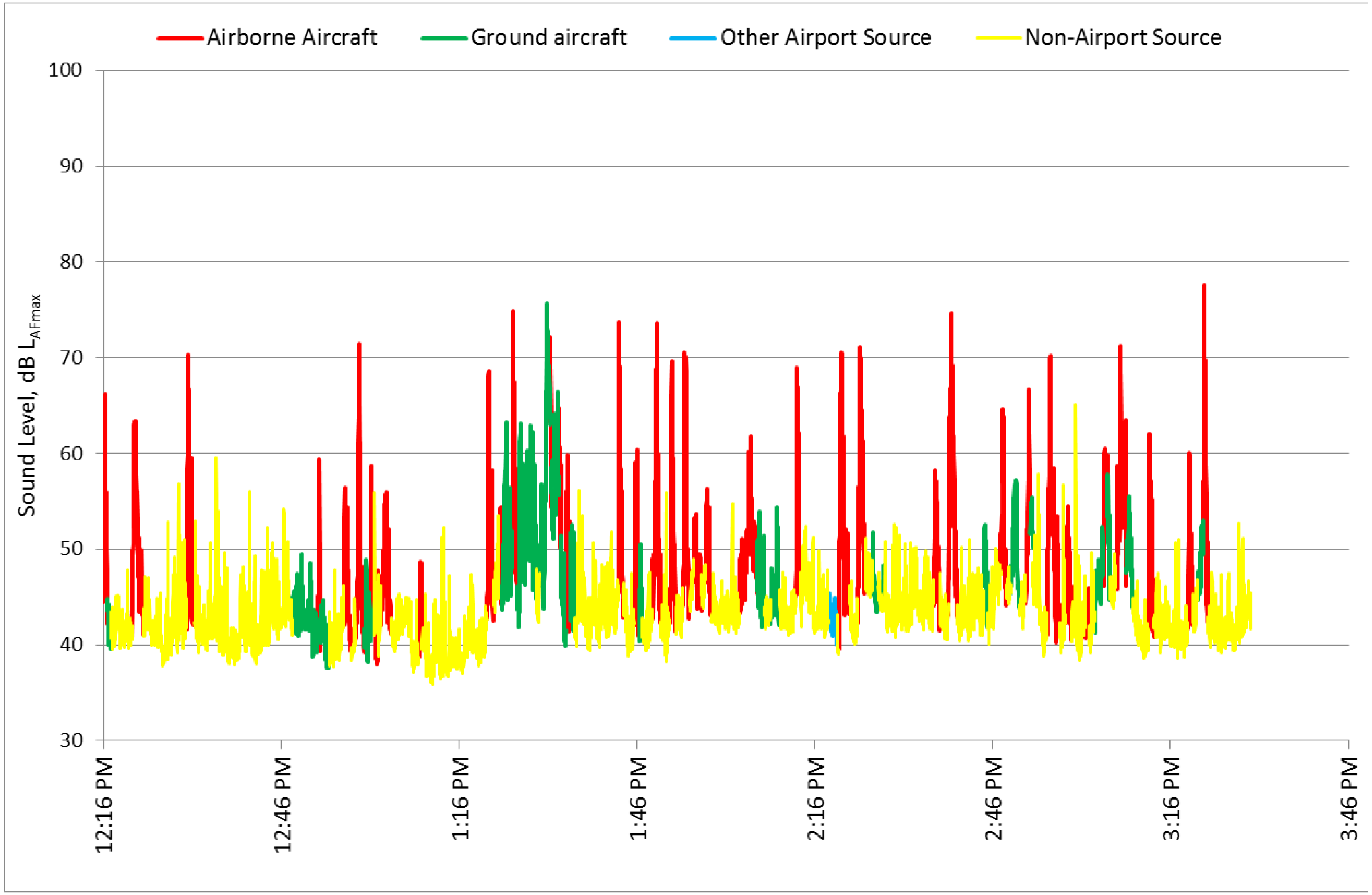

Figure A2. 6: Time History at NMP4, 30th July 2015

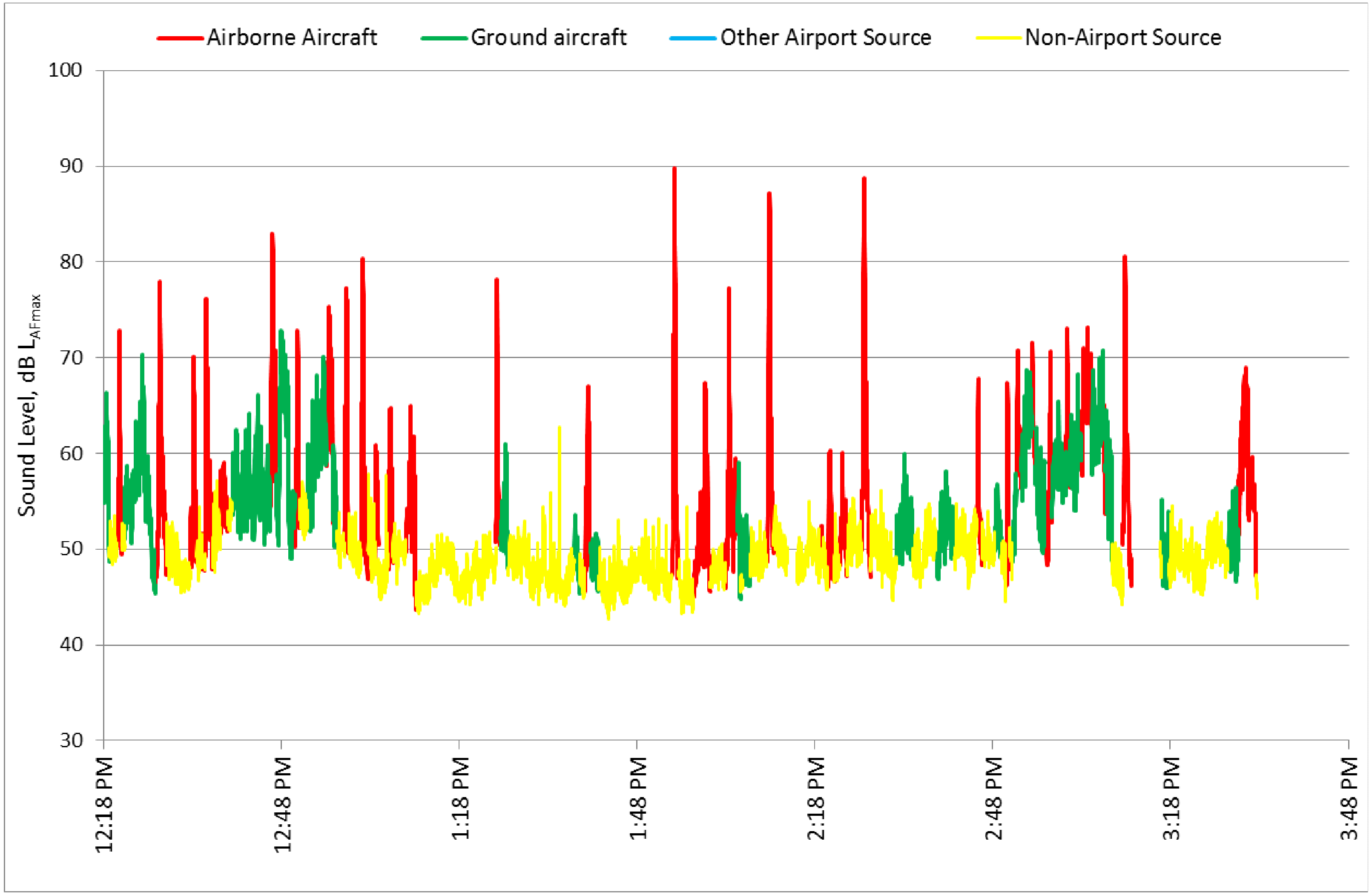

Figure A2. 7: Time History at NMP4, 31st July 2015

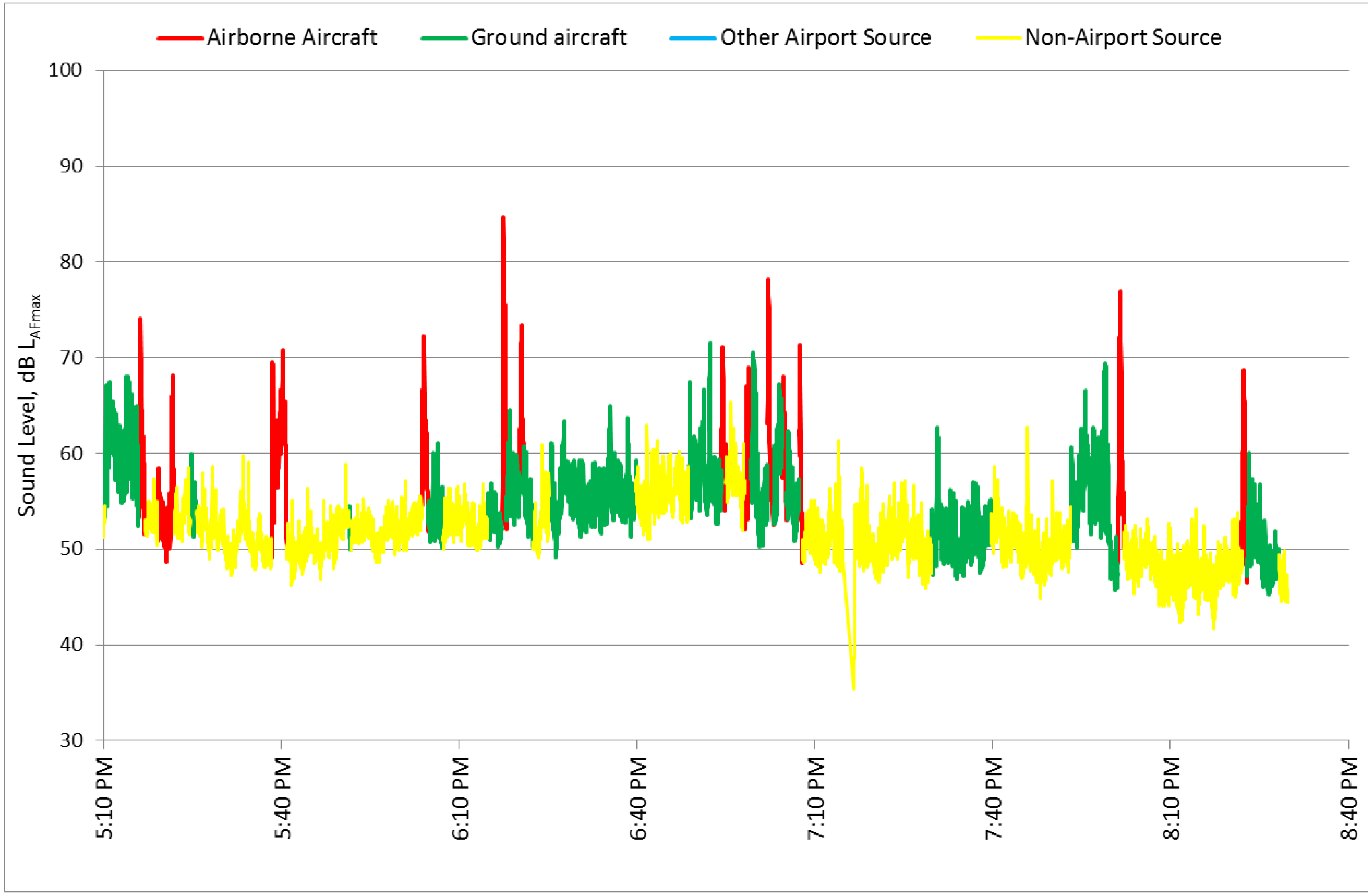

Figure A2. 8: Time History at NMP4, 4th August 2015

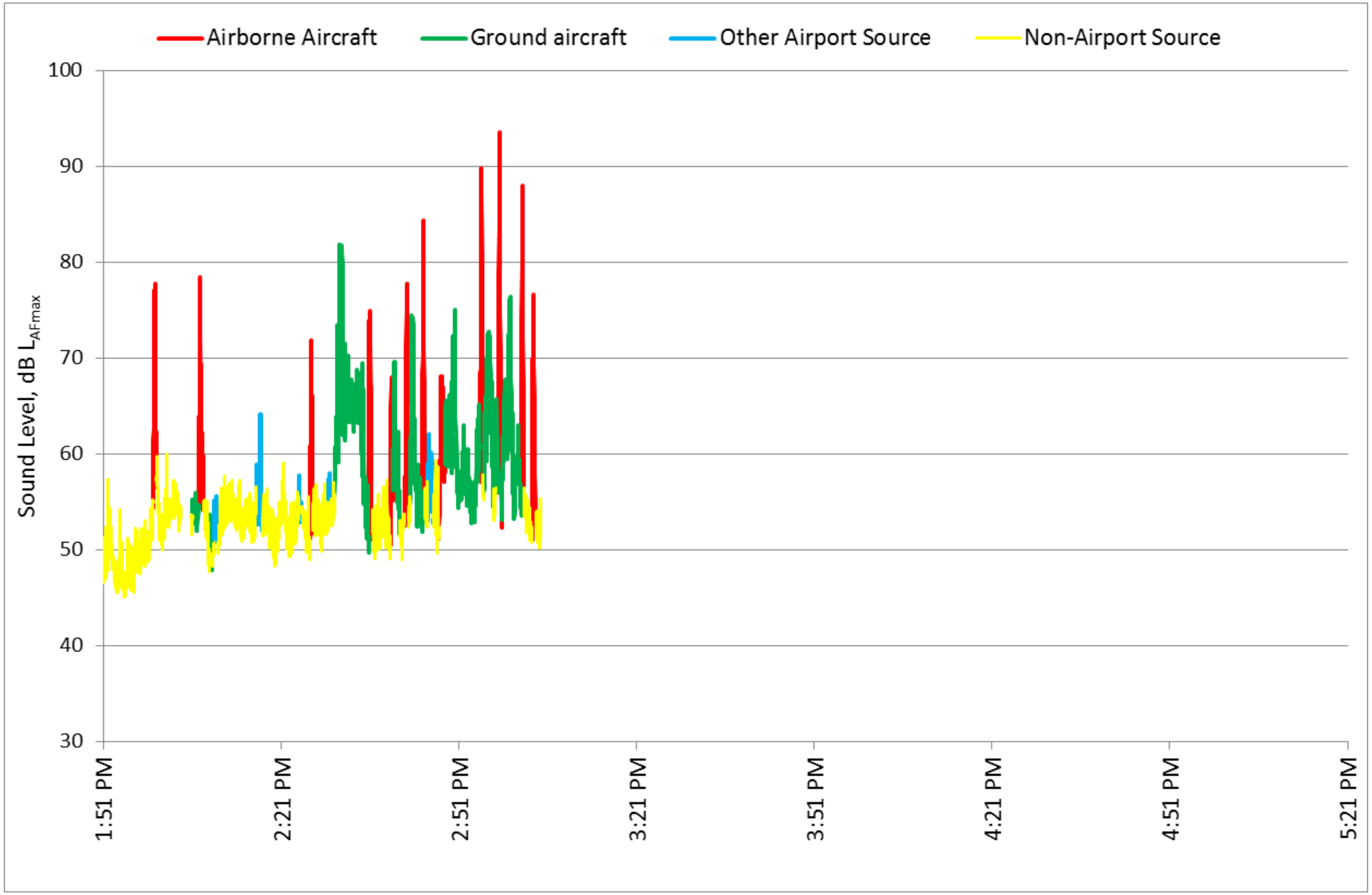

Figure A2. 9: Time History at NMP5, 9th July 2015

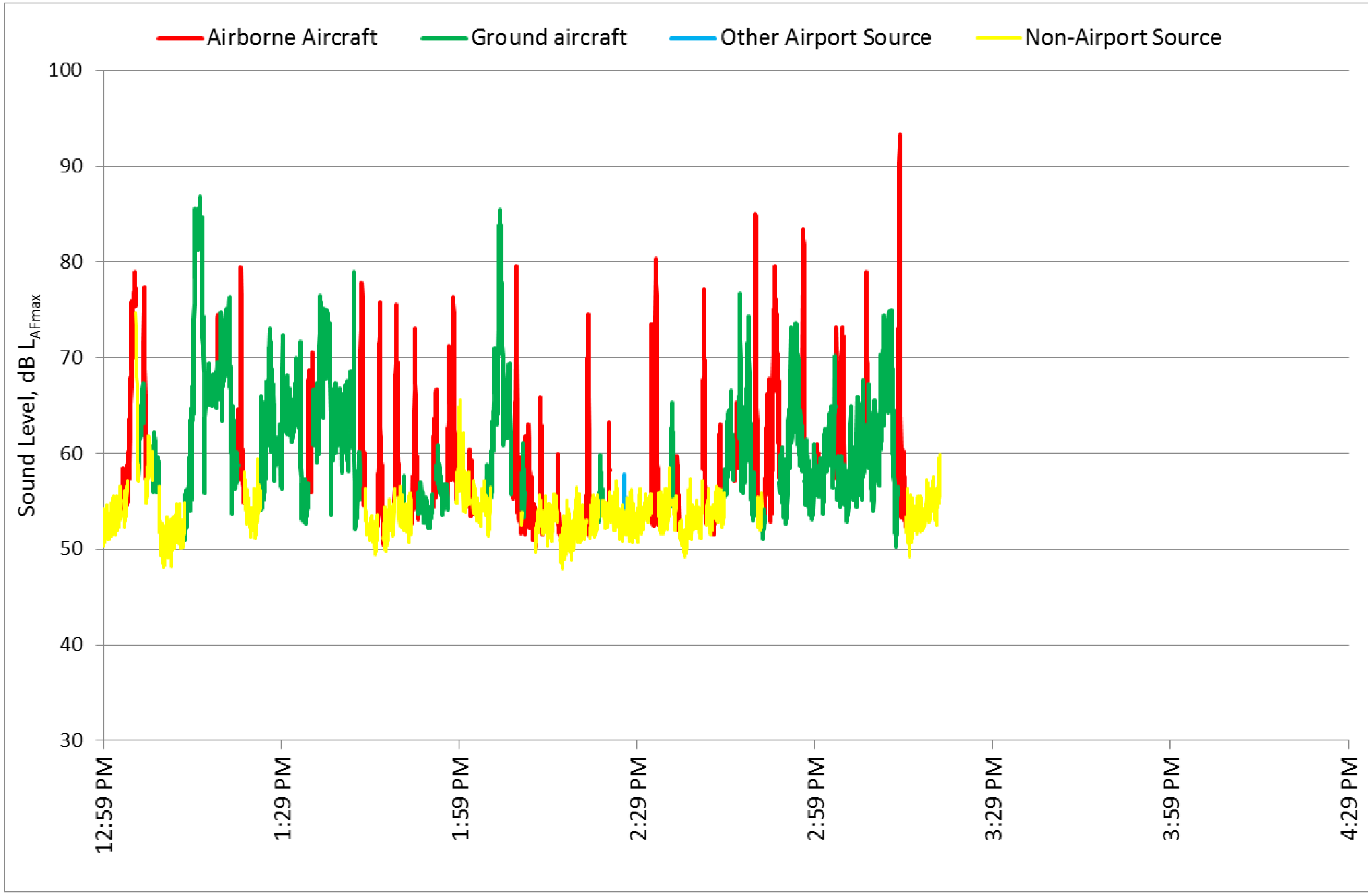

Figure A2. 10: Time History at NMP5, 23rd July 2015

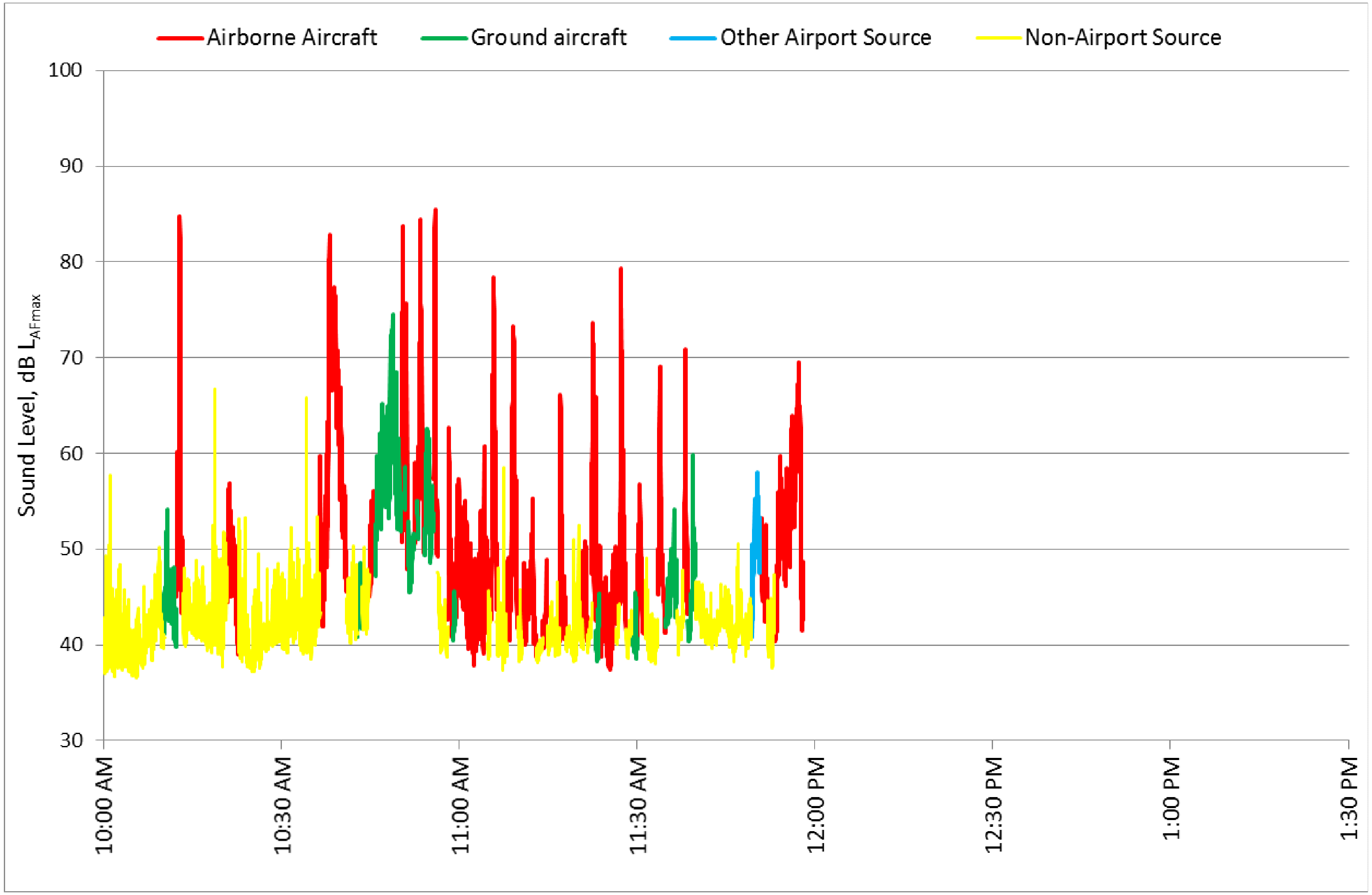

Figure A2. 11: Time History at NMP5, 30th July 2015

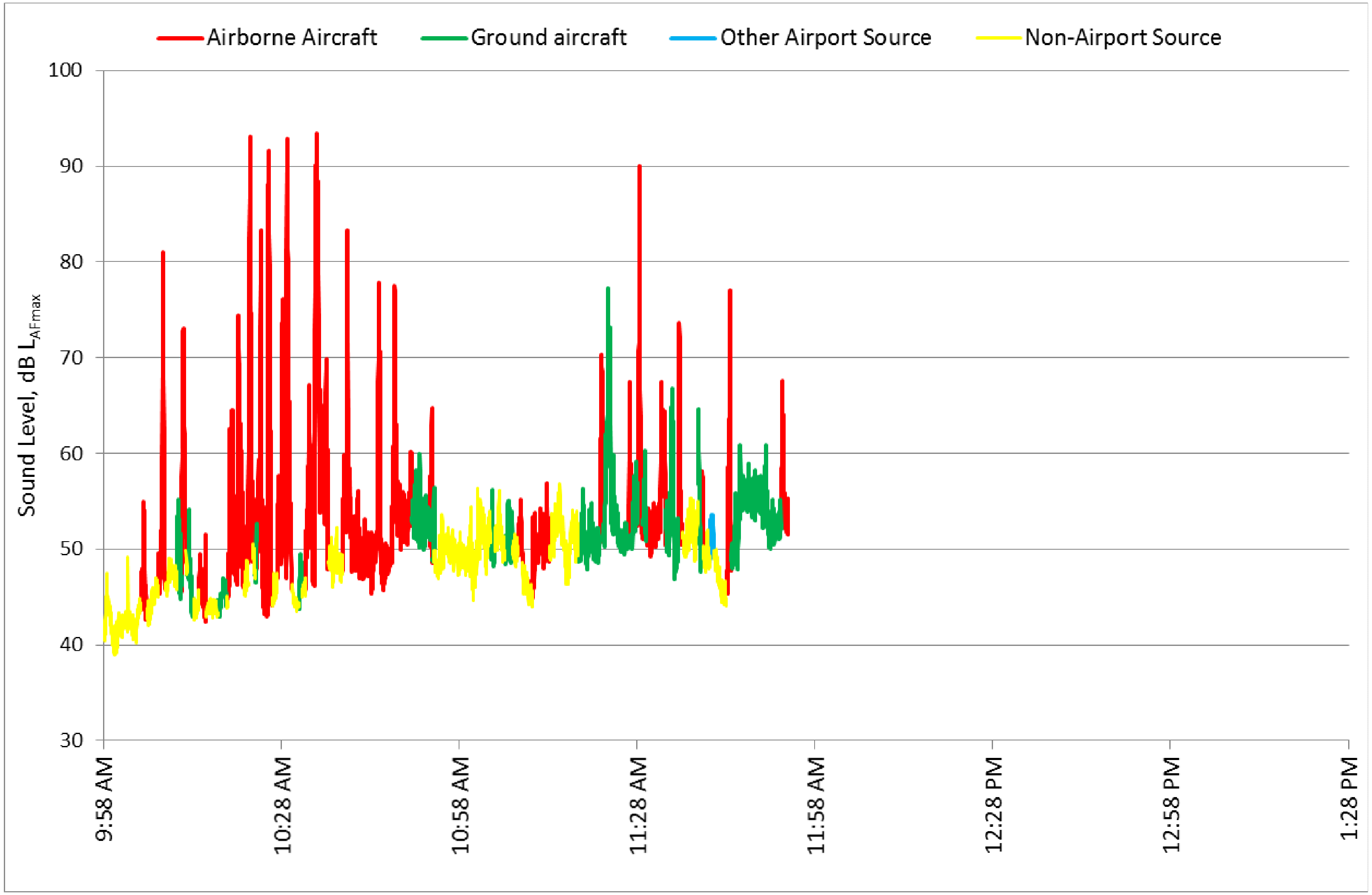

Figure A2. 12: Time History at NMP5, 31st July 2015

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EDDC Development Management and Environmental Health Joint Airport Noise Study

Updated Noise Impact Assessment, Exeter International Airport

Part 2

FINAL

Report to

East Devon District Council
Knowle
SIDMOUTH
Devon
EX10 8HL

A9894-R02-PH
4th February 2016

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Architects: Design and project management services which cover all stages of design, from feasibility and planning through to construction on site and completion.

Acoustic Consultants: Expertise in planning and noise, the control of noise and vibration and the sound insulation and acoustic treatment of buildings.

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1.0 INTRODUCTION

In October 2000, Bickerdike Allen Partners were commissioned by East Devon District Council (EDDC) to carry out an independent noise impact appraisal of Exeter Airport with specific reference to proposed residential developments in the vicinity. That report is available via EDDC Environmental Health. Exeter Airport is an established strategic transport facility, important to the South West and anticipated to continue to develop. The noise report concluded that residential development south of the old A30 was likely to be regularly affected by noise from the airport which could not be adequately mitigated. Effectively, for this and other reasons, the line of the old A30 was established as the southern boundary for development in the Cranbrook vicinity.

Now in 2015 the development of the Cranbrook New Community in East Devon near to Exeter International Airport is well underway. As of the 1st October there were over 1,100 occupied homes and a further 2,400 with the benefit of planning permission. The new East Devon Local Plan to 2031 anticipates Cranbrook expanding to accommodate circa 8,000 homes equating to a population of around 20,000 people. The expansion of Cranbrook is to be guided by a masterplanning exercise (the Cranbrook Plan) and already there are live applications for over 4,500 additional homes. It is an over-riding aim that Cranbrook develops as a healthy, sustainable and vibrant community whilst also safeguarding the operation of Exeter International Airport.

The extent of the Cranbrook Plan area relative to Exeter Airport is shown in Figure 1 below.

A planning application has been submitted for a large expansion area south of the old A30, much closer to the airport than identified to date, see Figure 2. In order to properly assess this application and other expansion sites, EDDC have identified a pressing need to obtain an updated noise report.

Bickerdike Allen Partners (BAP) have been instructed by EDDC to update the previous noise impact appraisal. This involves both noise modelling and noise monitoring with reporting in two parts, this being Part 2. This report is intended to be read in conjunction with Part 1.

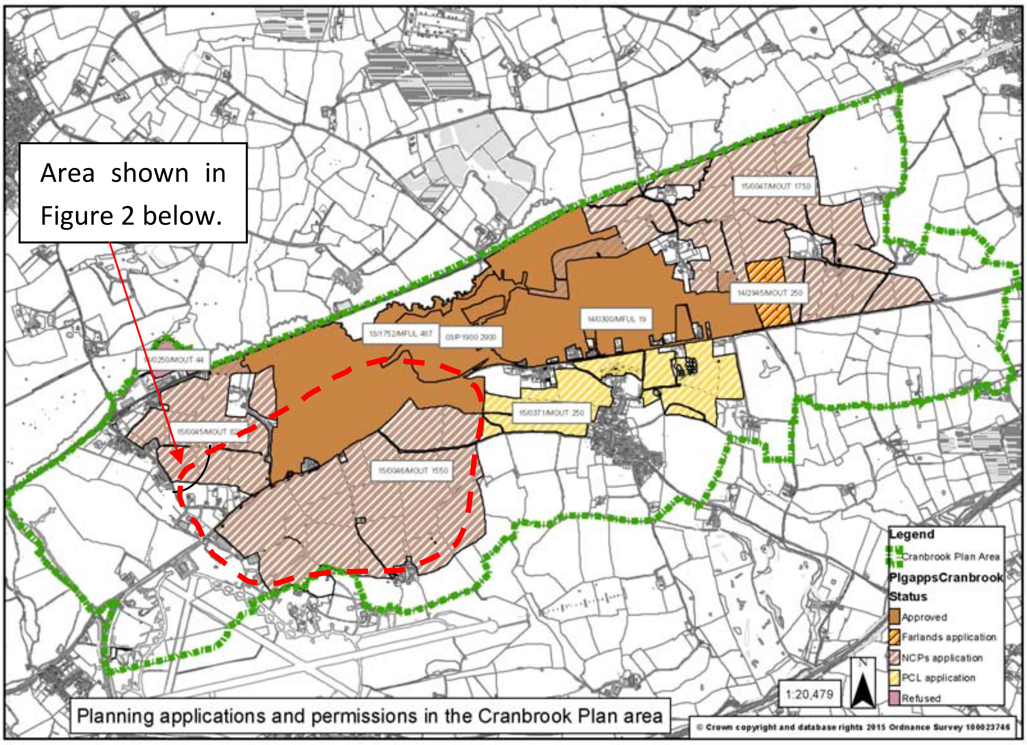

Figure 1 – Cranbrook Plan Area

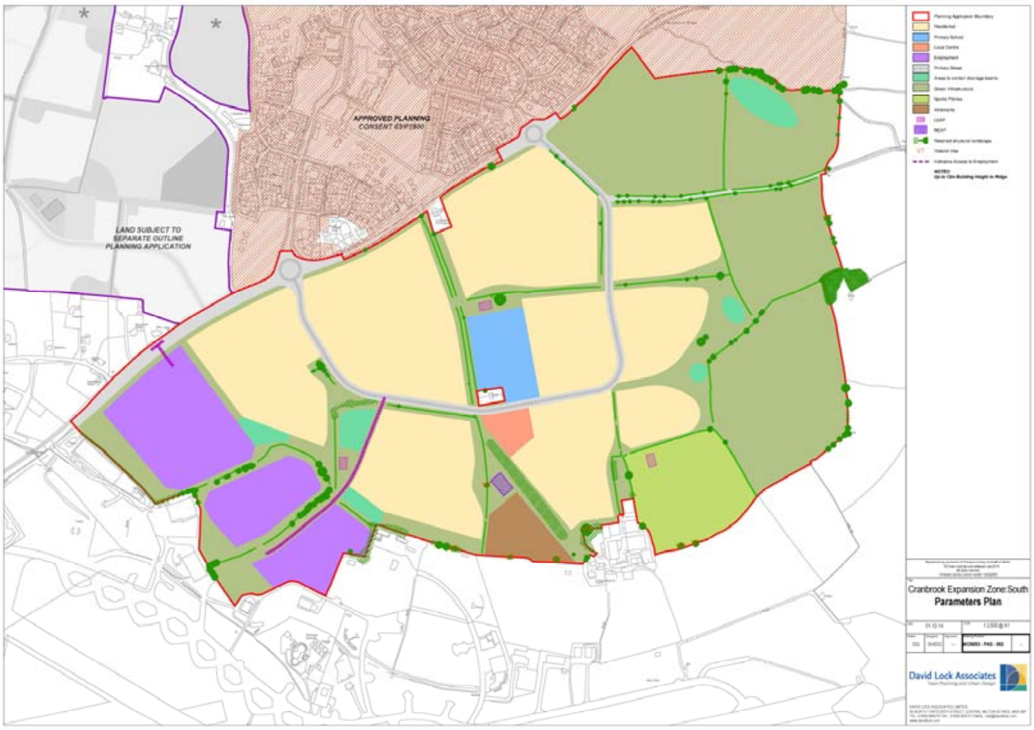

Figure 2 – Cranbrook Expansion Zone: South

This report is designed to assist EDDC in determining the acceptability of a site for development when affected by aircraft noise and other environmental noise sources. It is intended to assist in land use planning around Exeter Airport, and how aircraft and non-aircraft related operations from the airport infrastructure might impact on proposed development sites when taking account of expected activity levels, both now and in the future.

This report presents current UK and European legislation in relation to the control of aircraft noise for both daytime and night-time operations, and establishes the latest emerging guidance, particularly related to land use planning. Types of development are assessed against their acceptable noise exposure levels which can be used to reference the sites' suitability in relation to aircraft noise contours, assuming use of the existing and permitted airport infrastructure.

To assist in developing appropriate criteria contours for the Cranbrook Development, a series of noise monitoring exercises has been undertaken, comprising both attended and unattended noise monitoring at various locations around Exeter Airport. The results of attended monitoring were recorded in Part 1. This part of the report records the results of a long term noise monitoring exercise undertaken over the period from mid July to mid October. The long term noise monitor was positioned on the airport land, close to the runway and engine ground run location, as discussed further in Section 2.0 below.

Section 2.0 of this report describes the long term noise monitoring work and presents the results obtained. Section 3.0 sets out the legislative and guidance documents that relate to the control of transportation noise around a development site. Section 4.0 presents suggested noise design criteria for planning purposes.

Section 5.0 sets out suggested noise bands to assist EDDC in the assessment of a particular type of application site over its suitability for development. Section 6.0 describes noise maps related to Exeter Airport and the Cranbrook new community. Finally, Section 7.0 provides maps translating the guidance in this report into noise band lines on a map to assist EDDC in making noise related planning decisions both at a strategic and local level.

A glossary of acoustic terminology is given in Appendix 1. The detailed results of long term noise monitoring are given in Appendix 2. Engine ground running logs are presented in Appendix 3. Air noise contours from Exeter Airport in 2006 and those predicted in 2030 are given in Appendix 4, taken from Exeter Airport's Masterplan produced in 2008. Engine ground running noise contour maps determined by predictions are presented in Appendix 5.

2.0 LONG TERM NOISE MONITORING

2.1 Methodology

BAP installed a long term noise monitor at Exeter Airport on 9th July 2015 and collected it on 23rd October 2015. Over this period, noise monitoring was undertaken continuously (other than for a two week period in August) to obtain a record of the variation in noise levels around the airport over a three month period in the summer.

Figure 3 below shows the location of the long term noise monitor in relation to the airport, and a photo of the noise monitor is shown in Figure 4.

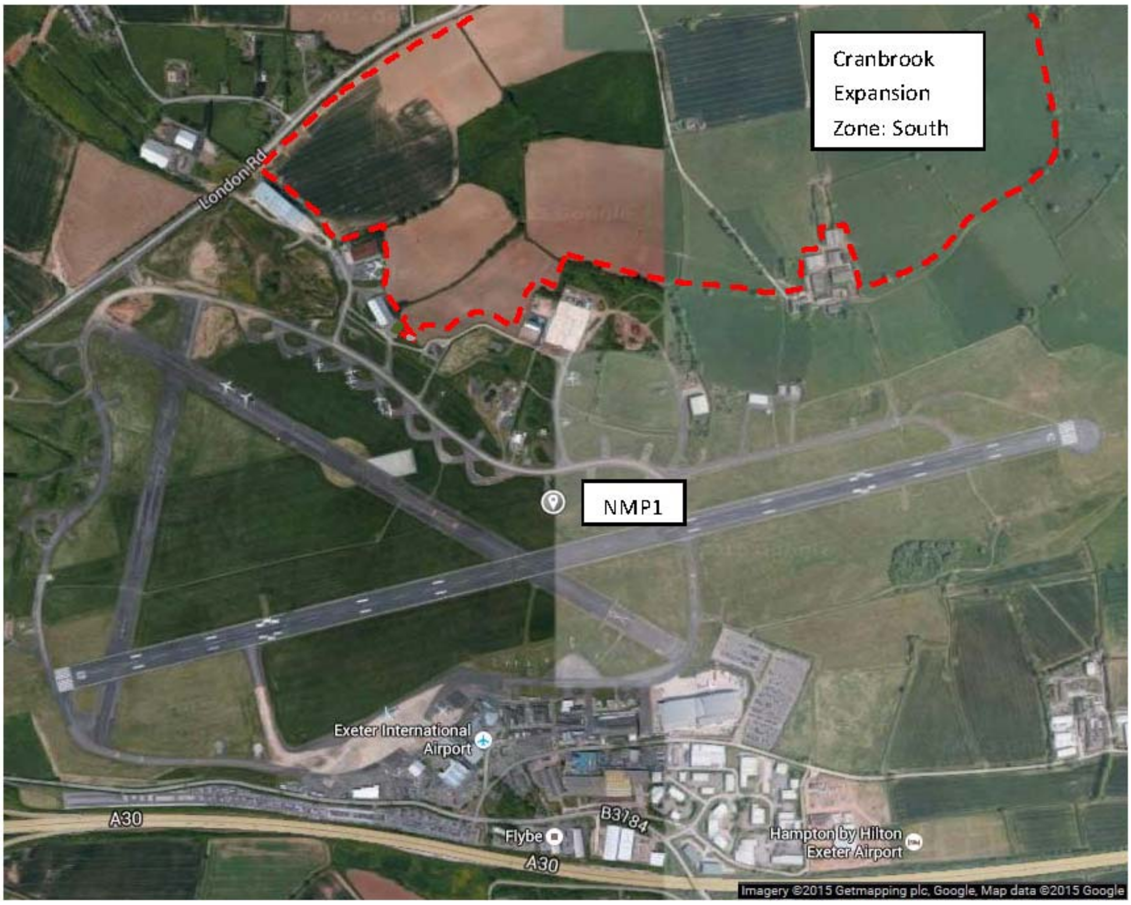

Figure 3: Location of Long Term Noise Monitor at Exeter Airport

Figure 4: Photo of Long Term Noise Monitor at Exeter Airport (facing South)

An unattended noise survey was carried out in accordance with BS 7445[1] using an 01dB Cube Smart Noise Monitoring Terminal (9th July to 28th August) and an 01dB Duo Smart Noise Monitor (28th August to 23rd October). The sound level meters were checked for calibration before and after measurement using a Norsonic Type 1251 calibrator and no significant drift was observed. Continuous samples of 1 second were made throughout the survey period, with the exception of 13th to 26th August when an issue with the equipment meant it was not recording. In total data was recorded for a period of 3 months.

The long term weather information, obtained from the airport's weather station, is presented in Appendix 2 for the period of the survey.

The noise monitoring equipment was set with a noise trigger level of 70 dB(A) so that any events producing this level of noise generated an audio file. This provides the facility to assist post processing of data and identification where required of specific high level noise producing events.

The dominant source of ambient noise observed on site, when there was no aircraft activity occurring, was road traffic noise from the A30 to the south.

---

[1] BS 7445:Part 1:2003 Description and measurement of environmental noise – Part 1: Guide to quantities and procedures

2.2 Results

2.2.1 Long Term Averages

The data from the unattended noise monitor has been analysed and the long term daytime and night time average noise levels have been presented in Figure 5. In Figure 6 the average noise level for each hour of the day is shown, with error bars showing ± 1 standard deviation.

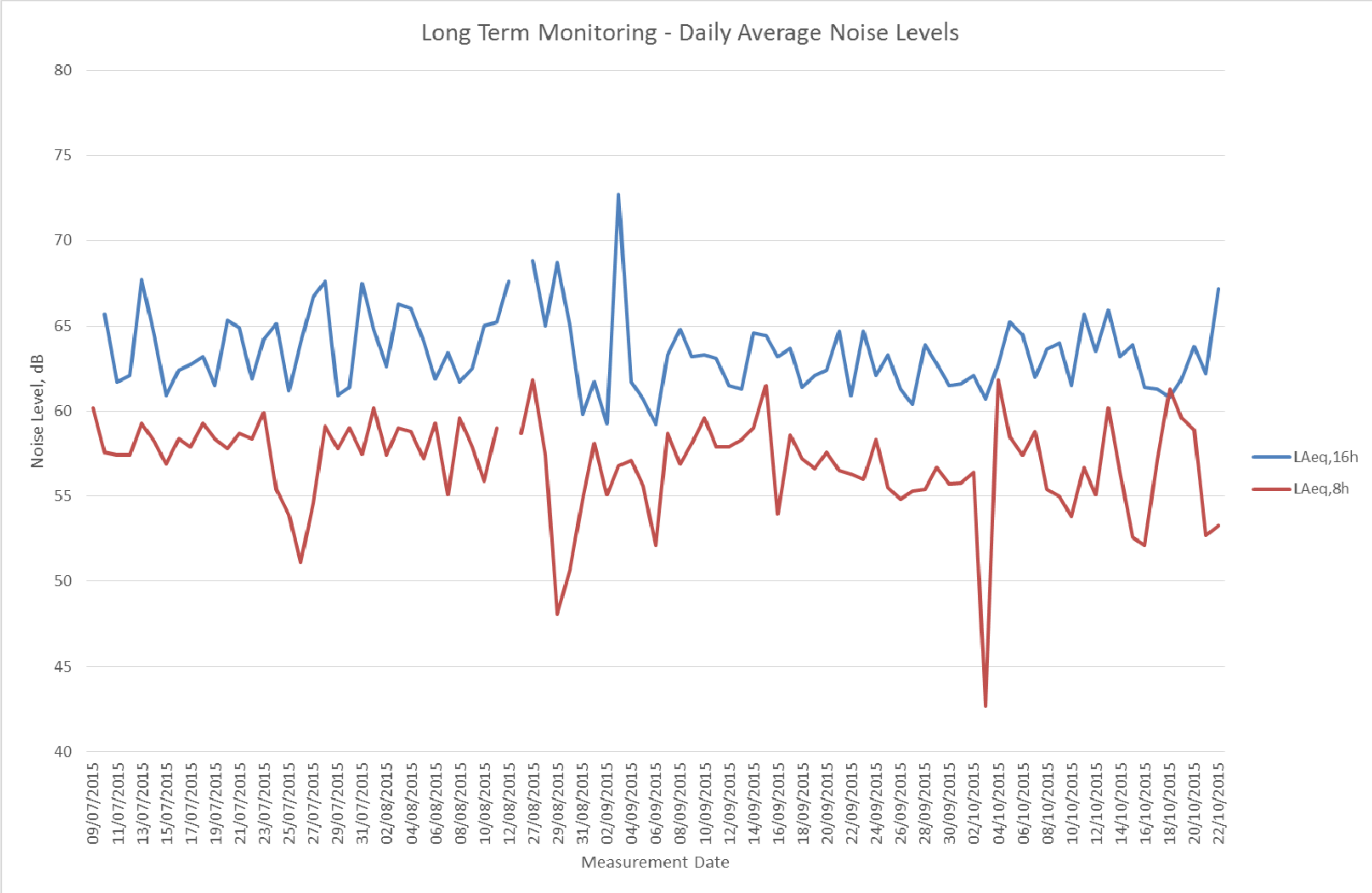

Figure 5: Long Term Daily Average Noise Levels

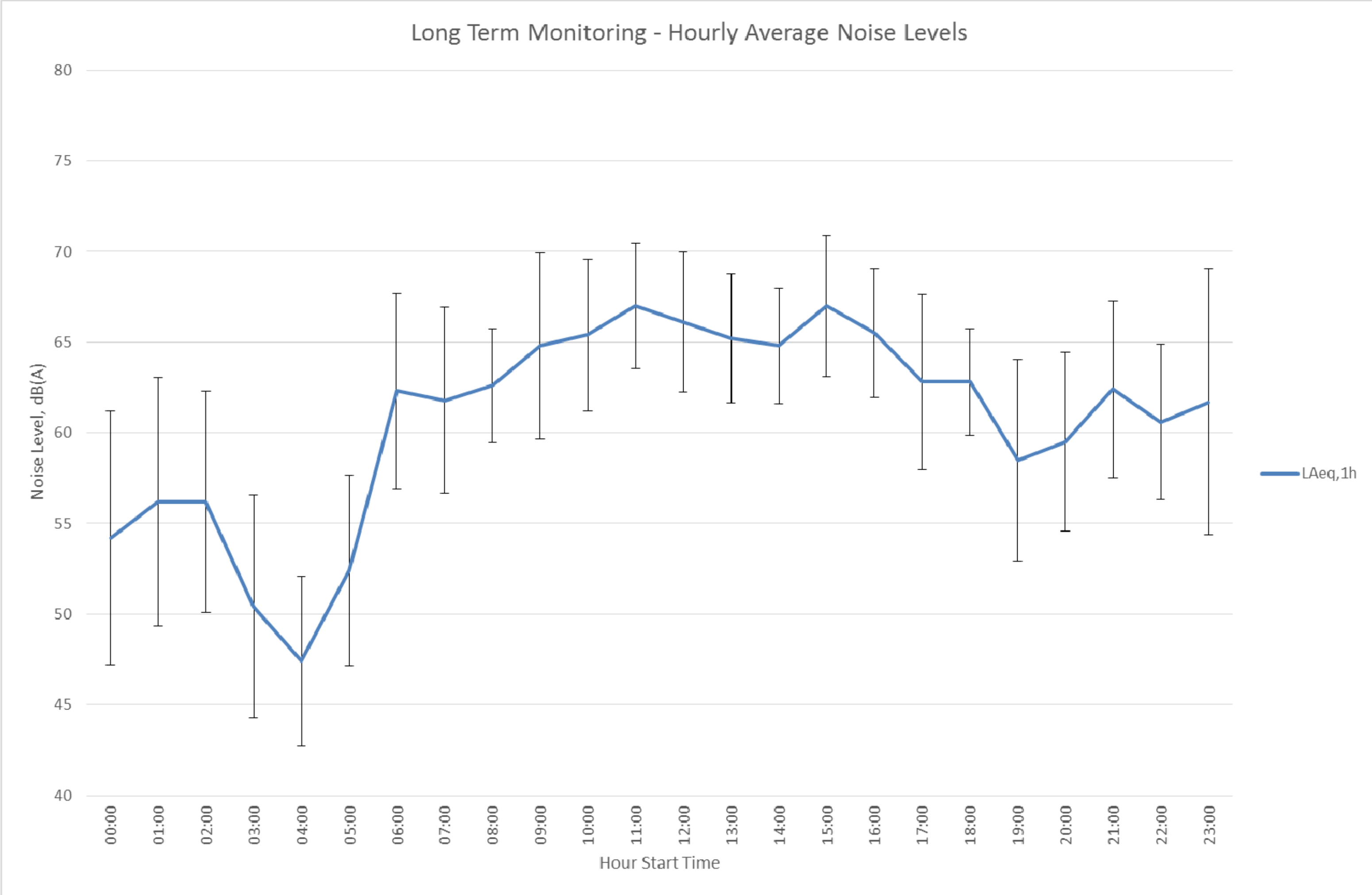

Figure 6: Long Term Hourly Average Noise Levels

2.2.2 Air Noise - Aircraft Departure/Arrival Events

A flight log for the measurement period has been received from the airport identifying when, during the survey period, aircraft departed and arrived at the airport. It has therefore been possible to correlate peak noise events with the flight log to separate out noise produced by aircraft air noise from "other" noise. Airborne aircraft noise events have been identified with a high level of accuracy, due to the noise monitoring position being close to the runway and having the facility to listen to audio files.

This analysis finds that, at the noise monitoring position NMP1, the overall $L_{Aeq,16h}$ value due to airborne aircraft noise determined over the three month noise monitoring period is 63 dB.

2.2.3 Engine Ground Running

Exeter Airport have provided logs of when engine ground running took place at the engine run-up base during the survey period. These logs are provided in Appendix 3.

The log specifies the time at which engine running began taking place. Observations made on site during attended monitoring, together with an inspection of long term noise monitoring results, finds that in practice, high power ground running associated with these maintenance events often occurs within 15 minutes or so of this time, however in some cases there were multiple instances of high power ground running by the same aircraft. The logs only identify the time of the first high power run so therefore it is necessary to review the noise monitoring records in detail to seek to identify when any high power ground running actually took place and what noise levels were generated as a result.

The noise monitoring graphs provided in Appendix 2 identify both the time and date that the ground running commenced (as specified by Exeter Airport) and also where it appears high power ground running actually occurred. The noise level produced by high power ground running is variable since it is dependent, not just on the aircraft type, but also the percentage of thrust being deployed at the time of the run.

Table 1 below summarises the findings of a detailed assessment of noise monitoring data based on the Exeter ground running logs. Data is provided only for those logs where it has been possible to determine with reasonable certainty that high power ground running is the source of noise. Information on the time of the ground run has been extracted as well as the average noise generated and maximum noise produced during the ground run.

Aircraft Type	No. of ground runs	Average duration (min:sec)	Average noise level, dB L_{Aeq}	Range of noise maxima, dB L_{AFmax}
BAe 146-200	3	7:03	65	68 – 73
Boeing 737-300	1	1:35	67	75
Dash 8-400	21	6:52	66	57 – 88
Embraer 145	1	2:48	64	72
Embraer 170	6	8:59	64	69 – 75
Embraer 195	6	5:06	65	70 – 80
OVERALL TOTAL/AVERAGE	38	6:42	66	57 – 88

Table 1: High Power Ground Running Noise Levels at NMP1

At NMP1, the average noise level generated during the period of high power ground running is around 66 dB $L_{Aeq,T}$, where T represents the time that the aircraft is carrying out identifiable high power ground running. The maximum noise level, determined as an average of these events, is 74 dB L_{Amax}. The range of noise maxima generated at this position during high power ground running varies considerably, from 57 to 88 dB L_{Amax}. The average exposure time of a given noise maximum will have varied over the ground running period at any given receptor.

In summary, the following key facts have been derived from an analysis of the engine ground run logs and associated noise monitoring results at NMP1:-

Average time ground running produced noticeable levels of noise, T:	6 min 42 secs
Average noise level produced during average ground run time T:	65.7 dB L_{Aeq}
Average ground run noise level spread over a 16-hour day:	43.1 dB $L_{Aeq,16h}$
Average ground run noise level spread over one hour:	55.1 dB $L_{Aeq,1h}$
Average ground run noise level spread over 30 minutes:	58.1 dB $L_{Aeq,30m}$
Average ground run maximum noise level:	74 dB L_{Amax}

The noise levels recorded at NMP1 during ground running on the engine run-up base are likely to be less than produced by ground running at an unscreened position 300m away, the distance separating NMP1 from the engine run-up base. This is because of partial screening caused by the DME building situated adjacent to the NMP1 microphone location. This is important when considering how ground running noise might affect adjacent land under consideration for development.

2.2.4 Other Noise Sources

Road traffic noise from the A30 and also general ground noise from the airport are the primary contributors to the residual noise recorded at NMP1. Following a detailed analysis of the recorded data, it has been possible to establish the magnitude of this residual noise relative to both air noise and engine ground running noise. In broad terms, the residual noise contributes a similar level of noise energy to that produced by air noise and engine ground running (the latter producing only a very small contribution due to its current occasional level of activity when considered over a 16 hour day period.

Contributions to 3 monthly average noise level at NMP1:

	Daytime ($L_{Aeq,16h}$)	Night-time ($L_{Aeq,8h}$)
OVERALL	64 dB	58 dB
Airborne Aircraft Noise	63 dB	56 dB
Road traffic (and ground noise)	58 dB	53 dB
Average background noise ($L_{AF90,T}$)	48 dB	40 dB

3.0 NOISE PREDICTIONS

3.1 Air Noise

The term air noise refers to noise from aircraft that are airborne or on an airport runway during take-off or landing. The total air noise to which local communities are exposed over a given period depends on the noise emitted by individual aircraft and the total number of aircraft movements (arrivals and departures) in that period. An overall measure of air noise exposure can be depicted by noise contours.

Exeter Airport, in their 2008 Masterplan, presented air noise contours for various periods, including at the time, the current year (for 2006) and future years at the time, 2015 and 2030. These noise contours are presented in Appendix 4. The numbers of aircraft movements into and out of the airport associated with each of these contours are presented in Table 2 below.

Year	Annual Aircraft Movements[(1)]
2006 (Actual)	16,500
2015 (Predicted)	24,750
2030 (Predicted)	38,000

Note: [(1)] From Exeter Airport 2008 Masterplan.

Table 2 – Number of Annual Aircraft Movements, 2006 to 2030

From CAA statistics, the total number of air transport movements into and out of Exeter Airport during 2014 was 13,238. This would suggest therefore that the airport is currently operating in a manner similar to but at a lower level of activity than what was occurring in 2006. A similar air noise contour plot might therefore be expected.

From a detailed inspection of measured noise data, it has been determined that, at NMP1, the current level of air noise during the summer is typically 63 dB $L_{Aeq,16h}$. This is lower by about 3 dB than the level of air noise predicted and illustrated in the contour plot for 2006 as shown in Appendix 4 at NMP1. It is difficult to compare air noise contours with measurements taken at one location but it demonstrates that the airport's air noise footprint (contours) are likely to lie similar to or smaller than those depicted in the Masterplan for 2006.

Until further air noise contours are generated by Exeter Airport, a reasonable approach is to assume that current and future air noise levels are represented by the contour plots in Appendix 4.

3.2 Ground Noise

Ground noise is commonly referred to as noise produced by aircraft activities and use of ancillary equipment on the ground, that is, by sources other than by aircraft in flight, taking off or landing. Sources of ground noise include:-

- taxiing and manoeuvring aircraft
- aircraft auxiliary power units (APU's)
- testing of aircraft engines (ground running)
- mobile ground equipment, e.g. ground power units (GPU's)

Airport ground noise is heard in the context of off-airport noise sources, such as road traffic noise, together forming the background noise audible around an airport. The most dominant contributor to the background noise climate in the areas surrounding Exeter International Airport is road traffic. Airport ground noise will be audible for locations close to the airport boundary and in areas beyond where background noise levels are low. The running of aircraft engines at high power levels for test and maintenance purposes currently gives rise to noticeable levels of ground noise around the vicinity of the airport and this activity has produced some complaints from local residents in the past. The use of APU's and aircraft taxiing also produce ground noise although at generally lower levels. The relative impact of these different sources of ground noise is controlled by their magnitude and duration.

3.2.1 Ground Noise from Aircraft Activities (excluding Ground Running)

The attended noise monitoring found that during periods when aircraft were not departing or arriving, a general level of noise was apparent at times coming from the airport as a result of various aircraft activities, such as taxiing, manoeuvring and running of auxiliary power units. These activities jointly give rise to general ground noise.

The magnitude of ground noise varies with the intermittent operation of the airport. The sporadic nature of aircraft departures and arrivals, and the varied taxi routes followed depending on runway usage and aircraft type (light aircraft accessing runways from the north and passenger aircraft from the south) means that any predictions would require a detailed knowledge of how and when aircraft operate at the airport. Observations on site found it generally difficult to separate from other non-aircraft related sources, such as generated by road traffic along the nearby A30. The exception is when aircraft taxi along the taxiways to reach the runway when this source then became dominant at the attended monitoring locations over road traffic noise.

The reliable prediction of ground noise from aircraft activities depends on a detailed knowledge of how aircraft operate at an airport over a typical day. Information required includes aircraft types and movements, taxi routes utilised during departures and arrivals from all runways, use of aprons and aircraft stands, how long aircraft operate auxiliary power units or ground power units prior to departure and after arrival, and how long aircraft hold on taxiways or runways prior to departure.

The plan below represents the output of a ground noise model prepared for Exeter Airport depicting ground noise in 2006 which, given the similarity in aircraft movements between now and then, indicates the current spread of ground noise around the airport.

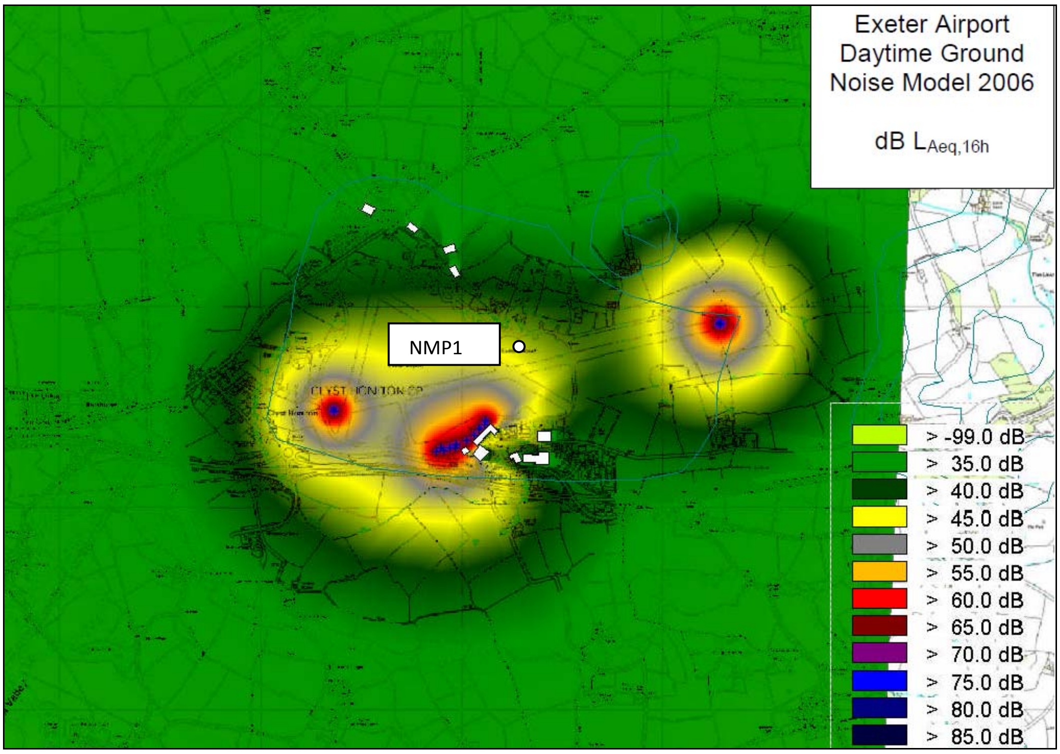

Figure 7 – Ground Noise at Exeter Airport - Daytime

It can be seen that at NMP1, the predicted level is around 45 dB $L_{Aeq,16h}$, similar to the average daily measured background noise level (see 2.2.4 above) at this position. This suggests ground noise from the airport, although observed to be variable and clearly noticeable at times on the southern boundary of the Cranbrook Expansion area, provides a relatively small contribution to the general noise received over the day in this area.

3.2.2 High Power Engine Ground Running

CadnaA noise modelling has been used as a means of predicting the spread of noise emissions from high power engine ground running around the airport, taking account of the local topography. The current engine run-up base location has been assumed as the point of activity with no allowance for any local shielding. The engine run-up location is indicated below.

Figure 8 – Engine run-up base and NMP1 position

Appendix 5 provides noise plots, in terms of maximum noise generated during high power ground running, for both the Dash 8-400 and also an Embraer 195 aircraft. Both aircraft types operate, or have operated at the airport, and are likely to continue to do so in the future.

During BAP's recent noise monitoring work, noise measurements of high powered engine ground running by a Dash 8-400 were observed and measured. The results obtained relate well to the noise predictions presented in Appendix 5, when allowing for the partial screening provided by the adjacent DME building to NMP1.

4.0 PLANNING POLICIES & GUIDELINES

The various policies and guidelines which have been considered in the development of noise criteria presented and used later in this report are summarised below. They include European and Central Government guidance on planning and noise, local government policies and plans, and individual guidance documents.

European Legislation

4.1.1 Operating Restrictions Directive 2002/30/EC (March 2002)

Reducing noise pollution from aircraft and improving the noise climate around airports are key objectives of the European Union air transport policy. The current Directive 2002/30/EC[2] of the European Parliament and Council of 26 March 2002 set out procedures and rules for the introduction of noise related operating restrictions to the busiest of the European airports. The purpose of this Directive is to prevent an overall increase in noise levels in areas around major airports. In the Directive, noise management is to be structured around a balanced approach, including solving noise problems on an 'airport-by-airport' basis and requiring the careful assessment of four key elements:

1. reduction of aeroplane noise at source;
2. land-use planning and management measures;
3. noise abatement operational procedures; and
4. local operating restrictions relating to noise problems.

In the UK, this Directive was implemented as the Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003.

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[2] Directive 2002/30/EC of the European Parliament and of the Council on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community Airports.

The European Commission are to repeal 2002/30/EC in June 2016 and introduce updated guidance to account for developments in the aviation world in the interim[3]. At present however, this Directive remains the basis of the legislation in the UK.

4.1.2 Environmental Noise Directive 2002/49/EC (June 2002)

The Environmental Noise Directive (END) concerning the assessment and management of environmental noise from transport, came into effect in June 2002[4]. Its aim was to define a common approach across the European Union with the intention of avoiding, preventing or reducing on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise. This involves:

- informing the public about environmental noise and its effects;
- preparation of strategic noise maps for large urban areas ('agglomerations'), major roads, major railways and major airports as defined in the END; and,
- preparation of action plans based on the results of the noise mapping exercise.

UK Legislation and Guidance

4.1.3 Environmental Noise Regulations (October 2006)

A transposition of EC/2002/49/EC was laid before Parliament in September 2006 as the Environmental Noise (England) Regulations 2006 (SI 2006/2238). These Regulations came into force on 1st October 2006.

A “major airport” (having more than 50,000 movements per annum) is required to produce noise maps on a rolling (5 year) basis. Exeter Airport has not been required to date to produce noise maps under this legislation as it does not have sufficient aircraft movements per annum or lie within a sufficiently dense populated area (agglomeration). The maps are used in “developing co-ordinated and cost-effective action plans to reduce noise” and are presented in terms of L_{den} and L_{night} indices. Regulations also require relevant airports to undertake an action planning process.

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[3] Regulation (EU) No. 598/2014 of the European Parliament and of the Council of 16 April 2014 on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Union airports within a Balanced Approach and repealing Directive 2002/30/EC

[4] Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise - Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment and management of environmental noise.

4.1.4 National Planning Policy Framework (NPPF) (March 2012)

The National Planning Policy Framework (NPPF) published 27th March 2012, sets out the UK Government's planning policies for England and how these are expected to be applied. It is designed to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth.

Government's current planning policy concerning noise is embodied in the National Planning Policy Framework (NPPF), and more specifically the Noise Policy Statement for England (NPSE). The aim of planning policies and decisions with respect to noise is addressed in paragraph 123 of the NPPF:

"avoid noise from giving rise to significant adverse impacts[5] *on health and quality of life as a result of new development;*

mitigate and reduce to a minimum other adverse impact on health and quality of life arising from noise from new development, including through the use of conditions;

recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established ; and

identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason."

The above policy refers to "significant adverse impacts" and "other adverse impacts" which are not defined numerically although reference is made to further research being underway in this regard in The Noise Policy Statement for England (NPSE). That research has not yet resulted in clarification on numerical levels.

4.1.5 Noise Policy Statement for England (March 2010)

The Noise Policy Statement for England (NPSE) provides the framework for noise management decisions to be made that ensure noise levels do not place an unacceptable burden on society.

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[5] See Explanatory Note to the Noise Policy Statement for England (Department for the Environment, Food and Rural Affairs).

The stated aims of the Noise Policy Statement for England are to:

- Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development;
- Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development; and
- Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

The NPSE introduces the concepts of NOEL (No Observed Effect Level), LOAEL (Lowest Observed Adverse Effect Level) and SOAEL (Significant Observed Adverse Effect Level). The definition of each is as follows:-

a) NOEL – No observed effect level. This is the level below which no effect can be detected.

b) LOAEL – Lowest observed adverse effect level. This is the level above which adverse effects on health and quality of life can be detected.

c) SOAEL – Significant observed adverse effect level. This is the level above which significant adverse effects on health and quality of life occur.

Further guidance on how planning authorities should take account of the acoustic environment and the mitigation strategies which should be applied in relation to the above terms is provided in the National Planning Practice Guidance which was published in March 2014[6].

The advice is that noise above the SOAEL should be avoided using appropriate mitigation while taking into account the guiding principles of sustainable development.

Where noise is between LOAEL and SOAEL, the advice is to take all reasonable steps to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development. Noise in this category is described as an observed adverse effect which is noticeable and intrusive.

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[6] National Planning Policy Guidance, Planning Practice Guidance, Noise, Department for Communities and Local Government, 6 March 2014

The NPSE states that it is not possible to give a single objective noise-based measure that defines a SOAEL that is applicable to all sources of noise for all situations. It acknowledges that the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It also acknowledges that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, it states that not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

The assessment in this report has sought to identify the LOAEL and SOAEL applicable to a given situation by setting out noise levels for different sources of noise which, if exceeded at a residential receptor, indicate a potential adverse and significant adverse effect. These noise levels are identified for a given noise source and for each type of receptor, whether outside a building or on an amenity area. These have been derived from a consideration of existing recognised guidelines and standards which have guided planning decisions on noise in recent years.

4.1.6 Planning Policy Guidance 24 (September 1994 - March 2012)

National planning policy guidance PPG24 "Planning and Noise" was withdrawn in March 2012. It dealt with new housing development in relation to existing noise generating development and also developments which generate noise. It is replaced by the National Planning Policy Framework of March 2012 (described above), which sets out the Government's planning policies for England. PPG24 is still currently referred to in UK local planning guidance around the UK. The criteria contained within PPG24 are also based around technical guidance which remains current today and, as a result, the technical guidance concerning the control of noise is still relevant to the assessment of noise impact.

The guidance given in PPG24 has historically been considered by Local Authorities in actions and decisions relating to planning applications for new dwellings near transportation sources such as airports, roads and railways. Table 3 below sets out noise levels corresponding to the noise exposure categories for air traffic and planning guidance associated with these noise levels. Appendix 1 contains a glossary of acoustic terms.

Daytime Aircraft Noise Level (dB $L_{Aeq,16h}$)	Night-time Aircraft Noise Level (dB $L_{Aeq,8h}$)	Guidance/Experience with regard to Aircraft Noise (Daytime)
< 57	< 48	Noise need not be considered as a determining factor in granting planning permission, although the noise level at the high end of the category should not be regarded as a desirable level. PPG24 Category A.
57 – 66	48 – 57	Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise. PPG24 Category B.
66 – 72	57 – 66	Planning permission for housing should not normally be granted. Where it is considered that planning permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise. PPG24 Category C.
> 72	> 66	Planning permission for housing should normally be refused. PPG24 Category D.

Table 3: PPG24 Guidance with regard to Aircraft Noise (Daytime)

In addition, PPG 24 states for air noise that:-

“60 Leq dB(A) should be regarded as a desirable upper limit for major new noise-sensitive development.”

In the UK, there is a growing consensus that the above limits are now out of date and that they should be tightened (made more stringent) in relation to applications for new dwellings.

4.1.7 UK Aviation Policy Framework (March 2013)

The Aviation Policy Framework (APF) was published in March 2013 by the Department for Transport (DfT). The APF defines the Government’s objectives and policies on the impacts of aviation in the UK.

On managing aviation's environmental impacts, and specifically noise, it states in paragraph 3.12 that the Government's overall objective on noise is to *"Limit and where possible reduce the number of people in the UK significantly affected by aircraft noise".*

It goes on in 3.13 to state that *"This is consistent with the Government's Noise Policy, as set out in the Noise Policy Statement for England (NPSE) which aims to avoid significant adverse impact on health and quality of life."*

Guidance is provided on the noise metric used to rate airborne noise in paragraph 3.13 where it states *"To provide historic continuity, the Government will continue to ensure that noise exposure maps are produced for the noise-designated airports on an annual basis providing results down to a level of 57 dB LAeq,16hour."*

The noise index is described in a footnote as *"the A-weighted average sound level over the 16 hour period of 07.00-23.00. This is based on an average summer day when producing noise contour maps at the designated airports."*

In paragraph 3.17 the interpretation of the contour is given as *"We will continue to treat the 57 dB LAeq,16hour contour as an average level of day time aircraft noise marking the approximate onset of significant community annoyance. However, this does not mean that all people within this contour will experience significant adverse effects from aircraft noise. Nor does it mean that no-one outside of this contour will consider themselves annoyed by aircraft noise."*

Under the heading "*Noise insulation and compensation"* the APF states that:

"The Government continues to expect airport operators to offer households exposed to levels of noise of 69 dB LAeq,16h or more, assistance with the cost of moving.

The Government also expects airport operators to offer acoustic insulation to noise sensitive buildings, such as schools and hospitals, exposed to levels of noise of 63 dB LAeq,16h or more. Where acoustic insulation cannot provide an appropriate or cost-effective solution, alternative mitigation measures should be offered."

With regard to airport development it continues:

"Where airport operators are considering developments which result in an increase in noise, they should review their compensation schemes to ensure that they offer appropriate compensation to those potentially affected. As a minimum, the Government would expect airport operators to offer financial assistance towards acoustic insulation to residential properties which experience an increase in noise of 3dB or more which leaves them exposed to levels of noise of 63 dB LAeq,16h or more."

Local Authority Guidance

4.1.8 New East Devon Local Plan

The developing Local policies are contained in the New East Devon Local Plan which was adopted on the 26th January 2016. . This includes a specific strategy, No.17, relating to development at or near Exeter International Airport which is repeated below.

Strategy 17 - Future Development at or near of Exeter International Airport:

The Local Plan recognises the importance of airport expansion and encourages supporting infrastructure to provide for its direct airport related growth.

It is recognised that many operational uses do not require planning permission and these developments, where compatible with safe and efficient airport operation and where they do not have adverse impacts on land within operational boundaries, will be supported. The Habitats Regulations require the Appropriate Assessment of any project where the likelihood of significant effects on European wildlife sites cannot be ruled out.

Developments that are near to or could be affected by noise from the airport will not be allowed unless evidence is provided that current or futures users or occupiers of new dwellings, schools, open spaces or other sensitive uses will not be significantly adversely affected, taking proposed mitigations into account, by airport related noise.

The Inspector's Report[7] on the New Local Plan reinforces the above, clarifying (in paragraph 64 of the report) that Exeter Airport is a major employer while making clear that new development that would compromise air safety or prejudice future expansion will not be permitted.

Other Publications and Guidance

4.1.9 World Health Organisation (WHO)

<u>Daytime Noise</u>

The WHO "Guidelines for community noise" provides a range of aspirational noise targets aimed at protecting the health and well being of the community. They therefore set out noise targets which represent goals for minimising the adverse effects of noise on health as opposed to setting absolute noise limits for planning purposes. For the control of noise in outdoor living areas, the relevant criteria relating to steady, continuous noise have been presented below in Table 4.

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[7] Report to East Devon District Council by Mr Anthony Thickett, The Planning Inspectorate, 15 January 2016.

Specific Environment	Critical Health Effects	Ambient Noise Level L_{Aeq} (dB)	Time Base (hours)
Outdoor living area	Serious annoyance, daytime evening	55	16
	Moderate annoyance, daytime evening	50	16

Table 4: WHO recommended Ambient Noise Levels for Outdoor Living Spaces

Although the attainment of these target values is not always achievable in practice, particularly where a dwelling is located close to a busy road, controlling the daytime noise level to 55 dB $L_{Aeq,16h}$ or below is commonly cited as a requirement in planning decisions and is therefore relevant when safeguarding land in respect of future noise from Exeter Airport.

Night-time Noise

Research studies in the field of the effects of aircraft noise at night are on-going and a working party for the World Health Organisation recently produced guidelines[8] reporting the latest findings concerning night noise from transportation sources and its effects on health and sleep. These guidelines acknowledge that the effect of noise on people at night depends not just on the magnitude of noise of a single event but also the number of events. It considers that in the long term, over a year, these effects can be described using the $L_{night,outside}$ index. This is essentially equivalent to the $L_{Aeq,8h}$ index commonly used in the UK, but instead of being based on aircraft activities during the average summer night, is based on the average annual night.

These guidelines were prepared by a working group set up to provide scientific advice to the Member States for the development of future legislation and policy action in the area of assessment and control of night noise exposure. The working group reviewed available scientific evidence on the health effects of night noise, and derived health-based guideline values. Although this provides guidance to the European Community in general and has no policy status, it provides a description of recent research into the health effects of noise and provides guidance on noise targets.

The following night noise guideline values are recommended by the working group for the protection of public health from night noise:

- Night noise guideline (NNG) $L_{night,outside}$ equal to 40 dB
- Interim target (IT) $L_{night,outside}$ equal to 55 dB

[8] WHO (2009), Night Noise Guidelines for Europe, World Health Organisation.

The NNG is a health based limit to aspire towards whereas the IT represents a feasibility based intermediate target. This is borne out to some extent by the recent Strategic Noise Mapping work undertaken across European Member States in compliance with the Environmental Noise Directive[9]. For night noise, Member States have been required to produce noise maps in terms of the $L_{night,outside}$ index no lower than 50 dB for strategic planning purposes.

The relationship between night noise exposure and health effects can be summarised as shown in Table 5.

$L_{night,outside}$ dB(1)	Relationship between night noise exposure and health effects
< 30	No effects on sleep are observed except for a slight increase in the frequency of body movements during sleep due to night noise
30 – 40	There is no sufficient evidence that the biological effects observed at the level below 40 dB $L_{night,outside}$ are harmful to health
40 – 55	Adverse health effects are observed at the level above 40 dB $L_{night,outside}$, such as self-reported sleep disturbance, environmental insomnia, and increased use of somnifacient drugs and sedatives
> 55	Cardiovascular effects become the major public health concern, which are likely to be less dependent on the nature of the noise

Note: (1) Equivalent to $L_{Aeq,8h}$

Table 5 – WHO guidance on the relationship between night noise exposure and health effects

4.1.10 Building Bulletin 93 (BB93) – Acoustic Design of Schools: Performance Standards

The latest version of BB93 was published in February 2015 which sets out minimum performance standards for the acoustics of school buildings, and describes means of demonstrating compliance with Building Regulations and provides guidance in support of the School Premises Regulations (2012) and the Independent School Standards (2013).

Compliance with Building Regulations relates to the design and contruction of new schools or schools brought about by a material change of use. Compliance with the School Premises Regulations and Independent School Standards relates to both existing, refurbished and new schools.

BB93 sets out performance standards for indoor ambient noise levels within different types of room in terms of the $L_{Aeq,30min}$ index as set out below. This differs from the $L_{Aeq,16h}$ unit commonly used for daytime noise planning.

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[9] Environmental Noise Directive 2002/49/EC

	Upper limit for indoor ambient noise level, $L_{Aeq,30min}$ (new school):
Classroom and general teaching area	35 dB
Teaching space (special communication needs)	30 dB

BB93 states that the above internal noise criteria can usually be achieved in a naturally ventilated school, provided the criteria are not exceeded by more than 16 dB for single sided ventilated spaces and 20 dB for cross ventilated or roof ventilated spaces. This suggests to achieve the internal ambient noise level inside a classroom using natural ventilation, external noise levels should not exceed 55 dB $L_{Aeq,30min}$. This is consistent with guidance in the previous 2003 version of BB93 which states:

"Noise levels in unoccupied playgrounds, playing fields and other outdoor areas should not exceed 55 dB LAeq,30min …"

4.1.11 HTM 08-01 (2013): Acoustics – Healthcare Facilities

Guidance on recommended internal noise levels for healthcare facilities is given in HTM 08-1 (2013)[10]. For hospital wards, the criteria for noise intrusion from external sources are as follows (to be met inside the space):

Daytime:	40 dB $L_{Aeq,1h}$
Night:	35 dB $L_{Aeq,1h}$
Night:	45 dB $L_{Amax,F}$

For operating theatres, a noise limit of 40 dB $L_{Aeq,1h}$ and an event limit of 50 dB $L_{Amax,F}$ is applicable.

The L_{Amax} limit is defined in HTM 08-01 as being applicable to events that occur several times during the night (for example passing trains) rather than sporadic events.

Specific guidance is given to the control of noise in external areas in hospitals:-

[10] Specialist Services, Health Technical Memorandum 08-01:Acoustics, Department of Health, 2013

The following provisions should apply, with the most stringent taking precedence:

- Noise levels at the site boundary should meet reasonable standards required by the local authority or other relevant body.
- Noise outside the buildings should be controlled to allow the internal noise criteria to be achieved (with windows or trickle vents open for ventilation if the space is naturally ventilated).
- Open external areas should be protected. Noise from services should not exceed the existing daytime background noise level or 50 dB L_{A90}, whichever is the higher. This limit should be achieved in any areas normally occupied by staff (except maintenance staff, notwithstanding the requirements of the Control of Noise at Work Regulations 2005) or the public (for example open courtyards and accessible landscaped areas). This means that noisy plantrooms should not face normally occupied external areas unless adequate acoustic control is provided.

Allowing for a sound reduction of 15 dB through a partly open window, an external noise limit of 55 dB $L_{Aeq,1h}$ would ensure recommended levels inside a ward are not exceeded during the daytime, and a limit of 50 dB $L_{Aeq,1h}$ would apply at night.

The guidance provides provision for relaxation of these criteria for emergency situations and sporadic events (such as helicopter flights) subject to agreement by the local authority or other relevant body.

4.1.12 BS 4142:2014

The general principle of the BS 4142:2014 assessment method is to use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

This standard describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

- Sound from industrial and manufacturing processes;
- Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and

- sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

The principle of the method is to determine the specific (industrial/commercial) noise level at the assessment location, as a discrete entity, free of other influences contributing to the ambient sound. The level is evaluated over a time period of one hour during the daytime and 15 minutes during the night-time.

To evaluate the specific sound level in an existing situation, it is usually necessary to also determine the residual sound, that is, the ambient sound remaining at the assessment location in the absence of the specific sound. The background sound is also evaluated from the residual sound. Finally, the rating level is determined from the specific sound accounting for any adjustments for the characteristic features of the sound.

An initial estimate of the impact of the specific sound is obtained by subtracting the background sound level from the rating level and considering the following:

a) Typically, the greater the difference, the greater the magnitude of the impact.

b) A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on context.

c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

4.1.13 BS 8233 (2014) Sound insulation and noise reduction in buildings – code of practice

The British Standard BS8233:2014 "*Sound insulation and noise reduction for buildings – Code of practice*" provides guidance on the control of external noise and is a revision of its 1987 (and later 1999) predecessor that informed PPG 24. The standard presents a number of design ranges for indoor noise levels in spaces when they are unoccupied. These are generally in keeping with guidance set by the World Health Organisation (1999) and also the 1999 version of BS 8233.

The criteria relevant to residential units on this site are presented in Table 6.

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,16\ hour}$	---
Dining	Dining room/area	40 dB $L_{Aeq,16\ hour}$	---
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16\ hour}$	30 dB $L_{Aeq,8\ hour}$

Table 6: BS 8233:2014 recommended indoor ambient noise levels in unoccupied spaces

Note 4: Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or L_{AFmax} , depending on the character and number of events per night. Sporadic noise events could require separate values.

The above suggests that any residential scheme design should ensure that for environmental noise, a limit is applied of 35 dB $L_{Aeq,16h}$ in living rooms and living/dining rooms during the day and design limits of 35 dB $L_{Aeq,\ 16h}$ and 30 dB $L_{Aeq,\ 8h}$ for bedrooms during daytime and at night, respectively. Assuming partly open windows, with a sound reduction of around 15 dB, an external noise limit of 50 dB $L_{Aeq,16h}$ would apply to avoid exceeding these daytime limits and 45 dB $L_{Aeq,8h}$ to avoid exceeding the night-time limit in bedrooms at anytime.

Taken over a year, the World Health Organisation utilise a sound reduction of 21 dB as an average measure to account for periods when people close or open their window over the year. On this basis, an external limit of 56 dB $L_{Aeq,16h}$ would apply to avoid exceeding the daytime limits, and 51 dB to avoid exceeding the night-time limit in bedrooms.

5.0 RECOMMENDED NOISE BANDS

Taking account of the Local, National and EU guidance for planning and aviation noise, guidance is given below on noise bands that can be adopted for the assessment of the planning suitability of a site by EDDC.

In summary, for noise sensitive developments, where the sound level on the proposed development site from the stated source is within:-

Noise Band A

- Noise shouldn't be a consideration for development suitability.

Noise Band B

- EDDC will need to consider the precise nature of the development in order to assess the extent to which the health and quality of life of the occupants/users could be adversely affected. EDDC may wish to ensure adequate noise mitigation is provided for in the design and planning as well as in the implementation of any developments.

Noise Band C

- EDDC may choose to oppose any noise sensitive developments given the extent of adverse impacts expected on the health and quality of life of the occupants/users but, if minded to permit the development, noise mitigation measures should be provided for in the design and demonstrated by post testing as having achieved their aim.

Noise Band D

- EDDC would normally oppose any development of a noise sensitive nature as external noise levels are above those recommended for desirable living conditions.

The L_{Aeq} unit has been retained for this purpose because the research underpinning community response has historically been based around this unit, rather than the relatively recently introduced European based indices of L_{den} and L_{night}. It may be appropriate in time however to switch across to a policy based around the L_{den} and L_{night} indices, once clear and recognised guidance is available on community response.

For night time noise, the L_{Aeq} unit is supplemented where necessary by the L_{Amax} unit to ensure peak noise levels are adequately controlled.

Criteria are considered by types of key noise sensitive development, including residential, schools and hospitals. Indicative guidance on other types of development is provided in Section 6 of this report. Indicative values of LOAEL and SOAEL are also provided below.

For noise from engine ground running, criteria are discussed separately in Section 5.4 below.

5.1 Residential Development

The situation with regard to residential development is summarised in Table 7 for the daytime period and Table 8 for the night-time period.

Noise Bands for Evaluation	**Air Noise dB $L_{Aeq,16h}$**	**Ground Noise dB $L_{Aeq,16h}$**	**Road Traffic Noise dB $L_{Aeq,16h}$**	**Industrial Noise (Rating Level)**
A – noise not a consideration	< 54	< 50	< 55	< background
LOAEL				
B – mitigation important[1]	54 - < 60	50 - < 55	55 - < 60	0 - 5 dB above background
C– opposition and mitigation	60 - < 63	55 - < 60	60 - < 63	6 - 9 dB above background
SOAEL				
D – opposition	63 and greater	60 and greater	63 and greater	≥ 10 dB above background

Note: [1] Mitigation required to ensure noise level on external amenity areas is no greater than 55 dB $L_{Aeq,16h}$.

Table 7: RESIDENTIAL - Recommended Noise Bands – Daytime

The local authority is likely to take account of various factors in determining a planning application for residential development on noise grounds, such as its size, location and whether it is a new development site or an application for an infill development. A slight relaxation in the above criteria might apply, for example, for infill developments where existing housing already exists.

Noise Bands for Evaluation	Air Noise dB $L_{Aeq,8h}$ (dB L_{Amax})	Ground Noise dB $L_{Aeq,8h}$	Road Traffic Noise dB $L_{Aeq,8h}$	Industrial Noise (Rating Level)
A – noise not a consideration	< 40 (< 60) [(1)]	N/A	<40	< background
LOAEL				
B – mitigation important	40 - < 50 (60 – 70) [(1)]	N/A	40 - < 50	0 -5 dB above background
C – opposition and mitigation	50 - < 55 (70 - 80) [(1)]	N/A	50 - < 55	6 - 9 dB above background
SOAEL				
D – opposition	55 and greater (>80) [(1)]	55 and greater	55 and greater	≥ 10 dB above background

Note: [(1)] Actual limit may vary according to how often noise events occur during the night.

Table 8: RESIDENTIAL - Recommended Noise Bands – Night-time

5.2 Schools

The situation with regard to school development is summarised in Table 9 for the daytime period.

Noise Bands for Evaluation	Environmental Noise dB $L_{Aeq,30min}$
A – noise not a consideration	< 50
LOAEL	
B – mitigation important	50 - 55
C– opposition and mitigation	> 55 - < 63
SOAEL	
D – opposition	63 and greater

Table 9: SCHOOLS - Recommended Noise Bands – Daytime

5.3 Healthcare Facilities

The situation with regard to healthcare facility development is summarised in Table 10 for the daytime period and Table 11 for the night-time period.

Noise Bands for Evaluation	Environmental Noise[(1)] dB $L_{Aeq,1hmin}$
A – noise not a consideration	< 50
LOAEL	
B – mitigation important	50 - 55
C– opposition and mitigation	>55 - <63
SOAEL	
D – opposition	63 and greater

Note: (1) A maximum noise level of 70 dB L_{AFmax} is applicable to protect operating theatres.

Table 10: HEALTHCARE FACILITIES - Recommended Noise Bands – Daytime

Noise Bands for Evaluation	Environmental Noise dB $L_{Aeq,1h}$ (dB L_{Amax})
A – noise not a consideration	< 40 (< 60)
LOAEL	
B – mitigation important[(1)]	40 - < 50 (60 – 70)
C – opposition and mitigation	50 - < 55 (70 - 80)
SOAEL	
D – opposition	55 and greater (>80)

Table 11: HEALTHCARE FACILITIES - Recommended Noise Bands – Night-time

5.4 Sites exposed to Ground Running Noise

As noted in section 3.2 ground noise is commonly referred to as noise produced by aircraft activities and use of ancillary equipment on the ground, that is, by sources other than by aircraft in flight, taking off or landing. Sources of ground noise include the testing of aircraft engines, commonly known as ground running or sometimes “engine testing”. For noise from engine high power ground running, there is no recognised method of assessing its acceptability at a proposed site. Consideration should be given to its magnitude, duration and frequency of operation.

At Exeter Airport, although the magnitudes of noise produced during high power ground running are high, their frequency appears from airport records to be around one run every three days. This can be expected to increase in the future, possibly by a factor of three in light of the expected future growth of the airport from 13,000 aircraft movements per annum currently (2014) to 38,000 by 2030.

The duration of individual ground runs is variable and will depend on factors such as the reason for the ground run, for example the testing of an engine after maintenance, and the aircraft type concerned. Runs may also include periods at high power interspersed with longer periods at lower power settings leading to an overall duration of an hour or more. This can make high power ground running a very distinctive sound with the potential to cause significant disturbance to the locality.

General ground noise from aircraft operations is often assessed over the 16 hour day, and one method of assessment would be to include ground running as a source of ground noise, spreading the noise energy over a suitable time frame, say 30 minutes (for schools) or one hour (for hospitals and residential accommodation). This method has been adopted in Section 2.2.3 above in presenting average ground running noise levels measured at NMP1 during recent noise survey work. Given its specific characteristics however, it can also be likened to an industrial source and, as a worst case, could be assessed on this basis using BS 4142. In broad terms, this would compare the noise produced during ground running, in terms of L_{Aeq}, with the prevailing background noise, making any adjustment for character, such as tonality, impulsivity and/or intermittency of the noise. This type of assessment, although conservative, is a means of ensuring that the amenity of any residents is adequately protected from the use of the airport’s engine test facility. Noise from the facility could be reduced by the introduction of a three sided noise pen although the detail of this would need evaluating given that the noise reduction achieved will depend on the orientation of the pen and aircraft when undergoing engine testing.

The background noise level in the vicinity of the Cranbrook site will vary from day to day but is likely to be typically around 45 dB L_{A90} during the day. This would suggest, ignoring any character corrections, that a short term noise level of 50 dB $L_{Aeq,1h}$ would be permissible on land for noise sensitive development based on a typical day-time engine ground run. This limit could apply both currently and in the future. For hospitals, this limit could also apply although additional account would need to be given to any peak noise levels and their effects on operating theatres.

For schools, given noise limits also relate to a 30 minute period, any individual ground run should not normally exceed 55 dB $L_{Aeq,30min}$. Compliance with the 50 dB $L_{Aeq,1h}$ requirement would ensure this standard is met.

6.0 NOISE BAND REFERENCE TABLES

Response categories for the appraisal of proposed developments with regard to the noise implications for a given environmental noise source where one dominates the acoustic environment at the site, or a combination of noise sources where no one source dominates, have been determined based on the planning policies and guidelines detailed in section 4.0.

6.1 Daytime

The response categories for daytime noise by development type are given in Table 12.

Type of Development	Environmental Noise, dB $L_{Aeq,T}$						
	≤50	53	55	58	60	63	65
Residential[(1)] – new	A	A	B	B	C	D	D
Residential[(1)] – infill	A	A	B	B	B	C	D
Hotels	A	A	A	A	A	B	B
Educational[(1)] / Community	A	B	B	C	C	D	D
Medical[(1)]	A	B	B	C	C	D	D
Offices	A	A	A	A	B	B	B
Commercial / Retail	A	A	A	A	A	A	A
Entertainment	A	A	A	A	A	B	B
Industrial	A	A	A	A	A	A	A
Sport/Recreational/Amenity	A	A	B	C	C	C	D

Note: [(1)] Ground running noise > 50 dB $L_{Aeq,1h}$ equates to Noise Band C

Table 12 – Recommended Response Categories – Daytime

A) Green — Noise shouldn't be a consideration for development suitability.

B) Yellow — Ensure adequate noise mitigation is provided for in the design and planning as well as in the implementation of any developments

C) Orange — normally oppose but, if minded to permit the development, noise mitigation measures should be provided for in the design and demonstrated by post testing as having achieved their aim.

D) Red — normally oppose any development of a noise sensitive nature.

6.2 Night-time

The response categories for night-time noise by development type are given in Table 13.

Type of development	Noise Bands, dB $L_{Aeq,8h}$ (dB L_{Amax})			
	<40 (<60)	40 - < 50 (60 - 70)	50- < 55 (70 – 80)	> 55 (>80)
Residential – new	A	B	C	D
Residential – infill	A	B	C	D
Hotels	A	A	B	B
Educational / Community	A	B	C	D
Medical	A	B	C	D
Offices	A	A	B	B
Commercial / Retail	A	A	A	A
Entertainment	A	A	A	B
Industrial	A	A	A	A

Table 13 - Recommended Noise Bands – Night-time

A) Green — Noise shouldn't be a consideration for development suitability.

B) Yellow — Ensure adequate noise mitigation is provided for in the design and planning as well as in the implementation of any developments

C) Orange — normally oppose but, if minded to permit the development, noise mitigation measures should be provided for in the design and demonstrated by post testing as having achieved their aim.

D) Red — normally oppose any development of a noise sensitive nature.

6.3 Discussion of development types

This section is intended to be used in conjunction with the tables in Section 6.1 and 6.2, and provide further elaboration on the suggested response to development applications.

6.3.1 Residential – new

In order to avoid the adverse effect of environmental noise on new significantly sized residential developments, it is recommended that any new large residential developments within the 60 dB $L_{Aeq,16h}$ day-time or 50 dB $L_{Aeq,8h}$ night-time noise contour band be opposed, unless mitigation measures offer adequate protection. It is feasible to provide adequate sound insulation for properties within these noise contours, however external noise levels in gardens would be higher than desirable, and acceptable internal noise conditions would not be achieved with windows open.

6.3.2 Residential – new, infill

While small, infill residential developments will face the same obstacles as large, consideration should be given to the nature of the surrounding development, and the prevailing noise environment. Likely future noise conditions should also be taken into account. Developments of this nature may therefore be considered on a case by case basis and it may be appropriate to relax slightly the criterion for opposition to a threshold of 63 dB $L_{Aeq,16h}$ day-time while maintaining a night-time threshold of 50 dB $L_{Aeq,8h.}$ Also, if surrounded by existing dwellings that have been exposed to ground running without complaint, the infill development may be acceptable even if not compliant with the noise band limits above.

6.3.3 Hotels

In regard to external noise levels, hotels have significant advantages over dwellings with respect to external noise: a) there is no real operational requirement for gardens or amenity spaces, and b) most new-build hotels have air conditioning, which removes the need to open windows for rapid ventilation, thereby not compromising façade sound insulation performance. Therefore, although hotels are ‘noise sensitive’, they can be easily designed to provide good internal conditions in noisy areas successfully. The local authority may therefore seek to ensure that noise mitigation will be adequate, especially where desirable night-time noise levels are exceeded, and implemented correctly. Developments such as guest houses or bed and breakfasts, where the construction will be similar to traditional dwellings and ventilation is likely to be by natural means, should be treated as residential for noise assessment purposes.

6.3.4 Educational / Community

This category includes any facility used for educational or childcare purposes, such as schools, training centres, nurseries, as well as places of worship etc. In the majority of cases (excepting boarding schools etc), night time noise will not normally be relevant as most educational facilities are day-time operation only. Confirmation should be sought that adequate noise mitigation measures are incorporated and that they are correctly implemented, to ensure compliance with recommended guidance (BB93) and it should be demonstrated that consideration has been given to noise impact on outdoor play areas where applicable.

6.3.5 Medical

This category includes medical centres such as hospitals and care homes. These should be considered noise sensitive, and are also usually subject to night noise evaluation. While the noise impact considerations will be similar to residential developments, medical use buildings can sometimes be considered more sensitive than residential developments, and construction methods may be markedly different. Confirmation should be sought that adequate noise mitigation measures are incorporated and that they are correctly implemented.

6.3.6 Offices

Offices is a broad category, encompassing business premises, some health practitioners (such as doctors or dentist surgeries), veterinary clinics and so on. With correct design, offices can be designed to provide an adequate level of protection against external noise, even in a very high noise environment. The need for amenity spaces is usually of relatively low importance compared with residential developments, and in most cases, only day-time noise is relevant. They are, however, still noise sensitive spaces and consideration needs to be given to noise mitigation. The local Planning Authority may still want to consider opposition of any proposed developments within the highest noise evaluation band on a case by case basis. A minimum response would be to seek confirmation that noise mitigation will be adequate for appropriate working conditions and implemented correctly.

6.3.7 Commercial / Retail

Commercial and retail developments, such as shops, garages etc are not normally considered noise sensitive although their design should take account of the local noise environment to ensure acceptable acoustic conditions are provided for the occupants. The location of such buildings can sometimes bring a noise benefit to a development site, separating and protecting noise sensitive receptors from major noise sources, such as a main road or engine ground running facility.

6.3.8 Entertainment

As with office developments, development of land into entertainment use, such as restaurants, cafes, cinemas etc, could be deemed noise sensitive. Provided however that buildings are constructed to provide sufficient protection against external noise, and consideration is given to external areas and their protection where appropriate, opposition on noise grounds is not normally necessary.

6.3.9 Industrial

This category includes developments such as agricultural buildings, factories, recycling centres, warehouses, depot, parking, telecoms / utility installations etc. These are not normally considered noise sensitive. As is the case for Commercial/Retail buildings, the location of such buildings can sometimes bring a noise benefit to a development site, separating and protecting noise sensitive receptors from major noise sources, such as a main road or engine ground running facility.

6.3.10 Sport / Recreational / Amenity

The sensitivity of these areas to noise will vary to some extent depending on their purpose. For sporting and recreational use, the prevailing noise environment should be sufficiently controlled to ensure that verbal communication is not impaired for the given use. The requirements for amenity areas may be more stringent as they are used for relaxation so consideration should be given to each site on a case by case basis. The options for controlling the noise affecting these sites are limited by the nature of the noise source. For aircraft in the air, little options exist but for road traffic and aircraft ground noise, some form of barrier might be deployed, using other buildings or landscaping to form bunds/fences.

7.0 NOISE MAPS

7.1 Air Noise

Appendix 4 provides an estimate of current daytime air noise levels around Exeter Airport (based on contours for 2006) as well as predicted future air noise levels for 2030, based on the airport's 2008 Masterplan. No night-time noise contours are available currently nor any contours depicting maximum noise levels (L_{Amax} or SEL) at night.

7.2 Ground Running Noise

Appendix 5 contains plans showing predictions of ground running noise for a Dash 8-400 and an Embraer 195 aircraft when operating at the Exeter Airport ground run-up base.

Contours are shown in two forms. Firstly, contour plans show what maximum noise levels are expected during high power ground running with a single engine operating at (or near) full power. Secondly, contour plans showing the average noise level predicted to result over one hour during which ground running occurs. During this one hour period, it is assumed that the aircraft is undertaking a typical ground run comprising periods of inactivity and also low and high power ground running. This average level of activity has been determined from a detailed assessment of the ground running that took place over a 3 month period at the airport over the summer.

7.3 Other Environmental Noise

It is not possible to model to a reasonable level of accuracy the general ground noise emanating from the airport or the road traffic noise around the airport without knowledge of the general activities that take place over the period of interest.

In the case of ground noise, this could be determined through consultation with the airport and understanding the nature of all different aircraft activities at the airport, the routes utilised for taxiing, as well as the apron and aircraft stands in use.

For road traffic noise, knowledge of the flow rates, traffic speeds, percentage of heavy goods vehicles and various other factors concerning the nature of the roads would be required.

In practice, the contribution of these noise sources to the noise environment has been determined at the long term noise monitor at NMP1 by measurement and review of measured noise data. For the Cranbrook Estate, whilst at times clearly noticeable, general ground noise forms a small element of the noise environment. Road traffic noise also forms a relatively small element but, along with ground noise, does form the general background noise level that will affect amenity areas and similar noise sensitive outdoor areas. In broad terms, at NMP1, the noise from the distant A30 to the south of the airport is estimated to produce around 50 dB $L_{Aeq,16h}$. A similar noise level from this source is expected for the Cranbrook site although it will vary across the site given size of the area and the local topography.

7.4 Development Appraisal Map

7.4.1 All Noise Sources – including Ground Running

Taking account of the noise contour maps shown in Appendix 4 and 5, and the criteria discussed in Section 5, the following noise safeguarding map, shown in Figure 10, is suggested which set out the boundaries of the noise bands described in Section 6 above for new residential, educational and medical development sites.

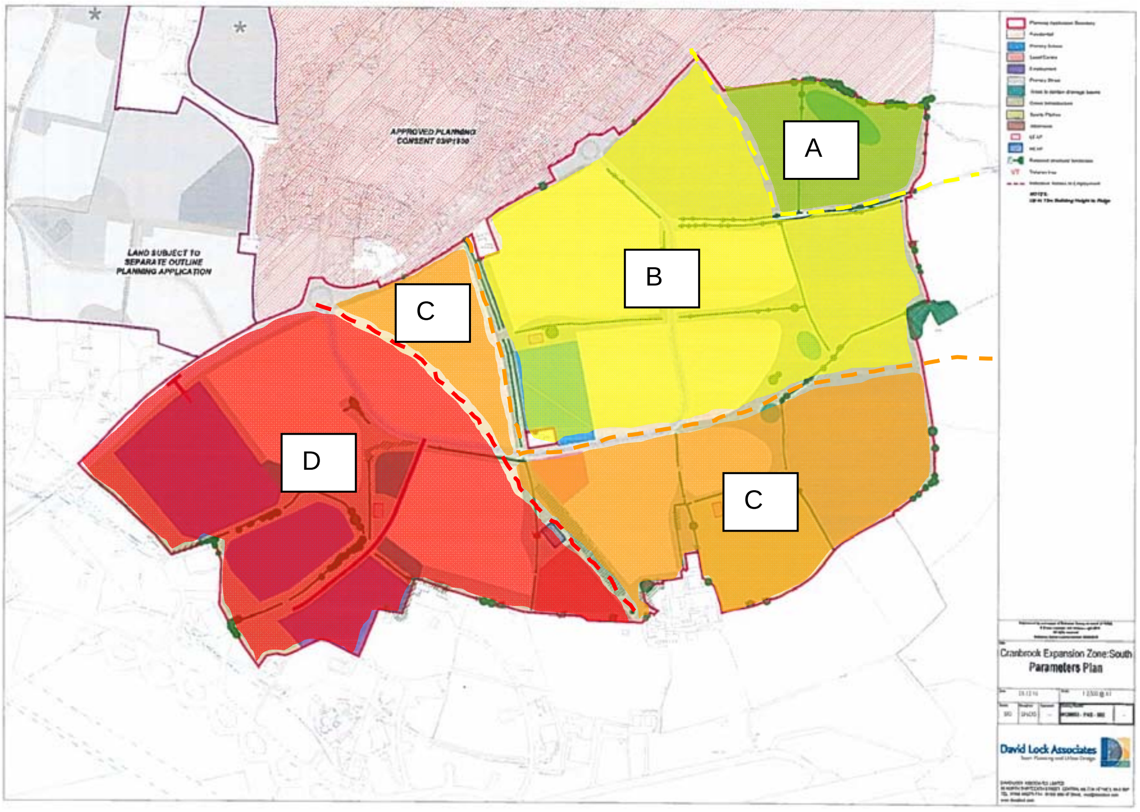


Figure 10 - Noise Band Map for Residential, Educational and Medical Development Sites at Cranbrook Expansion Zone: South - Daytime

No change to the above map is likely to arise based on a consideration of night-time noise in view of the limited aircraft operations that occur at night at Exeter Airport currently. A regular review of this situation is recommended as the airport develops and adjustments made as necessary to the above noise band map.

The safeguarding map takes account to some degree of the future noise expected to arise from activities at Exeter International Airport. For air noise, the 2030 contours have been used. For ground running, the safeguarding map is conservatively based on the maximum noise produced during high power ground running (using BS 4142), as opposed to how often this occurs, although this is assessed in average noise terms. If instead an average noise dose/ noise exposure assessment were to be undertaken over a one hour period, the red Zone D may reduce in size, replaced instead by an orange Zone C. The future impacts of high power ground running will therefore be affected both by the types of aircraft involved and the extent to which ground running takes place. A regular review of this is recommended as the airport develops.

Some flexibility around the map could be appropriate where it can be demonstrated that the specified noise limits will be maintained on outdoor amenity areas and other sensitive areas as a result of the careful phasing and planned layout of non-noise sensitive buildings between a noise source and noise sensitive area.

7.4.2 All Sources – Excluding Ground Running

The safeguarding map shown in Figure 10 includes the effect of high power engine ground run-up noise produced during aircraft engine testing and maintenance. If this source of noise were omitted, to reflect what might occur if a dedicated engine test pen were introduced for example, the safeguarding map shown in Figure 11 below would result.

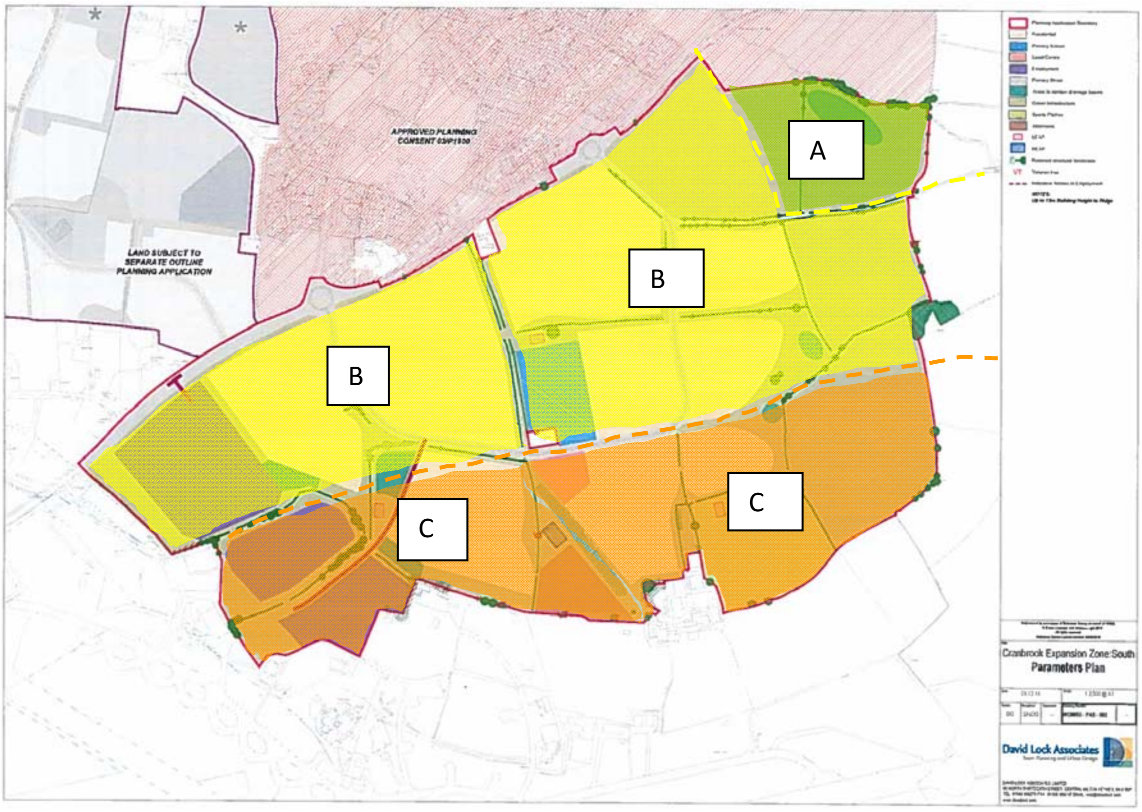


Figure 11 - Noise Band Map (excluding Ground Running Noise) for Residential, Educational and Medical Development Sites at Cranbrook Expansion Zone: South – Daytime

Note: Assumes road traffic noise from London Road puts adjacent land into Band B.

Peter Henson
Partner

APPENDIX 1

Glossary of Acoustic Terminology

The Decibel, dB

The unit used to describe the magnitude of sound is the decibel (dB) and the quantity measured is the sound pressure level. The decibel scale is logarithmic and it ascribes equal values to proportional changes in sound pressure, which is a characteristic of the ear. Use of a logarithmic scale has the added advantage that it compresses the very wide range of sound pressures to which the ear may typically be exposed to a more manageable range of numbers. The threshold of hearing occurs at approximately 0 dB (which corresponds to a reference sound pressure of 2 x 10^{-5} Pascals) and the threshold of pain is around 120 dB.

The sound energy radiated by a source can also be expressed in decibels. The sound power is a measure of the total sound energy radiated by a source per second, in watts. The sound power level, L_w is expressed in decibels, referenced to 10^{-12} watts.

Frequency, Hz

Frequency is analogous to musical pitch. It depends upon the rate of vibration of the air molecules that transmit the sound and is measure as the number of cycles per second or Hertz (Hz). The human ear is sensitive to sound in the range 20 Hz to 20,000 Hz (20 kHz). For acoustic engineering purposes, the frequency range is normally divided up into discrete bands. The most commonly used bands are octave bands, in which the upper limiting frequency for any band is twice the lower limiting frequency, and one-third octave bands, in which each octave band is divided into three. The bands are described by their centre frequency value and the ranges which are typically used for building acoustics purposes are 63 Hz to 4 kHz (octave bands) and 100 Hz to 3150 Hz (one-third octave bands).

A-weighting

The sensitivity of the ear is frequency dependent. Sound level meters are fitted with a weighting network which approximates to this response and allows sound levels to be expressed as an overall single figure value, in dB(A).

Environmental Noise Descriptors

Where noise levels vary with time, it is necessary to express the results of a measurement over a period of time in statistical terms. Some commonly used descriptors follow.

Statistical Term	Description
$L_{Aeq, T}$	The most widely applicable unit is the equivalent continuous A-weighted sound pressure level (LAeq, T). It is an energy average and is defined as the level of a notional sound which (over a defined period of time, T) would deliver the same A-weighted sound energy as the actual fluctuating sound.
L_{A90}	The level exceeded for 90% of the time is normally used to describe background noise.
$L_{Amax,T}$	The maximum A-weighted sound pressure level, normally associated with a time weighting, F (fast), or S (slow)

APPENDIX 2

Long Term Monitoring Results

(see separate document)

APPENDIX 3

Exeter Airport Ground Running Logs

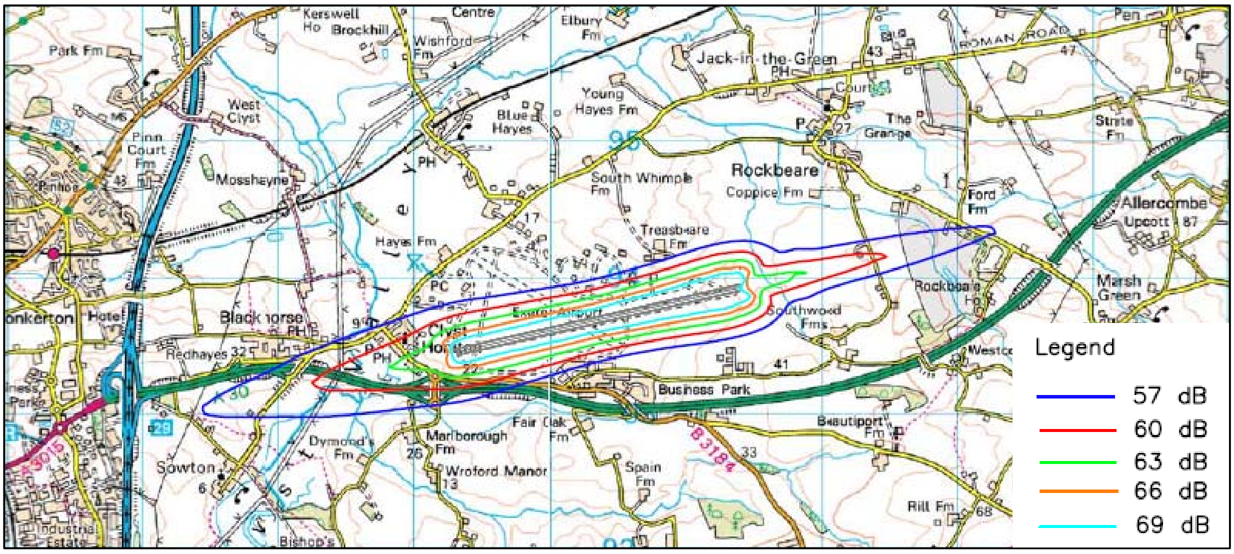
Counter	Actual Date	Actual Time	Aircraft Type	Aircraft Description	All Up Weight	Engine Type	Movement Type	Operator Name	Registration
1	20150614	13:00	RJ85	REGIONAL JET 85	42184		ET	Flybe Ltd - Aviation Services	A9CBDF
1	20150614	16:45	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe Ltd - Aviation Services	GPRPA
1	20150614	20:25	E170	EMBRAER 170	34999	1	ET	Flybe (Airways) Limited	GFBJE
1	20150615	12:02	RJ85	REGIONAL JET 85	42184		ET	Flybe Ltd - Aviation Services	A9CBDF
1	20150615	15:00	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEM
1	20150618	08:45	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEI
1	20150619	07:50	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEM
1	20150619	10:15	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe Ltd - Aviation Services	YLBBW
1	20150627	17:08	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEM
1	20150628	17:00	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEM
1	20150706	15:01	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GECOP
1	20150707	13:20	RJ1H	BAE 146-200/QT	42184	1	ET	Flybe Ltd - Aviation Services	OODWB
1	20150708	18:53	DH8D	BOMBARDIER DASH 8 Q400	28998	1	ET	Flybe (Airways) Limited	GJEDT
1	20150708	21:00	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GJECZ
1	20150709	07:00	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GJECZ
1	20150713	17:30	B733	BOEING 737 300	60999	1	ET	Atlantic Airlines Ltd	GJMCT
1	20150716	19:11	E170	EMBRAER 170	37500	1	ET	Flybe (Airways) Limited	GFBJI
1	20150719	19:14	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GECOI
1	20150721	13:10	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEH
1	20150722	11:23	E170	EMBRAER 170	34999	1	ET	Flybe (Airways) Limited	GFBJF
1	20150722	14:40	E170	EMBRAER 170	34999	1	ET	Flybe (Airways) Limited	GFBJF
1	20150723	12:04	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEH
1	20150723	15:20	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEH
1	20150723	16:50	E170	EMBRAER 170	34999	1	ET	Flybe (Airways) Limited	GFBJF
1	20150724	13:29	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEH
1	20150724	20:29	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GPRPB
1	20150727	09:20	DH8D	BOMBARDIER DASH 8 Q400	28998	1	ET	Flybe (Airways) Limited	GJEDW
1	20150728	12:15	E170	EMBRAER 170	34999	1	ET	Flybe (Airways) Limited	GFBJF
1	20150803	08:24	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GECOP
1	20150807	13:30	B462	BAC 146-200	42184	1	ET	Flybe Ltd - Aviation Services	GTYPH
1	20150814	20:00	DH8D	BOMBARDIER DASH 8 Q400	28998	1	ET	Flybe (Airways) Limited	GJEDM
1	20150819	13:55	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GECOK
1	20150821	20:30	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GFLBE
1	20150826	18:00	B462	BAC 146-200	42184	1	ET	Flybe Ltd - Aviation Services	GTYPH
1	20150826	19:58	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GECOD
1	20150829	14:00	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEM
1	20150830	08:45	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEM
1	20150830	14:42	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GECOF
1	20150831	10:45	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe Ltd - Aviation Services	OYGRK
1	20150903	12:46	E195	Embraer 195	48790	1	ET	Flybe (Airways) Limited	GFBEH
1	20150904	07:30	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GECOE
1	20150909	16:00	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GECOH
1	20150912	16:00	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GJECY
1	20150913	11:00	DH8D	BOMBARDIER DASH 8 Q400	28999	1	ET	Flybe (Airways) Limited	GJECY
1	20150914	11:34	E145	EMBRAER RJ145	21000	1	ET	Flybe Ltd - Aviation Services	GCGUS

Exeter Airport Ground Running Logs – 14th Jun to 14 Sep 2015

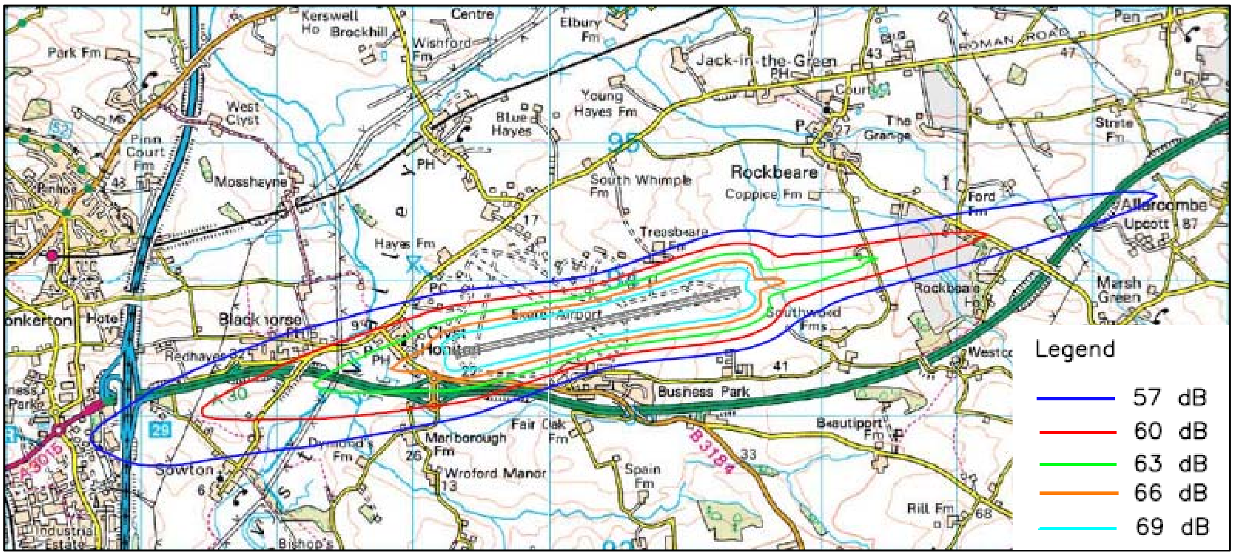
(Times are Greenwich Mean Time)

APPENDIX 4

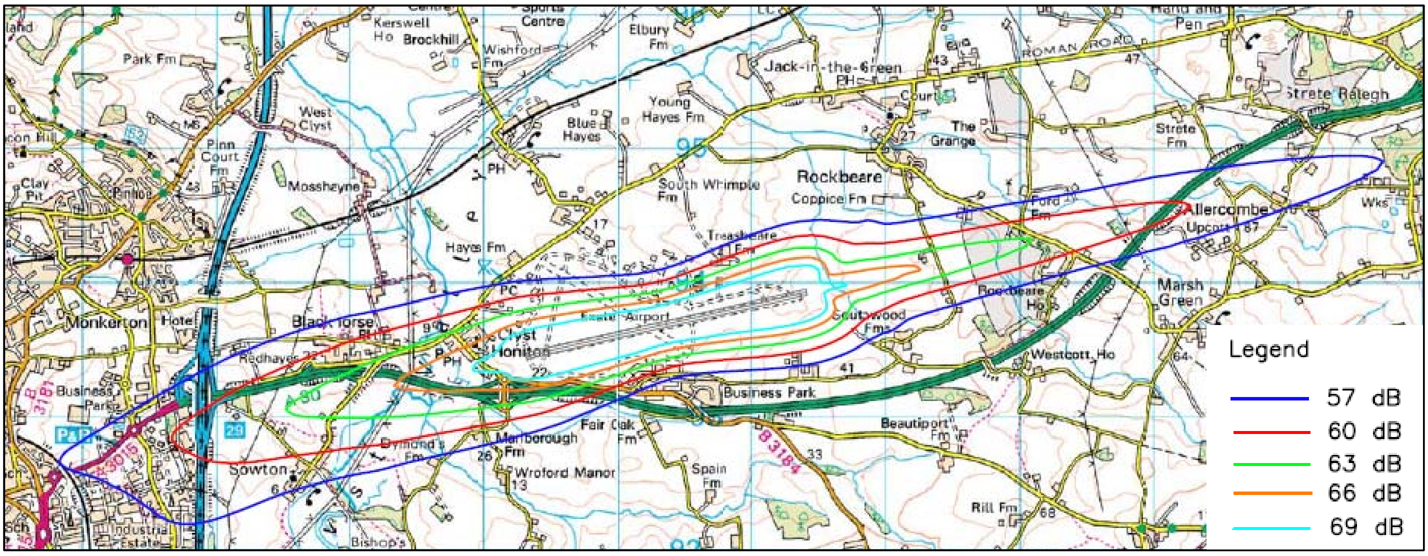
Exeter Airport – 2006, 2015 and 2030 Air Noise Contours



Exeter Airport - Daytime Air Noise Contours, $L_{Aeq,16h}$, Summer 2006



Exeter Airport - Daytime Air Noise Contours, $L_{Aeq,16h}$, Summer 2015

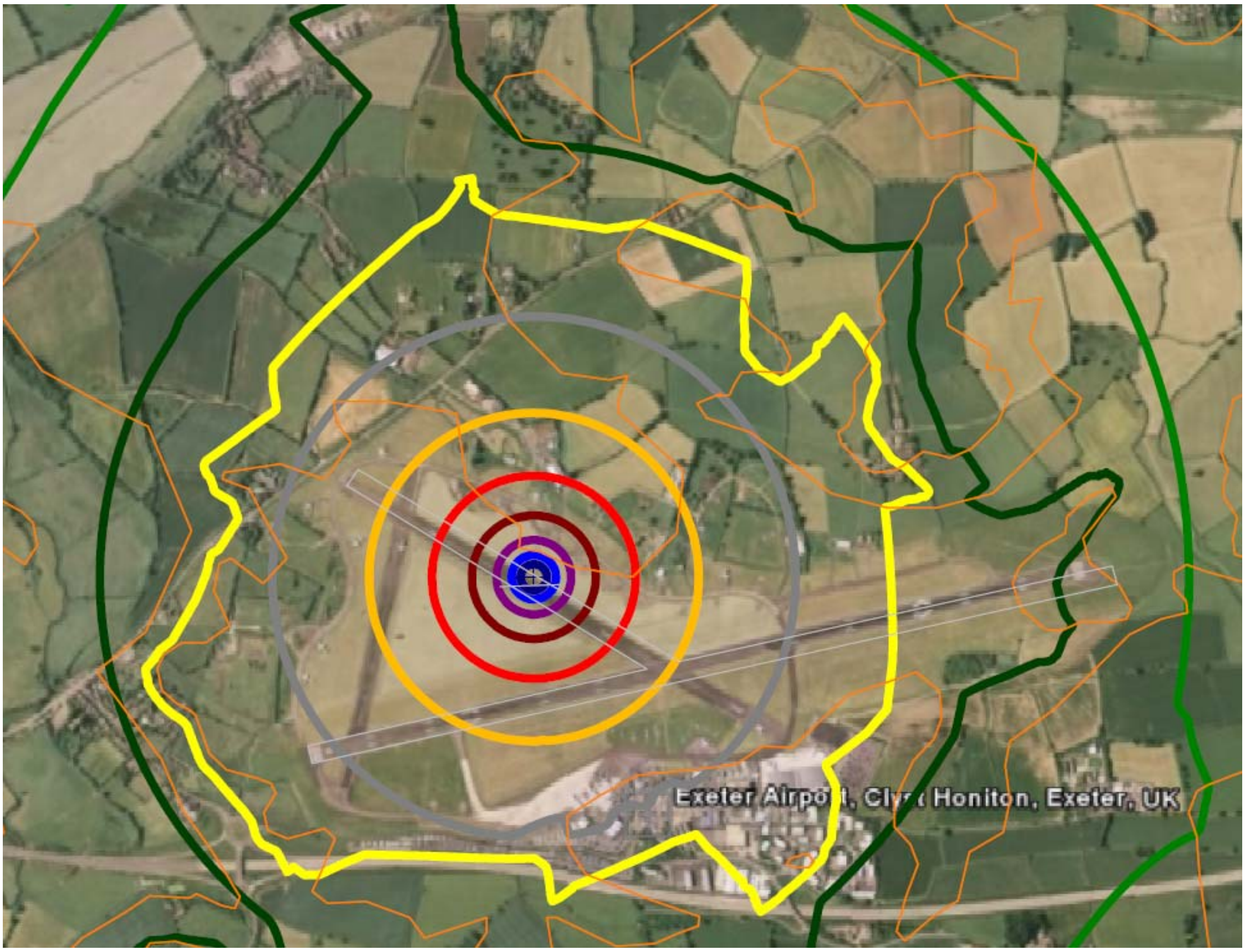


Exeter Airport - Daytime Air Noise Contours, $L_{Aeq,16h}$, Summer 2030

APPENDIX 5

Exeter Airport – Ground Running Noise Contours

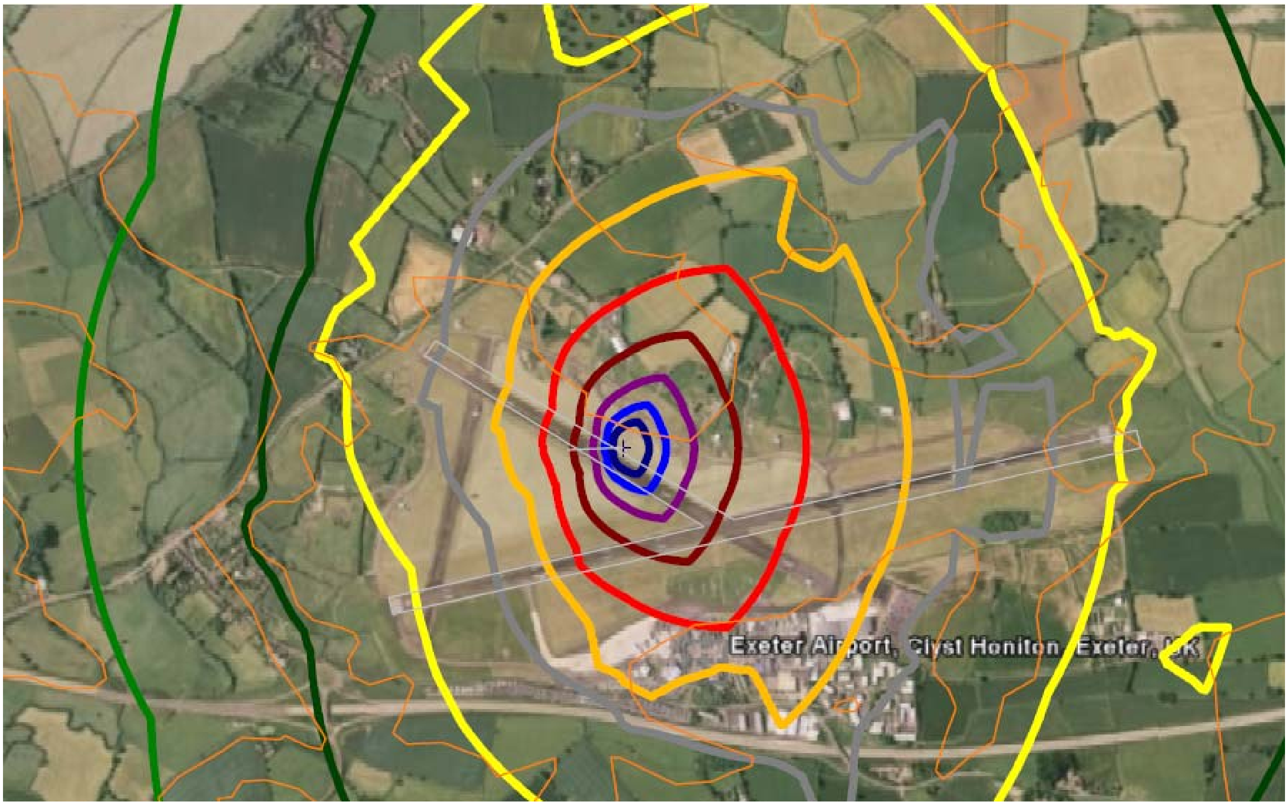
Average Noise Levels



(green)	35 dB(A)	(dark green)	40 dB(A)
(yellow)	45 dB(A)	(grey)	50 dB(A)
(orange)	55 dB(A)	(red)	60 dB(A)
(dark red)	65 dB(A)	(purple)	70 dB(A)
(blue)	75 dB(A)	(navy)	80 dB(A)

Exeter Airport – Dash 8-400 Ground Running Noise Contours, dB $L_{Aeq,1h}$

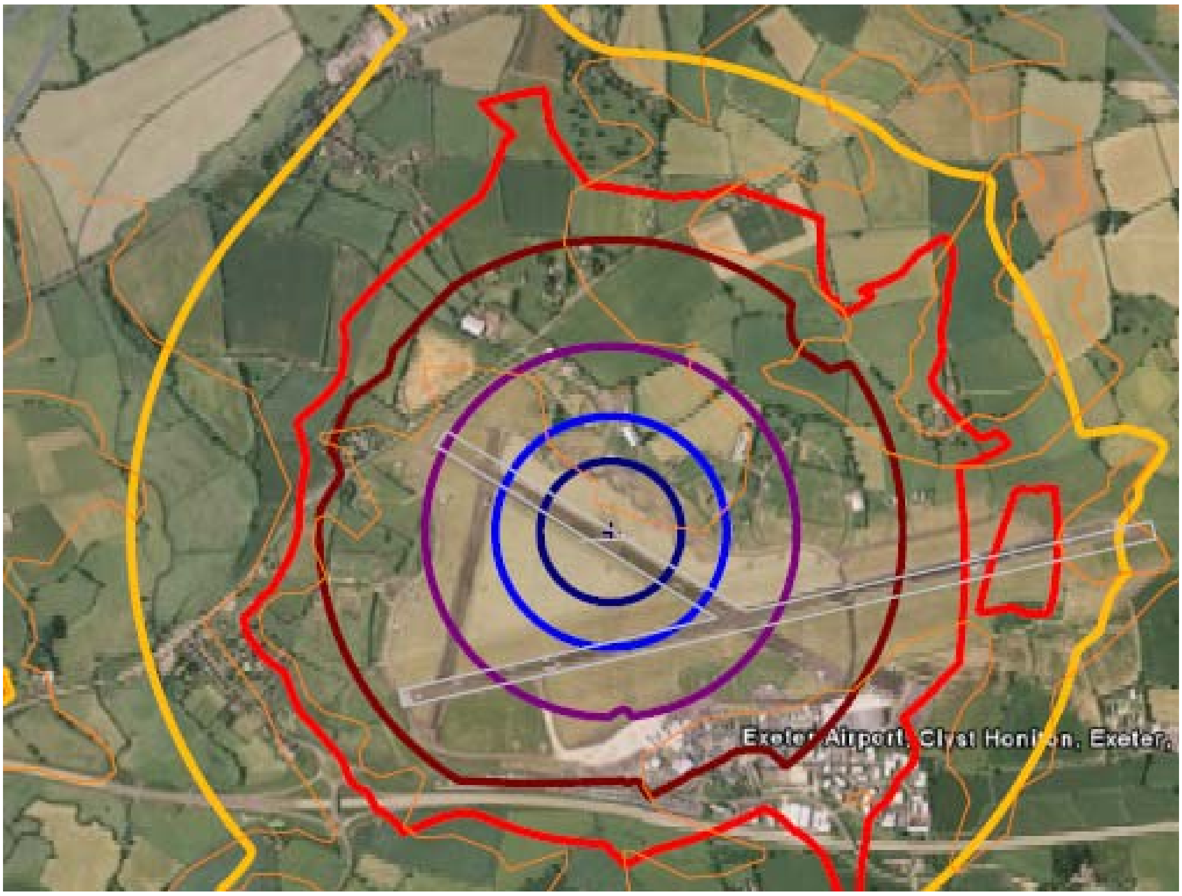
Average Noise Levels



(green line)	35 dB(A)	(dark green line)	40 dB(A)
(yellow line)	45 dB(A)	(grey line)	50 dB(A)
(orange line)	55 dB(A)	(red line)	60 dB(A)
(dark red line)	65 dB(A)	(purple line)	70 dB(A)
(blue line)	75 dB(A)	(dark blue line)	80 dB(A)

Exeter Airport – E195 Ground Running Noise Contours, dB $L_{Aeq,1h}$

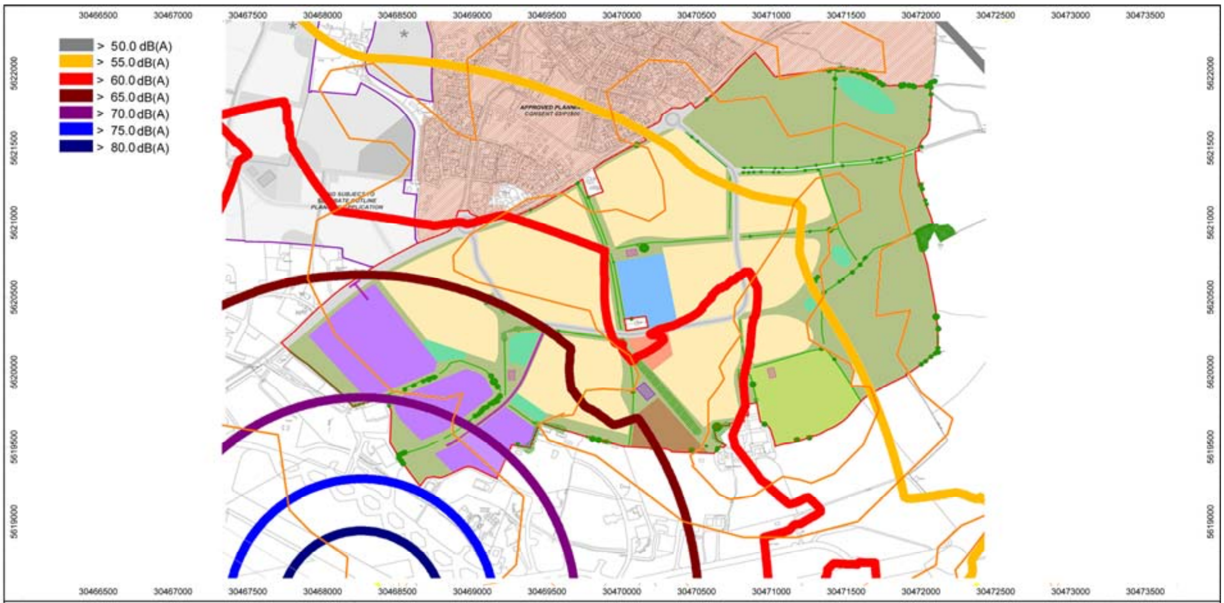
Maximum Noise Levels



(green line)	35 dB(A)	(dark green line)	40 dB(A)
(yellow line)	45 dB(A)	(grey line)	50 dB(A)
(orange line)	55 dB(A)	(red line)	60 dB(A)
(dark red line)	65 dB(A)	(purple line)	70 dB(A)
(blue line)	75 dB(A)	(navy line)	80 dB(A)

Exeter Airport – Dash 8-400 Ground Running Noise Contours, dB L_{Amax}

Maximum Noise Levels - Cranbrook Expansion Zone



Ground Noise LAmax dB(A)
Receiver height 4 m
Grid spacing 5 x 5 m

Not to scale

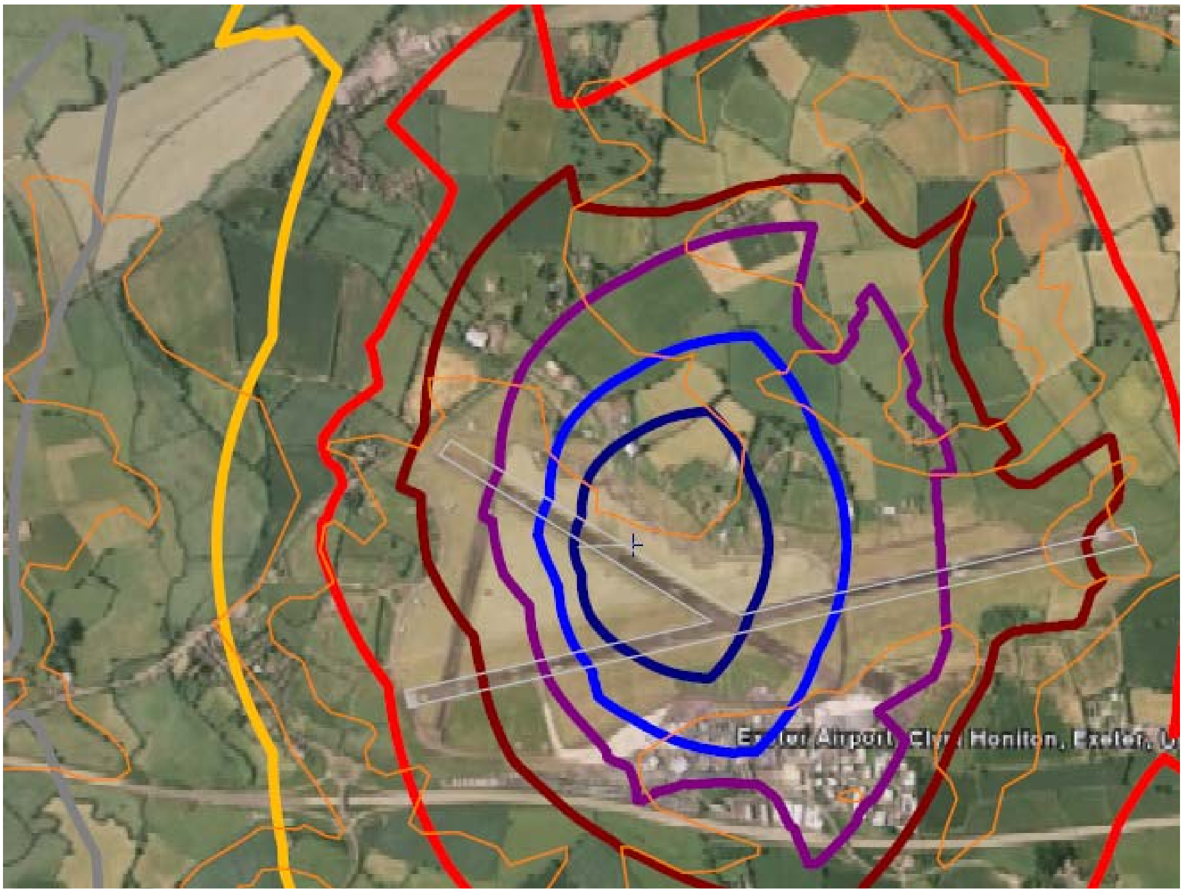
A9894 v4.5 13.11.2015

A9894 - Exeter Airport - Ground Noise Figure 1

Exeter Airport - Dash 8 ground running LAmax

CadnaA Aircraft ground noise contours

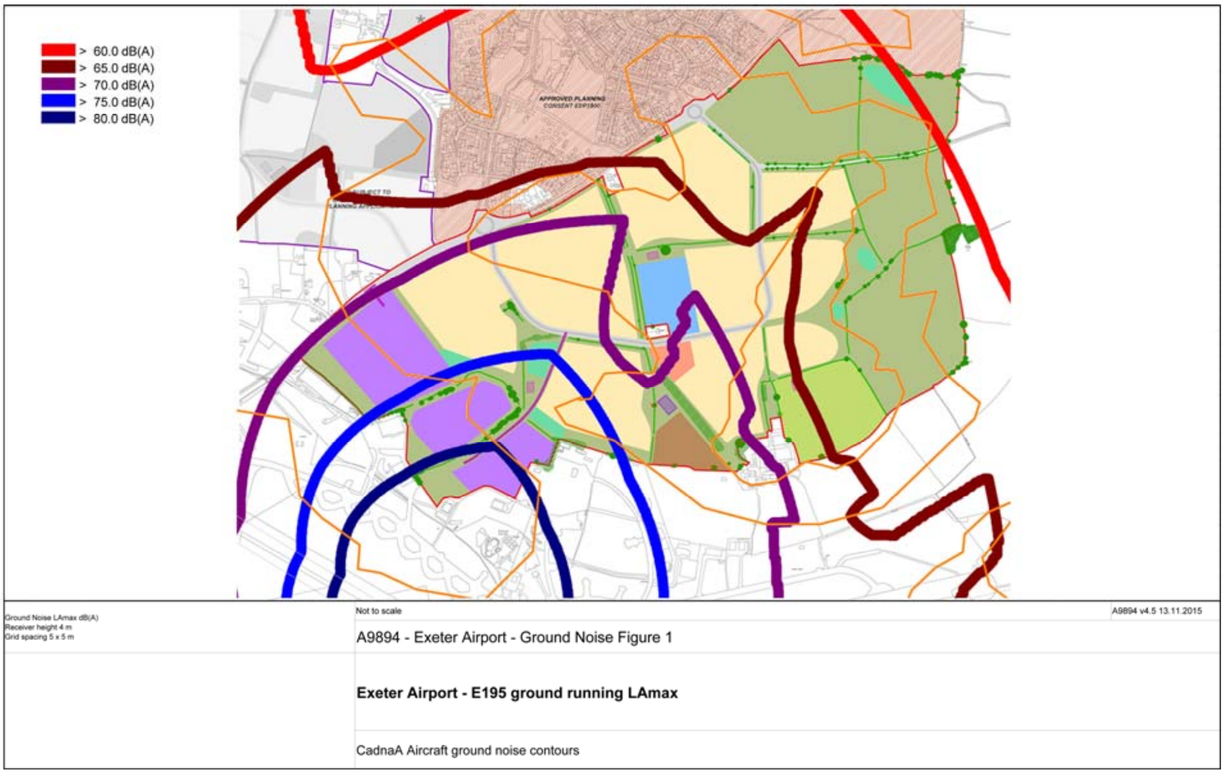
Maximum Noise Levels



35 dB(A)	40 dB(A)
45 dB(A)	50 dB(A)
55 dB(A)	60 dB(A)
65 dB(A)	70 dB(A)
75 dB(A)	80 dB(A)

Exeter Airport – E195 Ground Running Noise Contours, dB L_{Amax}

Maximum Noise Levels - Cranbrook Expansion Zone



Exeter Airport – E195 Ground Running Noise Contours, dB L_{Amax}