Appendix 7A
Glossary

7A.1 Acoustic terms

Sound

7A.1.1 This is a physical vibration in the air, propagating away from a source, whether heard or not.

The decibel (dB)

7A.1.2 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 $2x10^{-5}$Pa) and the threshold of pain is around 120 dB.

7A.1.3 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}W.

Frequency (Hz)

7A.1.4 Frequency is analogous to musical pitch. It depends upon the rate of vibration of the air molecules that transmit the sound and is measured 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

7A.1.5 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).

Ambient noise

7A.1.6 Usually expressed using $L_{Aeq,T}$ unit, commonly understood to include all sound sources present at any particular site, regardless of whether they are actually defined as noise.

Background noise

7A.1.7 This is the steady noise attributable to less prominent and mostly distant sound sources above which identifiable specific noise sources intrude.

Sound transmission in the open air

7A.1.8 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.

7A.1.9 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

7A.1.10 When sound waves encounter a hard surface, such as concrete, brickwork, glass, timber or plasterboard, they are 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

7A.1.11 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 immediately 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

7A.1.12 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.

Noise and vibration descriptors

7A.1.13 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.

$L_{Aeq, T}$

7A.1.14 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_{den}

7A.1.15 L_{den} is the day-evening-night noise indicator in decibels (dB) defined by the following formula:

$$L_{den} = 10 \times log\left(\frac{12 \times 10^{\left(\frac{L_{day}}{10}\right)} + 4 \times 10^{\left(\frac{L_{evening}+5}{10}\right)} + 8 \times 10^{\left(\frac{L_{night}+10}{10}\right)}}{24}\right)$$

7A.1.16 Where:

- L_{day} is the A-weighted long-term average sound level for the daytime period (07:00 to 19:00);
- $L_{evening}$ is the A-weighted long-term average sound for the evening period (19:00 to 23:00); and
- L_{night} is the A-weighted long-term average sound level for the night-time period (23:00 to 07:00).

L_{A90}

7A.1.17 L_{A90} is the noise level exceeded for 90% of the time and is normally used to describe background noise.

$L_{Amax,T}$

7A.1.18 $L_{Amax,T}$ is the maximum A-weighted sound pressure level, normally associated with a time weighting, F (fast), or S (slow).

Sound exposure level (SEL)

7A.1.19 An SEL is a measure of the total noise from an event such as an aircraft movement. The SEL noise level for an aircraft movement is the sum of all the noise energy for the event expressed as an average noise level for 1s.

N60 and N70

7A.1.20 Nx contours define the area exposed to a number of events with a maximum noise level of x dB L_{ASmax} or greater. For example, an N60,100 contour is the area exposed in a given period to 100 noise events each of which had a maximum noise level of at least 60 dB L_{ASmax}.

$L_{A10,18h}$

7A.1.21 $L_{A10,18h}$ is the noise level exceeded for 10% of an 18-hour period (06:00 to 00:00) and is normally used in the UK to assess road traffic noise.

Peak particle velocity (PPV)

7A.1.22 Peak Particle Velocity (PPV) is the instantaneous maximum velocity reached by a vibrating element as it oscillates about its rest position. PPV is the simplest indicator of both perceptibility and the risk of damage to structures.

7A.2 Aviation terms

Air transport movements (ATMs)

7A.2.1 Air Transport Movements (ATMs) are landings or take-offs of aircraft engaged on the transport of passengers, cargo or mail on commercial terms. All scheduled movements, including those operated empty, loaded charter and air taxi movements are included.

Noise preferential route (NPR)

7A.2.2 Departure flight ground tracks to be followed by aircraft to minimise noise disturbance on the surrounding population.

Dispersion

7A.2.3 Due to the effect of the wind, aircraft speed, and pilot choice differing aircraft tracks about the nominal track are flown; this is known as dispersion around a nominal track.

Start of roll

7A.2.4 The position on a runway where aircraft commence their take-off runs.

Threshold

7A.2.5 The beginning of that portion of the runway usable for landing.

Radar vectoring

7A.2.6 Aircraft are provided by Air Traffic Control (ATC) with various instructions which result in changes of heading, altitude and speed. The controller affects safe separation from other traffic by use of radar.

Nominal tracks

7A.2.7 Using recognised international design techniques, tracks across the ground can be delineated for departing and arriving aircraft. These tracks are nominal because they can be influenced by the wind, ATC instructions, the accuracy of navigational systems and the flight characteristics of individual aircraft. In the UK it is usual to permit a 1500 m swathe to be established about the nominal track for the purposes of assessing whether an aircraft has stayed on track.

Above aerodrome level (AAL)

7A.2.8 Height of aircraft above aerodrome level.

Altitude

7A.2.9 Height of aircraft above sea level.

Night period

7A.2.10 The period from 23:00 to 07:00 hours.

Noise footprint

7A.2.11 A noise contour which joins points on the ground which receive the same noise exposure from the nearby airborne aircraft; often for night studies 90 dB(A) SEL is the level used.

Appendix 7B
Relevant legislation, policy, technical guidelines and assessment criteria

7B.1 International regulation

7B.1.1 The International Civil Aviation Organisation (ICAO) is the inter-governmental body that oversees the worldwide civil aviation industry. ICAO has adopted a set of principles and guidance[1], constituting the 'balanced approach' to aircraft noise management, which encourages ICAO member states to address the following points:

- Mitigate aviation noise through selection at a local level the optimum combination of four key measures;
  - Reducing noise at source (from use of quieter aircraft);
  - Making best use of land (plan and manage the land surrounding airports);
  - Introducing operational noise abatement procedures (by using specific runways, routes or procedures);
  - Imposing noise-related operating restrictions (such as a night time operating ban or phasing out of noisier aircraft);
- Select the most cost-effective range of measures; and
- Not introduce noise-related operating restrictions unless the authority is in a position, on the basis of studies and consultations, to determine whether a noise problem exists and having determined that an operating restriction is a cost-effective way of dealing with the problem.

7B.1.2 ICAO has also set a number of standards for aircraft noise certification which are contained in Volume 1 of Annex 16 to the *Convention on International Civil Aviation*[2]. This document sets maximum acceptable noise levels for different aircraft during take-off and landing, categorised for subsonic jet aeroplanes as Chapter 2, 3, 4 and 14.

7B.1.3 Chapter 2 aircraft have been prevented from operating within the EU since 2002, unless they are granted specific exemption, and therefore the vast majority of aircraft fall within Chapter 3, 4 and 14 parameters. These aircraft are quieter than Chapter 2 aircraft.

7B.1.4 Chapter 4 standards have applied to all new aircraft manufactured since 2006. These aircraft must meet a standard of being cumulatively 10 dB quieter than Chapter 3 aircraft.

7B.1.5 Chapter 14 was adopted by the ICAO in 2014. This represents an increase in stringency of 7 dB compared with Chapter 4 and applies to new aircraft submitted for certification after 31st December 2017.

[1] ICAO (2006) Doc 9829 AN/451, Guidance on the Balanced Approach to Aircraft Noise Management 2nd Edition. ICAO.
[2] ICAO (2017), Annex 16 to the Convention on International Civil Aviation, Volume 1 8th Edition. ICAO.

7B.2 European regulation

EU Regulation 598-2014

7B.2.1 The European Commission introduced *EU Regulation 598-2014*[3] in 2016 to account for developments in the aviation world. This repeals 2002/30/EC[4] which set out procedures and rules for the introduction of noise related operating restrictions to the busiest of the European airports. This previous regime for managing airport noise placed the responsibility with the airport operator. The entry into force in 2016 of *EU Regulation 598/2014* represents a shift in responsibility from the airport operator to a separate, independent statutory entity or competent authority to oversee the delivery of the new, more prescriptive approach to airport noise management. The Independent Commission on Civil Aviation Noise (ICCAN) is considered to be best placed to perform this regulatory role in England.

7B.2.2 There are seven key elements of the new regulatory regime which are:

- Designation of a separate, independent statutory entity as the Competent Authority;
- Appropriate collaborative working arrangements;
- Robust consultation requirements;
- Adhere to the ICAO Balanced Approach;
- Compliance with Environmental Impact Assessment (EIA), Habitats & Birds, and the Environmental Noise Directives;
- Establishment of an appropriate, robust appeal mechanism, and
- Ongoing monitoring and enforcement activities.

7B.2.3 These new arrangements are to be given statutory effect by way of a Statutory Instrument.

Environmental Noise Directive 2002/49/EC 2002

7B.2.4 The *Environmental Noise Directive* (END)[5] concerning the assessment and management of environmental noise from transport, came into effect in June 2002. 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.

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[3] European Commission (2014). 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, [online]. Available at: https://publications.europa.eu/en/publication-detail/-/publication/b6947ca7-f1f6-11e3-8cd4-01aa75ed71a1/language-en [Checked 21/08/2018].

[4] European Commission (2002), Directive 2002/30/EC Directive of the European Parliament and the Council of 26th March 2002 on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0030&from=EN [Checked 21/11/2018].

[5] European Commission (2002). Directive 2002/49/EC Directive of the European Parliament and of the Council of 25th June 2002 relating to the assessment and management of environmental noise, [online]. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0049&from=EN [Checked 21/08/2018].

7B.3 National regulation and policy

Control of Pollution Act 1974

7B.3.1 The *Control of Pollution Act 1974*[6] provides a means for regulating construction noise and vibration. Section 60 sets out the legal powers of a Local Authority to control construction noise. The Local Authority, in acting under this section, would ensure that best practicable means are employed to minimise noise and vibration.

7B.3.2 Under Section 61, the person undertaking the construction works may apply for prior consent from the Local Authority over the method by which the works will be carried out and the steps proposed to minimise noise and vibration resulting from the works.

Aeroplane Noise Regulations 1999

7B.3.3 The *Aeroplane Noise Regulations 1999*[7] require that all civil propeller and jet aeroplanes registered in the UK shall have a noise certificate. A similar requirement applies to any foreign registered aeroplane which cannot land or take off in the UK without a noise certificate granted by the competent authority in the state where it is registered.

Aerodrome (Noise Restrictions) (Rules and Procedures) Regulations 2003

7B.3.4 *Directive 2002/30/EC*[4] (now replaced by EU/598[3]) was implemented as the *Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003* (SI 2003/1742)[8] which came into force on 6th August 2003. The Regulations apply to civil airports in the EU with more than 50,000 movements a year by civil subsonic jet aircraft with a maximum take-off mass of 34,000 kg or more, or with more than 19 passenger seats.

7B.3.5 Where it is proposed to introduce noise-related operating restrictions, the competent authority (currently Bristol Airport itself) is required to undertake a detailed assessment of the noise situation in the locality, and the full range of possible measures to address any noise problems identified. An Environmental Impact Assessment can be used under this legislation for introducing any noise related changes that occur as a result of infrastructure or significant airport operational changes.

Civil Aviation Act 2006

7B.3.6 The *Civil Aviation Act 2006*[9] included a number of measures aimed at strengthening the powers available to control noise. These included provision for airport operators to fix charges in respect of an aircraft or a class of aircraft based on the noise caused by the aircraft or the amount of emissions it produces. The Act also gave airport operators statutory powers to introduce noise control schemes for the purpose of avoiding, limiting or mitigating the effect of noise connected with the taking off or landing of aircraft. These could include penalties for straying from agreed flight paths that minimise the number of people affected by noise, fines for aircraft that breach noise controls and restrictions on aircraft of specified descriptions. Any income from penalty schemes would have to be put towards projects that benefit the local community.

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[6] Control of Pollution Act (1974), c.40. [online]. Available at: http://www.legislation.gov.uk/ukpga/1974/40/pdfs/ukpga_19740040_en.pdf [Checked 21/08/2018].
[7] The Aeroplane Noise Regulations (1999). No. 1452. [online]. Available at: http://www.legislation.gov.uk/uksi/1999/1452/contents/made [Checked 30/08/2018].
[8] The Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations (2003). No. 1742. [online]. Available at: http://www.legislation.gov.uk/uksi/2003/1742/made [Checked 21/11/2018].
[9] Civil Aviation Act (2006), c34. [online]. https://www.legislation.gov.uk/ukpga/2006/34/contents [Checked 30/08/2018].

Civil Aviation Act 2012

7B.3.7 The *Civil Aviation Act 2012*[10] placed a new duty on the Civil Aviation Authority (CAA) to make information about the environmental performance of the aviation sector available to the general public and measures taken to limit adverse environmental effects. The CAA consulted on its proposed Statement of Policy for the use of its information powers in 2013.

Environmental Noise (England) Regulations 2006 (as amended)

7B.3.8 These regulations[11] transpose the *European Environmental Noise Directive (Directive 2002/49/EC)*[5] into English law. They require operators of non-designated major civil airports to make and submit strategic noise maps to the Secretary of State every five years starting in 2007 which reflect the noise situation in the preceding calendar year. A major airport is defined as a civil airport that has more than 50,000 movements per year (a movement being a take-off or a landing). Regulation 18 places a duty on the operators of major airports, as the competent authority, to draw up a Noise Action Plan for places near the airport and submit this to the Secretary of State. There is then a continuing obligation on airport operators to review (and revise, if necessary) the Noise Action Plan every five years or sooner where a major development occurs.

7B.3.9 The Regulations require the Secretary of State to identify a number of noise sources for the strategic noise mapping and Action Plans. The *Environmental Noise (Identification of Noise Sources) (England) Regulations 2007*[12] identified Bristol Airport as a major airport outside an agglomeration and Bristol itself as an agglomeration with the area of the agglomeration indicated on an accompanying map.

Noise Insulation Regulations 1975 (as amended 1988)

7B.3.10 These regulations[13] [14] set out road traffic noise criteria to define dwellings which are significantly affected by the introduction of a new highway or changes to a highways scheme where the noise level rises above a certain value as a result of the change in traffic flow. Dwellings exposed to road traffic noise levels above these criteria must be offered sound insulation works.

National Planning Policy Framework (NPPF) 2018

7B.3.11 The *National Planning Policy Framework* (NPPF)[15] originally published 27th March 2012 and updated in July 2018, 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.

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[10] Civil Aviation Act (2012), c19. [Online]. http://www.legislation.gov.uk/ukpga/2012/19/contents/enacted [Checked 30/08/2018].
[11] The Environmental Noise (England) Regulations (2006). No. 2238. [online]. http://www.legislation.gov.uk/uksi/2006/2238/contents/made [Checked 30/08/2018].
[12] The Environmental Noise (Identification of Noise Sources) (England) (Amendment) Regulations 2007. No. 2458. [online]. Available at: http://www.legislation.gov.uk/uksi/2007/2458/contents/made [Checked 21/11/2018].
[13] The Noise Insulation Regulations (1975). No. 1736. [online]. http://www.legislation.gov.uk/uksi/1975/1763/contents/made [Checked 4/10/2018].
[14] The Noise Insulation (Amendment) Regulations (1988). No. 2000. [online]. https://www.legislation.gov.uk/uksi/1988/2000/contents/made [Checked 4/10/2018].
[15] Ministry of Housing, Communities and Local Government (2018). National Planning Policy Framework, [online]. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2 [Checked 21/11/2018].

7B.3.12 Government's current planning policy concerning noise is embodied in the NPPF (and more specifically the *Noise Policy Statement for England* or NPSE[16]). The aim of planning policies and decisions with respect to noise is addressed in paragraph 180 of the NPPF:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- *Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise from giving rise to significant adverse impacts on health and quality of life; and*
- *Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason".*

7B.3.13 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 NPSE[16]. That research has not yet resulted in clarification on numerical levels.

Noise Policy Statement for England (NPSE) 2010

7B.3.14 The *Noise Policy Statement for England* (NPSE)[16] provides the framework for noise management decisions to be made that ensure noise levels do not place an unacceptable burden on society.

7B.3.15 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.

7B.3.16 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 these is as follows:

- NOEL – No observed effect level. This is the level below which no effect can be detected;
- LOAEL – Lowest observed adverse effect level. This is the level above which adverse effects on health and quality of life can be detected; and
- SOAEL – Significant observed adverse effect level. This is the level above which significant adverse effects on health and quality of life occur.

[16] Defra (2010). Noise Policy Statement for England, [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf [Checked 10/04/2018].

7B.3.17 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[17].

7B.3.18 The advice is that noise above the SOAEL should be avoided using appropriate mitigation while taking into account the guiding principles of sustainable development.

7B.3.19 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.

7B.3.20 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.

7B.3.21 Where any adverse noise effects are predicted, these are identified and if these cannot be avoided, mitigation measures are recommended to ensure no significant residual effects on health and quality of life arise. This approach is considered consistent with the principal aims of the NPSE. It is important to note that findings against the LOAEL and SOAEL are measures of the effect of noise on health and quality of life, and not environmental impact assessment findings.

7B.3.22 As well as assisting with the interpretation of the NPSE, the *Planning Practice Guidance*[17] provides a web-based resource in support of the NPPF[15]. The *Planning Practice Guidance* states (Noise, paragraph 3) that local planning authorities should take account of the acoustic environment and in doing so consider:

"*whether or not a significant adverse effect is occurring or likely to occur,*

whether or not an adverse effect is occurring or likely to occur, and

whether or not a good standard of amenity can be achieved."

7B.3.23 The guidance advises on how planning can manage potential noise impacts in new development and provides a series of guidelines that are in line with the NPPF and the *Noise Policy Statement for England*. Paragraph 5 provides guidance on how to recognise when noise could be a concern. It advises that as noise increases beyond the lowest observed level noise it can start to cause small changes in behaviour and attitude, for example, having to turn up the volume on the television or needing to speak more loudly to be heard. It states that where noise could have an adverse effect consideration needs to be given to mitigating and minimising those effects (taking account of the economic and social benefits being derived from the activity causing the noise).

7B.3.24 The guidance includes a table that summarises the noise exposure hierarchy based on the likely average response. This is reproduced in **Table 7B.1.**

[17] Defra (2014). National Planning Policy Guidance, Planning Practice Guidance, Noise, [online] Available at: https://www.gov.uk/guidance/noise--2 [Checked 21/08/2018].

Table 7B.1 Noise exposure hierarchy based on the likely average response

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	No specific measures required
	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
		Lowest Observed Adverse Effect Level	
Noticeable and Intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
		Significant Observed Adverse Effect Level	
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

7B.3.25 The guidance advises that above the significant observed adverse effect level boundary, the planning process should be used to avoid this effect occurring, by use of appropriate mitigation such as by altering the design and layout. Such decisions must be made taking account of the economic and social benefit of the activity causing the noise, but it is undesirable for such exposure to be caused.

7B.3.26 At the highest extreme, noise exposure would cause extensive and sustained changes in behaviour without an ability to mitigate the effect of noise. The impacts on health and quality of life are such that regardless of the benefits of the activity causing the noise, this situation should be prevented from occurring.

UK Aviation Policy Framework 2013

7B.3.27 The *Aviation Policy Framework* (APF) was published in March 2013[18] by the Department for Transport (DfT). The APF defines the Government's objectives and policies on the impacts of aviation in the UK.

7B.3.28 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*".

7B.3.29 It goes on in paragraph 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.*"

7B.3.30 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 $L_{Aeq,16hour}$*'.

7B.3.31 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.*"

7B.3.32 In paragraph 3.17 the interpretation of the contour is given as "*We will continue to treat the 57 dB $L_{Aeq,16h}$ 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.*"

7B.3.33 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 $L_{Aeq,16h}$ 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 $L_{Aeq,16h}$ or more. Where acoustic insulation cannot provide an appropriate or cost-effective solution, alternative mitigation measures should be offered."

7B.3.34 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.*"

Final Report of the Airports Commission 2015

7B.3.35 The Airports Commission *Final Report*[19] concludes that to provide a new runway in the South East by 2030, it is best to expand Heathrow's runway capacity. The favoured option (out of two Heathrow options and one Gatwick option) is the new Northwest Runway Heathrow option. The

[18] Department for Transport (2013). Aviation Policy Framework. [online]. Available at: https://www.gov.uk/government/publications/aviation-policy-framework [Checked 19/03/2018].
[19] Airports Commission (2015). Airports Commission: Final Report. [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/440316/airports-commission-final-report.pdf [Checked 30/08/2018].

Airports Commission recommended a significant package of measures to address environmental and community impacts including, but not limited to:

- Following construction of a third runway at the airport there should be a ban on all scheduled night flights in the period 11:30pm to 6:00am;
- A clear 'noise envelope' should be agreed and Heathrow Airport must be legally bound to stay within these limits. This could include stipulating no overall increase above current levels;
- A third runway should allow periods of predictable respite to be more reliably maintained; and
- An independent aviation noise authority should be established with a statutory right to be consulted on flight paths and other operating procedures.

7B.3.36 The Commission noted in its final report that a new runway will not open for at least 10 years. It therefore considered it imperative that the UK continues to grow its domestic and international connectivity in this period, which it considered would require more intensive use of existing airports other than Heathrow and Gatwick.

Survey of Noise Attitudes 2014 (published in 2017)

7B.3.37 The Civil Aviation Authority *Survey of Noise Attitudes 2014* (or SoNA 2014)[20] includes the results of a survey to noise attitudes to civil aircraft. SoNA 2014 largely replaces *Attitudes to noise from aviation sources in England* (or ANASE)[21], the last large scale survey on attitudes to aircraft noise published in 2007.

7B.3.38 SoNA 2014 compared reported mean annoyance scores against average summer-day noise exposure defined using $L_{Aeq,16h}$, L_{den}, N70 and N65. Mean annoyance score correlated well with average summer day noise exposure, $L_{Aeq,16h}$. No evidence was found to suggest any of the other indicators correlated better with annoyance than $L_{Aeq,16h}$.

7B.3.39 The survey resulted in the 54 dB $L_{Aeq,16h}$ becoming the threshold of community annoyance rather than 57 dB $L_{Aeq,16h}$ which was based on the *UK Aircraft Noise Index Study* (or ANIS) from 1985[22].

UK Airspace Policy: A framework for balanced decisions on the design and use of airspace 2017 consultation

7B.3.40 Although the APF[18] remains the current national aviation policy document, in 2017 the Department for Transport reported on the outcome of consultations regarding changes to UK airspace (Consultation Response on UK Airspace Policy: A framework for balanced decisions on the design and use of airspace) which included a review of criteria and metrics for assessing aircraft noise[23]. This states in paragraph 9: "*The Government's current aviation policy is set out in the Aviation Policy Framework (APF). The policies set out within this document provide an update to some of the policies on aviation noise contained within the APF, and should be viewed as the current government policy. The government also intends to develop aviation noise policy further through the Aviation Strategy consultation process. As part of the Aviation Strategy consultation on*

[20] Civil Aviation Authority (2017). Survey of noise attitudes 2014: Aircraft, CAP 1506, [online]. Available at: https://publicapps.caa.co.uk/docs/33/CAP%201506%20FEB17.pdf [Checked 30/08/2018].
[21] Le Masurier, Paul et al (2007). Attitudes to noise from aviation sources in England (ANASE): Final Report for Department for Transport. Norwich: HMSO.
[22] Brooker et al (1985). United Kingdom Aircraft Noise Study: Main Report, DR Report 8402, Civil Aviation Authority Directorate of Operational Research and Analysis for Department of Transport. London: Civil Aviation Authority.
[23] Department for Transport (2017). Consultation Response on UK Airspace Policy: A framework for balanced decisions on the design and use of airspace. [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/653801/consultation-response-on-uk-airspace-policy-web-version.pdf [Checked 7/09/2018].

sustainable growth planned for 2018 the Government intends to consider the roles, structures and powers that currently exist and what, if any, new ones will be necessary to bring about the network wide, co-ordinated and complex changes needed for airspace modernisation".

7B.3.41 Based on this report, the Government will implement a range of proposals of which the key points are:

- The creation of an Independent Commission on Civil Aviation Noise (ICCAN) as an advisory non-departmental public body;
- The removal of the 3 dB minimum change requirement for financial assistance towards acoustic insulation to residential properties in the 63 dB $L_{Aeq,16h}$ level or above;
- A level of 54 dB $L_{Aeq,16h}$ is now acknowledged to correspond to the onset of significant community annoyance and replaces the 57 dB $L_{Aeq,16h}$ level in the APF; and
- Some adverse effects of annoyance can now be seen to occur down to 51 dB $L_{Aeq,16h}$. LOAEL of 51 dB $L_{Aeq,16h}$ and 45 dB L_{night}, for daytime and night-time noise respectively, are to be used in assessing and comparing noise impacts of airspace changes (N.B. Following consultation with the CAA, the Government consider it appropriate to use 45 dB $L_{Aeq,8h}$ as the LOAEL for air space change assessment, for consistency with daytime noise).

7B.3.42 As part of this consultation the Department for Transport published their draft *Air navigation guidance on airspace and noise management and environmental objectives*[24]. This proposes that rather than limiting the number of people exposed to any level of aircraft noise, the number of people experiencing significant adverse effects should be limited. For the purposes of assessing and comparing the noise impacts of airspace changes, a LOAEL of 51dB L_{Aeq} for daytime noise and 45dB L_{night} for night time noise is proposed.

Air Navigation Guidance 2017

7B.3.43 The *Air Navigation Guidance 2017*[25] provides guidance to the CAA on its environmental objectives when carrying out its air navigation functions. It also gives guidance to both the CAA and wider industry on airspace and noise management.

7B.3.44 To ensure a consistent and transparent assessment of the options within and across proposals, a single appraisal methodology should be followed. These options must follow WebTAG which is a series of guides and spreadsheet tools based on up-to-date evidence following the principles of HM Treasury's *Green Book*[26]. Elements of WebTAG (largely noise, air quality and carbon units) serve as a guide for airspace change options appraisals outside of government.

7B.3.45 ICCAN (see paragraph 7B.3.41) is mentioned as a source of best practice guidance on aviation noise for participants in the airspace change process.

[24] Department for Transport (2017). Air navigation guidance on airspace and noise management and environmental objectives. [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/587669/air-navigation-guidance-on-airspace-and-noise-management-and-environmental-objectives.pdf [Checked 30/08/2018].
[25] Department for Transport (2017). Air Navigation Guidance 2017. [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/653978/air-navigation-guidance-2017.pdf [Checked 30/08/2018].
[26] HM Treasury (2018). The Green Book Central Government Guidance on Appraisal and Evaluation. [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf Checked 30/08/2018].

Airports National Policy Statement: new runway capacity and infrastructure at airports in the South East of England 2018

7B.3.46 The *Airports National Policy Statement* (NPS)[27] provides the primary basis for decision making on development consent applications for a Northwest Runway at Heathrow Airport, and is a relevant consideration in respect of applications for new runway capacity and other airport infrastructure in southern areas of England.

7B.3.47 The Airports NPS sets out the Government's policy on the need for new airport capacity in the South East of England. The Government recognises noise related action will need to be taken. Such action should strike a fair balance between the negative impacts of noise and positive impacts of flights.

Beyond the horizon 2018

7B.3.48 HM Government's *Beyond the horizon, The future of UK aviation, Making best use of existing runways* was published following a call for evidence on a new aviation strategy for the UK in 2017[28]. This call for evidence asked specifically for views on the Government's proposal to support airports throughout the UK to make best use of their existing runways, subject to environmental issues being addressed.

7B.3.49 *Beyond the horizon, The future of UK aviation, Making best use of existing runways* records the outcome of the consultation (346 responses received), and the Government's recommendation. It concludes that the Government is supportive of airports beyond Heathrow making best use of their existing runways. It is recognised, however, that the development of airports can have negative as well as positive local impacts, including on noise levels. Any proposals should therefore be judged by the relevant planning authority, taking careful account of all relevant considerations, particularly economic and environmental impacts and proposed mitigations. It stresses that it leaves it up to local, rather than national government, to consider each case on its merits.

7B.4 Local Planning Framework

Bristol City Council Local Plan 2014 (Consultation 2018)

7B.4.1 Although Bristol Airport is not specifically mentioned, the Bristol City Council *Local Plan* Development Management policy DM35 'Noise Mitigation'[29] includes a provision that in areas of existing noise, new development sensitive to the effects of that noise is unlikely to be permitted where the presence of that sensitive development could threaten the ongoing viability of existing uses that are considered desirable for reasons of wider economic or social need.

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[27] Department for Transport (2018). Airports National Policy Statement: new runway capacity and infrastructure at airports in the South East of England. [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/714106/airports-nps-new-runway-capacity-and-infrastructure-at-airports-in-the-south-east-of-england-web-version.pdf [Checked 30/08/2018].
[28] HM Government (2018). Beyond the horizon, The future of UK aviation, Making best use of existing runways, [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/714069/making-best-use-of-existing-runways.pdf [Checked 30/08/2018].
[29] Bristol City Council (2018). Site Allocations and Development Management Policies, Local Plan, [online]. Available at: https://www.bristol.gov.uk/documents/20182/34540/BD5605%20Site%20Allocations_MAIN_text%20V8_0.pdf/46c75ec0-634e-4f78-a00f-7f6c3cb68398 [Checked 6/09/2018].

7B.4.2 A two-part consultation is on-going in 2018 as part of an update of the Bristol City Council Local Plan[30]. It is proposed that DM35 is retained in the updated *Local Plan*.

North Somerset Council Strategy Document 2017

7B.4.3 The north Somerset *Core Strategy*[31] sets out the broad long-term vision, objectives and strategic planning policies for North Somerset up to 2026.

7B.4.4 The Strategy identifies Bristol Airport as a regionally important facility. It states as part of its vision that the future planning of Bristol Airport will be guided by the need to balance the advantages of economic growth with the need to control the impacts on those who live nearby and on the natural environment.

7B.4.5 Policy CS23 'Bristol Airport' states "*Proposals for the development of Bristol Airport will be required to demonstrate the satisfactory resolution of environmental issues, including the impact of growth on surrounding communities and surface access infrastructure*".

7B.5 Technical guidance

General

7B.5.1 The technical guidelines which inform the air noise and ground noise assessment reported in the noise chapter of the ES are set out in this section. Assessment criteria for both air noise and ground noise are set out in **Section 7B.6**.

7B.5.2 For road traffic noise and construction noise, relevant technical guidance that has informed the assessment criteria for each of these two topics is set out in their respective sections of 7B.6.

World Health Organisation (WHO) – Guidelines for Community Noise

7B.5.3 WHO *Guidelines for Community Noise*[32] provide 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.

7B.5.4 For outside areas of dwellings, the WHO Guidelines state that to protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55 dB L_{Aeq} on balconies, terraces and in outdoor living areas. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level should not exceed 50 dB L_{Aeq}. Where it is practical and feasible, the lower outdoor sound level should be considered the maximum desirable sound level for new development. The WHO guidance cites a 16 hour period as applicable to the above limits.

7B.5.5 Although the attainment of these steady noise target values is not always achievable in practice, particularly where a dwelling is located close to a busy road or railway, controlling the daytime noise level to 55 dB $L_{Aeq,16h}$ or below in some gardens and amenity areas can sometimes be

[30] Bristol City Council (2018). Local Plan, [online]. Available at: https://www.bristol.gov.uk/planning-and-building-regulations/local-plan [Checked 6/09/2018].
[31] North Somerset Council (2017). Core Strategy, [Online]. Available at https://www.n-somerset.gov.uk/wp-content/uploads/2015/11/Core-Strategy-adopted-version.pdf [Checked 6/09/2018].
[32] Berglund, B. et al (1999). Guidelines for community noise. [Online]. Available at: http://apps.who.int/iris/bitstream/handle/10665/66217/a68672.pdf?sequence=1&isAllowed=y [Checked: 30/08/2018].

achieved for developments near roads and railways by the use of screening achieved using other buildings, fences or purpose made noise barriers.

WHO Night Noise Guidelines

7B.5.6 Guidance on absolute noise levels at night are given in by the WHO *Night Noise Guidelines* (NNG)[33]. These report findings from the WHO 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.

7B.5.7 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.

7B.5.8 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

7B.5.9 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 Strategic Noise Mapping work undertaken across European Member States in compliance with the Environmental Noise Directive[5]. For night noise, Member States are required to produce noise maps in terms of the $L_{night,outside}$ index no lower than 50 dB for strategic planning purposes.

7B.5.10 The relationship between night noise exposure and health effects as defined by WHO can be summarised as shown in **Table 7B.2**.

[33] World Health Organisation Europe (2009). Night Noise Guidelines for Europe, [Online]. Available at: http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf [Checked 7/09/ 2018].

Table 7B.2 WHO guidance on the relationship between night noise exposure and health effects

$L_{night,outside}$	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 – 50	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

WHO Environmental Noise Guidelines for the European Region

7B.5.11 During the course of this assessment (October 2018), the WHO have published their updated *Environmental Noise Guidelines*[34]. These guidelines strongly recommend that aircraft noise does not exceed 45 dB L_{den} or 40 dB L_{night}. These recommendations are considered aspirational and have not yet been adopted as policy.

7B.5.12 Some of the research underpinning the report related to noise effects at night had been published[35] earlier and considered for this assessment. This is discussed further in **Section 7B.6**.

BS 8233 Sound insulation and noise reduction in buildings – code of practice

7B.5.13 The British Standard *BS8233:2014 Sound insulation and noise reduction for buildings – Code of practice*[36] provides guidance on the control of external noise. The standard presents a number of design ranges for indoor noise levels for different types of space.

7B.5.14 Internal ambient noise guideline levels for dwellings are given in **Table 7B.3**.

Table 7B.3 *BS 8233:2014* Indoor ambient noise guideline levels for dwellings

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

[34] World Health Organization Regional Office for Europe (2018). Environmental Noise Guidelines for the European Region. [Online]. Available at: http://www.euro.who.int/__data/assets/pdf_file/0008/383921/noise-guidelines-eng.pdf [Checked: 25/10/2018].
[35] Basner, M. et al. (2018). WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep. Int. J. Environ. Res. Public Health 2018, 15, 519. [Online]. Available at: https://www.mdpi.com/1660-4601/15/3/519 [Checked 25/09/2018].
[36] British Standards Institution (2014). BS 8233:2014 Sound insulation and noise reduction for buildings – Code of practice. [Online]. Available at: https://shop.bsigroup.com/ProductDetail/?pid=000000000030241579&_ga=2.85437209.1462736480.1535108011-979344642.1535108011 [Checked: 24 /08/2018].

7B.5.15 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.

7B.5.16 These guideline noise levels can be used for rooms for residential purposes including hotels, hostels, halls of residence, school boarding houses, hospices and residential care homes.

7B.5.17 *BS8233:2014* also gives guideline ambient noise levels in non-domestic buildings. These are given in **Table 7B.4.**

Table 7B.4 *BS 8233:2014* Indoor ambient noise guideline levels for non-domestic buildings

Activity	Location	Design range $L_{Aeq,T}$ dB(A)
Speech or telephone communications	Department store, cafeteria, canteen, kitchen	50 to 55
	Concourse, corridor, circulation space	45 to 55
Study and work requiring concentration	Library, gallery, museum	40 to 50
	Staff/meeting room, training room	35 to 45
	Executive office	35 to 40
Listening	Place of worship, counselling, meditation, relaxation	30 to 35

7B.5.18 *BS 8233:2014*[36] gives the following design criteria for external noise in amenity spaces:

- For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited; and
- Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space.

Department of Education - Acoustic design of schools: performance standards BB93

7B.5.19 The Department of Education's *BB93*[37] gives upper limits for indoor ambient noise level in terms of $L_{Aeq,30min}$ for new and refurbished schools, and schools formed by a material change of use, are as follows:

- Classroom and general teaching area - 35 dB $L_{Aeq,30min}$; and
- Teaching space (special communication needs) - 30 dB $L_{Aeq,30min}$.

7B.5.20 For classrooms and teaching spaces with natural ventilation, these levels can be achieved if the external noise level does not exceed 55 dB $L_{Aeq,30min}$.

7B.5.21 These standards, while not required by legislation to be achieved within those existing schools built prior to their introduction, provide a guide to determine potential impacts on existing schools.

Department of Health - Specialist Services, Health Technical Memorandum 08-01: Acoustics

7B.5.22 Guidance on recommended internal noise levels for healthcare facilities is given in the Department of Health's *HTM 08-1*[38]. This recommends internal noise levels for healthcare facilities as follows:

- Hospital wards, daytime - 40 dB $L_{Aeq,1h}$;
- Hospital wards, night - 35 dB $L_{Aeq,1h}$;
- Hospital wards, night - 45 dB $L_{Amax,F}$;
- Operating theatres, night - 40 dB $L_{Aeq,1h}$; and
- Operating theatres, night - 50 dB $L_{Amax,F}$.

7B.5.23 The L_{Amax} limit is applicable to events that occur several times during the night (for example passing trains) rather than sporadic events.

7B.5.24 These criteria would be relaxed for emergency situations and sporadic events (such as helicopter flights) subject to agreement by the local authority or other relevant body.

7B.5.25 For hospital wards with natural ventilation, these levels can be achieved if the external noise level does not exceed 55 dB $L_{Aeq,1h}$ and 50 dB $L_{Aeq,1h}$ during the day and night respectively.

7B.5.26 For the control of noise in external areas in hospitals 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); and

[37] Department of Education (2015). Acoustic design of schools: performance standards Building bulletin 93, [Online]. Available at: https://www.gov.uk/government/publications/bb93-acoustic-design-of-schools-performance-standards [Checked 24/08/2018]
[38] Department of Health (2013). Specialist Services, Health Technical Memorandum 08-01: Acoustics, [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/144248/HTM_08-01.pdf [Checked 24/08/2018].

- 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[39]) 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.

CAP 1616 Airspace Design: guidance on the regulatory process for changing airspace design including community engagement requirements

7B.5.27 This guidance document[40] produced in 2017 by the Civil Aviation Authority for airspace change sponsors providing guidance on the seven-stage airspace change process used for permanent changes to the published airspace design. The document guides the user through each stage and describes what will happen at each stage of it, and why.

7B.5.28 WebTAG is to be used to compare route options for airspace change proposals, along with other analyses including Nx contours, flight pattern diagrams and a noise impact assessment.

7B.5.29 CAP 1616a forms a technical annex to this document and gives an outline of relevant methodologies for use in environmental assessment.

WebTag Environmental Impact Appraisal

7B.5.30 In December 2017, the Department for Transport issued updated guidance[41] on a new WebTAG module that can be used for valuing the impacts of noise including those from changes in aircraft noise, on health and quality of life. Adverse effects of airspace change proposals must be estimated in accordance with this methodology, along with additional noise metrics set out within Department for Transport guidance documents, and advised by the CAA or following engagement by the sponsor.

7B.5.31 It is not common practice to undertake a WebTag analysis as part of an Environmental Noise Assessment. The outputs of such an analysis are given in monetary terms, relating to the cost in health terms on the population exposed to noise. The method does however provide a means of comparing various scenarios or options and rating comparatively the overall noise effects on health and quality of life of the population.

Aviation Noise Metric – Research on the Potential Noise Impacts on the Historic Environment by Proposals for Airport Expansion in England

7B.5.32 This report[42], summarises the research into vibration effects of airborne aircraft, among other things. The conclusion is that aircraft noise levels above 97 dB L_{Cmax} are likely to produce an audible rattle of windows. While it is appreciated that low frequency noise from aircraft can induce perceptible vibration levels in lightweight structures and loose fitting components, the

[39] The Control of Noise at Work Regulations 2005. No. 1643. [online]. Available at: http://www.legislation.gov.uk/uksi/2005/1643/contents/made [checked 21/11/2018]
[40] Civil Aviation Authority (2017). CAP1616: Airspace Design: Guidance on the regulatory process for changing airspace design including community engagement requirements, [online]. Available at: https://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=8127 [Checked 2/10/2018].
[41] Department for Transport (2015). WebTAG: TAG unit A3 environmental impact appraisal, December 2015 (updated December 2017), [online]. Available at: https://www.gov.uk/government/publications/webtag-tag-unit-a3-environmental-impact-appraisal-december-2015 [Checked 2/10/2018].
[42] Historic England (2014). Aviation Noise Metric – Research on the Potential Noise Impacts on the Historic Environment by Proposals for Airport Expansion in England, [Online]. Available at: https://research.historicengland.org.uk/Report.aspx?i=15740 [Checked 26/11/2018]

levels of vibration are below those at which even minor cosmetic damage would be likely to occur.

7B.5.33 The report also notes that vibration effects due to airborne aircraft can vary depending on the specific details of the building, for example the room dimensions which can cause resonance effects at certain frequencies. Resonances increase the sound level in parts of the room and decrease it in others.

Airports and the Environment

7B.5.34 This report[43] discusses the key environmental factors affecting aviation. In particular there is discussion of the potential for vortex damage due to airborne aircraft which can be considered a vibration effect. It states the following on the subject:

7B.5.35 *"Less of an environmental problem, but one that affects community relations, is that of vortex damage to properties within neighbouring communities. Vortices, which are circulating currents of air created by the passage of aircraft, are generally dispersed by wind and air turbulence before they reach the ground. However, in certain weather conditions they can reach ground level and can dislodge unsecured roofing tiles."*

7B.6 Assessment Criteria

Air noise and vibration assessment criteria

General

7B.6.1 The Government, as set out in the APF [18] and supported by SoNA 2014[20], confirms that the current convention in the UK is to assess the impact of daytime aircraft noise in terms of daytime $L_{Aeq,16h}$ noise contours determined from an average summer day of aircraft movements. As a result, emphasis on the assessment of daytime noise in this chapter is placed on the UK methodology and $L_{Aeq,16h}$ unit. This unit has been used historically within the UK over the past 30 years to rate community response to aircraft noise.

7B.6.2 For night-time, the recent publication of the Government's response to the air space change consultation confirms the use of $L_{Aeq,8h}$ noise exposure contours determined from an average summer night of aircraft movements for describing aircraft noise at night. These contours are also now prepared and published annually for the designated airports such as Heathrow, Stansted and Gatwick, along with daytime $L_{Aeq,16h}$ contours. The L_{night} index is also referenced, alongside the $L_{Aeq,8h}$ index, as both are very similar.

7B.6.3 While average exposure noise contours of this type are well established and important at demonstrating trends in total noise around an airport, it is recognised in the APF that people do not experience noise in an averaged manner and that the L_{Aeq} indicator does not necessarily reflect all aspects of the perception of aircraft noise. Alternative indices are therefore considered as part of this air noise assessment which better reflect how aircraft noise is experienced in different localities. The purpose of this is to ensure a better understanding of noise impacts and to inform the development of targeted noise mitigation measures.

7B.6.4 Some of the additional indices that are included in this air noise assessment are introduced below and, where appropriate, described in more detail later in this appendix.

[43] Anne Paylor (1994). Airports and the Environment.

7B.6.5 In Europe, noise indicators based on the L_{Aeq} unit, known as the L_{den} and L_{night}, are used to rate environmental noise and are used in the UK to prepare Strategic Noise Maps. Noise contours, in terms of L_{den} and L_{night}, are therefore produced on a five-yearly basis for all major airports, including Bristol Airport. The development of criteria by which to judge this European index is in its relative infancy compared to the body of knowledge built around the $L_{Aeq,16h}$ unit, although guidance is continuing to emerge, particularly regarding noise exposure and potential health effects.

7B.6.6 The L_{den} is a unit that considers an average annual day of air traffic (although it can be applied equally to either rail or road traffic) over a 24 hour period, providing greater emphasis, by way of adding noise penalties of 5 dB and 10 dB to noise levels arising from evening and night traffic respectively. For many airports, the L_{den} equates approximately to the $L_{Aeq,16h}$ index by the relationship L_{den} = $L_{Aeq,16h}$ + 2 dB. The precise relationship however depends on the mix of aircraft traffic over the 24 hour period.

7B.6.7 The L_{night} equates approximately to the $L_{Aeq,8h}$ index commonly used to rate night noise in the UK with the exception that it is based on an average annual night mix of aircraft movements rather than an average summer mix.

7B.6.8 The N index is becoming more commonly used to describe aircraft noise, often using the N70 parameter for daytime and N60 parameter for night-time aircraft noise assessment. This index, originating from Australia, describes the number of times in a defined period, either the daytime or night-time, that a receptor will experience a maximum noise level as a result of an aircraft passby. For example, an N70 of 20 means that a receptor will experience 20 aircraft events producing 70dB(A) L_{ASmax} or more during the defined period of time. This allows an understanding of how, for a given noise level and above, the number of flights during the daytime might alter when comparing two scenarios, such as with or without an airport development.

7B.6.9 Noise annoyance ratings are also a useful way of explaining how a given noise environment is likely to impact the local community by identifying those likely to be 'highly annoyed' by aircraft noise. The measure considers the general population and it is accepted that some people would be more annoyed or less annoyed for a given noise exposure level. This method of assessment offers some advantages over simply banding a population into "low", "moderate" and "high" annoyance categories since it recognises that even at relatively low levels of aircraft noise, some people can by highly annoyed. It can therefore be usefully used as a means of evaluating differences between contour cases.

7B.6.10 While noise exposure contours take account of both the noisiness of aircraft events and the number of operations that occur during a day or night, they only provide an 'average' value. While this is required by Government for planning purposes, it does not reflect the temporal change that occurs over a day. It is therefore also relevant to consider how the noise level might vary at a given receptor in a given day, particularly when comparing two scenarios. This is often represented by considering the following:

- Single mode contours produced assuming either 100% westerly operations or 100% easterly operations; and
- The variation in noise level at representative locations over a typical day, for example, on an hourly basis.

7B.6.11 Consideration is given to both these methods within this assessment.

7B.6.12 In undertaking an assessment for an Environmental Statement, it is necessary to establish those effects that are considered to be adversely or beneficially significant. The thresholds to be adopted for this purpose are discussed later in this Assessment Criteria section.

7B.6.13 The Government, through the NPSE[16], and the introduction of the Significant Observed Adverse Effect Level (SOAEL), has introduced the concept of significance thresholds to rate health effects and quality of life. It is generally accepted that "significance" in this context differs from that used in an ES. As an example, a change of 5 dB from an air noise level of 50 dB to 55 dB $L_{Aeq,16h}$ during the daytime might be considered a significant change (see **Table 7B.5)**. In terms of health effects and quality of life however, this would lie well below what might be construed as a noise level likely to give rise to any significant observed adverse effects.

7B.6.14 The thresholds for assessing health effects and quality of life are important, particularly when considering and comparing different scenarios as well as establishing the need for and extent of noise mitigation. The NPSE introduces the concept of LOAELs and SOAELs and it is appropriate to consider what level of noise at Bristol Airport might be attributed to these values, in light of emerging guidance on the effects of noise on health and also Government guidance.

7B.6.15 The LOAEL, SOAEL and UAEL (Unacceptable Adverse Effect Level) are established for air noise (and for other environmental noise sources) in this section.

Daytime - Residential

7B.6.16 The Government, in the APF[18], acknowledges research in recent years which suggests that the balance of probability is that people are now relatively more sensitive to aircraft noise than in the past. At that time, the Government considered there was insufficient evidence to indicate a clear threshold noise level denoting the "*onset of significant community annoyance*". As a result, they retained within the APF the 57 dB $L_{Aeq,16h}$ contour as the average level of daytime aircraft noise marking the approximate onset of significant public annoyance.

7B.6.17 In 2017, following the Government's response to the UK Air Space Change consultation[23], the Government set out policies that provide an update to some of the policies on aviation noise contained within the APF. They advised that these should be viewed as the current government policy. Specifically, it advised that a level of 54 dB $L_{Aeq,16h}$ is now acknowledged to correspond to the onset of significant community annoyance and replaces the 57 dB $L_{Aeq,16h}$ level in the APF.

7B.6.18 The Government also advise that some adverse effects of annoyance can now be seen to occur down to 51 dB $L_{Aeq,16h}$ and that this should be used as the Lowest Observed Adverse Effect Level (LOAEL) when assessing and comparing noise impacts of airspace changes.

7B.6.19 Based on Government guidance as described above, the following contour values are relevant in terms of assessing daytime airborne aircraft noise:

a) 51 dB $L_{Aeq,16h}$ which provides a threshold below which there are no observed adverse effects from air noise (LOAEL); negligible impact.

b) 54 dB $L_{Aeq,16h}$ which currently provides an indication of the onset of significant community annoyance, minor impact.

c) 63 dB $L_{Aeq,16h}$ which denotes moderate levels of community annoyance, commonly used at airports and recommended by the Government as an eligibility criterion for sound insulation grant schemes. As a result, this value is commonly considered to represent the Significant Observed Adverse Effect Level (SOAEL); moderate impact.

d) 69 dB $L_{Aeq,16h}$ which denotes high levels of community annoyance where UK Government guidance is for consideration to be given by airports to assist in the costs of re-locating people from exposed dwellings, or, under certain circumstances, to offer to purchase such dwellings. This represents the unacceptable adverse effect level (UAEL); very substantial impact.

7B.6.20 The absolute noise values corresponding to indicative NPSE, LOAEL and SOAEL values for daytime air noise are given in **Table 7B.5**.

Table 7B.5 Air noise assessment criteria – absolute, outdoors (daytime)

Action	Effect Level	Indicative daytime level $L_{Aeq,16h}$ dB
Mitigate and reduce to a minimum	Lowest Observed Adverse Effect Level (LOAEL)	51
Avoid	Significant Observed Adverse Effect Level (SOAEL)	63
Prevent	Unacceptable Adverse Effect Level (UAEL)	69

7B.6.21 The subjective description of the absolute levels of air noise, expressed in terms of the air noise contour bands are given in **Table 7B.6**.

Table 7B.6 Air noise assessment criteria – subjective, outdoors (daytime)

Subjective description of Impact	Daytime criteria, dB $L_{Aeq,16h}$
Negligible	51 (LOAEL)
Very minor	54
Minor	57
Minor/Moderate	60
Significant - Moderate	63 (SOAEL)
Significant - Substantial	66
Significant - Very Substantial	69 (UAEL)

7B.6.22 In addition to absolute noise level, the relative change in noise level between operational scenarios is used to assess air noise. A potential significance rating for a change in level is given in **Table 7B.7**. A semantic scale of this type, based on the Institute of Environmental Management and Assessment (IEMA) *Guidelines on Environmental Noise Impact Assessment* [44], has been used successfully in various airport Public Inquiries.

[44] Institute of Environmental Management and Assessment (2014). Guidelines on Environmental Noise Impact Assessment. London: IEMA.

Table 7B.7 Air noise impact ratings - outdoors, change in noise level

Change in noise level dB	Subjective impression	Potential Impact classification
0 to 2	Imperceptible change	Negligible
2 to 3	Barely perceptible change	Minor
3 to 6	Perceptible change	Moderate
6 to 9	Up to a halving or a doubling of loudness	Substantial
> 9	Equal to or more than a halving or doubling of loudness	Very substantial

7B.6.23 To assess the overall effect of a change in noise, consideration needs to be given both to the magnitude of the change as well as the absolute level when assessing the effects of the resulting noise impacts. If, for example, the noise level at a dwelling were to change from 45 dB to 50 dB $L_{Aeq,16h}$, (below the LOAEL) the overall effect for the occupants would be less than if the same change were to increase the noise level from 63 dB (above the SOAEL) to 68 dB $L_{Aeq,16h}$.

7B.6.24 **Table 7B.8** is used in this assessment to indicate those dwellings that will be exposed both to a given level of absolute noise and a change in noise, resulting from a change in operations from one scenario to another.

Table 7B.8 Number of dwellings exposed to absolute noise and change in noise - daytime

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,16h}$ (lower limit)**	**No. of dwellings in band**	**Beneficial /Adverse change**	**Negligible**	**Minor**	**Moderate**	**Substantial**	**Very Substantial**
Negligible	**51 (LOAEL)**		Benef.					
			Adv					
Very minor	**54**		Benef.					
			Adv.					
Minor	**57**		Benef.					
			Adv.					
Minor/Moderate	**60**		Benef.					
			Adv.					
Significant - Moderate	**63 (SOAEL)**		Benef.					
			Adv.					
Significant - Substantial	**66**		Benef.					
			Adv.					
Significant – Very Substantial	**69 (UAEL)**		Benef.					
			Adv.					

7B.6.25 N70 contours are used in this assessment to illustrate how, for a given point on the ground, the number of aircraft events producing a level of 70 dB(A) or more will change between two scenarios. A level of 70 dB L_{Amax} is used (derived from Australia) on the basis that, when accounting for the noise reduction through a typical building fabric with an open window, typically 15 dB, it represents an indoor speech interference level typical of an Australian home.

7B.6.26 Noise annoyance ratings can be used as a means of evaluating differences between scenarios. SoNA 2014[20] provides methods for doing this and has been used in this assessment, using the $L_{Aeq,16h}$ metric, to determine the percentage of people that are likely to be highly annoyed.

7B.6.27 The given relationships between noise dose and the percentage of a population likely to be highly annoyed based on SoNA 2014 (CAP 1506) are given in **Table 7B.9**.

Table 7B.9 Daytime aircraft noise annoyance

Average summer day noise exposure, $L_{Aeq,16h}$ ((dB)	% Highly Annoyed SoNA 2014
51 (LOAEL)	7%
54	9%
57	13%
60	17%
63 (SOAEL)	23%
66	31%
69 (UAEL)	39%

7B.6.28 It is of note that when moving from 63 dB to 66 dB, the increase in those highly annoyed is 8% (31% - 23%), as opposed to 2% when changing from 51 to 54 dB. This highlights the fact made earlier that a change (in this case 3 dB) will bring about a different community response, depending on the absolute level at which it occurs.

7B.6.29 Whereas air noise contours are based on averages (as required by the Government for planning purposes), it is also relevant to consider how the noise level might vary at a given receptor in a given day.

7B.6.30 An assessment has been undertaken of how the noise level is predicted to change on an hourly basis under each scenario. This provides a useful illustration, for a given receptor, of how the noise level is predicted to vary throughout the daytime and night-time periods, based on average mode, westerly and easterly operations.

7B.6.31 While single mode contours and hourly noise values are beneficial in demonstrating how noise will spread over a given day or night, they cannot be related directly to any community response criteria. Single mode, hourly noise values are however relevant to the consideration of schools and have been used in this assessment for this purpose.

Night-time - Residential

7B.6.32 It is recognised[35] that undisturbed sleep of sufficient length is essential for daytime alertness and performance, quality of life, and health. Noise has been shown to fragment sleep, reduce sleep continuity, and reduce total sleep time. There is overwhelming evidence that chronically disturbed or curtailed sleep is associated with negative health outcomes.

7B.6.33 Night-time aircraft noise can be evaluated in a number of different ways. The common method is to rate night noise in terms of noise exposure, using the $L_{Aeq,8h}$ index and the L_{night} index (for the period 23:00 to 07:00). It is also important however to consider overflight/passby noise, using noise indices such as the Single Event Level (SEL) and/or the L_{Amax},

7B.6.34 In the UK, the CAA use the $L_{Aeq,8h}$ index to describe noise exposure at night in respect of air space change proposals. The L_{night} index however is also used for planning and optioneering by the UK Government by way of the WebTAG[41] Analysis procedure. This procedure can also be used generally to check on impacts of different scenarios.

7B.6.35 The WHO sets out night noise guidelines[33] in terms of L_{night} which are commonly used to rate the acceptability of environmental noise at night. While the Night Noise Guideline of 40 dB L_{night} is set out as an environmental goal to aspire towards, 55 dB L_{night} is suggested as an Interim Target. The UK Government also recognise 45 dB L_{night} as representing the Lowest Observed Adverse Effect Level (LOAEL) while adopting the 45 dB $L_{Aeq,8h}$ index for this purpose for consistency with the $L_{Aeq,16h}$ daytime noise index.

7B.6.36 The $L_{Aeq,8h}$ index differs only slightly from the L_{night} index in that it relates to an average summer day of aircraft activity, as opposed to an average annual day. As summer activity is generally higher than at other times of the year, the adoption of the $L_{Aeq,8h}$ unit, in place of the L_{night} unit represents a conservative approach. Similarly, on this basis, 55 dB $L_{Aeq,8h}$ is adopted as the Significant Observed Adverse Effect Level (SOAEL) in this assessment.

7B.6.37 The UK Government, in their response to the Consultation on Air Space Changes in the UK[23], have identified 45 dB $L_{Aeq,8h}$ as the Lowest Observed Adverse Effect Level. This assessment has therefore adopted the absolute noise criteria for assessing night-time noise exposure given in **Table 7B.10.**

Table 7B.10 Air noise assessment criteria – absolute, outdoors (night-time)

Action	**Effect Level**	**Indicative night-time level $L_{Aeq,8h}$ dB**
Mitigate and reduce to a minimum	Lowest Observed Adverse Effect Level (LOAEL)	45
Avoid	Significant Observed Adverse Effect Level (SOAEL)	55
Prevent	Unacceptable Adverse Effect Level (UAEL)	63

7B.6.38 The subjective description of the absolute levels of air noise, expressed in terms of the air noise contour bands are given in **Table 7B.11**.

Table 7B.11 Air noise assessment criteria – subjective, outdoors (night-time)

Subjective description of Impact	**Night-time criteria $L_{Aeq,8h}$ dB**	
Negligible	45	LOAEL
Very minor	48	
Minor	51	
Minor/Moderate	54	
Significant - Moderate	55	SOAEL
Significant - Substantial	60	
Significant – Very Substantial	63	

7B.6.39 As in the case of daytime noise, this assessment includes consideration of both absolute noise at night and how changes might occur for dwellings between one operational scenario and another. **Table 7B.12** is used for this purpose.

Table 7B.12 Number of dwellings exposed to absolute noise and change in noise – night-time

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,8h}$ (lower limit)**	**No. of receptors in band**	**Beneficial /Adverse change**	**Negligible**	**Minor**	**Moderate**	**Substantial**	**Very Substantial**
Negligible	**45 (LOAEL)**		Benef.					
			Adv					
Very minor	**48**		Benef.					
			Adv.					
Minor	**51**		Benef.					
			Adv.					
Minor/Moderate	**54**		Benef.					
			Adv.					
Significant - Moderate	**55 (SOAEL)**		Benef.					
			Adv.					
Significant - Substantial	**60**		Benef.					
			Adv.					
Significant – Very Substantial	**63**		Benef.					
			Adv.					

7B.6.40 The value of using equivalent noise exposure levels in describing the effects of noise on sleep is limited, as different noise scenarios may calculate to the same equivalent noise level, but differ substantially in their sleep disturbing properties. Research[35] suggests that the number and acoustical properties of single noise events better reflect the actual degree of sleep disturbance in a single night.

7B.6.41 The WHO guidelines[32] provide advice that for a good sleep, indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10-15 times per night. Accounting for sleeping with a bedroom window slightly open (and a reduction from outside to inside of 15 dB), this translates to an outside sound pressure level of 60 dB L_{Amax}. (alias 70 dB(A) SEL).

7B.6.42 In the UK, where night noise is considered sufficiently high, a value of 90 dB(A) SEL (approximately equivalent to 80 dB L_{Amax}) is commonly used as the eligibility threshold for a sound insulation scheme, often based on one movement or more on average per night by the noisiest or most common aircraft operating during the night. This threshold was developed based on research published in 1992 by the Department of Transport[45].

7B.6.43 An interpretation of the research study results is that there is no significant risk of sleep disturbance for locations outside the 90 dB(A) SEL footprint area. For locations within 90 dB(A) SEL footprint, a very slight risk of sleep disturbance will be present. The chance of "awakening" (1 in 75) relates not to aircraft noise levels at 90 dB(A) SEL, but to aircraft noise levels in the range 90 to 100 dB(A) SEL.

7B.6.44 This study, in contrast to some other similar studies, used social survey methods with actigraphy and Electroencephalogram (EEG) recordings on a sub-group of participants, to enable validation of the actigraphy with respect to aircraft noise-induced sleep disturbance. The participants of the sub groups were tested to determine what movements they made during the night while asleep in their homes against the varying noise environment. The findings suggest that the extent to which people experience sleep disturbance due to aircraft noise is much less pronounced in field studies where they are sleeping in their own home, compared to laboratory studies, where subjects are sleeping in unfamiliar surroundings.

7B.6.45 Research reported by Basner[35] recently for the WHO, records the findings of a more developed method of assessing sleep disturbance, stating that the gold standard for measuring sleep is polysomnography, which involves EEG but also eye movement and muscle tone measurement. This research results in a method for estimating the probability of a sleep stage change to awake.

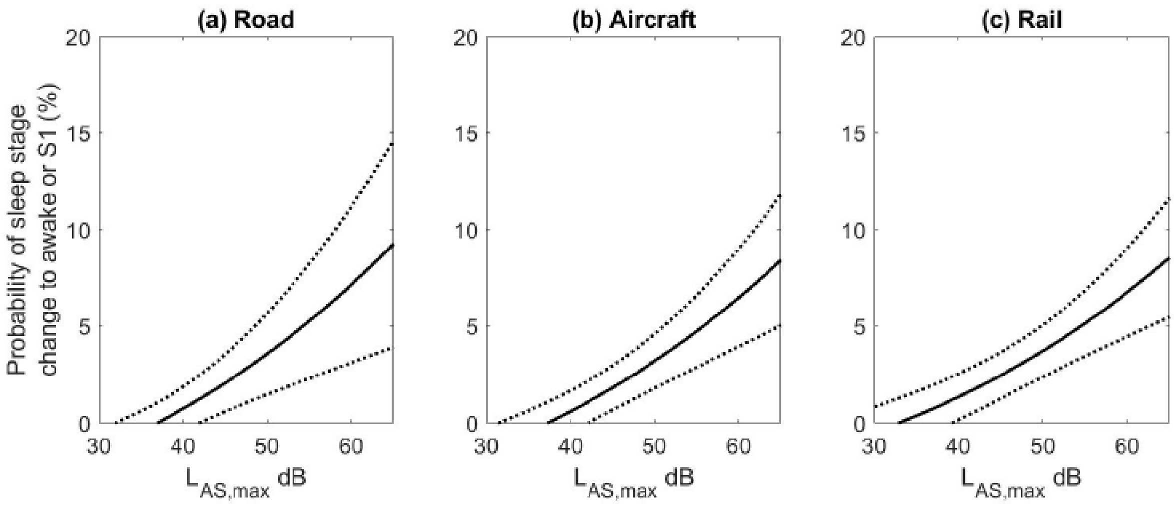


Figure 6. Probability of additional sleep stage changes to awake or S1 in a 90 s time window following noise event onset depending on the maximum indoor sound pressure level ($L_{AS,max}$) for (a) road (STRAIN and DEUFRAKO, *N* = 94 subjects); (b) aircraft (STRAIN, *N* = 61); and (c) rail noise (DEUFRAKO, *N* = 33). 95% confidence intervals (dashed lines). Results are for the three unadjusted models.

7B.6.46 The above graphs indicates that, for an indoor sound level of 45 dB L_{Amax}, there is around a 2% probability of an additional sleep stage change to awake. At 65 dB L_{Amax}, this increases to around 8%. It is relevant to note that individuals will not only awaken during the night due to noise events but also spontaneously.

[45] Ollerhead, J.B. et al (1992). Report of a Field Study of Aircraft Noise and Sleep Disturbance: A Study Commissioned by the Civil Aviation Policy Directorate of the Department of Transport from the Department of Safety, Environment and Engineering, Civil Aviation Authority. London: HMSO.

7B.6.47 This latest research has not yet been translated into any direct guidance for the assessment of environmental noise at night. The assessment of the effects of individual aircraft events are therefore based on the information in **Table 7B.13** in this noise chapter.

Table 7B.13 Air noise assessment criteria – Single Aircraft Events, outdoors (night-time)

Action	Description	L_{Amax} dB(A)	SEL dB(A)
Mitigate and reduce to a minimum	More than 10 -15 events per night	60	70
Avoid	More than one event per night	80	90
Prevent	More than one event per night	90	100

7B.6.48 N60 contours are used in this assessment to illustrate how, for a given point on the ground, the number of aircraft events producing a level of 60 dB L_{Amax} or more will change between two scenarios.

7B.6.49 SEL and L_{Amax} contours are also presented for the most common aircraft operating at Bristol Airport, such as the Airbus A320, Boeing 737-800, and the future aircraft types, the Boeing 737Max and Airbus A320Neo.

7B.6.50 In addition to the above, to assist in drawing together the effects of noise on sleep for each of the four scenarios considered in this ES, the percentage of those people likely to be highly sleep disturbed has been calculated. The method used is that recommended by Defra[46] based on the L_{night} index and used in Defra's WebTag analysis tools to monetise the impacts of noise relating to sleep disturbance. It uses the following relationship for air noise:

7B.6.51 $\% \text{ Highly Sleep Disturbed} = 18.147 – 0.956 L_{night} + 0.01482(L_{night})^2$

7B.6.52 Defra advise that data below 45 dB should be excluded due to the unreliability of noise data at very low levels due to the weak relationship at this level. Data above 65 dB is assumed to be constant due to a lack of data to establish a robust relationship at high levels.

Non-Residential Receptors - schools

7B.6.53 BB93[37] sets out performance standards for indoor ambient noise levels within different types of room in terms of the $L_{Aeq,30min}$ index as given in **Table 7B.14**.

Table 7B.14 Schools – Indoor Ambient Noise Levels

Location	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

[46] Department for Environment Food and Rural Affairs (2014). Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet. [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/380852/environmental-noise-valuing-imapcts-PB14227.pdf [Checked 26/09/2018].

7B.6.54 To achieve the internal ambient noise level inside a classroom using natural ventilation, external noise levels should not exceed 55 dB $L_{Aeq,30min}$.

7B.6.55 Noise levels in unoccupied playgrounds, playing fields and other outdoor areas should not exceed 55 dB $L_{Aeq,30min}$.

Non-Residential Receptors - Healthcare Facilities

7B.6.56 Guidance on recommended internal noise levels for healthcare facilities is given in HTM 08-1 (2013)[38] 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 $L_{Amax,F}$ (events that occur several times per night)

7B.6.57 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, assuming a partly open window.

Non-Residential Receptors - Places of Worship

7B.6.58 There is no specific assessment criteria for places of worship. They are however places where quiet conditions are required and, for the purposes of this assessment, the same criteria as used to rate the effects of noise on residential receptors has been adopted, for the daytime period only.

Non-Residential Receptors - Amenity Areas

7B.6.59 Amenity areas includes those external areas used by the public for their quiet enjoyment of the outdoors. This includes, for example, parks, playgrounds, sports fields and public gardens.

7B.6.60 Based on guidance in *BS 8233*[36], it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$.

7B.6.61 It is recognised in *BS 8233* that these guideline values are not achievable in all circumstances where development might be desirable.

Airborne aircraft vibration

7B.6.62 Low frequency noise from airborne aircraft has the potential to cause perceptible vibration levels within dwellings. For this reason, the most appropriate noise metric to assess the likelihood of these effects is the maximum C-weighted noise level, denoted L_{Cmax}. C-weighting gives more weight to low frequency noise rather than the more commonly used A-weighting, which approximates the average human hearing response to noise in different frequencies.

7B.6.63 This effect is most obviously characterised by effects such as windows rattling. As discussed in the Historic England report[42], aircraft passbys that produce a maximum noise level above 97 dB L_{Cmax} are likely to produce an audible rattle of windows. While it is appreciated that low frequency noise from aircraft can induce perceptible vibration levels in lightweight structures and loose fitting components, the levels of vibration are below those at which even minor cosmetic damage would be likely to occur.

7B.6.64 Vibration effects due to airborne aircraft can vary depending on the specific details of the building, for example the room dimensions which can cause resonance effects at certain frequencies. Resonances increase the sound level in parts of the room and decrease it in others.

7B.6.65 The noise level of 97 dB L_{Cmax} has therefore been taken as a threshold for potential significance of vibration effects due to airborne aircraft. Whether a significant effect occurs between scenarios will depend on the number of dwellings affected and the frequency of the events.

7B.6.66 The other potential effect from airborne aircraft vibration is vortex damage to buildings. This is best explained by an extract from the *Airports and the Environment*[43] report:

7B.6.67 "*Less of an environmental problem, but one that affects community relations, is that of vortex damage to properties within neighbouring communities. Vortices, which are circulating currents of air created by the passage of aircraft, are generally dispersed by wind and air turbulence before they reach the ground. However, in certain weather conditions they can reach ground level and can dislodge unsecured roofing tiles.*"

7B.6.68 This effect is both rare and unpredictable as specific weather conditions are required for it to occur. As the Proposed Development does not affect which aircraft types are able to use Bristol Airport, it is not expected that there will be any significant effect on the occurrence of vortex damage, as aircraft type influences the magnitude of the associated vortices, and therefore this has not been assessed in detail.

Ground noise assessment criteria

7B.6.69 There is no definitive agreement on the method of assessment of aircraft ground noise. Various methods have been adopted in the past, and these have led to the assessment of ground noise in terms of the equivalent continuous sound level, $L_{Aeq,T}$, for various time periods. As is convention, consideration is given in this assessment to the $L_{Aeq,16h}$ metric for the daytime period of 07:00 to 23:00 and the $L_{Aeq,8h}$ metric for the night-time period of 23:00 to 07:00.

Residential

7B.6.70 The ground noise level assessed at various receptors can be compared to the existing ambient environmental noise and published guidelines for the assessment of environmental noise. WHO recommends a guideline value of 50 dB $L_{Aeq,16h}$ to prevent 'moderate' community annoyance and 55 dB $L_{Aeq,16h}$ for 'serious' community annoyance[32].

7B.6.71 To put these guidance criteria into context over half of the population is exposed to levels which exceed the 55 dB L_{Aeq} guideline for 'serious' community annoyance. This was confirmed by the results of the Defra funded 2000/2001 *National Noise Incidence Study*[47] given in **Table 7B.15**.

[47] BRE (2002). The National Noise Incidence Study 2000/2001 (United Kingdom): Volume 1 – Noise Levels, Client report number 206344f, [online]. Available at: http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=2ahUKEwi-t-mQ16jdAhVJUlAKHTMiD-kQFjAAegQIABAC&url=http%3A%2F%2Frandd.defra.gov.uk%2FDocument.aspx%3FDocument%3D10280_NIS1206344f.pdf&usg=AOvVaw2R14Uu8gQF3HgMnuM0z5ui [Checked 07/09/2018].

Table 7B.15 Results of 2000/2001 National Noise Incidence Survey

Environmental Noise Levels in UK, daytime $L_{Aeq,16h}$ dBA	Population of UK so exposed (%)
50	90
55	54
60	23
65	9

7B.6.72 The ambient noise levels in the area around Bristol Airport have been measured to lie in the range 50 dB(A) to 60 dB(A) $L_{Aeq,16h}$ during the daytime with an underlying background noise level in the range 35 dB(A) to 50 dB(A) L_{AF90}. The background noise levels better reflect the noise environment in the absence of aircraft noise and other intermittent environmental noise sources.

7B.6.73 The area around Bristol Airport is generally rural in nature and therefore non aircraft related ambient noise levels and background noise levels can be expected to be lower than would be measured in a city.

7B.6.74 **Table 7B.16** sets out the general noise criteria used in this assessment based on the WHO guidance.

Table 7B.16 General noise criteria for ground noise assessment

Source	Sound Level $L_{Aeq,16h}$ dB(A)	Form of Criterion
WHO daytime	50	Daytime - Prevents moderate community annoyance
WHO Night-time	45	Night-time – Allows people to sleep with windows open

7B.6.75 Based on the standards in *BS 8233*[36] for dwellings, the above levels would ensure that the recommended indoor noise levels of 35 dB $L_{Aeq,16h}$ within living rooms and 30 dB $L_{Aeq,8h}$ within bedrooms, would be achieved with windows partly open.

7B.6.76 If windows are closed, an additional protection of around 10 dB can be expected. If ground noise were to rise above these levels, some form of additional mitigation, such as sound insulation treatment to the dwelling, would be required to protect people inside dwellings from the effects of ground noise.

7B.6.77 Sound insulation can only provide so much protection to a dwelling, typically around 35 dB, and once the noise level outside a dwelling rises beyond a certain value, mitigation in itself will not provide sufficient protection.

7B.6.78 On the basis of the above, the absolute noise values corresponding to indicative LOAEL, SOAEL and UAEL values are given in **Table 7B.17**.

Table 7B.17 Ground noise assessment criteria – absolute, outdoors

Action	Effect Level	Indicative daytime level $L_{Aeq,16h}$ dB(A)	Indicative night-time level $L_{Aeq,8h}$ dB(A)
Mitigate and reduce to a minimum	Lowest Observed Adverse Effect Level (LOAEL)	50	45
Avoid	Significant Observed Adverse Effect Level (SOAEL)	60	55
Prevent	Unacceptable Adverse Effect Level (UAEL)	70	65

7B.6.79 The subjective description of the absolute levels of ground noise, expressed in terms of the ground noise contour bands used in the figures in this noise chapter, can be expressed as per the information presented in **Table 7B.18**.

Table 7B.18 Ground noise assessment criteria – subjective, outdoors

Significance of Impact	Daytime criteria $L_{Aeq,16h}$ dB(A)	Night-time criteria $L_{Aeq,8h}$ dB(A)	
Negligible	50	45	LOAEL
Minor	55	50	
Significant - Moderate	60	55	SOAEL
Significant - Substantial	65	60	
Significant – Very Substantial	70	65	UAEL

7B.6.80 In addition to absolute noise level, the relative change in noise level between operational scenarios is used to assess ground noise. A potential significance rating for a change in level is given in **Table 7B.19**.

Table 7B.19 Ground noise impact ratings - outdoors, change in noise level

Change in noise level dB	Subjective impression	Impact classification
0 to 2	Imperceptible change	Negligible
2 to 3	Barely perceptible change	Minor
3 to 6	Perceptible change	Moderate
6 to 9	Up to a halving or a doubling of loudness	Substantial
> 9	Equal to or more than a halving or doubling of loudness	Very substantial

7B.6.81 **Table 7B.20** is used in this assessment to indicate those dwellings that will be exposed both to a given level of absolute noise and a change in noise, resulting from a change in operations from one scenario to another. The contour values given in **Table 7B.20** relate to the daytime assessment. A similar table with different contour values is used for the night-time assessment.

Table 7B.20 Number of Dwellings exposed to Absolute Noise and Change in Noise - Daytime

Subjective description of impact	Contour band dB $L_{Aeq,16h}$	Number of dwellings in band	Beneficial or adverse change	Negligible 0 – 2 dB	Minor 2 – 3 dB	Moderate 3 – 6 dB	Substantial 6 – 9 dB	Very Substantial >9 dB
				Change in Noise Level, dB Potential Impact Classification				
Negligible	**50 (LOAEL)**		Beneficial					
			Adverse					
Minor	**55**		Beneficial					
			Adverse					
Significant Moderate	**60 (SOAEL)**		Beneficial					
			Adverse					
Significant Substantial	**65**		Beneficial					
			Adverse					
Significant Very Substantial	**70 (UAEL)**		Beneficial					
			Adverse					
Total			Beneficial					
			Adverse					

Non-Residential Receptors - schools

7B.6.82 BB93[37] sets out performance standards for indoor ambient noise levels within different types of rooms in terms of the $L_{Aeq,30min}$ index as given in **Table 7B.21**.

Table 7B.21 Schools – Indoor Ambient Noise Levels

Location	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

7B.6.83 To achieve the internal ambient noise level inside a classroom using natural ventilation, external noise levels should not exceed 55 dB $L_{Aeq,30min}$.

7B.6.84 Noise levels in unoccupied playgrounds, playing fields and other outdoor areas should not exceed 55 dB $L_{Aeq,30min}$.

Non-Residential Receptors - Healthcare Facilities

7B.6.85 Guidance on recommended internal noise levels for healthcare facilities is given in HTM 08-1 (2013)[38] 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 $L_{Aeq,1h}$; and
- Night: 45 dB $L_{Amax,F}$ (events that occur several times per night).

7B.6.86 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, assuming a partly open window.

Non-Residential Receptors - Places of Worship

7B.6.87 There is no specific assessment criteria for places of worship. They are however places where quiet conditions are required and, for the purposes of this assessment, the same criteria as used to rate the effects of noise on residential receptors has been adopted, for the daytime period only.

Non-Residential Receptors - Amenity Areas

7B.6.88 Amenity areas includes those external areas used by the public for their quiet enjoyment of the outdoors. This includes, for example, parks, playgrounds, sports fields and public gardens.

7B.6.89 Based on guidance in *BS 8233*[36], it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$.

7B.6.90 It is recognised in *BS 8233* that these guideline values are not achievable in all circumstances where development might be desirable.

Road traffic noise assessment criteria

7B.6.91 The criteria used in the road traffic noise assessment considers the noise criteria within the *Noise Insulation Regulations 1975* (as amended 1988)[14] and the Highways England's *Design Manual for Roads and Bridges* (DMRB)[48].

7B.6.92 Road traffic noise is commonly measured and assessed in the UK in terms of the L_{A10} index over the 18 hour period from 06:00 to 24:00. This index, known as $L_{A10,18h}$, is used to rate the potential impacts of road traffic noise arising for example from a change in a highway. Legislation exists in the form of the *Noise Insulation Regulations* to offer sound insulation to people who are significantly affected by the introduction of a new highway or changes to a highways scheme where the noise level rises above a certain value as a result of the change in traffic flow. Under this legislation, the trigger level for introducing a noise insulation scheme is expressed as a façade level of 68 dB $L_{A10,18h}$. This can be converted back to an $L_{Aeq,16h}$ index by applying a correction of -3 dBA to convert from the façade level to a free-field level, and by applying a further correction of -2 dBA to convert from $L_{A10,18h}$ to $L_{Aeq,16h}$ for road traffic noise. The resulting trigger level in this case is 63 dB $L_{Aeq,16h}$.

7B.6.93 The significance of impacts from the magnitude (or absolute) noise from road traffic noise is given in **Table 7B.22**.

[48] Highways England (2018). Design Manual for Roads and Bridges, [Online]. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/index.htm [Checked 24/04/ 2018].

Table 7B.22 Road traffic noise assessment criteria – outdoor absolute level

Significance of Impact	Daytime criteria facade $L_{A10,18h}$ dB
Negligible	55 (LOAEL)
Minor	60
Significant - Moderate	68 (SOAEL)
Significant - Substantial	70
Significant – Very Substantial	75 (UAEL)

7B.6.94 The absolute noise values corresponding to indicative NPSE LOAEL and SOAEL values are given in **Table 7B.23**.

Table 7B.23 Road traffic noise assessment criteria – Indicative values for LOAEL and SOAEL

Action	Effect Level	Daytime criteria facade $L_{A10,18h}$ dB
Mitigate and reduce to a minimum	Lowest Observed Adverse Effect Level (LOAEL)	60
Avoid	Significant Observed Adverse Effect Level (SOAEL)	68
Prevent	Unacceptable Adverse Effect Level (UAEL)	75

7B.6.95 The subjective importance of changes in road traffic noise level on people relates to the magnitude of the change and, to some extent, when it occurs. A significance rating for a change in level, taken from the *DMRB*[48].

7B.6.96 *DMRB* provides objective assessment criteria in terms of changes in noise for both the 'short term' and the 'long term'. Evidence suggests that residents are much more likely to perceive very small changes in average daytime noise level (1 to 3 dBA) following the opening of a major road infrastructure project. Over time, people become accustomed to the change and respond to any changes in traffic flow and associated change in noise conditions with reduced sensitivity.

7B.6.97 These are indicative as the impact of a relative change in level also depends on the absolute level associated with it and the noise conditions prior to the change.

7B.6.98 In addition to absolute noise level, the relative change in noise level between operational scenarios is used to assess road traffic noise. Accepting that the overall effects of road traffic noise require a consideration of both the absolute level as well as the change in noise level, a potential significance rating for a change in level is given in **Table 7B.24** for short term and long term impacts.

Table 7B.24 Road traffic noise impact ratings: Significance magnitude classification

Significance of impact	Change in Noise Level $L_{A10,18h}$ (dB)	
	Short Term	Long Term
No change	0.0	0.0
Negligible - Adverse	0.1 to 0.9	0.1 to 2.9
Significant Minor - Adverse	1.0 to 2.9	3.0 to 4.9
Significant Moderate - Adverse	3.0 to 4.9	5.0 to 9.9
Significant Substantial - Adverse	≥ 5.0	≥ 10.0

7B.6.99 As no new roads are being built as part of the Proposed Development, the long term changes in noise level given in **Table 7B.24** are the only changes relevant to this assessment.

Construction noise and vibration assessment criteria

Construction noise

7B.6.100 *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*[49] (referred to herein as *BS 5228-1*) is the current guidance and approved code of practice document for the control of construction noise. This provides guidance on methods of controlling noise and provides methods to predict, measure and assess the impact of construction and demolition noise. The guidance in the document can be considered to present recommendations for best practical means to control noise on site.

7B.6.101 An informative Annex is included in *BS 5228-1* that provides guidance on objectively assessing the significance of construction noise. It advises that a pragmatic approach needs to be taken when assessing the noise effects of any construction project and suggests the guidance provided in the annex would generally only apply to projects of significant size, and lesser projects might not need to be assessed or might only require general consideration of noise effects and mitigation. For large infrastructure projects for example, it highlights historically the procedure that has developed in the UK based on the use of fixed noise limits and also additionally introduces alternative methods used to rate the potential significance of construction noise, based on prevailing ambient noise conditions.

7B.6.102 There are no universally recognised or mandatory UK standards or guidelines that set out limits for construction noise. The historical use of fixed noise limits for projects of significant size is described in *BS 5228* which sets out a subjective principle as follows:

"Noise from construction and demolition sites should not exceed the level at which conversation in the nearest building would be difficult with the windows shut."

7B.6.103 It also goes onto describe external noise limits as:

"Noise levels, between say 07:00 and 19:00 hours, outside the nearest window of the occupied room closest to the site boundary should not exceed:

[49] British Standards Institution (2008). BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise, [online]. Available at: https://shop.bsigroup.com/ProductDetail?pid=000000000030258086 [Checked 24/08/2018].

- *70 decibels (dBA) in rural, suburban and urban areas away from main road traffic and industrial noise;*
- *75 decibels (dBA) in urban areas near main roads in heavy industrial areas*."

7B.6.104 *BS 5228-1* also provides details of alternative methods of assessment to determine the potential for a significant noise effect, reproduced in **Table 7B.25**, by testing the construction noise level against the prevailing baseline noise level (that is, the noise level in the absence of construction noise). If the site noise level exceeds the appropriate category value, then a potential significant effect is indicated. The assessor then needs to consider other project-specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect.

Table 7B.25 Example threshold of potential significant effect at dwelling

Assessment category and threshold value period	$L_{Aeq,T}$ Threshold value dB(A)		
	Category A[1]	Category B[2]	Category C[3]
Daytime (07:00–19:00) and Saturdays (07:00–13:00)	65	70	75
Night-time (23:00 – 07:00)	45	50	55

1. Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.
2. Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.
3. Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.

7B.6.105 A further alternative method is available where noise levels generated by site activities are deemed to be potentially significant if the total noise (pre-construction ambient plus site noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB $L_{Aeq,T}$ from site noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant effect.

7B.6.106 *BS 5228-1* also provides examples of noise thresholds used for the introduction of both sound insulation treatment (or the reasonable costs thereof) and temporary re-location. It is stated in BS 5228-1 that:

"If the contractor has applied best practicable means to the provision of mitigation, i.e. all reasonable measures have been taken to reduce the noise levels, but levels are still such that widespread community disturbance or interference with activities or sleep is likely to occur, there are two further provisions that can be made if the construction activities are likely to continue for a significant period of time either continuously or sporadically."

7B.6.107 The first provision is noise insulation. For eligibility for sound insulation the daytime Monday to Friday (08:00-18:00) and Saturday morning (08:00-13:00) threshold is 75 dB $L_{Aeq,10h/5h}$ at 1 metre outside the most exposed window or door of the façade of any eligible dwelling. This level also needs to be exceeded for a period of 10 or more days of working in any 15 consecutive days or for a total number of days exceeding 40 in any 6 consecutive months.

7B.6.108 The second provision is temporary or permanent re-housing. For eligibility for temporary rehousing the daytime Monday to Friday (08:00-18:00) and Saturday morning (08:00-13:00) threshold is at least 85 dB $L_{Aeq,10h/5h}$. This level also needs to be exceeded for a period of 10 or more days of working in any 15 consecutive days or for a total number of days exceeding 40 in any 6 consecutive months.

7B.6.109 Typical daytime ambient noise levels around Bristol Airport lie between 50dB $L_{Aeq,12h}$ and 60dB $L_{Aeq,12h}$ during the daytime and 45dB $L_{Aeq,8h}$ and 55dB $L_{Aeq,8h}$ during the night-time (see **Appendix 7C**). On this basis, based on the ABC method in *BS 5228-1*, a value of 65dB $L_{Aeq,12h}$ would be appropriate as a threshold for a potentially significant effect to be indicated for the Proposed Development construction works during the daytime and 55 dB $L_{Aeq,8h}$ during the night-time. These criteria should be considered a target not normally to be exceeded at 1m from the façade of any noise sensitive residential or business receptors.

7B.6.110 The criteria adopted to rate construction noise are summarised in **Table 7B.26**. These are daytime noise levels that, if exceeded outside a noise sensitive receptor, indicate a potential adverse and significant adverse effect. This table also provides an indication of the Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL) values as referred to in the *Noise Policy Statement for England*[16], as well as the Unacceptable Adverse Effect Level as referred to in the *Planning Practice Guidance*[17].

Table 7B.26 Construction noise assessment criteria – absolute

Significance of impact	Effect level	Daytime outdoor noise level, dB $L_{Aeq,12h}$	Night-time outdoor noise level, dB $L_{Aeq,8h}$
Negligible	LOAEL	55	45
Minor		60	50
Significant - Moderate	SOAEL	65	55
Significant - Substantial		75	65
Significant – Very Substantial	UAEL	85	75

7B.6.111 In summary, the threshold for a potentially significant effect from construction noise adopted in this assessment is 65 dB $L_{Aeq,12h}$ for the daytime (07:00-19:00) and 55 dB $L_{Aeq,8h}$ for the night-time (23:00-07:00).

Construction vibration

7B.6.112 Vibration levels due to construction works associated with the Proposed Development have been assessed using the significance criteria given in *BS 5228-2:2009+A1:2014*[50] (*BS5228-2*) in terms of peak particle velocity (PPV).

7B.6.113 Vibration criteria are given in both terms of human and building response, where human response criteria are more stringent. **Table 7B.27** contains the assessment criteria used, which are based on absolute values.

[50] British Standards Institution (2009). BS5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration, [online]. Available at: https://shop.bsigroup.com/ProductDetail/?pid=000000000030258089 [checked 28/09/2018].

Table 7B.27 Vibration limits for human response and building damage

Vibration limit, PPV mms^{-1}	Effect	Impact
< 0.14	Vibration unlikely to be perceptible.	None
0.14	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.	Negligible
0.3	Vibration might be just perceptible in residential environments.	Minor
1.0	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.	Moderate
7.5	Guide value for cosmetic damage of residential buildings where dynamic loading may lead to resonance.	Significant
10.0	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.	Very Significant

7B.6.114 On the basis of the above table, the threshold for a potentially significant effect from construction vibration adopted in this assessment is 1.0 mms^{-1} PPV during the daytime (07:00-23:00) and 0.3 mms^{-1} during the night-time.

Appendix 7C
Baseline Noise and Vibration

7C.1 Introduction

7C.1.1 This appendix of the Environmental Statement (ES) provides a description of the baseline noise and vibration environment in the vicinity of Bristol Airport. The baseline in this context is the current noise and vibration environment.

7C.1.2 The baseline vibration conditions in the vicinity of residential buildings around Bristol Airport are generally dictated by localised road traffic conditions. For dwellings along major roads, heavy vehicles such as buses and lorries have the potential when passing to produce perceptible vibration levels within them. For those dwellings located away from busy roads, vibration levels will be low and the occupants are unlikely to be aware of any vibration within their premises from outside sources. As a result, no vibration measurements have been undertaken and it is this low baseline of vibration against which the Proposed Development will be assessed.

7C.1.3 Measurements of baseline noise have been taken through long-term unattended surveys in addition to attended surveys for the assessment of environmental and construction noise.

7C.1.4 This appendix includes:

- The basis of the baseline noise measurement;
- The methodology of the baseline noise measurement; and
- The results of the baseline noise measurement.

7C.2 Baseline measurement methodology

7C.2.1 The survey equipment used is summarised in **Table 7C.1**. All instrumentation was calibrated prior to and after the surveys with no significant drift observed. Calibration certificates for all sound level meters used are available on request.

Table 7C.1 Baseline noise monitoring instrumentation

Measurement	Manufacturer	Model	Serial number
Long-term	Norsonic	140	4311021
Long-term	Norsonic	140	4310309
Long-term	Norsonic	140	4191723
Long-term	Norsonic	140	4294723
Ground noise	Norsonic	140	1403409
Road traffic noise	Norsonic	140	1405622

Long-term noise monitoring

7C.2.2 Daytime and night-time noise surveys were undertaken at several locations around Bristol Airport during the period 13 March 2018 to 5 April 2018, with each survey lasting at least three weeks. Long-term noise monitoring locations are shown in **Figure 7C.1** and summarised in **Table 7C.2**.

Table 7C.2 Long-term noise monitoring locations

Receptor	Location	Dates of noise survey
A	Cooks Bridle Path, Downside	14 March 2018 to 4 April 2018
B	Downside Road, Lulsgate Bottom	13 March 2018 to 5 April 2018
C	School Lane, Lulsgate Bottom	13 March 2018 to 3 April 2018
D	Red Hill (A38), Redhill	14 March 2018 to 5 April 2018

7C.2.3 Each noise survey comprised unattended, free-field monitoring of a continuous sequence of 5 minute periods. Observations were made at each monitoring location of the noise climate prevailing at the time that measurements were started.

7C.2.4 Noise levels have been presented in terms of $L_{Aeq,T}$ and L_{AF90} for the 16 hour day (07:00 to 23:00), 12 hour day (07:00 to 19:00) and 8 hour night (23:00 to 07:00) periods.

7C.2.5 Plots showing long-term noise profiles at each of the above four receptor locations are shown in **Graph 7C.1** to **Graph 7C.12** at the end of this Appendix.

Ground noise monitoring

7C.2.6 A daytime attended noise survey was undertaken at Bristol Airport on 26 July 2018 to measure the ground noise of taxiing arriving and departing aircraft.

7C.2.7 The measurements were taken at position G1, shown in **Figure 7C.2**, which was at a distance of approximately 40 meters from the centre of the Apron.

7C.2.8 Measurements were free-field, of 30 second duration and recorded in terms of $L_{Aeq,T}$, SEL and L_{ASmax}, with observations made of the aircraft type at each time.

Road traffic noise monitoring

7C.2.9 An attended noise survey was undertaken to measure environmental noise, including road traffic noise at various locations around Bristol Airport, shown in **Figure 7C.2** and summarised in **Table 7C.3**, on 26 July 2018. All measurement locations were free-field positions.

7C.2.10 The principles of the Department of Transport's *Calculation of Road Traffic Noise*[1] (*CRTN*) shortened measurement method were used, with three measurements of 5 minute duration taken in three consecutive hours at each location. Values of $L_{A10,T}$ were obtained at each location, along with other environmental noise indices including $L_{Aeq,T}$, $L_{A90,T}$ and L_{AFmax}.

[1] Department of Transport (1988). Calculation of Road Traffic Noise. Department of Transport Welsh Office. London: HMSO.

Table 7C.3 Road traffic noise monitoring locations

Position	Location
R1	Downside Road
R2	A38 / Downside Road intersection
R3	A38 / North Side Road roundabout
R4	A38 / road to Old Barn Lane intersection

7C.3 Baseline measurement basis

7C.3.1 The noise climate around Bristol Airport includes noise from aircraft activity as well as non-aircraft related activities. The baseline at any given location will largely depend on its proximity to Bristol Airport as well as to major or minor roads. The A38 in particular is a major contributor to noise, with occasional noise also produced by traffic on minor roads, alongside departing and arriving aircraft at Bristol Airport and aircraft activity on the ground.

7C.3.2 Noise monitoring locations were selected to obtain representative ambient and background noise levels at those noise sensitive receptor locations close to Bristol Airport, that is, at receptors most at risk of being affected by aircraft operations from Bristol Airport.

7C.4 Baseline measurement results

Long-term noise monitoring

7C.4.1 A summary of average values for each measurement location is given in **Table 7C.4** to **Table 7C.6**.

Table 7C.4 Long-term noise monitoring results – all receptors, average 16 hour day (07:00 – 23:00)

Metric	Receptor			
	A	B	C	D
$L_{Aeq,16h}$ dB	53	58	59	50
Average L_{AF90} dB[1]	38	49	47	42

1. Average of $L_{AF90,5m}$ measurements

Table 7C.5 Long-term noise monitoring results – all receptors, average 12 hour day (07:00 – 19:00)

Metric	Receptor			
	A	B	C	D
$L_{Aeq,12h}$ dB	54	59	60	51
Average L_{AF90} dB[1]	39	51	48	43

1. Average of $L_{AF90,5m}$ measurements

Table 7C.6 Long-term noise monitoring results – all receptors, average 8 hour night (23:00 – 07:00)

Metric	Receptor			
	A	B	C	D
$L_{Aeq,8h}$ dB	49	54	54	47
Average L_{AF90} dB[1]	37	47	42	37

1. Average of $L_{AF90,5m}$ measurements

7C.4.2 The results indicate that the general ambient noise level around Bristol Airport lies in the range of 50 to 60 dB L_{Aeq} during daytime with an underlying background noise level in the range 35 to 50 dB L_{AF90}.

7C.4.3 During the night, ambient noise levels generally lie in the range 45 to 55 dB L_{Aeq}, with background levels generally around 35 to 45 dB L_{AF90}.

Receptor A (Cooks Bridle Path)

7C.4.4 The noise survey at Receptor A (Cooks Bridle Path) was carried out from 14 March 2018 to 4 April 2018. This receptor lies on the north side of the runway, away from major roads, and is the closest of all four measurement positions to the runway. Noise levels are dominated by aircraft movements with little to no traffic noise.

7C.4.5 Results are given in **Table 7C.7** to **Table 7C.9**.

Table 7C.7 Long-term noise monitoring results – Receptor A, 16 hour day (07:00 – 23:00)

Date	$L_{Aeq,16h}$ dB	Average $L_{AF90,5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
14/03/2018	57	48	7	1.2
15/03/2018	55	40	4	6.8
16/03/2018	55	39	3	11.4
17/03/2018	52	42	8	0.4
18/03/2018	53	47	8	0.0
19/03/2018	51	42	8	2.4
20/03/2018	47	33	4	0.0
21/03/2018	54	36	4	0.0
22/03/2018	55	36	5	0.4
23/03/2018	55	37	5	4.4
24/03/2018	48	32	4	3.8
25/03/2018	50	30	3	0.0
26/03/2018	54	35	3	0.8
27/03/2018	55	37	6	6.2
28/03/2018	55	34	4	7.2
29/03/2018	56	34	4	4.6
30/03/2018	52	40	3	7.6
31/03/2018	51	30	4	4.2
01/04/2018	53	43	3	8.0
02/04/2018	58	37	5	11.4
03/04/2018	57	39	5	0.0
Range	47 – 58	30 – 48	3 – 8	0 – 11.4
Average	53	38	5	3.8

Table 7C.8 Long-term noise monitoring results – Receptor A, 12 hour day (07:00 – 19:00)

Date	$L_{Aeq,12h}$ dB	Average $L_{AF90,5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
14/03/2018	59	48	7	1.2
15/03/2018	56	40	4	6.8
16/03/2018	55	37	3	11.4
17/03/2018	53	46	8	0.4
18/03/2018	53	44	8	0.0
19/03/2018	51	44	8	2.4
20/03/2018	48	36	4	0.0
21/03/2018	54	36	4	0.0
22/03/2018	56	36	5	0.4
23/03/2018	56	37	5	4.4
24/03/2018	49	36	4	3.8
25/03/2018	50	31	3	0.0
26/03/2018	54	32	3	0.8
27/03/2018	55	39	6	6.2
28/03/2018	55	38	4	7.2
29/03/2018	57	39	4	4.6
30/03/2018	53	40	3	7.6
31/03/2018	52	33	4	4.2
01/04/2018	52	36	3	8.0
02/04/2018	58	41	5	11.4
03/04/2018	57	40	5	0.0
Range	48 – 59	31 – 48	3 – 8	0 – 11.4
Average	54	39	5	3.8

Table 7C.9 Long-term noise monitoring results – Receptor A, 8 hour night (23:00 – 07:00)

Date	$L_{Aeq,8h}$ dB	Average $L_{AF90.5m}$ dB	Daily Average Wind speed ms[-1]	Daily Precipitation mm
15/03/2018	49	41	4	6.8
16/03/2018	49	35	3	11.4
17/03/2018	48	38	8	0.4
18/03/2018	44	39	8	0.0
19/03/2018	43	38	8	2.4
20/03/2018	45	35	4	0.0
21/03/2018	44	33	4	0.0
22/03/2018	43	34	5	0.4
23/03/2018	52	40	5	4.4
24/03/2018	46	39	4	3.8
25/03/2018	47	35	3	0.0
26/03/2018	51	30	3	0.8
27/03/2018	54	40	6	6.2
28/03/2018	49	34	4	7.2
29/03/2018	53	34	4	4.6
30/03/2018	52	38	3	7.6
31/03/2018	50	35	4	4.2
01/04/2018	48	30	3	8.0
02/04/2018	57	43	5	11.4
03/04/2018	57	37	5	0.0
04/04/2018	57	41	6	4.0
Range	43 – 57	30 – 43	3 – 8	0 – 11.4
Average	49	37	5	4.0

Receptor B (Downside Road)

7C.4.6 The noise survey at Receptor B (Downside Road) was carried out from 13 March 2018 to 5 April 2018. Downside Road runs near parallel to the north side of Bristol Airport. Noise levels are dominated by aircraft movements, as the location is close to flight paths, and frequent road traffic noise.

7C.4.7 Results are given in **Table 7C.10** to **Table 7C.12**.

Table 7C.10 Long-term noise monitoring results – Receptor B, 16 hour day (07:00 – 23:00)

Date	$L_{Aeq,16h}$ dB	Average $L_{AF90.5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
13/03/2018	56	50	3	0.0
14/03/2018	59	52	7	1.2
15/03/2018	59	49	4	6.8
16/03/2018	59	49	3	11.4
17/03/2018	59	47	8	0.4
18/03/2018	58	48	8	0.0
19/03/2018	58	48	8	2.4
20/03/2018	60	48	4	0.0
21/03/2018	58	52	4	0.0
22/03/2018	61	53	5	0.4
23/03/2018	59	49	5	4.4
24/03/2018	57	44	4	3.8
25/03/2018	55	47	3	0.0
26/03/2018	57	49	3	0.8
27/03/2018	59	52	6	6.2
28/03/2018	59	52	4	7.2
29/03/2018	60	52	4	4.6
30/03/2018	56	50	3	7.6
31/03/2018	52	46	4	4.2
01/04/2018	58	49	3	8.0
02/04/2018	61	51	5	11.4
03/04/2018	60	51	5	0.0
04/04/2018	58	50	6	4.0
Range	52 – 61	44 - 53	3 – 8	0 – 11.4
Average	58	49	5	3.8

wood.

Table 7C.11 Long-term noise monitoring results – Receptor B, 12 hour day (07:00 – 19:00)

Date	$L_{Aeq,12h}$ dB	Average $L_{AF90,5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
13/03/2018	57	50	3	0.0
14/03/2018	59	52	7	1.2
15/03/2018	60	51	4	6.8
16/03/2018	60	51	3	11.4
17/03/2018	60	50	8	0.4
18/03/2018	58	47	8	0.0
19/03/2018	59	50	8	2.4
20/03/2018	61	49	4	0.0
21/03/2018	59	53	4	0.0
22/03/2018	61	55	5	0.4
23/03/2018	59	52	5	4.4
24/03/2018	58	47	4	3.8
25/03/2018	56	47	3	0.0
26/03/2018	58	51	3	0.8
27/03/2018	60	54	6	6.2
28/03/2018	59	53	4	7.2
29/03/2018	60	52	4	4.6
30/03/2018	56	50	3	7.6
31/03/2018	53	48	4	4.2
01/04/2018	58	47	3	8.0
02/04/2018	61	52	5	11.4
03/04/2018	60	53	5	0.0
04/04/2018	60	52	6	4.0
Range	53 – 61	47 – 55	3 – 8	0 – 11.4
Average	59	51	5	3.8

Table 7C.12 Long-term noise monitoring results – Receptor B, 8 hour night (23:00 – 07:00)

Date	$L_{Aeq,8h}$ dB	Average $L_{AF90.5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
14/03/2018	54	46	7	1.2
15/03/2018	54	48	4	6.8
16/03/2018	55	47	3	11.4
17/03/2018	53	43	8	0.4
18/03/2018	46	43	8	0.0
19/03/2018	48	43	8	2.4
20/03/2018	49	41	4	0.0
21/03/2018	54	44	4	0.0
22/03/2018	53	46	5	0.4
23/03/2018	58	52	5	4.4
24/03/2018	53	45	4	3.8
25/03/2018	54	42	3	0.0
26/03/2018	57	48	3	0.8
27/03/2018	60	50	6	6.2
28/03/2018	54	49	4	7.2
29/03/2018	57	50	4	4.6
30/03/2018	58	47	3	7.6
31/03/2018	51	47	4	4.2
01/04/2018	50	44	3	8.0
02/04/2018	58	52	5	11.4
03/04/2018	60	50	5	0.0
04/04/2018	57	47	6	4.0
05/04/2018	51	46	4	0.0
Range	46 – 60	41 – 52	3 – 8	0 – 11.4
Average	54	47	5	3.8

Receptor C (School Lane)

7C.4.8 The noise survey at Receptor C (School Lane) was carried out from 13 March 2018 to 3 April 2018. School Lane runs perpendicular to the A38 and is located close to flight paths from Bristol Airport. Noise levels are dominated by aircraft movements and frequent road traffic noise.

7C.4.9 Results are given in **Table 7C.13** to **Table 7C.15**.

Table 7C.13 Long-term noise monitoring results – Receptor C, 16 hour day (07:00 – 23:00)

Date	$L_{Aeq,16h}$ dB	Average $L_{AF90.5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
13/03/2018	55	48	3	0.0
14/03/2018	61	49	7	1.2
15/03/2018	62	46	4	6.8
16/03/2018	61	46	3	11.4
17/03/2018	61	46	8	0.4
18/03/2018	59	45	8	0.0
19/03/2018	61	46	8	2.4
20/03/2018	60	46	4	0.0
21/03/2018	57	49	4	0.0
22/03/2018	58	51	5	0.4
23/03/2018	59	47	5	4.4
24/03/2018	61	43	4	3.8
25/03/2018	57	46	3	0.0
26/03/2018	57	47	3	0.8
27/03/2018	57	50	6	6.2
28/03/2018	57	50	4	7.2
29/03/2018	61	49	4	4.6
30/03/2018	59	47	3	7.6
31/03/2018	53	47	4	4.2
01/04/2018	61	44	3	8.0
02/04/2018	60	49	5	11.4
Range	53 – 62	43 – 51	3 – 8	0 – 11.4
Average	59	47	5	3.8

Table 7C.14 Long-term noise monitoring results – Receptor C, 12 hour day (07:00 – 19:00)

Date	$L_{Aeq,12h}$ dB	Average $L_{AF90,5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
13/03/2018	56	48	3	0.0
14/03/2018	62	50	7	1.2
15/03/2018	63	48	4	6.8
16/03/2018	61	48	3	11.4
17/03/2018	62	48	8	0.4
18/03/2018	59	44	8	0.0
19/03/2018	61	47	8	2.4
20/03/2018	61	47	4	0.0
21/03/2018	57	50	4	00
22/03/2018	58	52	5	0.4
23/03/2018	59	51	5	4.4
24/03/2018	62	45	4	3.8
25/03/2018	58	46	3	0.0
26/03/2018	57	49	3	0.8
27/03/2018	58	52	6	6.2
28/03/2018	58	51	4	7.2
29/03/2018	62	49	4	4.6
30/03/2018	59	47	3	7.6
31/03/2018	54	48	4	4.2
01/04/2018	62	43	3	8.0
02/04/2018	61	51	5	11.4
Range	45 – 63	43 - 52	3 – 8	0 – 11.4
Average	60	48	5	3.8

Table 7C.15 Long-term noise monitoring results – Receptor C, 8 hour night (23:00 – 07:00)

Date	$L_{Aeq,8h}$ dB	Average $L_{AF90.5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
14/03/2018	55	39	7	1.2
15/03/2018	54	43	4	6.8
16/03/2018	54	43	3	11.4
17/03/2018	56	40	8	0.4
18/03/2018	44	39	8	0.0
19/03/2018	45	38	8	2.4
20/03/2018	51	39	4	0.0
21/03/2018	52	40	4	0.0
22/03/2018	50	44	5	0.4
23/03/2018	55	48	5	4.4
24/03/2018	56	39	4	3.8
25/03/2018	59	40	3	0.0
26/03/2018	56	45	3	0.8
27/03/2018	57	45	6	6.2
28/03/2018	52	43	4	7.2
29/03/2018	59	42	4	4.6
30/03/2018	61	42	3	7.6
31/03/2018	50	43	4	4.2
01/04/2018	50	41	3	8.0
02/04/2018	57	45	5	11.4
03/04/2018	57	45	5	0.0
Range	44 – 61	38 - 48	3 – 8	0 – 11.4
Average	54	42	5	3.8

Receptor D (Red Hill)

7C.4.10 The noise survey at Receptor D (Red Hill) was carried out from 14 March 2018 to 5 April 2018. The monitor was located on a private driveway west of the A38 and south of Bristol Airport. It is the farthest of the measurement locations from Bristol Airport and the noise climate is dominated by road traffic.

7C.4.11 Results are given in **Table 7C.16** to **Table 7C.18**.

Table 7C.16 Long-term noise monitoring results – Receptor D, 16 hour day (07:00 – 23:00)

Date	$L_{Aeq,16h}$ dB	Average $L_{AF90.5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
14/03/2018	55	49	7	1.2
15/03/2018	51	45	4	6.8
16/03/2018	49	42	3	11.4
17/03/2018	54	48	8	0.4
18/03/2018	53	48	8	0.0
19/03/2018	53	47	8	2.4
20/03/2018	49	42	4	0.0
21/03/2018	47	38	4	0.0
22/03/2018	48	41	5	0.4
23/03/2018	49	41	5	4.4
24/03/2018	49	40	4	3.8
25/03/2018	48	38	3	0.0
26/03/2018	58	39	3	0.8
27/03/2018	49	39	6	6.2
28/03/2018	48	38	4	7.2
29/03/2018	50	43	4	4.6
30/03/2018	51	45	3	7.6
31/03/2018	50	39	4	4.2
01/04/2018	48	43	3	8.0
02/04/2018	49	43	5	11.4
03/04/2018	49	43	5	0.0
04/04/2018	50	39	6	4.0
Range	47 – 58	38 – 49	3 – 8	0 – 11.4
Average	50	42	5	3.8

Table 7C.17 Long-term noise monitoring results – Receptor D, 12 hour day (07:00 – 19:00)

Date	$L_{Aeq,12h}$ dB	Average $L_{AF90,5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
14/03/2018	56	50	7	1.2
15/03/2018	52	46	4	6.8
16/03/2018	50	42	3	11.4
17/03/2018	55	51	8	0.4
18/03/2018	53	47	8	0.0
19/03/2018	54	49	8	2.4
20/03/2018	50	43	4	0.0
21/03/2018	48	39	4	0.0
22/03/2018	49	41	5	0.4
23/03/2018	49	41	5	4.4
24/03/2018	50	42	4	3.8
25/03/2018	47	38	3	0.0
26/03/2018	59	39	3	0.8
27/03/2018	49	41	6	6.2
28/03/2018	48	40	4	7.2
29/03/2018	51	46	4	4.6
30/03/2018	52	45	3	7.6
31/03/2018	51	41	4	4.2
01/04/2018	48	41	3	8.0
02/04/2018	50	46	5	11.4
03/04/2018	50	45	5	0.0
04/04/2018	51	43	6	4.0
Range	47 – 59	38 – 51	3 – 8	0 – 11.4
Average	51	43	5	3.8

Table 7C.18 Long-term noise monitoring results – Receptor D, 8 hour night (23:00 – 07:00)

Date	$L_{Aeq,8h}$ dB	Average $L_{AF90.5m}$ dB	Daily Average Wind speed ms^{-1}	Daily Precipitation mm
15/03/2018	46	40	4	6.8
16/03/2018	45	36	3	11.4
17/03/2018	49	39	8	0.4
18/03/2018	47	42	8	0.0
19/03/2018	47	43	8	2.4
20/03/2018	44	38	4	0.0
21/03/2018	46	36	4	0.0
22/03/2018	44	33	5	0.4
23/03/2018	48	40	5	4.4
24/03/2018	47	37	4	3.8
25/03/2018	47	37	3	0.0
26/03/2018	49	41	3	0.8
27/03/2018	47	36	6	6.2
28/03/2018	44	33	4	7.2
29/03/2018	46	34	4	4.6
30/03/2018	47	34	3	7.6
31/03/2018	49	39	4	4.2
01/04/2018	50	37	3	8.0
02/04/2018	48	40	5	11.4
03/04/2018	47	36	5	0.0
04/04/2018	50	37	6	4.0
05/04/2018	48	37	4	0.0
Range	44 – 50	33 - 43	3 – 8	0 – 11.4
Average	47	37	5	4.0

Ground noise monitoring

7C.4.12 Results of the ground noise survey are given in **Table 7C.19**. These have been processed to present the loudest 10 seconds around the aircraft ground noise event, in order to exclude noise from other sources.

Table 7C.19 Ground noise monitoring results

Time	Airline and Aircraft Type	$L_{Aeq,T}$[1] dB	SEL dB(A)	L_{ASmax} dB	Comments
10:20	Ryanair B738	84	94	88	Passenger jet
10:24	easyJet A320	82	92	83	Passenger jet
10:38	easyJet A320	84	94	86	Passenger jet
10:45	easyJet A319	78	88	82	Passenger jet
10:49	BMI E145	78	88	81	Passenger jet
11:03	easyJet A320	83	93	84	Passenger jet
11:20	easyJet A320	82	92	84	Passenger jet
11:45	BMI E145	75	85	77	Passenger jet
12:22	easyJet A319	80	90	83	Passenger jet
12:25	easyJet A319	80	90	83	Passenger jet
12:30	easyJet A319	81	91	83	Passenger jet
12:35	easyJet A320	81	91	84	Passenger jet
12:51	Aer Lingus AT76	94	104	96	Passenger large propeller aircraft
Average		82	92	84	

1. T = 10 seconds.

Road traffic noise monitoring

A summary of results for the road traffic noise monitoring is given in **Table C.20**. Measurement results for each location are given in **Table 7C.21** to **Table 7C.24**.

Table C.20 Road traffic noise monitoring results – summary of all positions

Location	$L_{Aeq,15m}$ dB(A)	L_{A10} dB(A)	L_{A90} dB(A)	L_{AFmax} dB(A)	Dominant Noise Source
R1 Downside Road	69	71 – 73	42 – 47	87 – 92	Road traffic
R2 A38 / Downside Road intersection	75	78 – 79	63 – 65	86 – 89	Road traffic
R3 A38 / North Side Road roundabout	69	69 – 71	59 – 60	82 – 89	Road traffic
R4 A38 / road to Old Barn Lane intersection	72	75 – 77	47 – 52	83 – 86	Road traffic

7C.4.13 At position R1 the dominant noise source was road traffic with a steady flow of traffic and occasional heavy goods vehicles or tractors. The weather was warm and clear with average wind speed below 5ms^{-1}.

Table 7C.21 Road traffic noise monitoring results – Position R1 (Downside Road)

Start Time	No. of cars	$L_{Aeq,5m}$ dB	L_{A10} dB	L_{A90} dB	L_{AFmax} dB	Comments
10:00	34	68	72	42	87	Large lorry 1 minute into measurement
11:00	37	68	71	42	88	Occasional sound of people talking nearby
12:00	43	70	73	47	92	Tractor 1 minute into measurement
Range		68 – 70	71 – 73	42 – 47	87 – 92	
Overall	114	69 $L_{Aeq,15m}$				

7C.4.14 At position R2 the dominant noise source was road traffic with the highest flow of traffic among the four positions. The weather was warm and clear with average wind speed below $5ms^{-1}$.

Table 7C.22 Road traffic noise monitoring results – Position R2 (A38 / Downside Road intersection)

Start Time	No. of cars	$L_{Aeq,5m}$ dB	L_{A10} dB	L_{A90} dB	L_{AFmax} dB	Comments
10:18	171	75	78	64	86	Plane flyover 4 minutes into measurement
11:13	174	76	79	65	89	Two lorries and a tractor
12:12	160	75	78	63	87	Two loud trucks at end of measurement
Range		75 – 76	78 – 79	63 – 65	86 – 89	
Overall	505	75 $L_{Aeq,15m}$				

7C.4.15 At position R3 the dominant noise source was road traffic with cars entering and exiting Bristol Airport via the roundabout. The weather was warm and clear with average wind speed below $5ms^{-1}$.

Table 7C.23 Road traffic noise monitoring results – Position R3 (A38 / North Side Road roundabout)

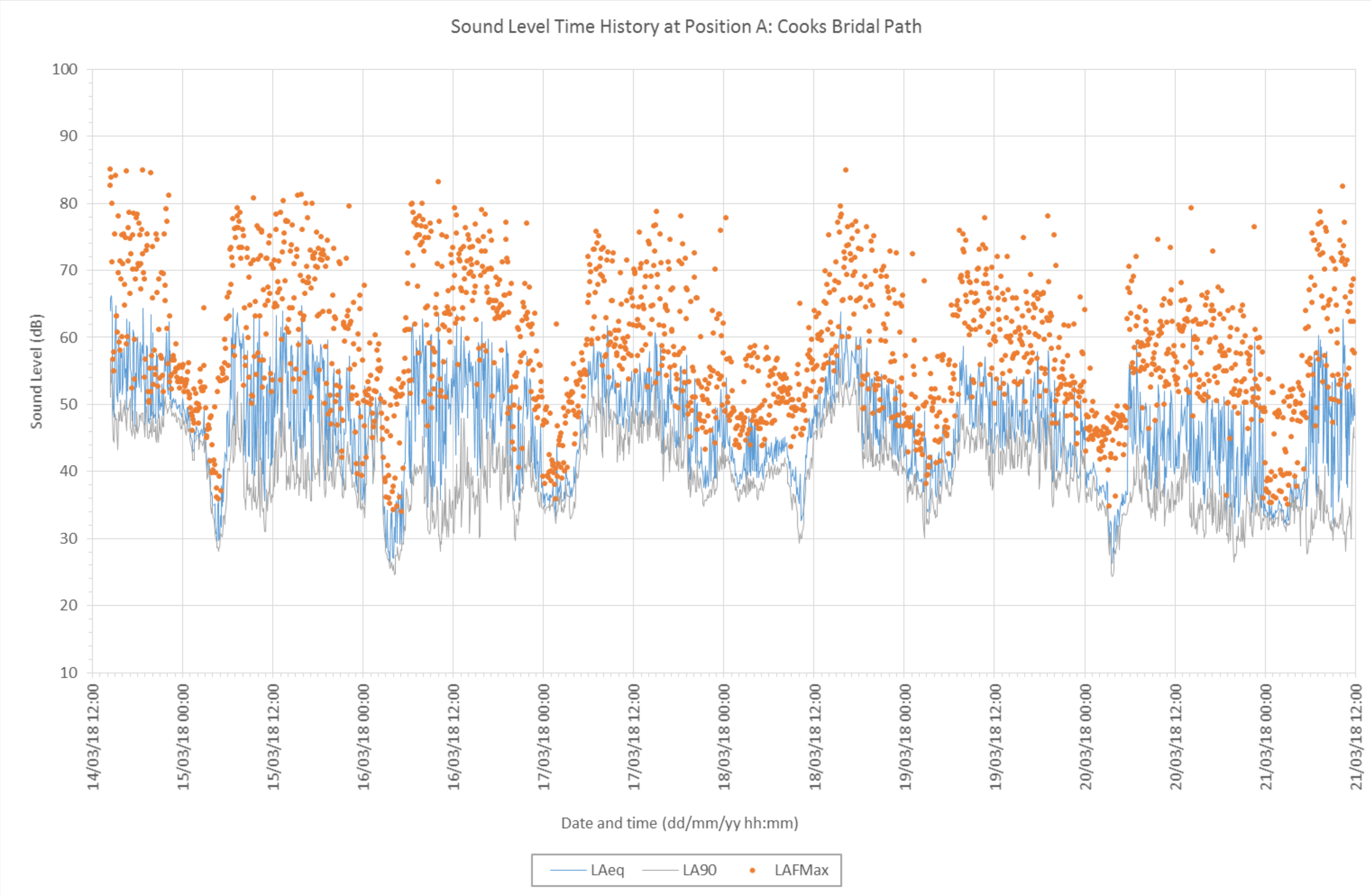
Start Time	No. of cars	$L_{Aeq,5m}$ dB	L_{A10} dB	L_{A90} dB	L_{AFmax} dB	Comments
10:26	113	70	71	59	87	Helicopter 3 minutes into measurement
11:20	93	69	69	59	89	Plane departure and two lorries
12:20	91	67	69	60	82	Three plane arrivals
Range		67 – 70	69 – 71	59 – 60	82 – 89	
Overall	297	69 $L_{Aeq,15m}$				

7C.4.16 At position R4 the dominant noise source was road traffic. The weather was warm and clear with average wind speed below $5ms^{-1}$.

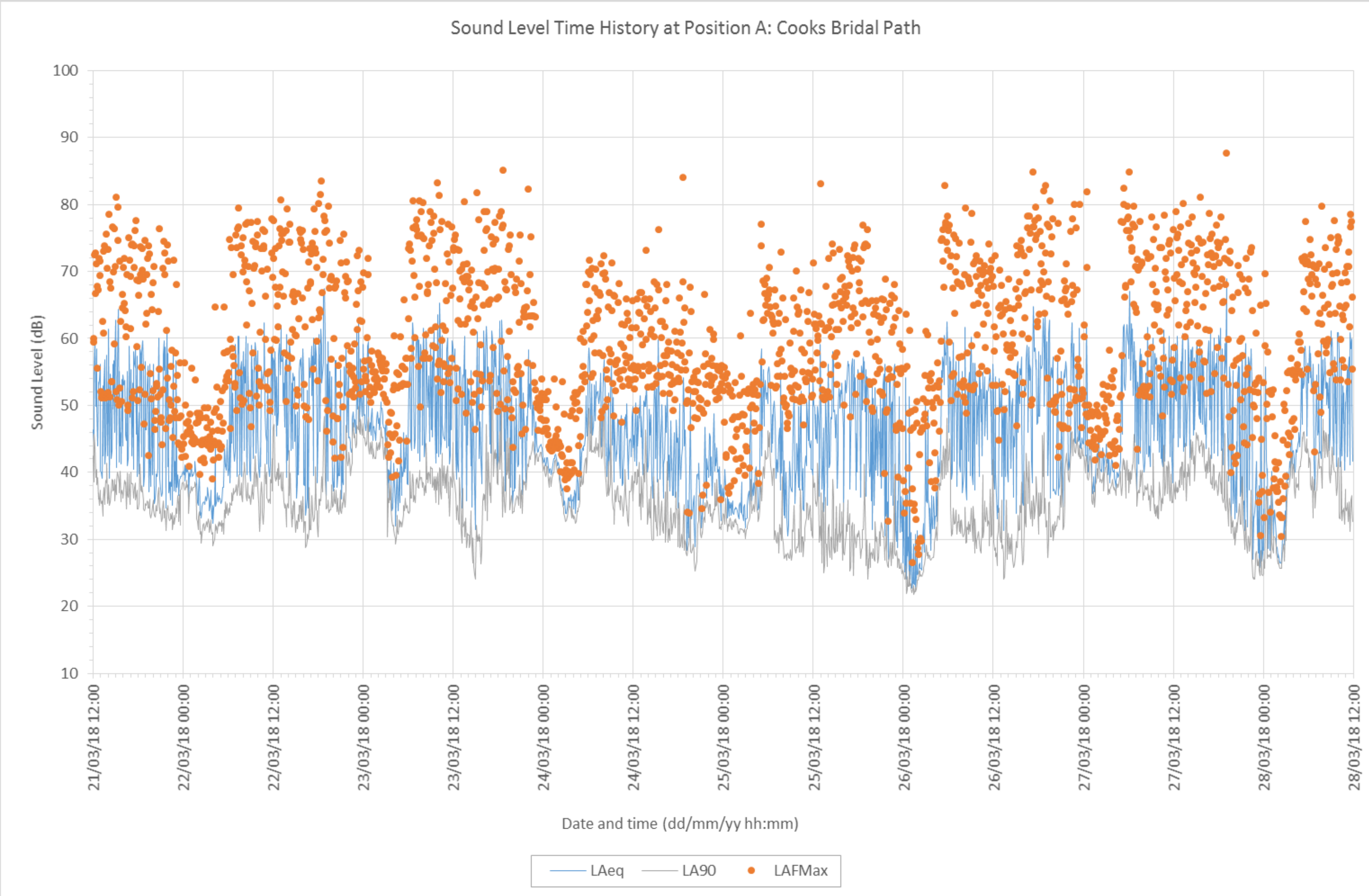
Table 7C.24 Road traffic noise monitoring results – Position R4 (A38 / road to Old Barn Lane intersection)

Start Time	No. of cars	$L_{Aeq,5m}$ dB	L_{A10} dB	L_{A90} dB	L_{AFmax} dB	Comments
10:42	65	72	76	52	86	Loud motorbike 4 minutes into measurement
11:41	60	71	75	47	84	Two loud motorbikes
12:36	82	72	77	48	83	
Range		71 – 72	75 – 77	47 – 52	83 – 86	
Overall	207	72 $L_{Aeq,15m}$				

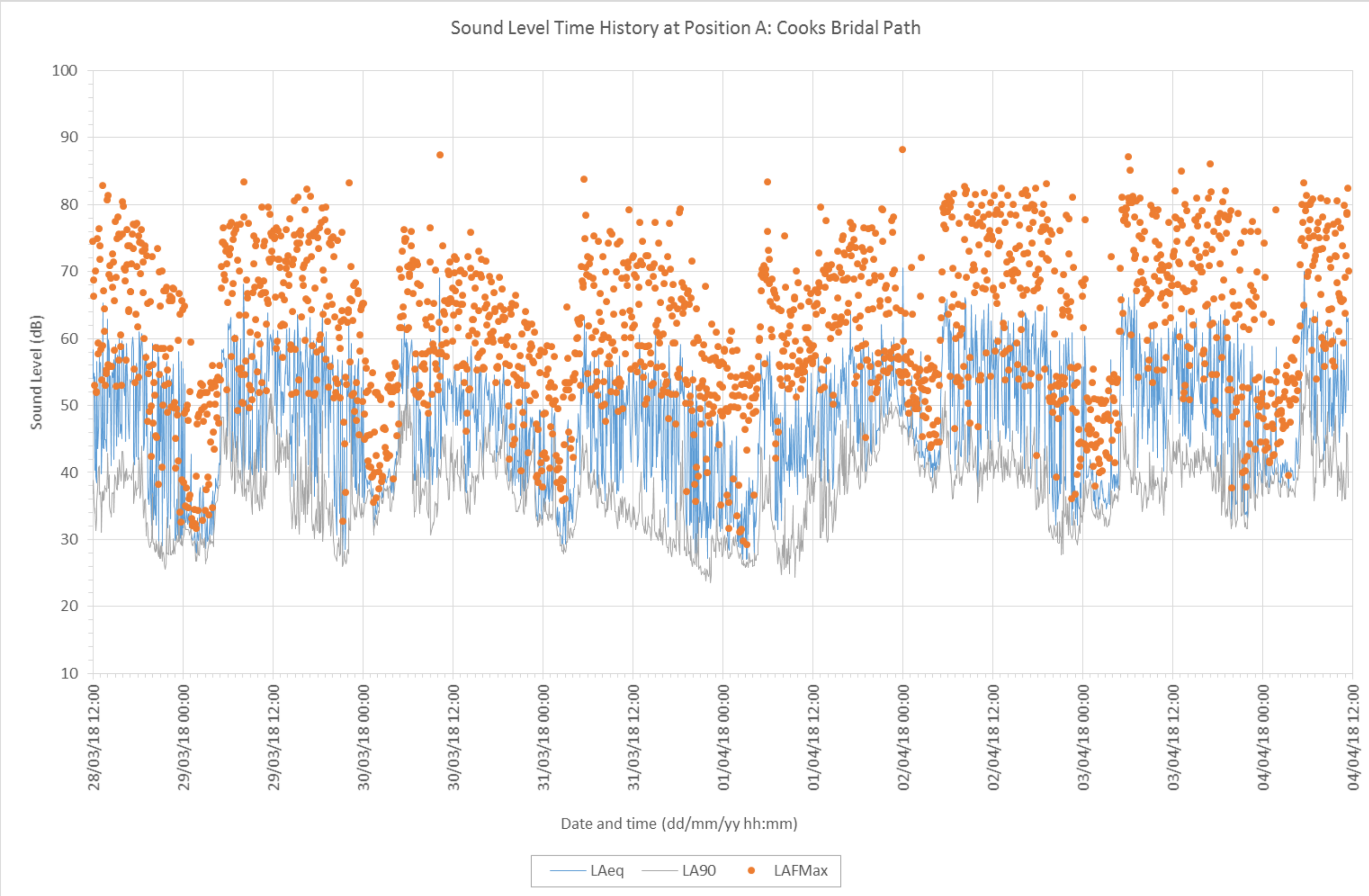
Graph 7C.1 Sound Level Time History at Position A: Cooks Bridal Path, 14 March to 21 March 2018



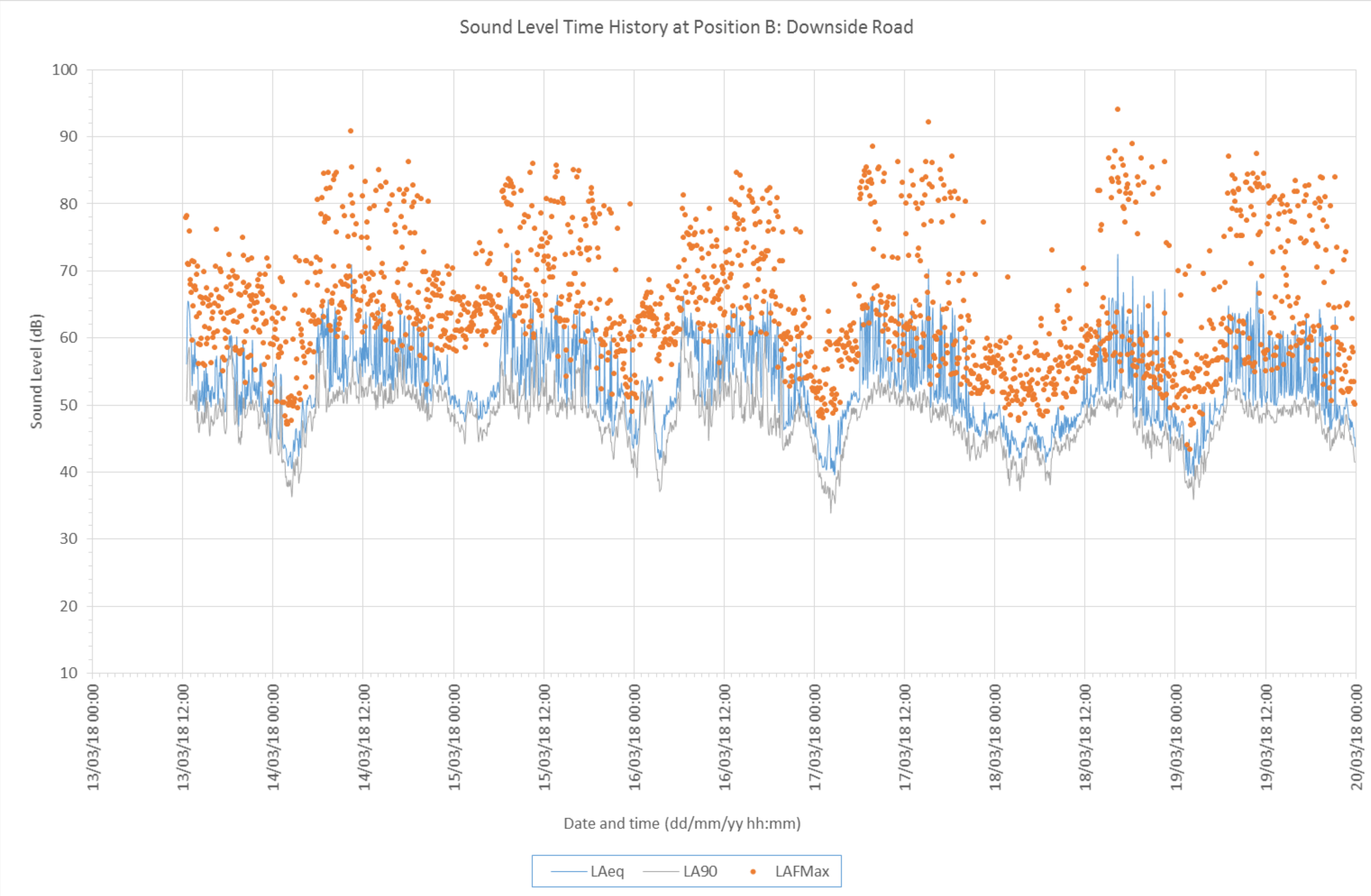
Graph 7C.2 Sound Level Time History at Position A: Cooks Bridal Path, 21 March to 28 March 2018



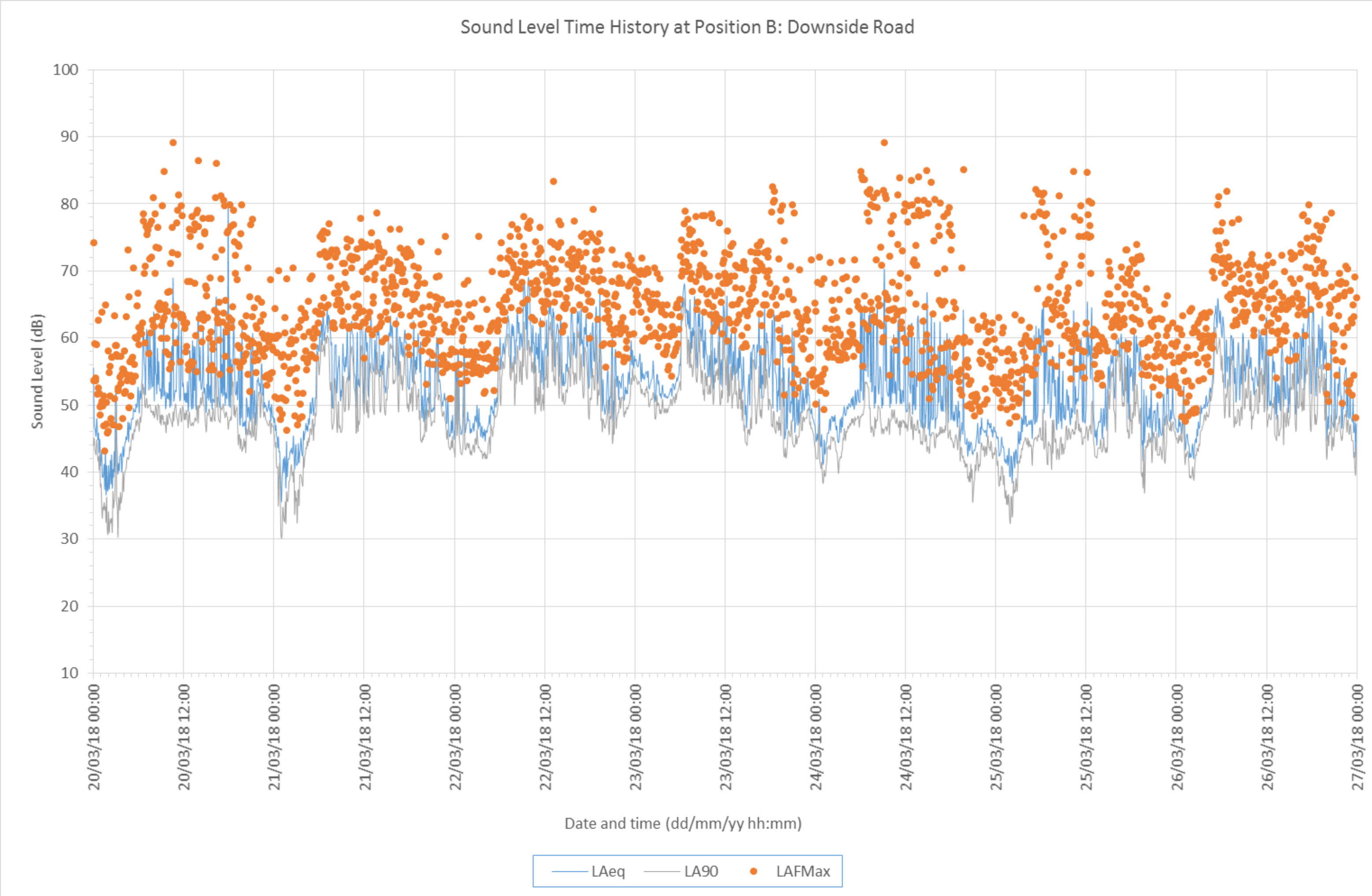
Graph 7C.3 Sound Level Time History at Position A: Cooks Bridal Path, 28 March to 4 April 2018



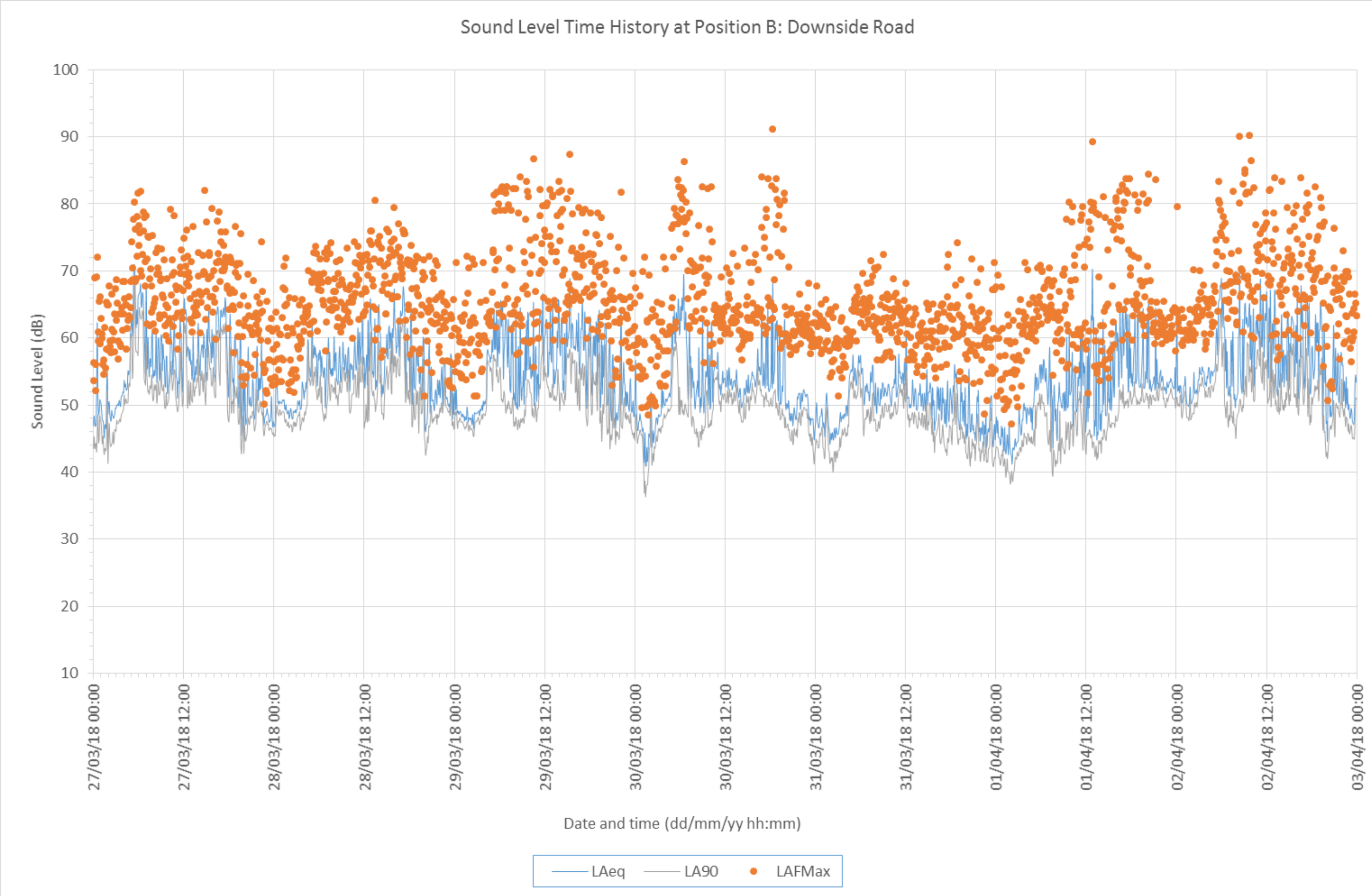
Graph 7C.4 Sound Level Time History at Position B: Downside Road, 13 March to 19 March 2018



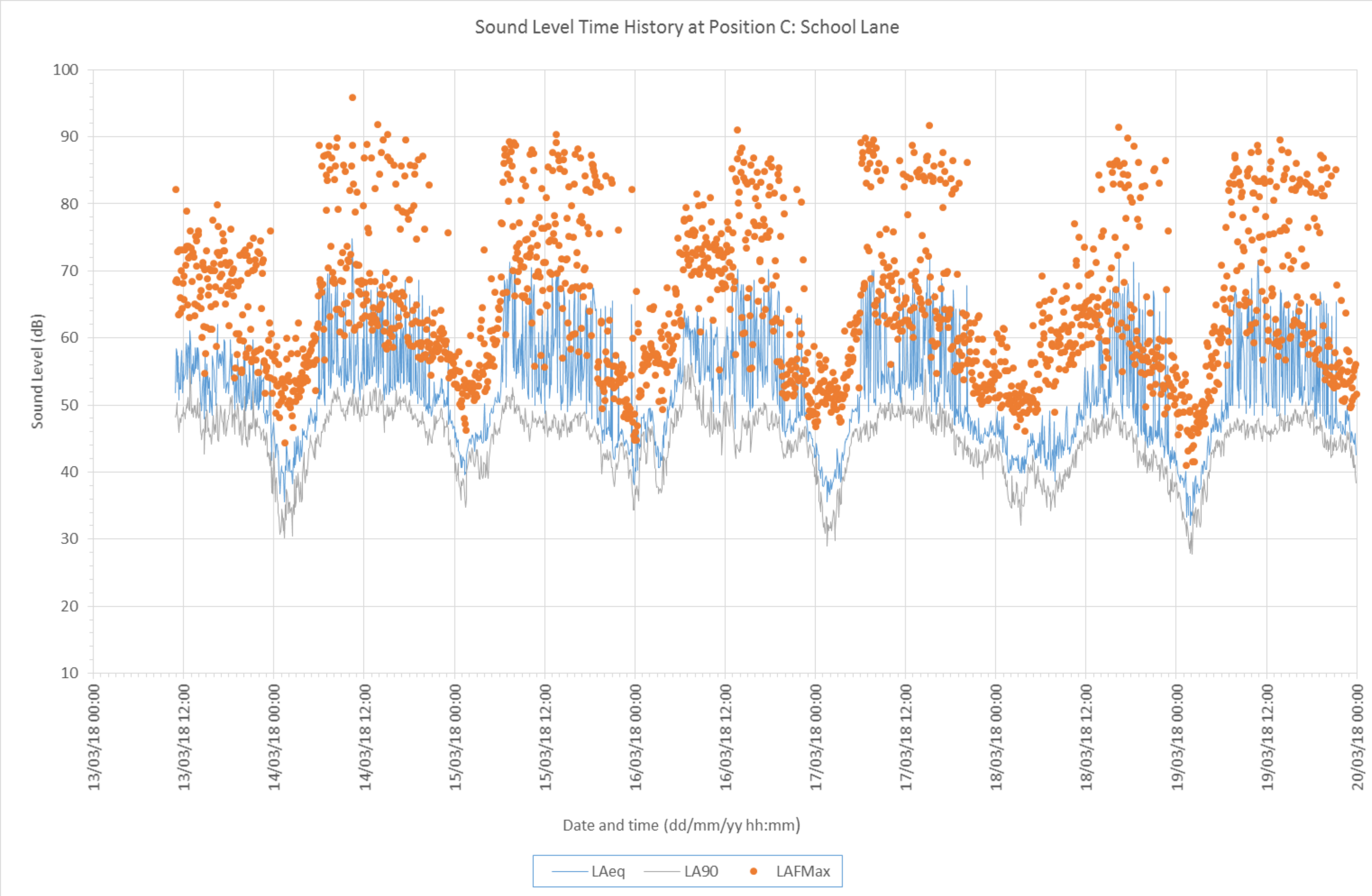
Graph 7C.5 Sound Level Time History at Position B: Downside Road, 20 March to 26 March 2018



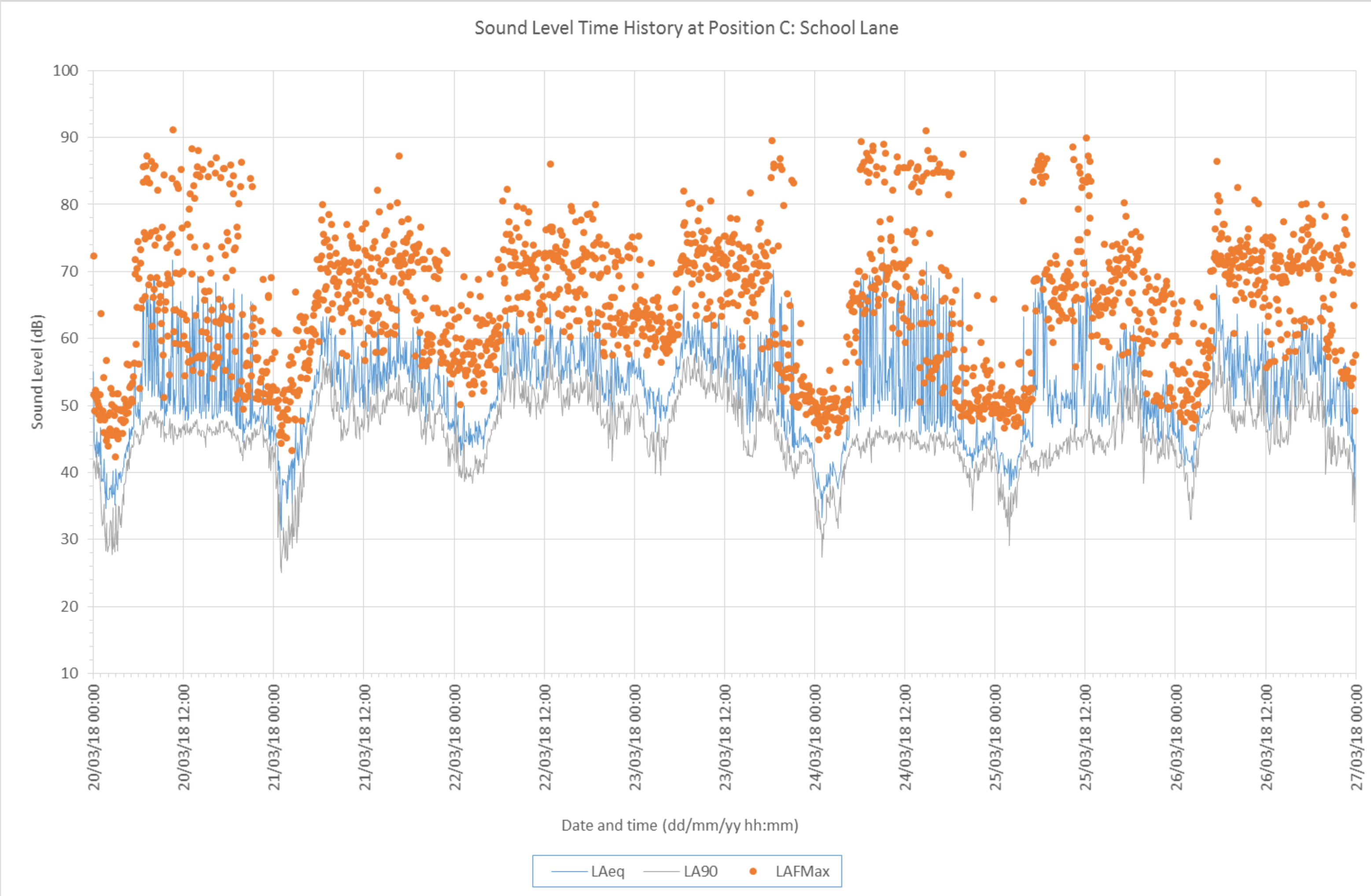
Graph 7C.6 Sound Level Time History at Position B: Downside Road, 27 March to 2 April 2018



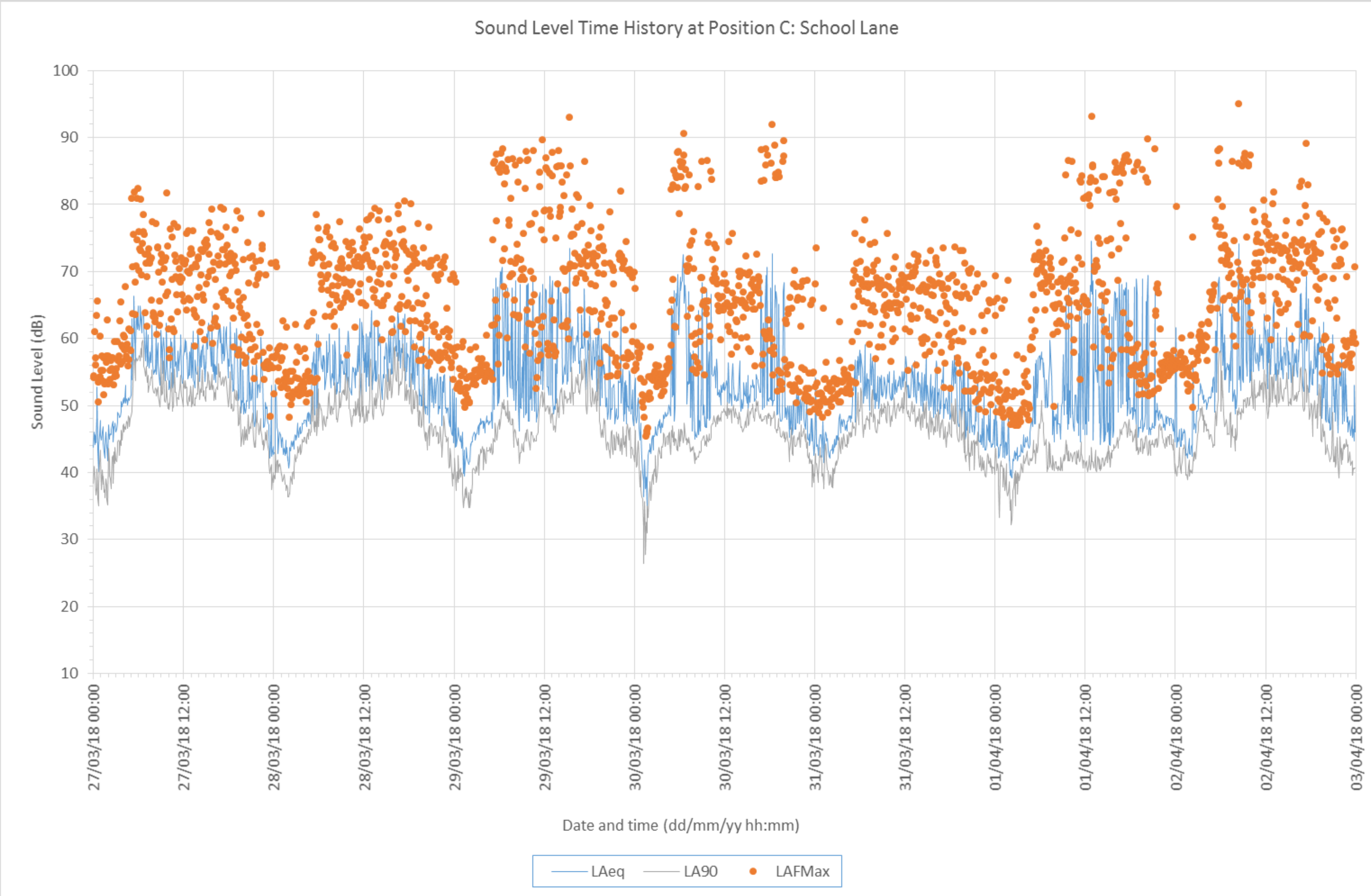
Graph 7C.7 Sound Level Time History at Position C: School Lane, 13 March to 19 March 2018



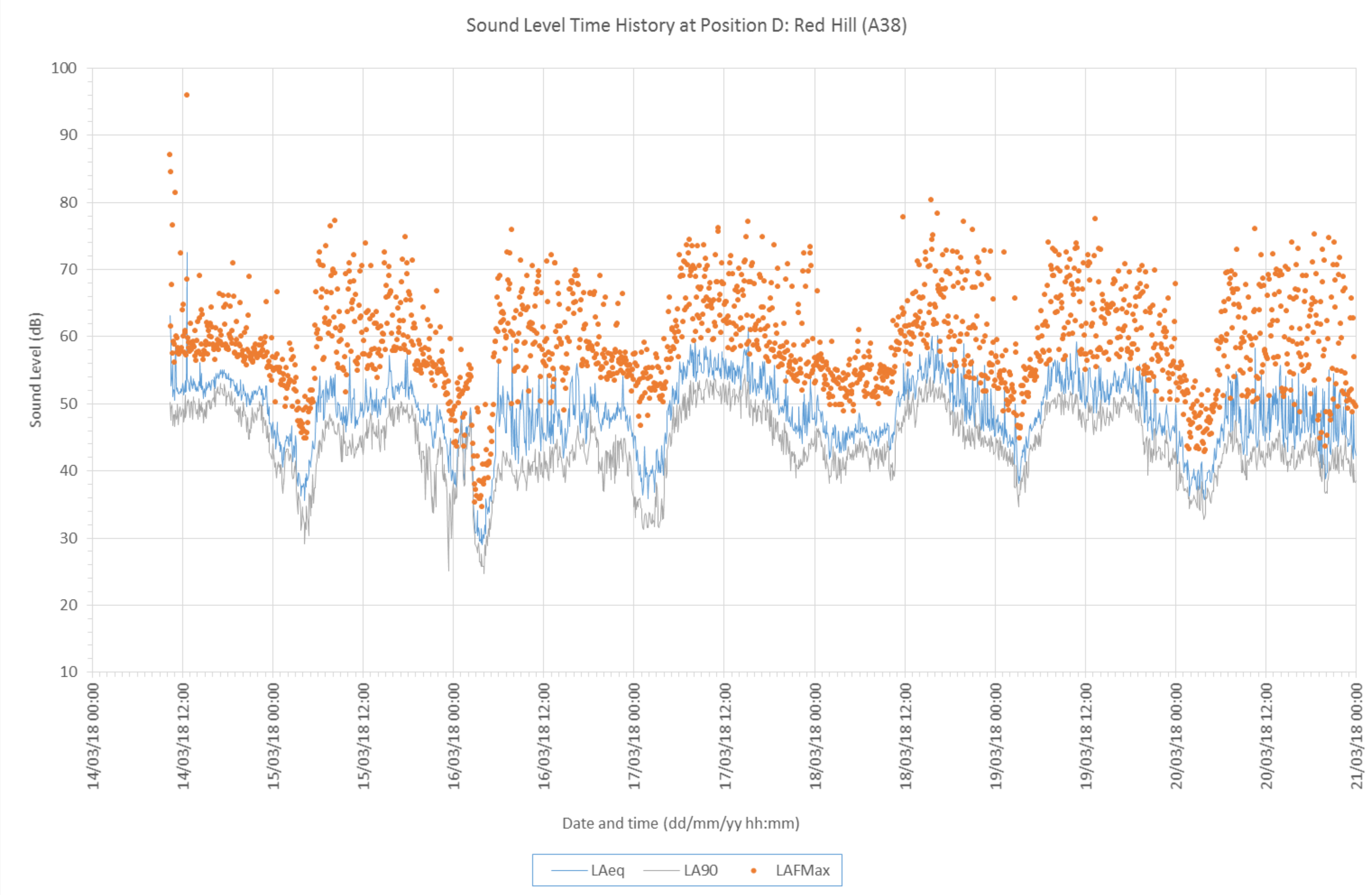
Graph 7C.8 Sound Level Time History at Position C: School Lane, 20 March to 26 March 2018



Graph 7C.9 Sound Level Time History at Position C: School Lane, 27 March to 2 April 2018

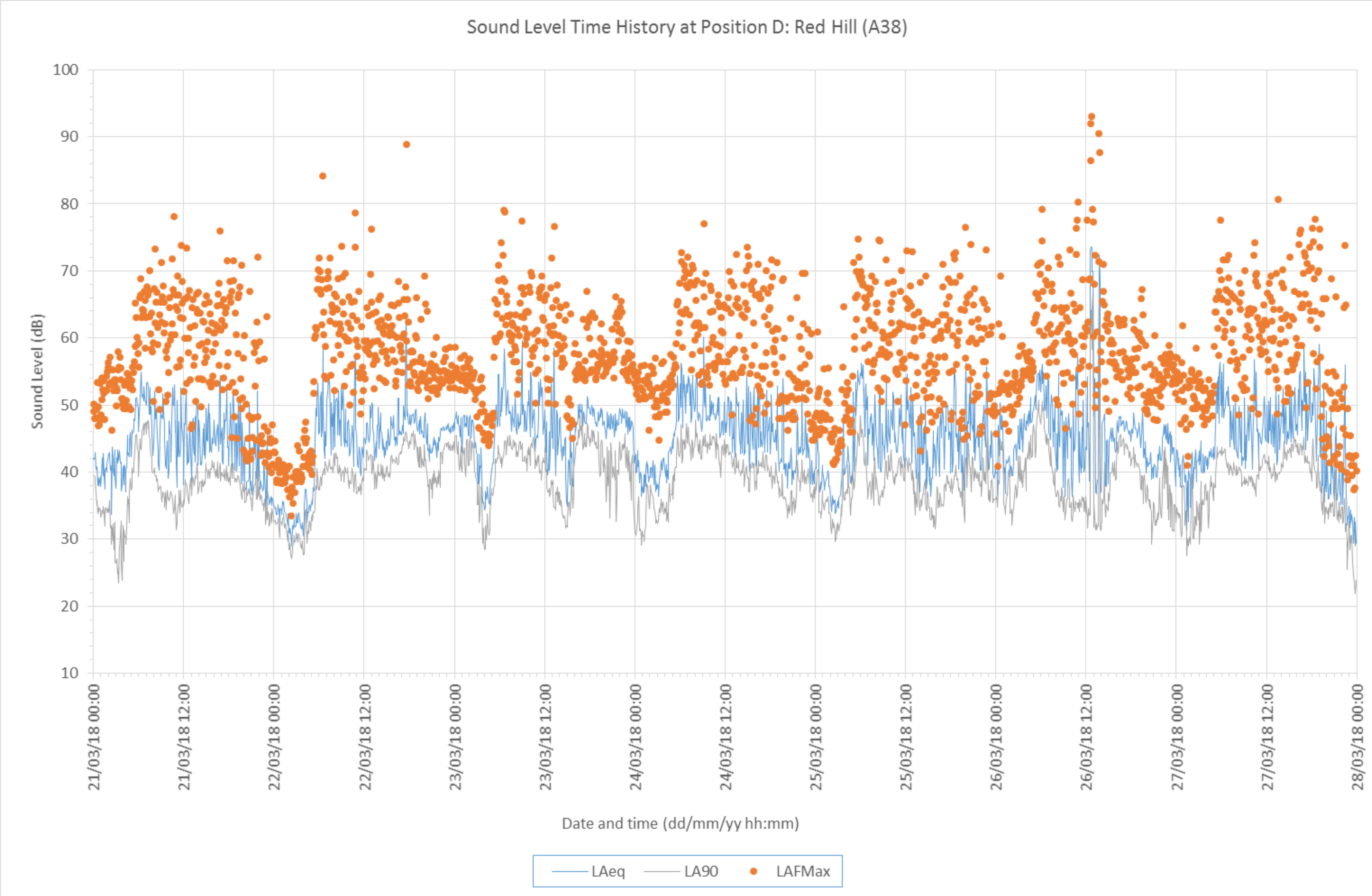


Graph 7C.10 Sound Level Time History at Position D: Red Hill (A38), 14 March to 20 March 2018



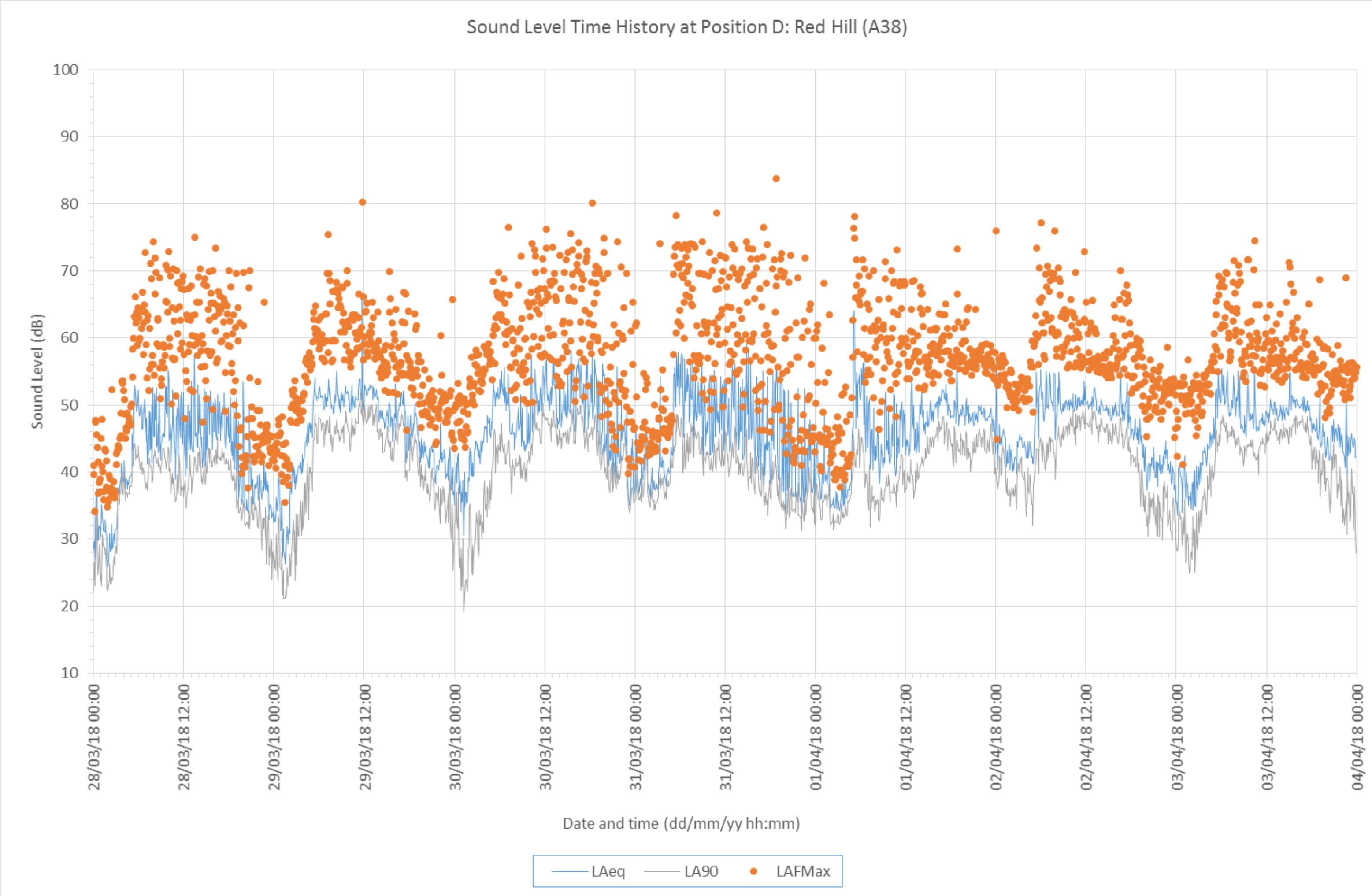
wood.

Graph 7C.11 Sound Level Time History at Position D: Red Hill (A38), 21 March to 27 March 2018



wood.

Graph 7C.12 Sound Level Time History at Position D: Red Hill (A38), 28 March to 3 April 2018



Appendix 7D
Air Noise and Vibration

7D.1 Introduction

7D.1.1 This appendix of the Environmental Statement (ES) considers air noise and vibration, defined as the operational noise and vibration associated with flights arriving and departing from Bristol Airport.

7D.1.2 Air noise encompasses that produced by aircraft during their departure and arrival at Bristol Airport. It is produced when an aircraft starts its departure roll, runs along the runway and climbs into the air as well as when an aircraft approaches Bristol Airport, touches down and slows to taxiing speed on the runway. It therefore includes reverse thrust noise when this takes place.

7D.1.3 Consideration is also given to the effects of vibration that might arise in a building as a result of airborne aircraft in flight nearby. This can arise as a result of the noise generated by the aircraft causing elements of the structure to vibrate.

7D.1.4 This appendix includes:

- Criteria used to assess air noise and vibration;
- The basis of the assessment used to assess air noise and vibration;
- The methodology used to assess air noise and vibration;
- Air noise and vibration assessment results;
- Assessment of the effects of air noise and vibration; and
- Recommended mitigation measures, where appropriate, with respect to air noise and vibration.

7D.2 Air noise and vibration assessment criteria

7D.2.1 This section of the appendix summarises the numerical assessment criteria used to assess air noise and vibration. These are noise levels that, if exceeded outside a sensitive receptor, indicate a potential adverse effect. Other secondary parameters, such as N60 and N70 indices, have also been used to assist in rating the impacts of air noise. Details of the background, derivation and selection of air noise and vibration assessment criteria is given in **Appendix 7B**.

7D.2.2 Detailed descriptions of all metrics are given in **Appendix 7A**.

Daytime – Residential

7D.2.1 The absolute noise values corresponding to indicative *Noise Policy Statement for England* (NPSE)[1] Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL) values for daytime air noise are given in **Table 7D.1**.

[1] Defra (2010). Noise Policy Statement for England, [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf [Checked 10/04/2018].

Table 7D.1 Air noise assessment criteria – absolute, outdoors (daytime)

Action	Effect Level	Indicative daytime level $L_{Aeq,16h}$ dB
Mitigate and reduce to a minimum	Lowest Observed Adverse Effect Level (LOAEL)	51
Avoid	Significant Observed Adverse Effect Level (SOAEL)	63
Prevent	Unacceptable Adverse Effect Level (UAEL)	69

7D.2.2 The subjective description of the absolute levels of air noise, expressed in terms of the air noise contour bands used in the figures in this appendix, can be expressed as follows:

Table 7D.2 Air noise assessment criteria – subjective, outdoors (daytime)

Subjective description of Impact	Daytime criteria $L_{Aeq,16h}$ dB	
Negligible	51	LOAEL
Very minor	54	
Minor	57	
Minor/Moderate	60	
Significant - Moderate	63	SOAEL
Significant - Substantial	66	
Significant – Very Substantial	69	UAEL

7D.2.3 In addition to absolute noise level, the relative change in noise level between operational scenarios is used to assess air noise. A potential significance rating for a change in level is given in **Table 7D.3**. A semantic scale of this type, based on the Institute of Environmental Management and Assessment noise impact guidelines[2], has been used successfully in various airport Public Inquiries.

[2] Guidelines for Environmental Noise Impact Assessment, Institute of Environmental Management & Assessment, October 2014

Table 7D.3 Air noise impact ratings - change in noise level, outdoors

Change in noise level dB	Subjective impression	Potential Impact classification
0 to 2	Imperceptible change	Negligible
2 to 3	Barely perceptible change	Minor
3 to 6	Perceptible change	Moderate
6 to 9	Up to a halving or a doubling of loudness	Substantial
> 9	Equal to or more than a halving or doubling of loudness	Very substantial

7D.2.4 To assess the overall effect of a change in noise, consideration needs to be given both to the magnitude of the change as well as the absolute level when assessing the effects of the resulting noise impacts. If, for example, the noise level at a dwelling were to change from 45 dB to 50 dB $L_{Aeq,16h}$, (below the LOAEL) the overall effect for the occupants would be less than if the same change were to increase the noise level from 63 dB (above the SOAEL) to 68 dB $L_{Aeq,16h}$.

Night-time – Residential

7D.2.5 The common method to rate night noise is in terms of noise exposure, using the $L_{Aeq,8h}$ index and the L_{night} index (for the period 23:00 to 07:00). **Table 7D.4** sets out the absolute noise criteria adopted for this assessment.

Table 7D.4 Air noise assessment criteria – absolute, outdoors (night-time)

Action	Effect Level	Indicative night-time level $L_{Aeq,8h}$ dB
Mitigate and reduce to a minimum	Lowest Observed Adverse Effect Level (LOAEL)	45
Avoid	Significant Observed Adverse Effect Level (SOAEL)	55
Prevent	Unacceptable Adverse Effect Level (UAEL)	63

7D.2.6 As in the case of daytime noise, this assessment includes consideration of both absolute noise at night and how changes might occur for dwellings between one operational scenario and another. **Table 7D.5** presents the subjective noise criteria.

Table 7D.5 Air noise assessment criteria – subjective, outdoors (night-time)

Subjective description of Impact	Night-time criteria $L_{Aeq,8h}$ dB	
Negligible	45	LOAEL
Very minor	48	
Minor	51	
Minor/Moderate	54	
Significant - Moderate	55	SOAEL
Significant - Substantial	60	
Significant – Very Substantial	63	UAEL

7D.2.7 The assessment of the effects of individual aircraft events are based on the criteria set out in **Table 7D.6**.

Table 7D.6 Air noise assessment criteria – single aircraft events, outdoors (night-time)

Action	Description	L_{Amax} dB	SEL dB(A)
Mitigate and reduce to a minimum	More than 10 -15 events per night	60	70
Avoid	More than one event per night	80	90
Prevent	More than one event per night	90	100

Non-Residential Receptors

Schools

7D.2.8 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 in **Table 7D.7**.

Table 7D.7 Schools – Indoor Ambient Noise Levels

	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

7D.2.9 To achieve the internal ambient noise level inside a classroom using natural ventilation, external noise levels should not exceed 55 dB $L_{Aeq,30min}$.

7D.2.10 Noise levels in unoccupied playgrounds, playing fields and other outdoor areas should not exceed 55 dB $L_{Aeq,30min}$.

Healthcare Facilities

7D.2.11 Guidance on recommended internal noise levels for healthcare facilities is given in HTM 08-1 (2013)[3]. For hospital wards, the criteria for noise intrusion from external sources are given in **Table 7D.8** (to be met inside the space):

Table 7D.8 Healthcare Facilities – Indoor Noise Levels

Time Period	Upper limit for indoor noise levels
Daytime	40 dB $L_{Aeq,1h}$
Night-time	35 dB $L_{Aeq,1h}$
Night-time	45 dB $L_{Amax,F}$ (events that occur several times per night)

7D.2.12 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, assuming a partly open window.

Places of Worship

7D.2.13 There are no specific assessment criteria for places of worship. They are however places where quiet conditions are required and, for the purposes of this assessment, the same criteria as used to rate the effects of noise on residential receptors has been adopted, for the daytime period only.

Amenity Areas

7D.2.14 Amenity areas includes those external areas used by the public for their quiet enjoyment of the outdoors. This includes, for example, parks, playgrounds, sports fields and public gardens.

7D.2.15 Based on guidance in BS 8233, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$.

7D.2.16 It is recognised in BS 8233 that these guideline values are not achievable in all circumstances where development might be desirable.

Airborne aircraft vibration

7D.2.17 The noise level of 97 dB L_{Cmax} has been taken as a threshold for potential significance of vibration effects due to airborne aircraft. Whether a significant effect occurs between scenarios will depend on the number of dwellings affected and the frequency of the events.

7D.3 Air noise and vibration assessment methodology

7D.3.1 The methodology used to compute air noise contours is in accordance with current Government Guidance and European guidance. Air noise contours have been generated using the Version 2d of AEDT[4]. This modelling software is accepted as complying with the methodology set out in

[3] Department of Health (2013). Specialist Services, Health Technical Memorandum 08-01: Acoustics, [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/144248/HTM_08-01.pdf [Checked 24/08/2018].
[4] Federal Aviation Administration (2017). Aviation Environmental Design Tool (AEDT) Version 2d, [Online]. Available at: https://aedt.faa.gov/2d_information.aspx [Checked 28/08/2018].

ECAC.CEAC Doc 29 4th edition and is suitable for producing noise contours in the UK for planning purposes, as well as airport noise maps used in the Strategic Noise Mapping exercise and production of airport Noise Action Plans as required under the Environmental Noise (England) Regulations 2006.

7D.3.2 The AEDT software has also been used to predict maximum C-weighted noise levels produced by aircraft operations at the relevant receptors. These levels have been used to assess the likelihood of vibration effects.

7D.3.3 In accordance with Government guidance, air noise has been evaluated and expressed in the form of contours, showing dB $L_{Aeq,16h}$ day time noise levels and $L_{Aeq,8h}$ night time noise levels for an average day during the summer period, as is the common convention in the UK. These are the primary noise indicators used in this assessment, as required under the Aviation Policy Framework.

7D.3.4 Consideration has also been given to key receptors around Bristol Airport to illustrate how the $L_{Aeq,16h}$ and $L_{Aeq,8h}$ noise levels vary. In addition an assessment has been undertaken to illustrate how, over a typical day, the air noise level received will vary by the hour. A variation will occur because there will be more aircraft movements in the peak hours than at other hours of the day.

7D.3.5 Annoyance and sleep disturbance due to air noise, evaluated and expressed in the form of $L_{Aeq,16h}$ and L_{night} contour bands are also presented, based on the method described in **Appendix 7B**.

7D.3.6 Sensitive noise receptors considered include dwellings as well as non-residential receptors including:

- Schools;
- Healthcare facilities;
- Places of worship; and
- Amenity areas.

7D.3.7 Secondary noise indicators are also used to inform this assessment, each of which is described in more detail in **Appendix 7B**. The contours generated using these secondary indicators include:

- Annual day, evening, night contours (L_{den});
- Annual night noise contours (L_{night});
- N60 night time and N70 daytime summer noise contours;
- Single mode summer noise contours ($L_{Aeq,16h}$, $L_{Aeq,8h}$), westerly and easterly; and
- SEL and L_{Amax} contours for individual movements by key aircraft types.

7D.4 Air noise and vibration assessment basis

7D.4.1 This section of the appendix gives details of basis of the air noise and vibration assessment. It includes details of aircraft movements by scenario and also gives details of the assumptions made and the data used in the assessment.

Air noise and vibration assessment scenarios

7D.4.2 The effects of the Proposed Development are evaluated with respect to the existing noise conditions in the Baseline Year (2017) as well as those in 2021/2026 assuming that the Proposed Development does not proceed. The assessment considers the following scenarios:

- Baseline year (2017);
- 10 mppa (million passengers per annum) in 2021. This aircraft mix and number of movements corresponds to Bristol Airport reaching its current passenger limit; and
- 12 mppa. This aircraft mix and number of movements corresponds to 2026 following implementation of the Proposed Development.

In addition, a sensitivity case is considered reflecting how Bristol Airport may operate in 2026 in the event that the Proposed Development is not implemented.

- 10 mppa Without Proposed Development. This aircraft mix and number of movements corresponds to 2026 without implementation of the Proposed Development.

Geographical information

7D.4.3 Geographical information about the location and height of the runway have been taken from the latest version of the UK Aeronautical Information Package (AIP) for Bristol Airport[5].

7D.4.4 The AEDT model of Bristol Airport includes the effect of local topography based on the Ordnance Survey (OS) Landform Panorama Digital Terrain Model (DTM) product[6] processed for use in the model.

Current and forecast aircraft movements

7D.4.5 Current and future aircraft types and movement information have been supplied by BAL.

7D.4.6 Aircraft movement data has been processed in relation to aircraft type, departure and arrival route, and runway usage to enable input into the AEDT model to determine noise contours and predict noise levels at specific locations.

7D.4.7 Processed current and forecast annual aircraft movements for use in the AEDT model are summarised in **Table 7D.9**, **Table 7D.10, Table 7D.11** and **Table 7D.12**.

7D.4.8 Day, evening and night refer to the periods 07:00 to 19:00, 19:00 to 23:00 and 23:00 to 07:00 respectively.

Table 7D.9 Number of Annual Aircraft Movements, Current (2017)

Aircraft type	AEDT designator[1]	Day	Evening	Night	Total
Boeing 717-200 Series	717200	2	2	0	4
Boeing 737-300 Series	737300	28	4	4	36
Boeing 737-400 Series	737400	6	16	0	22
Boeing 737-700 Series	737700	8	8	0	15
Boeing 767-300 Series	767300	2	0	4	6
Raytheon Beech 1900-D	1900D	2	0	0	2

[5] National Air Traffic Services (2017). IAIP Bristol – EGGD Textual data and Charts related to the Airport, [Online]. Available at: http://www.nats-uk.ead-it.com/public/index.php%3Foption=com_content&task=blogcategory&id=36&Itemid=85.html [Checked 28/08/2018].

[6] eMapsite (2018). OS Landform Panorama DTM ASCII XYZ, [Online]. Available at http://www.emapsite.com/mapshop/sample.aspx?map=30 [Checked 27/06/2018].

Aircraft type	AEDT designator[1]	Day	Evening	Night	Total
Boeing B787-8R	7878R	105	0	43	148
Airbus A319-131	A319#	9,674	4,244	1,945	15,863
Airbus A320-211	A320#	8,866	3,731	2,368	14,965
Airbus A321-232	A321#	973	358	615	1,946
Airbus A330-300 Series	A330-301	4	0	4	8
Boeing 737-800	B738#	7,566	1,872	1,992	11,430
Boeing 757-200	B752#	1,123	445	650	2,218
BAE 146-200	BAE146	70	43	35	148
Bombardier Global 6000 Business	BD-700-1A10	36	0	4	40
Raytheon Beech Baron 58	BEC58P	296	0	0	296
Cessna 650 Citation III	CIT3	4	0	0	4
Bombardier Challenger 600	CL600	159	17	2	178
Bombardier Challenger 601	CL601	71	35	0	106
Cessna 172 Skyhawk	CNA172	223	0	0	223
Cessna 182	CNA182	286	0	0	286
Cessna 206	CNA206	6	0	0	6
Cessna 208 Caravan	CNA208	56	5	0	61
Cessna 500 Citation I	CNA500	2	0	0	2
CESSNA CITATION 510	CNA510	101	31	0	132
Cessna 525 CitationJet	CNA525C	662	241	32	934
Cessna 550 Citation II	CNA55B	32	9	0	41
Cessna 560 Citation V	CNA560U	61	5	5	70
Cessna 560 Citation XLS	CNA560XL	291	56	8	356
Cessna 680 Citation Sovereign	CNA680	16	2	0	18
Cessna 750 Citation X	CNA750	12	0	0	12
Bombardier CRJ-900	CRJ9-ER	7	2	0	9
Bombardier CRJ-700-LR	CRJ9-LR	2	0	2	4
De Havilland Dash 8-400	DH8D#	3	8	8	18
De Havilland DHC-6-200 Twin Otter	DHC6	1,493	4	11	1,508
De Havilland DHC-8-100	DHC8	155	35	19	210

Aircraft type	AEDT designator[1]	Day	Evening	Night	Total
Eclipse 500	ECLIPSE500	6	0	0	6
Embraer ERJ145	EMB145	6,392	3,187	268	9,848
Embraer ERJ145-LR	EMB14L	14	4	0	18
Embraer ERJ170-LR	EMB170	231	67	8	306
Embraer ERJ175	EMB175	58	2	0	60
Embraer ERJ190	EMB190	2,074	687	30	2,792
Embraer ERJ195-LR	EMB195	0	6	4	10
Fokker F100	F10062	18	2	0	20
Fokker F100	F10065	10	0	2	12
Dassault Falcon 20-D	FAL20	4	0	0	4
EADS Socata TB-9 Tampico	GASEPF	696	0	0	696
Piper PA-24 Comanche	GASEPV	373	0	0	373
Gulfstream II	GII	12	0	0	12
Gulfstream IV-SP	GIV	10	2	2	14
Gulfstream G550	GV	68	23	11	102
Hawker HS748-2B	HS748A	3,995	73	0	4,068
Israel IAI-1125 Astra	IA1125	18	2	0	20
Bombardier Learjet 35A	LEAR35	95	27	6	128
Boeing MD-81	MD81	1	0	1	2
Boeing MD-82	MD82	5	0	3	8
Mitsubishi MU-300 Diamond	MU3001	14	2	0	16
Piper PA-28 Cherokee Series	PA28	3,608	0	0	3,608
Britten-Norman BN-2 Islander	PA31	14	0	0	14
Shorts 330-200 Series	SD330	27	5	0	32
Saab 340-B	SF340	54	14	0	68
	Total	**50,201**	**15,276**	**8,086**	**73,562**

1. '#' indicates a validated aircraft type.

Table 7D.10 Number of Annual Aircraft Movements, 10 mppa (2021) without Proposed Development

Aircraft type	AEDT designator[1]	Day	Evening	Night	Total
Boeing 737-800 Series	737800	98	0	0	98

Aircraft type	AEDT designator[1]	Day	Evening	Night	Total
Boeing B738MAX	7378MAX	2,255	294	1,030	3,579
Boeing B787-8R	7878R	539	0	294	833
Airbus A320-211	A320#	7,648	1,961	2,304	11,913
Airbus A320neo (A320-211)	A320n#	17,748	5,148	4,461	27,357
Airbus A321-232	A321#	1,324	196	932	2,451
Airbus A321neo (A321-232)	A321n#	833	294	0	1,128
Boeing 737-800	B738#	14,414	2,402	4,608	21,425
Cessna 441 Conquest II	CNA441	981	0	0	981
Embraer ERJ145	EMB145	8,089	1,667	882	10,639
Embraer ERJ170-LR	EMB170	1,177	294	294	1,765
Embraer ERJ190	EMB190	147	49	196	392
Hawker HS748-2B	HS748A	4,118	294	0	4,412
	Total	**59,371**	**12,600**	**15,002**	**86,973**

1. '#' indicates a validated aircraft type.

Table 7D.11 Number of Annual Aircraft Movements, 12 mppa (2026) with Proposed Development

Aircraft type	AEDT designator[1]	Day	Evening	Night	Total
Boeing 737-800 Series	737800	94	0	0	94
Boeing B738MAX	7378MAX	11,727	1,837	3,579	17,143
Boeing B787-8R	7878R	518	0	283	801
Airbus A320-211	A320#	4,239	801	1,884	6,923
Airbus A320neo (A320-211)	A320n#	21,523	6,028	5,322	32,872
Airbus A321-232	A321#	1,272	188	895	2,355
Airbus A321neo (A321-232)	A321n#	3,014	612	612	4,239
Boeing 737-800	B738#	6,970	1,413	2,496	10,879
Bombardier CRJ-900	CRJ9-ER	659	0	0	659
Cessna 441 Conquest II	CNA441	942	0	0	942
De Havilland Dash 8-400	DH8D#	1,319	0	0	1,319
Embraer ERJ145	EMB145	3,438	706	47	4,191
Embraer ERJ170-LR	EMB170	3,579	612	612	4,804
Embraer ERJ175	EMB175	94	0	0	94

Aircraft type	AEDT designator[1]	Day	Evening	Night	Total
Embraer ERJ190	EMB190	4,333	612	895	5,840
Hawker HS748-2B	HS748A	3,956	283	0	4,239
	Total	**67,676**	**13,092**	**16,625**	**97,393**

1. '#' indicates a validated aircraft type.

Table 7D.12 Number of Annual Aircraft Movements, 10 mppa (2026) without Proposed Development

Aircraft type	AEDT designator[1]	Day	Evening	Night	Total
Boeing 737-800 Series	737800	98	0	0	98
Boeing B738MAX	7378MAX	10,302	1,666	3,322	15,290
Boeing B787-8R	7878R	539	0	294	833
Airbus A320-211	A320#	3,927	1,099	1,769	6,795
Airbus A320neo (A320-211)	A320n#	21,469	6,010	4,997	32,475
Airbus A321-232	A321#	619	141	553	1,313
Airbus A321neo (A321-232)	A321n#	1,538	350	378	2,266
Boeing 737-800	B738#	6,367	1,030	2,316	9,714
Cessna 441 Conquest II	CNA441	981	0	0	981
Embraer ERJ145	EMB145	8,089	1,667	882	10,639
Embraer ERJ170-LR	EMB170	1,177	294	294	1,765
Embraer ERJ190	EMB190	147	49	196	392
Hawker HS748-2B	HS748A	4,118	294	0	4,412
	Total	**59,371**	**12,600**	**15,002**	**86,973**

1. '#' indicates a validated aircraft type.

Annual and summer movements

7D.4.9 The number and types of aircraft that operated into and out of Bristol Airport during the calendar year of 2017 has been provided by BAL. To determine the number and mix of aircraft during the summer period, from 16th June to 15th September inclusive, data from the Civil Aviation Authority (CAA) has been considered. The CAA publish monthly aircraft movement data which allows the summer period movements to be estimated based on August, September and an average of June/September data. This established that 29% of the annual activity occurred during the summer period in 2017. This factor has been applied to the annual data to provide the summer movement and aircraft mix for 2017.

7D.4.10 For the forecast years of 2021 and 2026, for each scenario considered, BAL has provided a forecast week of aircraft activity as well as an annual total. The forecast week of activity relates to the summer period and therefore has been used to represent the aircraft movement and mix for an average summer day. This average summer day of aircraft movement data has then been used, along with the annual movement total, to establish the average annual day of aircraft movements for noise contouring purposes.

Flight tracks and dispersion

7D.4.11 SID (Standard Instrument Departure) and STAR (STandard instrument ARrival) flight tracks are used at Bristol Airport. These are given in the AIP[5] for Bristol Airport.

7D.4.12 STAR flight tracks involve straight final approaches with the aircraft typically joining the extended centreline of the runway around six nautical miles from the thresholds.

7D.4.13 There are a total of six published SID flight tracks, three from each runway end. These are based on the beacons at EXMOR, BADIM, WOTAN and BCN.

7D.4.14 The use of the departure flight tracks is monitored by Bristol Airport's Airport Noise Monitoring and Management System (ANOMS). Representative departure tracks for use in the AEDT model were generated based on the actual tracks flown.

7D.4.15 The mean track traffic has also been dispersed. The dispersion model assumes that there are six 'dispersed' tracks associated with each departure route. These comprise the centre track of each route and three sub-tracks on either side. The percentage allocation of movements to each sub-track is given in **Table 7D.13**.

Table 7D.13 Dispersion distribution

Track	% allocation
Centre track	28.2%
Inner sub-track	22.2%
Middle sub-track	10.6%
Outer sub-track	3.1%

7D.4.16 The location of sub-tracks with respect to the centre track follows the guidance in the European Civil Aviation Conference (ECAC) Document 29 *Report on Standard Method of Computing Noise Contours around Civil Airports*[7] adjusted to account for the actual tracks flown.

Traffic distribution by runway and route

7D.4.17 For the 2017 scenario, the actual runway usage by type has been used. This is approximately 80% and 20% for arrivals and departures using Runway 27 and Runway 09 respectively.

7D.4.18 For the future scenarios, the average runway usage spilt from 2001 to 2017 given in the BAL *2017 Operations Monitoring Report*[8] is used. This is 78% and 22% for arrivals and departures using Runway 27 and Runway 09 respectively.

[7] European Civil Aviation Conference (2016). ECAC Doc 29 Report on Standard Method of Computing Noise Contours around Civil Airports - 4th Edition, [Online]. Available at https://www.ecac-ceac.org/ecac-docs [Checked 28/08/2018].
[8] Bristol Airport (2017). 2017 Operations Monitoring Report, [Online]. Available at https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwjb-r7GgZDdAhUEElAKHevOC5cQFjAAegQIABAC&url=https%3A%2F%2Fwww.bristolairport.co.uk%2F~%2Fmedia%2Ffiles%2Fbrs%2Fabout-us%2Fenvironment%2F2017-operations-monitoring-report.ashx%3Fla%3Den&usg=AOvVaw08RjZl1qAodXxwf_UpeuOC [Checked 28/08/2018].

7D.4.19 For each runway there is a single arrival route and three departure routes. EXMOR turns to the south. BADIM and WOTAN turn to the northeast. BCN turns towards to the northwest. The ANOMS data for 2017 has been used to determine the distribution of movements on these departure routes for both the 2017 and future scenarios. The departure route distribution is given in **Table 7D.14**.

Table 7D.14 Departure route distribution

Runway	Departure route	% distribution
09	BRECO 1Z	23%
	EXMOR 1Z	26%
	No SID given[1]	24%
	WOTAN 1Z	27%
27	BADIM 1X	41%
	BRECO 1X	23%
	EXMOR 1X	24%
	No SID given[1]	11%

1. No SID given for the departure in the ANOMS information.

7D.4.20 Where no SID is given for the departure in the ANOMS information, it has been assumed that the departure is a straight departure route along the runway centre-line.

Flight profiles

7D.4.21 AEDT offers a number of standard flight profiles for departing aircraft. These relate to different departure weights which are greatly affected by the length of the flight, and consequently the fuel load. In AEDT this is referred to as the stage length. Stage lengths occur in increments of 500 and then 1,000 nautical miles. As the stage length increases the aircraft has to depart with greater fuel and so its flight profile is slightly lower than when a shorter stage length is flown. AEDT assumes all aircraft take off with a full load irrespective of stage length.

7D.4.22 Stage lengths are provided by BAL for the future scenarios. The destinations given in the ANOMS data for 2017 have been used to determine the distribution of stage lengths for the 2017 scenario.

Movement timings

7D.4.23 The time of an arrival or departure has been provided by BAL for the future scenarios. These are used to categorise movements by day (07:00 to 19:00), evening (19:00 to 23:00) or night (23:00 to 07:00) where necessary. The arrival and departure times given in the ANOMS data for 2017 have been used to distribute movements by time of day on an aircraft type basis.

7D.4.24 A similar approach has been used to categorise movements by hour for the assessment of variation in air noise over a day.

Future aircraft types

7D.4.25 For the future scenarios, it is forecast that there will be some aircraft operating at Bristol Airport that do not currently operate in significant numbers. For most of these types, there are corresponding AEDT aircraft types are used to model them.

7D.4.26 As the Airbus A320neo (new engine option) and A321neo were only introduced recently, AEDT does not contain a specific corresponding aircraft type. The current engine option (ceo) equivalent AEDT aircraft types have therefore been used with modifications made to their engine noise levels to reflect the lower noise levels of the new aircraft.

7D.4.27 The current engine option equivalents to the Airbus A320neo and A321neo are the Airbus A320-211 and A321-232 respectively.

7D.4.28 The modifications to the engine noise levels are based on a comparison of the ECAC aircraft certification noise levels for the current and new variants of the particular aircraft. Specifically the noise levels of the A320neo have been reduced by 3.0 dB for arrivals and 5.8 dB for departures compared to the A320ceo. The noise levels of the A321neo have been reduced by 1.5 dB for arrivals and 5.0 dB for departures compared to the A321ceo.

7D.4.29 In order to demonstrate how the aircraft fleet at Bristol Airport has changed historically, BAL have provided a summary of the most common aircraft types operating at various points in time. This is given in **Table 7D.15**.

Table 7D.15 Summary of historical fleet mix

Year	Most common aircraft types
1987	BAC 1-11, Boeing 727, Dash-7, Douglas DC9, Embraer 120, Fokker 27/50, HS748, McDonnell Douglas MD80, Saab 340, Shorts 330/360.
2007	ATR 42/72, Avro RJ85/100, BAe 146, Beechcraft 200, Boeing 737-700/800, 757-200, 767-300, Cessna 550/560, Dash-8, Embraer 145, Fokker 70/100, Hawker 800, McDonnell Douglas MD80/83, Saab 2000.
2017	Airbus A319, A320, A321, Boeing 737-800, 757-200, 787, Cessna 525, Dash-8, Embraer 135, 145, 190, Fokker 70, Global 6000, Learjet 45/75, Sukhoi 100.
2026 (forecast)	Airbus A320, A320neo, A321, A321neo, ATR 72, Boeing 737-800, B738MAX, 787, Dash-8, Embraer 145, 170, 190,

Validation of AEDT model

7D.4.30 Validation of the AEDT model for Bristol Airport has been carried out by comparison of predicted noise levels for individual operations by key aircraft types with the measured noise levels obtained from Bristol Airport's Noise Monitoring Terminals (NMTs).

7D.4.31 NMT2 (Congresbury) and NMT5 (Littleton Hill) are located 6.5km from the Start of Roll (SOR) to the west and east of Bristol Airport respectively.

7D.4.32 The five aircraft with the most impact on the noise contours have been included in the validation. Impact in this case is a function of their number of movements and noise levels at the NMTs. The average measured Sound Exposure Level (SEL) noise levels for these five aircraft in 2017 have been compared with the AEDT predicted SEL noise levels for the corresponding default AEDT aircraft type. Where the measured and predicted noise levels differ, modifications have been made to the engine noise levels of the AEDT aircraft.

7D.4.33 A single engine noise level modification is used for arrivals to, and a single noise level modification was used for departures from, both runway ends. The aim of the engine noise level modification is to ensure that the movement-weighted average difference between the measured and validated predicted noise levels at the two NMTs is 0 dB.

7D.4.34 Comparisons of average measured and predicted noise levels and the resulting noise level modifications are given in **Table 7D.16** and **Table 7D.17** for arrivals and departures respectively. The modifications made to the noise levels are small and are generally less than 1 dB.

Table 7D.16 Average measured and default predicted noise levels and validated modifications - arrivals

Aircraft type	AEDT type	2017 number of measured results		2017 average measured noise levels SEL dB(A)		Default AEDT predicted noise levels SEL dB(A)		Noise level modification dB(A)	Movement-weighted average noise level difference[1] SEL dB(A)
		NMT2	NMT5	NMT2	NMT5	NMT2	NMT5		
Airbus A319	A319-131	1,557	6,182	83.8	85.3	83.3	85.3	+0.1	0.0
Airbus A320	A320-211	1,453	5,862	83.8	85.5	84.1	85.9	-0.4	0.0
Airbus A321	A321-232	181	763	84.2	85.9	83.7	85.7	+0.3	0.0
Boeing 737-800	737800	1,128	4,437	84.6	86.3	85.8	87.5	-1.2	0.0
Boeing 757	757RR	214	860	84.7	86.3	84.5	86.3	+0.1	0.0

1. Validated minus measured.

Table 7D.17 Average measured and default predicted noise levels and validated modifications - departures

Aircraft type	AEDT type	2017 number of measured results		2017 average measured noise levels SEL dB(A)		Default predicted noise levels SEL dB(A)		Noise level modification dB(A)	Movement-weighted average noise level difference[1] SEL dB(A)
		NMT2	NMT5	NMT2	NMT5	NMT2	NMT5		
Airbus A319	A319-131	6,036	1,589	83.4	83.5	82.3	83.5	+0.9	0.0
Airbus A320	A320-211	5,668	1,508	83.4	83.2	83.7	84.9	-0.6	0.0
Airbus A321	A321-232	728	198	85.4	85.7	83.9	85.3	+1.3	0.0
Boeing 737-800	737800	4,295	1,141	85.7	86.0	85.8	86.7	-0.3	0.0
Boeing 757	757RR	822	234	84.6	85.2	85.1	86.2	-0.6	0.0

1. Validated minus measured.

Sensitive receptors

7D.4.35 The assessment of the air noise effects included all noise sensitive receptors within the lowest air noise contour bands.

Dwelling and population counts

7D.4.36 The dwelling and populations counts have been determined using data supplied by CACI Ltd. This data, based on census information, consists of a single location, number of dwellings and population for each postcode and has been adjusted to account for developments that have been built out up to the current baseline year of 2017. This data has been used in the dwelling and population assessments for both the current and future scenarios.

Specific Residential Receptors

7D.4.37 A series of key representative residential receptors have been identified for specific assessment. Details of these are given in **Section 7.7** of **Chapter 7**.

Non-residential receptors

7D.4.38 A database of noise-sensitive non-residential receptors, i.e. schools, healthcare facilities, places of worship and amenity areas, has been compiled from the OS AddressBase Plus product, obtained on 7 September 2018. This database has been used in the non-residential receptor assessments for both the current and future scenarios. Details of these receptors are given in **Section 7.7** of **Chapter 7**.

7D.5 Air noise and vibration assessment results

General

7D.5.1 This section presents the results of the air noise assessment undertaken using both the primary and secondary indicators described in **Section 7D.2**. Results are presented for each of the following scenarios:

- Baseline year (2017);
- 10 mppa (million passengers per annum) in 2021; and
- 12 mppa in 2026 with implementation of the Proposed Development.

7D.5.2 Results are also presented in the case of the primary indicator for the sensitivity case:

- 10 mppa without the Proposed Development in 2026.

7D.5.3 Results are firstly introduced in terms of air noise contour figures. To assist in finding the relevant figure, a table is provided which sets out the figure reference for a given noise indicator and scenario.

7D.5.4 Secondly, results are presented for residential receptors in terms of contour areas, dwelling and population counts for the primary noise indicator, the L_{Aeq} index, both for daytime and night-time. Key receptors are also considered as well as the number of people likely to be highly annoyed or sleep disturbed under a given scenario.

7D.5.5 Thirdly, results are presented for residential receptors in terms of contour areas, dwelling and population counts for the secondary noise indicators.

7D.5.6 Fourthly, results are presented for non-residential receptors in terms of numbers lying within specified noise bands under a given scenario.

7D.5.7 Fifthly, results are presented showing how air noise levels are expected to vary each hour over the day for each of the different scenarios.

7D.5.8 Finally, the results of the assessment of vibration due to airborne aircraft are presented.

7D.5.9 For all tables, areas are rounded to the nearest 0.1km^2. Dwelling and population counts are rounded to the nearest 50 above 100 and to the nearest 10 below 100. Below 10, the actual number is given.

Air Noise Contours

7D.5.10 **Table 7D.18** and **Table 7D.19** denote the relevant figure numbers for the relevant air noise contours.

Table 7D.18 Air noise contour figure references, primary and secondary indicators

Contour Type	Scenario			
	Baseline 2017	10 mppa 2021	12 mppa 2026 With Proposed Development	10 mppa 2026 Without Proposed Development
PRIMARY INDICATORS				
$L_{Aeq,16h}$ average mode, summer day	7D.1	7D.2	7D.3	7D.26
$L_{Aeq,8h}$ average mode, summer night	7D.4	7D.5	7D.6	7D.27
SECONDARY INDICATORS				
L_{den} average mode, annual day	7D.8	7D.9	7D.10	7D.28
L_{night} average mode, annual night	7D.11	7D.12	7D.13	7D.29
$L_{Aeq,16h}$, easterly mode, summer day	7D.14	7D.15	7D.16	-
$L_{Aeq,8h}$, easterly mode, summer day	7D.17	7D.18	7D.19	-
$L_{Aeq,16h}$, westerly mode, summer day	7D.20	7D.21	7D.22	-
$L_{Aeq,8h}$, westerly mode, summer day	7D.23	7D.24	7D.25	-
N70, average mode, summer day	7D.30	7D.31	7D.32	7D.33
N60, average mode, summer night	7D.34	7D.35	7D.36	7D.37

Table 7D.19 Air noise contour figure references, single event indicators

Contour Type	Aircraft Type	
	Airbus A320 and A320neo	Boeing B738 and B738MAX
SEL		
Runway 09 Arrivals	7D.38	7D.42
Runway 09 Departures	7D.39	7D.43
Runway 27 Arrivals	7D.40	7D.44

Contour Type	Aircraft Type	
	Airbus A320 and A320neo	Boeing B738 and B738MAX
Runway 27 Departures	7D.41	7D.45
L_{Amax}		
Runway 09 Arrivals	7D.46	7D.50
Runway 09 Departures	7D.47	7D.51
Runway 27 Arrivals	7D.48	7D.52
Runway 27 Departures	7D.49	7D.53

Residential Receptors – Primary Indicators

Daytime

7D.5.11 **Table 7D.20, Table 7D.21** and **Table 7D.22** give the area, number of dwellings and population counts respectively within each contour band for the three different scenarios and for the sensitivity case. The counts include all those dwellings or people within a specified contour band so, for example, 200 dwellings within a 60 dB contour includes those within the 63 dB, 66 and 69 dB bands as well.

Table 7D.20 Contour areas, $L_{Aeq,16h}$ average mode summer day

Contour $L_{Aeq,16h}$ (dB)	Contour Areas (km²)			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
51 (LOAEL)	37.7	36.9	37.0	29.9
54	19.9	19.6	19.7	16.0
57	11.0	10.7	10.9	8.6
60	6.1	5.9	5.7	4.5
63 (SOAEL)	3.1	2.9	2.8	2.2
66	1.6	1.5	1.4	1.2
69 (UAEL)	0.9	0.9	0.8	0.7

Table 7D.21 Number of dwellings, $L_{Aeq,16h}$ average mode summer day

Contour $L_{Aeq,16h}$ (dB)	Number of Dwellings			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
51 (LOAEL)	3,250	3,150	3,100	2,200
54	950	900	900	750
57	450	450	450	400

Contour $L_{Aeq,16h}$ (dB)	Number of Dwellings			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
60	150	150	150	80
63 (SOAEL)	20	10	10	10
66	1	1	1	0
69 (UAEL)	0	0	0	0

Table 7D.22 Population count, $L_{Aeq,16h}$ average mode summer day

Contour $L_{Aeq,16h}$ (dB)	Population Count			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
51 (LOAEL)	7,900	7,600	7,500	5,400
54	2,350	2,250	2,200	1,800
57	1,050	1,050	1,150	950
60	300	300	300	200
63 (SOAEL)	50	40	40	40
66	3	3	3	0
69 (UAEL)	0	0	0	0

Night-time

7D.5.12 **Table 7D.23**, **Table 7D.24** and **Table 7D.25** give the area, number of dwellings and population counts respectively within each contour band for the three different scenarios and for the sensitivity case. The counts include all those dwellings or people within a specified contour band.

Table 7D.23 Contour areas, $L_{Aeq,8h}$ average mode summer night

Contour $L_{Aeq,8h}$ (dB)	Contour Areas (km^2)			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
45 (LOAEL)	46.7	64.5	65.6	54.7
48	25.2	35.8	36.7	29.8
51	13.9	18.8	19.3	15.7
54	7.4	10.3	10.5	8.4
55 (SOAEL)	6.0	8.4	8.5	6.8
57	3.8	5.5	5.6	4.3
60	1.9	2.7	2.7	2.1

Contour $L_{Aeq,8h}$ (dB)	Contour Areas (km^2)			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
63 (UAEL)	1.1	1.3	1.4	1.1

Table 7D.24 Number of dwellings, $L_{Aeq,8h}$ average mode summer night

Contour $L_{Aeq,8h}$ (dB)	Number of Dwellings			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
45 (LOAEL)	3,750	5,150	5,050	4,150
48	1,300	2,950	3,000	2,000
51	650	900	850	750
54	300	450	450	400
55 (SOAEL)	150	300	350	250
57	60	150	150	80
60	1	10	10	10
63 (UAEL)	0	1	1	0

Table 7D.25 Population count, $L_{Aeq,8h}$ average mode summer night

Contour $L_{Aeq,8h}$ (dB)	Population Count			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
45 (LOAEL)	9,150	12,550	12,300	10,100
48	3,100	7,150	7,250	4,900
51	1,600	2,200	2,200	1,800
54	700	1,050	1,100	900
55 (SOAEL)	400	750	800	600
57	150	300	300	200
60	3	40	40	40
63 (UAEL)	0	3	3	0

Receptor Analysis

7D.5.13 **Table 7D.26** and **Table 7D.27** give the average summer day and night noise levels at a series of representative receptors around Bristol Airport for the three different scenarios and for the sensitivity case.

Table 7D.26 Residential receptor noise exposure levels, $L_{Aeq,16h}$ average mode summer day

	Receptor	$L_{Aeq,16h}$ (dB)			
		Baseline 2017	**10 mppa 2021**	**12 mppa 2026**	**10 mppa 2026**
1	Henley Park, Yatton	53	53	53	52
2	Bishops Road, Cleeve	54	53	53	52
3	Fountain Treeworks, Brockley	62	62	61	60
4	Cooks Bridle Path, Downside	61	60	60	59
5	Downside Road, Downside	60	60	59	58
6	School Lane, Lulsgate Bottom	62	62	61	60
7	Hillview Gardens, Felton	55	55	55	54
8	Market Place, Winford	59	59	60	59
9	Chew Magna, North Wick	54	54	55	54
10	Church Road, Norton Malreward	50	50	50	49
11	Lye Mead, Winford	53	54	54	53
12	Red Hill, Redhill	51	51	51	49
13	Wrington Hill, Wrington	59	53	53	52
14	Southlands Way, Congresbury	53	53	53	52

Table 7D.27 Receptor noise exposure levels, $L_{Aeq,8h}$ average mode summer night

	Receptor	$L_{Aeq,8h}$ (dB)			
		Baseline 2017	**10 mppa 2021**	**12 mppa 2026**	**10 mppa 2026**
1	Henley Park, Yatton	48	50	50	49
2	Bishops Road, Cleeve	48	50	50	49
3	Fountain Treeworks, Brockley	57	58	58	57
4	Cooks Bridle Path, Downside	56	57	57	56
5	Downside Road, Downside	54	56	56	55
6	School Lane, Lulsgate Bottom	57	58	58	57
7	Hillview Gardens, Felton	50	52	52	51
8	Market Place, Winford	55	56	57	56
9	Chew Magna, North Wick	50	51	52	51
10	Church Road, Norton Malreward	46	47	47	47

Receptor		$L_{Aeq,8h}$ (dB)			
		Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
11	Lye Mead, Winford	49	51	51	50
12	Red Hill, Redhill	46	48	48	46
13	Wrington Hill, Wrington	53	50	50	49
14	Southlands Way, Congresbury	47	50	50	49

Annoyance

7D.5.14 **Table 7D.28** gives the number of people likely to be highly annoyed by air noise around Bristol Airport for the three different scenarios and for the sensitivity case. The results are given for each 3 dB wide contour band as well as the total.

Table 7D.28 Highly annoyed population count, $L_{Aeq,16h}$ average mode summer day

Contour Band $L_{Aeq,16h}$ (dB)	% Highly Annoyed	Highly Annoyed Population Count			
		Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
51 - 54	8	450	450	400	300
54 - 57	11	150	150	100	100
57 - 60	15	100	100	150	100
60 - 63	20	50	50	50	30
63 - 66	27	10	10	10	10
66 - 69	35	1	1	1	0
Total[1]		750	750	750	550

1. Total based on unrounded data.

Sleep Disturbance

7D.5.15 **Table 7D.29** gives the number of people likely to be highly sleep disturbed by air noise around Bristol Airport for the three different scenarios and for the sensitivity case. The results are given for each 5 dB wide contour band as well as the total.

Table 7D.29 Highly sleep disturbed population count, L_{night} average mode annual night

Contour Band L_{night} (dB)	% Highly Sleep Disturbed	Highly Sleep Disturbed Population Count			
		Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
45 - 50	6	350	600	550	450
50 - 55	9	100	150	150	150
55 - 60	12	20	80	80	60

Contour Band L_{night} (dB)	% Highly Sleep Disturbed	Highly Sleep Disturbed Population Count			
		Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
60 – 65	16	0	6	6	0
65+[1]	19	0	0	0	0
Total[2]		450	850	800	650

1. Data included for completeness. Sleep disturbance data normally confined to 45 to 65 dB Lnight for accuracy.
2. Total based on unrounded data.

Residential Receptors – Secondary Indicators

L_{den} Annual Day

7D.5.16 **Table 7D.30**, **Table 7D.31** and **Table 7D.32** give the area, number of dwellings and population counts respectively within each contour band for the three different scenarios and for the sensitivity case. The counts include all those dwellings or people within a specified contour band.

Table 7D.30 Contour areas, L_{den} average mode annual day

Contour L_{den} (dB)	Contour Areas (km²)			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
50	66.1	87.9	64.8	75.8
55	24.6	34.6	25.7	28.6
60	9.0	12.4	9.8	10.2
65	3.0	4.2	3.4	3.2
70	1.1	1.4	1.2	1.1
75	0.5	0.6	0.5	0.5

Table 7D.31 Number of dwellings, L_{den} average mode annual day

Contour L_{den} (dB)	Number of Dwellings			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
50	5,300	6,950	6,600	5,450
55	1,300	2,800	2,650	1,750
60	350	600	550	450
65	20	70	70	60
70	0	1	1	0
75	0	0	0	0

Table 7D.32 Population count, L_{den} average mode annual day

Contour L_{den} (dB)	Population Count			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
50	12,900	16,950	16,050	13,350
55	3,150	6,900	6,400	4,250
60	800	1,450	1,400	1,050
65	50	200	150	150
70	0	3	3	0
75	0	0	0	0

L_{night} Annual Night

7D.5.17 **Table 7D.33**, **Table 7D.34** and **Table 7D.35** give the area, number of dwellings and population counts respectively within each contour band for the three different scenarios and for the sensitivity case. The counts include all those dwellings or people within a specified contour band.

Table 7D.33 Contour areas, L_{night} average mode annual night

Contour L_{night} (dB)	Contour Areas (km^2)			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
45	35.8	61.5	60.6	52.1
50	13.0	21.8	21.8	18.2
55	4.6	8.0	7.7	6.4
60	1.5	2.5	2.4	1.9
65	0.6	0.9	0.9	0.8

Table 7D.34 Number of dwellings, L_{night} average mode annual night

Contour L_{night} (dB)	Number of Dwellings			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
45	3,000	4,900	4,600	4,000
50	600	1,100	1,000	850
55	70	300	300	250
60	1	10	10	1
65	0	0	0	0

Table 7D.35 Population count, L_{night} average mode annual night

Contour L_{night} (dB)	Population Count			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
45	7,250	12,000	11,250	9,800
50	1,450	2,650	2,500	2,050
55	200	750	750	550
60	3	40	40	3
65	0	0	0	0

N70 Summer Day

7D.5.18 **Table 7D.36**, **Table 7D.37** and **Table 7D.38** give the area, number of dwellings and population counts respectively within each contour band for the three different scenarios and for the sensitivity case. The counts include all those dwellings or people within a specified contour band.

Table 7D.36 Contour areas, N70 average mode summer day

No. of Events	Contour Areas (km^2)			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
10	34.0	36.0	32.3	29.1
20	24.0	27.8	24.2	21.4
50	16.3	13.8	15.2	12.2
100	2.7	4.6	8.0	4.4
200	0.0	0.2	0.8	0.2

Table 7D.37 Number of dwellings, N70 average mode summer day

No. of Events	Number of Dwellings			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
10	3,100	3,300	2,800	2,500
20	1,450	2,350	1,300	1,050
50	650	600	650	550
100	20	250	350	250
200	0	0	0	0

Table 7D.38 Population count, N70 average mode summer day

No. of Events	Population Count			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
10	7,450	8,000	6,800	6,100
20	3,550	5,750	3,250	2,600
50	1,550	1,450	1,650	1,300
100	50	600	900	600
200	0	0	0	0

N60 Summer Night

7D.5.19 **Table 7D.39**, **Table 7D.40** and **Table 7D.41** give the area, number of dwellings and population counts respectively within each contour band for the three different scenarios and for the sensitivity case. The counts include all those dwellings or people within a specified contour band.

Table 7D.39 Contour areas, N60 average mode summer night

No. of Events	Contour Areas (km^2)			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
10	56.7	72.3	78.1	65.7
20	3.6	33.5	43.8	32.1
50	0.0	0.0	0.7	0.0
100	0.0	0.0	0.0	0.0
200	0.0	0.0	0.0	0.0

Table 7D.40 Number of dwellings, N60 average mode summer night

No. of Events	Number of Dwellings			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
10	3,800	5,150	6,350	4,400
20	90	2,050	3,300	2,000
50	0	0	1	0
100	0	0	0	0
200	0	0	0	0

Table 7D.41 Population count, N60 average mode summer night

No. of Events	Population Count			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
10	9,300	12,450	15,500	10,800
20	250	5,150	8,000	5,000
50	0	0	2	0
100	0	0	0	0
200	0	0	0	0

Single Mode, Summer Day $L_{Aeq,16h}$ – Easterly

7D.5.20 **Table 7D.42**, **Table 7D.43** and **Table 7D.44** give the area, number of dwellings and population counts respectively within each contour band for the three different scenarios. The counts include all those dwellings or people within a specified contour band.

Table 7D.42 Contour areas, $L_{Aeq,16h}$ easterly mode summer day

Contour $L_{Aeq,16h}$ (dB)	Contour Areas (km^2)		
	Baseline 2017	10 mppa 2021	12 mppa 2026
51 (LOAEL)	37.1	36.0	36.6
54	19.4	18.8	19.2
57	10.6	10.4	10.3
60	6.2	6.0	5.8
63 (SOAEL)	3.2	3.0	2.9
66	1.7	1.6	1.5
69 (UAEL)	0.9	0.8	0.8

Table 7D.43 Number of dwellings, $L_{Aeq,16h}$ easterly mode summer day

Contour $L_{Aeq,16h}$ (dB)	Number of Dwellings		
	Baseline 2017	10 mppa 2021	12 mppa 2026
51 (LOAEL)	1,850	1,900	2,250
54	1,000	950	1,000
57	750	750	750
60	500	450	300
63 (SOAEL)	150	100	80
66	10	10	0

Contour $L_{Aeq,16h}$ (dB)	Number of Dwellings		
	Baseline 2017	10 mppa 2021	12 mppa 2026
69 (UAEL)	0	0	0

Table 7D.44 Population count, $L_{Aeq,16h}$ easterly mode summer day

Contour $L_{Aeq,16h}$ (dB)	Population Count		
	Baseline 2017	10 mppa 2021	12 mppa 2026
51 (LOAEL)	4,550	4,700	5,450
54	2,350	2,250	2,400
57	1,850	1,850	1,800
60	1,300	1,150	800
63 (SOAEL)	350	250	200
66	40	40	0
69 (UAEL)	0	0	0

Single Mode, Summer Day $L_{Aeq,16h}$ – Westerly

7D.5.21 **Table 7D.45**, **Table 7D.46** and **Table 7D.47** give the area, number of dwellings and population counts respectively within each contour band for the three different scenarios. The counts include all those dwellings or people within a specified contour band.

Table 7D.45 Contour areas, $L_{Aeq,16h}$ westerly mode summer day

Contour $L_{Aeq,16h}$ (dB)	Contour Areas (km^2)		
	Baseline 2017	10 mppa 2021	12 mppa 2026
51 (LOAEL)	37.2	36.3	36.7
54	19.5	19.2	19.5
57	10.9	10.7	11.1
60	6.2	6.0	5.8
63 (SOAEL)	3.3	3.1	2.9
66	1.6	1.5	1.5
69 (UAEL)	0.9	0.8	0.8

Table 7D.46 Number of dwellings, $L_{Aeq,16h}$ westerly mode summer day

Contour $L_{Aeq,16h}$ (dB)	Number of Dwellings		
	Baseline 2017	10 mppa 2021	12 mppa 2026
51 (LOAEL)	3,500	3,300	3,200
54	950	900	850
57	350	350	400
60	100	100	100
63 (SOAEL)	3	2	10
66	1	1	1
69 (UAEL)	0	0	0

Table 7D.47 Population count, $L_{Aeq,16h}$ westerly mode summer day

Contour $L_{Aeq,16h}$ (dB)	Population Count		
	Baseline 2017	10 mppa 2021	12 mppa 2026
51 (LOAEL)	8,500	8,050	7,700
54	2,250	2,250	2,000
57	900	900	1,000
60	250	250	250
63 (SOAEL)	7	5	40
66	3	3	3
69 (UAEL)	0	0	0

Single Mode, Summer Night $L_{Aeq,8h}$ – Easterly

7D.5.22 **Table 7D.48**, **Table 7D.49** and **Table 7D.50** give the area, number of dwellings and population counts respectively within each contour band for the three different scenarios. The counts include all those dwellings or people within a specified contour band.

Table 7D.48 Contour areas, $L_{Aeq,8h}$ easterly mode summer night

Contour $L_{Aeq,8h}$ (dB)	Contour Areas (km^2)		
	Baseline 2017	10 mppa 2021	12 mppa 2026
45 (LOAEL)	46.1	64.3	66.2
48	24.3	34.7	35.9
51	12.8	17.8	18.6
54	7.4	9.9	10.0

Contour $L_{Aeq,8h}$ (dB)	Contour Areas (km^2)		
	Baseline 2017	10 mppa 2021	12 mppa 2026
55 (SOAEL)	6.1	8.3	8.4
57	4.0	5.6	5.7
60	2.0	2.8	2.8
63	1.0	1.5	1.4

Table 7D.49 Number of dwellings, $L_{Aeq,8h}$ easterly mode summer night

Contour $L_{Aeq,8h}$ (dB)	Number of Dwellings		
	Baseline 2017	10 mppa 2021	12 mppa 2026
45 (LOAEL)	2,800	5,450	6,250
48	1,350	1,900	2,250
51	850	900	1,000
54	550	750	750
55 (SOAEL)	450	700	650
57	200	350	300
60	50	80	70
63	0	0	0

Table 7D.50 Population count, $L_{Aeq,8h}$ easterly mode summer night

Contour $L_{Aeq,8h}$ (dB)	Population Count		
	Baseline 2017	10 mppa 2021	12 mppa 2026
45 (LOAEL)	6,800	13,450	15,400
48	3,200	4,650	5,450
51	2,050	2,200	2,400
54	1,450	1,850	1,800
55 (SOAEL)	1,150	1,700	1,650
57	400	850	800
60	150	200	200
63	0	0	0

Single Mode, Summer Night $L_{Aeq,8h}$ – Westerly

7D.5.23 **Table 7D.51**, **Table 7D.52** and **Table 7D.53** give the area, number of dwellings and population counts respectively within each contour band for the three different scenarios. The counts include all those dwellings or people within a specified contour band.

Table 7D.51 Contour areas, $L_{Aeq,8h}$ westerly mode summer night

Contour $L_{Aeq,8h}$ (dB)	Contour Areas (km²)		
	Baseline 2017	10 mppa 2021	12 mppa 2026
45 (LOAEL)	46.2	63.7	65.8
48	24.9	35.3	36.6
51	13.8	18.5	19.3
54	7.5	10.3	10.8
55 (SOAEL)	6.1	8.4	8.5
57	4.0	5.7	5.7
60	1.9	2.8	2.8
63	1.0	1.4	1.4

Table 7D.52 Number of dwellings, $L_{Aeq,8h}$ westerly mode summer night

Contour $L_{Aeq,8h}$ (dB)	Number of Dwellings		
	Baseline 2017	10 mppa 2021	12 mppa 2026
45 (LOAEL)	4,100	5,600	5,450
48	1,200	3,100	3,000
51	500	850	800
54	200	350	400
55 (SOAEL)	100	250	300
57	20	100	100
60	1	2	10
63	0	1	1

Table 7D.53 Population count, $L_{Aeq,8h}$ westerly mode summer night

Contour $L_{Aeq,8h}$ (dB)	Population Count		
	Baseline 2017	10 mppa 2021	12 mppa 2026
45 (LOAEL)	9,950	13,750	13,250
48	2,900	7,500	7,250

Contour $L_{Aeq,8h}$ (dB)	Population Count		
	Baseline 2017	10 mppa 2021	12 mppa 2026
51	1,250	2,050	1,950
54	550	900	1,000
55 (SOAEL)	250	650	750
57	50	250	250
60	3	5	40
63	0	3	3

SEL contours - Runway 09

7D.5.24 **Table 7D.54** to **Table 7D.59** give the area, number of dwellings and population counts respectively within each contour band for the Airbus A320ceo and A320neo, and the Boeing 737-800 and B738MAX. These include the most common and loudest aircraft operations that occur at least once per night in all scenarios. The counts include all those dwellings or people within a specified contour band.

Table 7D.54 Contour areas, SEL, runway 09 arrivals

Contour SEL (dB(A))	Contour Areas (km²)			
	B738	B738MAX	A320	A320neo
80	12.1	15.2	8.7	4.1
90	0.9	1.1	0.7	0.4
100	0.1	0.1	0.1	0.1

Table 7D.55 Number of dwellings, SEL, runway 09 arrivals

Contour SEL (dB(A))	Number of Dwellings			
	B738	B738MAX	A320	A320neo
80	800	1,250	500	40
90	0	2	0	0
100	0	0	0	0

Table 7D.56 Population count, SEL, runway 09 arrivals

Contour SEL (dB(A))	Population Count			
	B738	B738MAX	A320	A320neo
80	2,000	3,050	1,150	80

Contour SEL (dB(A))	Population Count			
	B738	B738MAX	A320	A320neo
90	0	5	0	0
100	0	0	0	0

Table 7D.57 Contour areas, SEL, runway 09 departures

Contour SEL (dB(A))	Contour Areas (km^2)			
	B738	B738MAX	A320	A320neo
80	40.9	12.1	20.1	7.7
90	6.1	1.6	3.6	1.2
100	0.7	0.2	0.5	0.2

Table 7D.58 Number of dwellings, SEL, runway 09 departures

Contour SEL (dB(A))	Number of Dwellings			
	B738	B738MAX	A320	A320neo
80	1,450	850	1,000	700
90	600	50	200	0
100	0	0	0	0

Table 7D.59 Population count, SEL, runway 09 departures

Contour SEL (dB(A))	Population Count			
	B738	B738MAX	A320	A320neo
80	3,550	2,050	2,400	1,750
90	1,500	150	400	0
100	0	0	0	0

SEL contours - Runway 27

7D.5.25 **Table 7D.60** to **Table 7D.65** give the area, number of dwellings and population counts respectively within each contour band for the Airbus A320ceo and A320neo, and the Boeing 737-800 and B738MAX. These include the most common and loudest aircraft operations that occur at least once per night in all scenarios. The counts include all those dwellings or people within a specified contour band.

Table 7D.60 Contour areas, SEL, runway 27 arrivals

Contour SEL (dB(A))	Contour Areas (km^2)			
	B738	B738MAX	A320	A320neo
80	13.9	16.9	10.1	5.3
90	0.9	1.1	0.8	0.4
100	0.1	0.1	0.1	0.0

Table 7D.61 Number of dwellings, SEL, runway 27 arrivals

Contour SEL (dB(A))	Number of Dwellings			
	B738	B738MAX	A320	A320neo
80	700	800	550	450
90	10	60	10	0
100	0	0	0	0

Table 7D.62 Population count, SEL, runway 27 arrivals

Contour SEL (dB(A))	Population Count			
	B738	B738MAX	A320	A320neo
80	1,700	1,950	1,400	1,050
90	40	150	40	0
100	0	0	0	0

Table 7D.63 Contour areas, SEL, runway 27 departures

Contour SEL (dB(A))	Contour Areas (km^2)			
	B738	B738MAX	A320	A320neo
80	41.1	11.0	19.1	7.8
90	6.1	1.5	3.6	1.1
100	0.7	0.2	0.5	0.2

Table 7D.64 Number of dwellings, SEL, runway 27 departures

Contour SEL (dB(A))	Number of Dwellings			
	B738	B738MAX	A320	A320neo
80	4,500	250	1,600	90
90	70	1	5	0

Contour SEL (dB(A))	Number of Dwellings			
	B738	B738MAX	A320	A320neo
100	0	0	0	0

Table 7D.65 Population count, SEL, runway 27 departures

Contour SEL (dB(A))	Population Count			
	B738	B738MAX	A320	A320neo
80	10,950	550	3,900	250
90	150	3	10	0
100	0	0	0	0

L_{Amax} contours - Runway 09

7D.5.26 **Table 7D.66** to **Table 7D.71** give the area, number of dwellings and population counts respectively within each contour band for the Airbus A320ceo and A320neo, and the Boeing 737-800 and B738MAX. These include the most common and loudest aircraft operations that occur at least once per night in all scenarios. The counts include all those dwellings or people within a specified contour band.

Table 7D.66 Contour areas, L_{Amax}, runway 09 arrivals

Contour L_{Amax} (dB(A))	Contour Areas (km^2)			
	B738	B738MAX	A320	A320neo
70	7.2	7.7	5.1	3.3
80	1.5	1.5	1.1	0.6
90	0.4	0.3	0.3	0.2

Table 7D.67 Number of dwellings, L_{Amax}, runway 09 arrivals

Contour L_{Amax} (dB(A))	Number of Dwellings			
	B738	B738MAX	A320	A320neo
70	150	150	50	9
80	2	2	0	0
90	0	0	0	0

Table 7D.68 Population count, L_{Amax}, runway 09 arrivals

Contour L_{Amax} (dB(A))	Population Count			
	B738	B738MAX	A320	A320neo
70	400	400	100	20
80	5	5	0	0
90	0	0	0	0

Table 7D.69 Contour areas, L_{Amax}, runway 09 departures

Contour L_{Amax} (dB(A))	Contour Areas (km^2)			
	B738	B738MAX	A320	A320neo
70	27.1	11.3	13.7	6.8
80	6.1	2.3	3.8	1.6
90	1.2	0.5	0.8	0.4

Table 7D.70 Number of dwellings, L_{Amax}, runway 09 departures

Contour L_{Amax} (dB(A))	Number of Dwellings			
	B738	B738MAX	A320	A320neo
70	1,150	800	900	700
80	650	80	200	10
90	0	0	0	0

Table 7D.71 Population count, L_{Amax}, runway 09 departures

Contour L_{Amax} (dB(A))	Population Count			
	B738	B738MAX	A320	A320neo
70	2,750	2,000	2,200	1,700
80	1,600	200	500	40
90	0	0	0	0

L_{Amax} contours - Runway 27

7D.5.27 **Table 7D.72** to **Table 7D.77** give the area, number of dwellings and population counts respectively within each contour band for the Airbus A320ceo and A320neo, and the Boeing 737-800 and B738MAX. These include the most common and loudest aircraft operations that occur at least once per night in all scenarios. The counts include all those dwellings or people within a specified contour band.

Table 7D.72 Contour areas, L_{Amax}, runway 27 arrivals

Contour L_{Amax} (dB(A))	Contour Areas (km²)			
	B738	B738MAX	A320	A320neo
70	8.8	9.5	6.4	4.3
80	1.5	1.5	1.1	0.7
90	0.4	0.4	0.3	0.2

Table 7D.73 Number of dwellings, L_{Amax}, runway 27 arrivals

Contour L_{Amax} (dB(A))	Number of Dwellings			
	B738	B738MAX	A320	A320neo
70	550	550	500	350
80	70	80	50	10
90	0	0	0	0

Table 7D.74 Population count, L_{Amax}, runway 27 arrivals

Contour L_{Amax} (dB(A))	Population Count			
	B738	B738MAX	A320	A320neo
70	1,350	1,350	1,200	800
80	150	200	150	40
90	0	0	0	0

Table 7D.75 Contour areas, L_{Amax}, runway 27 departures

Contour L_{Amax} (dB(A))	Contour Areas (km²)			
	B738	B738MAX	A320	A320neo
70	25.4	10.0	12.5	6.8
80	6.1	2.2	3.7	1.4
90	1.1	0.5	0.8	0.4

Table 7D.76 Number of dwellings, L_{Amax}, runway 27 departures

Contour L_{Amax} (dB(A))	Number of Dwellings			
	B738	B738MAX	A320	A320neo
70	2,500	150	300	60
80	40	0	5	0

Contour L_{Amax} (dB(A))	Number of Dwellings			
	B738	B738MAX	A320	A320neo
90	0	0	0	0

Table 7D.77 Population count, L_{Amax}, runway 27 departures

Contour L_{Amax} (dB(A))	Population Count			
	B738	B738MAX	A320	A320neo
70	6,000	350	700	150
80	100	0	10	0
90	0	0	0	0

Non-residential receptors

7D.5.28 **Table 7D.78**, **Table 7D.79** and **Table 7D.80** give the average summer day noise level for the schools, places of worship and amenity areas in the vicinity of Bristol Airport for the three different scenarios and for the sensitivity case. There are no healthcare facilities in the vicinity of Bristol Airport.

Table 7D.78 Schools noise exposure levels, $L_{Aeq,16h}$ average mode summer day

Receptor		$L_{Aeq,16h}$ (dB)			
		Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
S1	St. Katharine's School, Felton	63	63	62	61
S2	Winford Primary, Winford	58	58	58	58
S3	St. Andrew's Primary, Congresbury	51	51	51	50
S4	Yatton Junior, Yatton	51	51	51	49
S5	Marksbury Primary, Marksbury	34	34	35	34
S6	St. Anne's Primary, Hewish	50	50	50	49
S7	Chew Magna Primary, Chew Magna	41	41	41	40
S8	Wrington Primary, Wrington	48	48	47	46
S9	Court de Wyck Primary, Cleeve	51	50	50	49
S10	Pensford Primary, Pensford	42	42	42	41
S11	Dundry Primary, Dundry	44	44	44	43
S12	Stanton Drew Primary, Stanton Drew	38	38	38	37
S13	Woodspring School, Weston-Super-Mare	48	48	48	47

Table 7D.79 Places of worship noise exposure levels, $L_{Aeq,16h}$ average mode summer day

Receptor		$L_{Aeq,16h}$ (dB)			
		Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
W1	St Thomas A Becket's Church, Pensford	41	41	42	41
W2	Marksbury Methodist Church, Marksbury	34	34	35	34
W3	St Barnabas Church, Claverham	48	48	47	46
W4	St Dunstan And St Anthony Church, Claverham	53	53	52	51
W5	Chew Magna Baptist Church, Chew Magna	40	40	40	39
W6	Sacred Heart Church, Chew Magna	40	40	40	39
W7	All Saints Church, Publow	43	43	44	43
W8	St James Church, Regil	39	40	39	38
W9	Holy Trinity Church, Cleeve	52	52	52	51
W10	St Margaret's Church, Queen Charlton	44	45	45	44
W11	St Mary and St Peters Church, Winford	56	56	57	56
W12	St Mary's Church, Compton Dando	43	44	44	44
W13	Congresbury Methodist Church, Congresbury	51	50	50	49
W14	Chewton Keynsham Church, Chewton Keynsham	46	47	48	47
W15	Dundry Baptist Church, Dundry	47	47	47	46
W16	St Nicholas Church, Brockley	47	48	47	46
W17	St Andrews Church of England, Hartcliffe	42	43	43	42
W18	Wrington United Reformed Church, Wrington	49	49	49	48
W19	Holy Saviour's Church, Hewish	48	47	47	46
W20	Yatton Methodist Church, Yatton	51	50	50	49
W21	St Andrews Church, Congresbury	51	51	50	49
W22	Holy Trinity Church, Norton Malreward	50	50	51	50
W23	St Katherine's Church, Felton	59	59	58	57
W24	All Saints Church, Wrington	47	47	46	45
W25	All Saints Church, Kingston Seymour	46	45	45	44
W26	Claverham Free Church, Claverham	50	50	50	49
W27	The Church of Saint Mary The Virgin, Yatton	52	52	52	51
W28	Christ Church, Redhill	47	47	46	45

Receptor		$L_{Aeq,16h}$ (dB)			
		Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
W29	St Michael, Dundry	44	45	45	43
W30	Gospel Hall - Pensford Gospel Church, Pensford	40	41	41	40
W31	St Michael's Church, Burnett	45	45	47	46
W32	St Mary's Church, Stanton Drew	39	39	39	38
W33	St. Andrew, Chew Magna	40	41	41	40
W34	Winford Baptist, Winford	56	56	56	55
W35	Horsecastle Chapel, Yatton	48	47	47	46

Table 7D.80 Amenity areas noise exposure levels, $L_{Aeq,16h}$ average mode summer day

Receptor		$L_{Aeq,16h}$ (dB)			
		Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
A1	The Glebe Field, Wrington	46	46	46	44
A2	Yatton Village Green, Yatton	52	52	52	50
A3	Glebelands Gardens, Yatton	52	52	51	50
A4	Bishport Avenue Open Space, Hartcliffe	43	43	44	42
A5	Streamcross Playing Field, Claverham	50	50	50	48
A6	Crosscombe Walk Open Space, Hartcliffe	42	42	42	41
A7	Court Farm Road Open Space, Whitchurch	43	43	43	42
A8	Cadbury Hill, Yatton	55	55	55	54
A9	Vee Lane Play Area, Felton	59	59	60	59
A10	Manor Road Playing Field, Keynsham	42	42	43	43
A11	Marksbury Playground, Marksbury	34	34	35	34
A12	Chew Magna Playing Field, Chew Magna	43	43	43	42
A13	Orchid Drive Play Area, Keynsham	42	42	43	42
A14	Publow Lane Recreation Ground, Publow	43	43	43	42
A15	The Mead Play Area, Keynsham	42	42	43	42
A16	Hamilton Way Play Area, Whitchurch	44	44	44	43
A17	Congresbury Millennium Green, Congresbury	52	51	51	50
A18	Hangstones Playing Field, Yatton	51	51	50	49

	Receptor	$L_{Aeq,16h}$ (dB)			
		Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
A19	Rock Road Playing Field, Yatton	53	53	53	52
A20	Land at Saxon Court, St. Georges	45	45	45	44
A21	Holmoak Road Playing Field, Keynsham	42	42	43	42
A22	Chalfield Close Play Area, Keynsham	44	44	46	45
A23	Whitchurch Playground, Whitchurch	45	45	46	45
A24	Felton Common, Felton	68	68	68	68

Variation in Air Noise over a Day

7D.5.29 The variation in air noise throughout the day is given in **Table 7D.81**, **Table 7D.82** and **Table 7D.83** for each scenario on an hourly basis. These tables relate to an average mode, summer day so includes activity by aircraft in both a westerly and easterly direction, in proportion to how often the wind blows towards the west or east over the year. While in practice, aircraft will fly in both a westerly and easterly direction at different times during the same day, there will also be days when aircraft operate solely in a westerly direction or solely in an easterly direction. On these occasions, the hourly noise exposure level at any given receptor will vary differently over the day from that experienced under average mode conditions.

7D.5.30 **Table 7D.84**, **Table 7D.85** and **Table 7D.86** provide results of this analysis for easterly operations only, for each of the three scenarios.

7D.5.31 **Table 7D.87**, **Table 7D.88** and **Table 7D.89** provide results of this analysis for westerly operations only, for each of the three scenarios.

7D.5.32 The hour designator in these tables represents the start of the hour, i.e. hour "02" denotes the period 02:00 to 02:59.

Average mode, Baseline 2017

7D.5.33 **Table 7D.81** gives the hourly variation in noise exposure in 2017, in terms of $L_{Aeq,1h}$, at the air noise receptor locations, based on an average mode, summer day of aircraft activities.

Table 7D.81 Daily noise variation at residential receptors, $L_{Aeq,1h}$ average mode summer, Baseline 2017

	Noise Level at Location, dB													
Hour	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
$L_{Aeq,16h}$	53	54	62	61	60	62	55	59	54	50	53	51	59	53

	Noise Level at Location, dB													
Hour	**1 Henley Park**	**2 Bishops Road**	**3 Fountain Treeworks**	**4 Cooks Bridle Path**	**5 Downside Road**	**6 School Lane**	**7 Hillview Gardens**	**8 Market Place**	**9 Chew Magna**	**10 Church Road**	**11 Lye Mead**	**12 Red Hill**	**13 Wrington Hill**	**14 Southlands Way**
$L_{Aeq,8h}$	48	48	57	56	54	57	50	55	50	46	49	46	53	47
00	45	43	50	52	49	52	48	56	52	47	49	42	46	43
01	44	40	45	48	43	49	47	57	52	48	49	37	41	42
02	40	36	42	45	40	45	43	53	48	43	45	34	38	38
03	36	32	37	41	35	42	40	49	44	40	41	31	33	34
04	31	28	34	39	33	38	34	43	39	34	36	28	30	29
05	44	46	55	52	52	54	47	48	39	36	44	43	51	44
06	56	56	65	64	63	65	57	57	50	47	54	54	61	55
07	56	57	66	65	63	65	58	60	53	49	55	55	62	56
08	53	53	61	61	59	61	55	58	53	49	53	51	58	53
09	52	52	60	60	59	60	53	57	51	47	51	50	57	51
10	51	51	60	59	57	59	53	57	51	47	51	49	56	50
11	50	50	58	58	56	58	53	60	54	49	52	48	55	50
12	55	55	63	62	60	62	56	62	57	52	55	52	59	54
13	55	55	64	63	61	63	56	59	53	49	54	53	60	54
14	53	53	61	61	59	61	54	58	53	49	53	51	58	52
15	52	52	60	60	58	60	54	60	55	50	53	50	57	51
16	54	55	63	62	61	63	56	60	54	50	54	52	60	54
17	54	55	63	62	61	63	56	60	55	51	55	53	59	54
18	55	55	64	63	62	64	56	60	54	50	54	53	60	54
19	54	54	63	62	60	62	56	60	55	50	54	51	59	53
20	53	53	62	61	59	61	55	58	53	49	53	51	59	53
21	51	51	60	58	57	59	53	57	52	47	51	49	56	50
22	47	46	54	53	51	54	50	58	53	49	51	43	50	46
23	46	43	49	51	47	52	49	58	54	50	51	41	45	44

Average mode, 10 mppa – 2021

7D.5.34 **Table 7D.82** gives the hourly variation in noise exposure in 2021, in terms of $L_{Aeq,1h}$, at the air noise receptor locations, based on an average mode, summer day of aircraft activities.

Table 7D.82 Daily noise variation at residential receptors, $L_{Aeq,1h}$ average mode summer, 10 mppa 2021

	Noise Level at Location, dB													
Hour	**1 Henley Park**	**2 Bishops Road**	**3 Fountain Treeworks**	**4 Cooks Bridle Path**	**5 Downside Road**	**6 School Lane**	**7 Hillview Gardens**	**8 Market Place**	**9 Chew Magna**	**10 Church Road**	**11 Lye Mead**	**12 Red Hill**	**13 Wrington Hill**	**14 Southlands Way**
$L_{Aeq,16h}$	53	53	62	60	60	62	55	59	54	50	54	51	58	53
$L_{Aeq,8h}$	50	50	58	57	56	58	52	56	51	47	51	48	55	49
00	45	40	46	48	43	49	47	56	52	48	49	37	42	42
01	46	42	47	50	44	50	49	58	53	49	50	39	43	44
02	41	37	42	45	39	46	44	53	48	44	45	34	38	39
03	37	33	39	43	36	42	40	49	45	40	41	32	34	35
04	37	33	38	42	36	42	40	49	44	40	41	31	34	35
05	44	44	54	51	50	53	47	51	46	42	46	42	50	43
06	57	59	67	65	65	67	60	59	51	49	57	57	64	57
07	55	56	65	63	62	64	58	59	52	48	55	54	61	55
08	52	53	61	59	59	61	54	58	53	49	53	51	58	52
09	51	51	60	58	58	60	53	57	52	47	52	50	57	51
10	52	53	61	60	58	60	54	57	52	48	52	50	57	52
11	52	51	59	59	57	60	54	61	56	51	54	49	56	51
12	55	55	63	62	60	63	57	61	56	52	55	52	60	54
13	55	55	64	62	62	64	57	60	54	51	55	53	60	54
14	52	52	60	58	58	60	54	58	53	49	53	49	57	51
15	53	52	60	59	57	60	54	60	55	51	54	49	57	52
16	54	55	63	62	61	63	57	61	55	51	55	53	60	54
17	56	56	65	63	63	65	58	60	55	51	56	54	61	55
18	54	55	63	61	61	63	56	60	54	50	54	53	60	54
19	54	54	62	61	60	62	56	60	54	51	54	52	59	53

Hour	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
	Noise Level at Location, dB													
20	48	48	57	55	54	57	51	56	51	47	50	46	53	48
21	49	49	57	55	56	58	51	57	52	47	50	47	54	48
22	47	45	52	51	50	53	49	57	53	49	50	42	49	45
23	48	44	49	52	46	52	50	59	55	51	52	42	45	46

Average mode, 12 mppa – 2026 (With Proposed Development)

7D.5.35 **Table 7D.83** gives the hourly variation in noise exposure in 2026 following the implementation of the Proposed Development, in terms of $L_{Aeq,1h}$, at the air noise receptor locations, based on an average mode, summer day of aircraft activities.

Table 7D.83 Daily noise variation at residential receptors, $L_{Aeq,1h}$ average mode summer, 12 mppa 2026

Hour	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
	Noise Level at Location, dB													
$L_{Aeq,16h}$	53	53	61	60	59	61	55	60	55	50	54	51	58	52
$L_{Aeq,8h}$	50	50	58	57	56	58	52	57	52	47	51	48	55	49
00	44	40	45	47	42	48	47	56	51	47	48	36	41	42
01	46	41	47	49	44	50	48	57	53	49	50	38	43	43
02	41	37	42	45	39	46	44	53	48	44	45	34	38	39
03	37	33	39	43	36	42	40	49	45	40	41	32	34	35
04	36	32	37	41	35	41	39	48	43	39	40	30	33	34
05	43	44	54	51	50	53	47	50	44	40	45	42	50	43
06	57	58	67	65	65	67	59	59	52	49	56	56	63	57
07	57	58	67	65	65	67	59	59	52	49	56	56	63	57

Hour	Noise Level at Location, dB													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
08	53	53	61	61	59	61	55	60	55	51	54	51	58	53
09	52	52	60	58	59	61	54	58	53	49	52	50	57	51
10	51	51	59	58	56	58	52	57	52	47	51	48	55	51
11	53	52	59	60	57	60	55	62	57	52	55	50	56	52
12	56	55	64	63	61	63	57	62	57	52	56	53	60	55
13	55	55	64	62	61	63	57	60	55	51	55	53	60	54
14	51	52	60	58	57	59	53	58	53	49	52	48	56	50
15	52	52	60	58	57	59	54	61	56	51	54	49	56	51
16	54	54	62	62	60	62	56	61	55	51	55	52	59	53
17	55	55	64	63	61	63	57	61	56	51	55	53	60	55
18	54	54	62	62	59	62	56	62	56	52	55	52	58	53
19	54	55	63	62	61	63	57	60	54	51	55	53	60	54
20	49	48	56	55	54	56	51	57	53	48	51	46	53	48
21	47	44	52	51	49	52	48	56	52	47	49	41	48	45
22	47	44	52	51	50	53	49	57	53	48	50	42	49	45
23	50	46	51	53	48	54	52	61	57	53	54	42	47	48

Easterly mode, Baseline 2017

7D.5.36 **Table 7D.84** gives the hourly variation in noise exposure in 2017, in terms of $L_{Aeq,1h}$, at the air noise receptor locations, based on an easterly mode, summer day of aircraft activities.

Table 7D.84 Daily noise variation at residential receptors, $L_{Aeq,1h}$ easterly mode summer, Baseline 2017

Hour	Noise Level at Location, dB													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
$L_{Aeq,16h}$	52	48	54	61	61	64	61	60	53	51	58	52	50	50
$L_{Aeq,8h}$	49	44	50	56	55	59	55	55	47	45	52	47	46	46
00	51	47	52	53	49	51	48	46	41	39	44	42	48	48
01	51	47	52	49	34	31	24	17	< 10	< 10	17	35	48	49
02	47	43	48	46	35	36	29	28	21	18	26	33	44	45
03	43	39	44	43	28	25	18	11	< 10	< 10	11	29	40	41
04	38	34	39	39	34	36	30	29	23	20	27	28	35	35
05	32	29	37	53	52	57	53	54	44	42	51	43	33	30
06	39	38	46	63	64	67	64	63	56	53	61	55	43	37
07	49	45	52	64	65	68	64	64	57	54	61	56	48	47
08	52	48	53	60	60	63	60	60	53	51	57	52	49	49
09	50	45	51	59	59	62	59	58	51	49	56	51	47	47
10	50	45	51	58	58	62	58	58	51	48	55	50	47	47
11	53	49	55	58	57	60	57	56	49	46	54	48	50	51
12	55	51	57	61	61	65	61	61	54	52	58	53	53	53
13	51	47	53	62	63	66	63	62	55	53	59	54	49	49
14	52	47	53	60	60	64	60	60	52	50	57	52	49	49
15	54	49	55	59	59	63	59	59	52	49	56	50	51	51
16	53	49	54	62	62	65	62	62	54	52	59	53	50	50
17	54	50	55	62	62	65	61	61	54	52	58	53	51	51
18	53	48	54	63	62	66	62	62	54	52	59	53	50	50
19	53	49	54	61	61	65	61	61	54	51	58	52	50	50
20	51	46	52	60	61	65	61	61	53	51	58	52	48	48
21	50	46	51	58	58	62	58	58	50	48	55	49	48	48
22	52	48	53	53	51	55	52	51	44	41	48	43	49	50

	Noise Level at Location, dB													
Hour	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
23	53	49	54	52	44	47	43	43	35	33	40	40	50	51

Easterly mode, 10 mppa – 2021

7D.5.37 **Table 7D.85** gives the hourly variation in noise exposure in 2021, in terms of $L_{Aeq,1h}$, at the air noise receptor locations, based on an easterly mode, summer day of aircraft activities.

Table 7D.85 Daily noise variation at residential receptors, $L_{Aeq,1h}$ easterly mode summer, 10 mppa 2021

	Noise Level at Location, dB													
Hour	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
$L_{Aeq,16h}$	52	48	54	60	60	64	60	60	53	50	58	51	50	50
$L_{Aeq,8h}$	50	46	51	57	57	60	57	57	49	46	54	48	47	47
00	51	47	52	49	35	32	25	17	< 10	< 10	17	35	48	49
01	53	48	54	51	37	34	27	20	< 10	< 10	20	37	50	50
02	48	44	49	47	33	29	23	16	< 10	< 10	15	33	45	45
03	44	40	45	44	29	26	19	12	< 10	< 10	12	30	41	41
04	44	39	45	44	29	25	19	11	< 10	< 10	11	29	41	41
05	45	40	46	52	51	56	52	53	43	40	49	42	42	42
06	39	40	49	65	65	69	66	66	58	55	63	57	45	38
07	48	45	52	63	63	67	64	63	55	53	61	54	47	46
08	51	47	53	60	59	63	60	59	52	49	57	51	49	49
09	50	46	52	59	59	62	59	58	50	48	56	50	48	48
10	50	46	51	59	59	62	59	59	52	49	57	50	47	47
11	55	51	56	59	58	61	58	58	50	47	55	49	52	52

Hour	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
	Noise Level at Location, dB													
12	54	50	56	62	62	65	62	62	55	52	59	53	52	52
13	53	49	54	62	62	66	63	62	54	52	60	53	50	50
14	52	48	53	59	58	62	59	59	51	48	56	49	49	49
15	54	50	55	59	58	62	59	59	51	49	56	49	51	52
16	54	49	55	62	61	65	62	62	54	51	59	53	51	51
17	53	49	54	63	63	67	63	63	55	53	61	54	50	50
18	52	48	54	62	62	65	62	62	54	51	59	53	50	50
19	53	49	54	61	61	65	61	61	53	51	58	52	50	51
20	50	46	51	55	55	58	55	55	47	45	52	46	47	48
21	51	47	52	56	56	59	56	54	47	45	52	47	48	49
22	52	48	53	53	49	53	50	50	41	38	47	42	49	50
23	55	50	55	54	40	37	31	24	13	11	23	41	52	52

Easterly mode, 12 mppa – 2026 (With Proposed Development)

7D.5.38 **Table 7D.86** gives the hourly variation in noise exposure in 2026 following the implementation of the Proposed Development, in terms of $L_{Aeq,1h}$, at the air noise receptor locations, based on an easterly mode, summer day of aircraft activities.

Table 7D.86 Daily noise variation at residential receptors, $L_{Aeq,1h}$ easterly mode summer, 12 mppa 2026

Hour	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
	Noise Level at Location, dB													
$L_{Aeq,16h}$	53	49	55	60	60	63	60	60	52	50	57	51	51	51
$L_{Aeq,8h}$	51	47	52	57	57	60	57	57	49	46	54	48	48	49

Hour	Noise Level at Location, dB													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
00	51	46	52	48	34	31	24	17	< 10	< 10	17	34	48	48
01	52	48	53	51	36	33	27	20	< 10	< 10	19	37	49	50
02	52	48	53	51	36	33	27	20	< 10	< 10	19	37	49	50
03	44	40	45	44	29	26	19	12	< 10	< 10	12	30	41	41
04	43	38	44	43	27	24	17	10	< 10	< 10	< 10	28	40	40
05	43	38	44	52	51	56	52	53	43	40	49	42	40	40
06	43	41	49	65	66	69	66	66	58	55	63	57	46	41
07	49	45	51	62	63	66	63	63	55	52	60	54	47	46
08	54	49	55	60	60	63	60	60	53	50	57	52	51	51
09	52	48	53	59	59	63	59	58	51	48	56	50	49	49
10	51	47	52	58	57	60	57	58	50	48	55	49	48	48
11	56	52	57	59	59	61	57	57	50	48	55	50	53	54
12	55	51	57	62	63	66	62	62	55	53	59	54	53	53
13	54	49	55	62	62	66	62	62	54	52	59	53	51	51
14	52	48	53	58	57	61	58	59	50	48	56	48	49	50
15	55	50	56	58	57	61	58	59	51	48	56	49	52	52
16	54	50	56	61	61	64	61	61	53	50	58	52	52	52
17	54	50	55	62	63	66	62	62	55	52	59	54	51	52
18	55	51	57	61	61	64	60	61	53	50	58	52	53	53
19	53	49	54	62	62	66	62	62	54	52	59	53	50	51
20	52	48	53	55	54	58	54	54	47	44	51	46	49	50
21	51	47	52	52	49	53	49	50	43	40	46	41	48	49
22	52	48	53	52	49	53	50	50	41	38	47	42	49	50
23	57	52	57	54	41	38	31	23	13	11	23	41	54	54

Westerly mode, Baseline 2017

7D.5.39 **Table 7D.87** gives the hourly variation in noise exposure in 2017, in terms of $L_{Aeq,1h}$, at the air noise receptor locations, based on an westerly mode, summer day of aircraft activities.

Table 7D.87 Daily noise variation at residential receptors, $L_{Aeq,1h}$ westerly mode summer, Baseline 2017

	Noise Level at Location, dB													
Hour	**1 Henley Park**	**2 Bishops Road**	**3 Fountain Treeworks**	**4 Cooks Bridle Path**	**5 Downside Road**	**6 School Lane**	**7 Hillview Gardens**	**8 Market Place**	**9 Chew Magna**	**10 Church Road**	**11 Lye Mead**	**12 Red Hill**	**13 Wrington Hill**	**14 Southlands Way**
$L_{Aeq,16h}$	54	54	63	61	59	61	50	59	54	49	51	51	59	53
$L_{Aeq,8h}$	48	49	58	56	54	56	46	55	50	46	47	46	54	48
00	41	41	50	52	49	52	48	57	53	48	50	42	46	41
01	11	16	26	47	44	50	48	58	53	49	50	37	22	12
02	22	23	31	45	40	46	44	54	49	44	46	34	27	22
03	< 10	10	20	41	36	42	40	50	45	41	42	31	16	< 10
04	24	24	32	39	33	38	35	44	40	35	37	27	28	24
05	45	47	56	52	52	53	37	39	34	30	32	43	52	45
06	57	57	66	64	62	63	47	46	41	36	40	54	62	56
07	57	58	67	65	63	64	50	57	51	45	48	55	63	57
08	53	54	62	61	59	60	50	58	53	48	51	51	59	53
09	52	53	61	60	58	60	48	56	51	47	48	50	57	52
10	51	52	60	59	57	58	48	56	51	47	48	49	57	51
11	50	50	59	58	56	58	51	60	55	50	52	48	55	49
12	55	55	64	62	60	61	53	62	57	52	54	52	60	54
13	56	56	65	63	61	62	50	57	53	48	50	53	61	55
14	53	54	62	61	59	60	50	58	53	49	50	51	59	53
15	52	53	61	60	58	60	51	60	55	51	52	50	58	52
16	55	55	64	63	60	61	51	59	54	50	52	52	60	54
17	55	55	64	63	60	62	52	60	56	51	53	52	60	54
18	55	56	64	63	62	63	51	60	54	49	51	53	61	55
19	54	55	63	62	59	60	51	60	55	50	52	51	60	54

Hour	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
	Noise Level at Location, dB													
20	54	54	63	62	59	60	49	57	52	48	49	51	60	53
21	51	52	60	58	57	58	48	57	52	47	49	49	57	51
22	44	45	54	53	51	54	49	59	54	49	51	43	50	44
23	36	37	46	51	47	53	50	59	55	50	52	41	42	36

Westerly mode, 10 mppa – 2021

7D.5.40 **Table 7D.88** gives the hourly variation in noise exposure in 2021, in terms of $L_{Aeq,1h}$, at the air noise receptor locations, based on an westerly mode, summer day of aircraft activities.

Table 7D.88 Daily noise variation at residential receptors, $L_{Aeq,1h}$ westerly mode summer, 10 mppa 2021

Hour	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
	Noise Level at Location, dB													
$L_{Aeq,16h}$	53	54	63	60	60	61	51	59	54	50	51	51	59	53
$L_{Aeq,8h}$	50	51	59	57	56	58	48	56	51	47	48	48	56	49
00	11	16	26	47	43	50	48	57	53	49	50	37	22	12
01	13	18	29	49	45	51	50	59	54	50	51	39	25	15
02	< 10	14	24	45	40	47	45	54	49	45	46	35	20	10
03	< 10	10	21	42	37	43	41	50	46	41	43	32	17	< 10
04	< 10	< 10	20	42	36	43	41	50	45	41	42	31	16	< 10
05	44	45	55	51	50	51	42	51	46	42	43	42	51	43
06	59	60	68	65	65	66	50	45	39	35	42	57	65	58
07	56	57	66	63	62	63	49	56	50	45	48	54	62	56
08	53	54	62	59	59	60	50	57	53	49	50	50	59	52

	Noise Level at Location, dB													
Hour	**1 Henley Park**	**2 Bishops Road**	**3 Fountain Treeworks**	**4 Cooks Bridle Path**	**5 Downside Road**	**6 School Lane**	**7 Hillview Gardens**	**8 Market Place**	**9 Chew Magna**	**10 Church Road**	**11 Lye Mead**	**12 Red Hill**	**13 Wrington Hill**	**14 Southlands Way**
09	51	52	61	57	58	60	49	56	52	47	49	50	58	51
10	53	54	62	60	58	60	48	56	52	47	49	50	58	53
11	51	51	60	58	57	59	52	62	57	52	54	49	56	50
12	55	56	64	62	60	62	52	61	56	52	53	52	61	55
13	55	56	65	62	62	63	51	59	54	50	52	53	61	55
14	52	53	61	58	58	59	50	58	54	49	51	49	58	51
15	52	53	61	59	57	59	52	61	56	51	53	49	58	52
16	55	56	64	62	61	62	52	60	55	51	52	53	61	54
17	56	57	66	63	63	64	52	59	54	50	52	54	62	56
18	56	57	66	63	63	64	52	59	54	50	52	54	62	56
19	54	55	63	61	59	61	51	59	55	50	52	51	60	54
20	48	49	57	55	54	56	47	57	52	47	49	46	54	48
21	48	49	58	55	56	57	49	57	53	48	50	47	54	48
22	42	43	52	51	50	53	49	58	54	50	51	42	49	41
23	17	22	32	52	47	53	52	61	56	52	53	42	28	18

Westerly mode, 12 mppa – 2026 (With Proposed Development)

7D.5.41 **Table 7D.89** gives the hourly variation in noise exposure in 2026 following the implementation of the Proposed Development, in terms of $L_{Aeq,1h}$, at the air noise receptor locations, based on an westerly mode, summer day of aircraft activities.

Table 7D.89 Daily noise variation at residential receptors, $L_{Aeq,1h}$ westerly mode summer, 12 mppa 2026

Hour	Noise Level at Location, dB													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
$L_{Aeq,16h}$	53	54	62	61	59	60	51	60	55	50	52	51	59	53
$L_{Aeq,8h}$	50	51	59	57	56	57	48	56	52	48	49	48	56	49
00	10	15	26	47	43	49	48	57	52	48	49	36	22	12
01	13	18	28	49	45	51	49	58	54	50	51	39	24	14
02	< 10	14	24	45	40	47	45	54	49	45	46	35	20	10
03	< 10	10	21	42	37	43	41	50	46	41	43	32	17	< 10
04	< 10	< 10	19	41	36	42	40	49	44	40	41	30	15	< 10
05	44	45	55	51	50	51	41	49	44	40	41	42	51	43
06	59	59	68	65	65	66	49	50	45	41	44	56	64	58
07	56	57	65	63	61	62	49	57	51	45	48	53	61	55
08	53	54	62	61	59	60	51	60	55	51	52	51	59	53
09	52	52	61	58	59	60	50	58	53	49	51	50	58	52
10	51	52	60	58	56	58	48	56	52	47	49	48	56	51
11	51	52	60	61	57	59	54	63	58	53	55	49	56	51
12	56	56	65	63	61	62	53	62	57	52	54	53	61	55
13	55	56	65	62	61	62	52	60	55	51	52	53	61	55
14	51	52	61	58	57	58	50	58	54	49	51	48	57	51
15	52	52	60	58	57	59	52	61	56	52	53	49	57	51
16	54	55	63	62	60	61	52	61	56	51	53	52	59	54
17	56	56	65	63	61	62	52	60	56	51	53	53	61	55
18	54	54	63	62	59	61	53	62	57	52	54	51	59	53
19	55	55	64	62	61	62	51	59	55	50	52	52	61	54
20	47	48	57	55	54	56	49	58	54	48	51	46	53	47
21	43	43	52	51	49	52	48	57	53	48	50	41	48	43
22	42	43	52	51	50	53	49	58	54	49	51	42	49	41

Hour	Noise Level at Location, dB													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
23	10	15	26	47	43	49	48	57	52	48	49	36	22	12

Airborne Aircraft Vibration

7D.5.42 The maximum noise level in terms of L_{Cmax} was calculated for 56 dwellings bordering Felton Common. **Table 7D.90** gives the noise exposure of these dwellings including the number exposed to levels of 95 dB L_{Cmax} or higher. Dwellings not in this area are expected to be exposed to lower noise levels due to their greater separation from flight paths and the Bristol Airport runway.

Table 7D.90 Maximum noise levels in various scenarios, L_{Cmax}

Maximum noise level, dB L_{Cmax}	Number of dwellings exposed to given noise level			
	2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
<95	23	23	23	23
95	5	5	5	5
96	22	26	26	26
97	6	2	2	2
>97	0	0	0	0

7D.5.43 The number of operations by aircraft causing the noise maxima of 97 dB L_{Cmax} is less than one per day on average in each case.

7D.6 Assessment of air noise effects

General

7D.6.1 To assess the effects of air noise arising from the impacts that have been described in **Section 7D.5**, the assessment criteria set out in **Appendix 7B** have been applied. The effects arise because of both the absolute noise level experienced at a receptor as well as the change in noise level that occurs through the introduction of the Proposed Development.

7D.6.2 Consideration is given below to how the impacts resulting from a change in the air noise conditions are likely to affect residential and non-residential receptors for the following scenarios:

- Baseline vs future scenarios (10 mppa in 2021 and 12 mppa in 2026); and
- Future 10 mppa in 2021 vs 12 mppa in 2026.

7D.6.3 A sensitivity assessment is also included in respect of:

- Future 10 mppa in 2026 vs 12 mppa in 2026.

7D.6.4 The assessment firstly compares air noise effects for residential receptors for each of the comparisons above, both for daytime and night-time. The number of people likely to be highly annoyed under a given noise scenario is then set out, followed by those likely to be highly sleep disturbed.

7D.6.5 The expected variation in noise level per day is assessed, by comparing some of the key scenarios.

7D.6.6 The number of non-residential noise sensitive receptors that are likely to be significantly affected by air noise currently and/or in the future are identified.

7D.6.7 Finally, the results of the secondary noise indicators are assessed, including average annual L_{den} and L_{night} contours, average summer N70, N60 and single mode contours, and single event SEL and L_{Amax} contours.

Baseline (2017) vs Future (10 mppa in 2021)

7D.6.8 **Figure 7D.1** and **Figure 7D.2** give the daytime air noise $L_{Aeq,16h}$ noise contours for the Baseline 2017 and for 10 mppa in 2021 respectively. **Figure 7D.4** and **Figure 7D.5** provide the corresponding night-time air noise $L_{Aeq,8h}$ contours.

7D.6.9 The impact of air noise on residential receptors assuming that the Proposed Development does not proceed and Bristol Airport continues to grow to its current permitted capacity of 10 mppa by 2021 will give rise to the effects given in **Table 7D.91** for the daytime and **"Beneficial"** rows include a small number of dwellings with zero change.

7D.6.10 Table 7D.92 for the night-time. Those receptors that do not experience any change in noise between two scenarios are given in these tables in the "beneficial" receptor column.

Table 7D.91 Dwellings exposed to absolute noise and change in noise, 2017 to 10 mppa 2021, daytime

Subjective description of impact	Contour band, dB $L_{Aeq,16h}$	Number of dwellings in band, 10 mppa (2021)	Beneficial[1] or adverse change	Change in Noise Level, dB Potential Impact Classification				
				Negligible 0 – 2 dB	Minor 2 – 3 dB	Moderate 3 – 6 dB	Substantial 6 – 9 dB	Very Substantial >9 dB
Negligible	**51 (LOAEL)**	2,050	Beneficial	2,050	0	0	0	0
		200	Adverse	200	0	0	0	0
Very minor	**54**	200	Beneficial	200	0	0	0	0
		300	Adverse	300	0	0	0	0
Minor	**57**	200	Beneficial	200	0	0	0	0
		100	Adverse	100	0	0	0	0
Moderate	**60**	100	Beneficial	100	0	0	0	0
		20	Adverse	20	0	0	0	0

Subjective description of impact	Contour band, dB $L_{Aeq,16h}$	Number of dwellings in band, 10 mppa (2021)	Beneficial[1] or adverse change	Change in Noise Level, dB Potential Impact Classification				
				Negligible	Minor	Moderate	Substantial	Very Substantial
				0 – 2 dB	2 – 3 dB	3 – 6 dB	6 – 9 dB	>9 dB
Significant Moderate	**63 (SOAEL)**	10	Beneficial	10	0	0	0	0
		0	Adverse	0	0	0	0	0
Significant Substantial	**66**	1	Beneficial	1	0	0	0	0
		0	Adverse	0	0	0	0	0
Significant Very Substantial	**69 (UAEL)**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		2,550	Beneficial	2,550	0	0	0	0
		600	Adverse	600	0	0	0	0

1. “Beneficial” rows include a small number of dwellings with zero change.

Table 7D.92 Dwellings exposed to absolute noise and change in noise, 2017 to 10 mppa 2021, night-time

Subjective description of impact	Contour band, dB $L_{Aeq,8h}$	Number of dwellings in band, 10 mppa (2021)	Beneficial[1] or adverse change	Change in Noise Level, dB Potential Impact Classification				
				Negligible	Minor	Moderate	Substantial	Very Substantial
				0 – 2 dB	2 – 3 dB	3 – 6 dB	6 – 9 dB	>9 dB
Negligible	**45 (LOAEL)**	0	Beneficial	0	0	0	0	0
		2,200	Adverse	1,850	350	0	0	0
Very minor	**48**	0	Beneficial	0	0	0	0	0
		2,050	Adverse	1,950	100	0	0	0
Minor	**51**	0	Beneficial	0	0	0	0	0
		450	Adverse	450	4	0	0	0
Minor/ Moderate	**54**	0	Beneficial	0	0	0	0	0
		100	Adverse	100	2	0	0	0
Significant Moderate	**55 (SOAEL)**	0	Beneficial	0	0	0	0	0
		300	Adverse	300	20	0	0	0

Subjective description of impact	Contour band, dB $L_{Aeq,8h}$	Number of dwellings in band, 10 mppa (2021)	Beneficial[1] or adverse change	Change in Noise Level, dB Potential Impact Classification				
				Negligible 0 – 2 dB	Minor 2 – 3 dB	Moderate 3 – 6 dB	Substantial 6 – 9 dB	Very Substantial >9 dB
Significant Substantial	**60**	0	Beneficial	0	0	0	0	0
		10	Adverse	10	0	0	0	0
Significant Very Substantial	**63**	0	Beneficial	0	0	0	0	0
		1	Adverse	1	0	0	0	0
Total		0	Beneficial	0	0	0	0	0
		5,150	Adverse	4,650	500	0	0	0

1. "Beneficial" rows include a small number of dwellings with zero change.

Baseline (2017) vs Future (12 mppa in 2026)

7D.6.11 **Figure 7D.1** and **Figure 7D.3** give the daytime air noise $L_{Aeq,16h}$ noise contours for the Baseline 2017 and for 12 mppa in 2026 respectively. **Figure 7D.4** and **Figure 7D.6** provide the corresponding night-time air noise $L_{Aeq,8h}$ contours.

7D.6.12 The impact of air noise on residential receptors assuming that the Proposed Development proceeds and Bristol Airport continues to grow to 12 mppa by 2026 will give rise to the effects given in **Table 7D.93** for the daytime and **Table 7D.94** for the night-time:

Table 7D.93 Dwellings exposed to absolute noise and change in noise, 2017 to 12 mppa 2026, daytime

Subjective description of impact	Contour band dB $L_{Aeq,16h}$	Number of dwellings in band, 12 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification				
				Negligible 0 – 2 dB	Minor 2 – 3 dB	Moderate 3 – 6 dB	Substantial 6 – 9 dB	Very Substantial >9 dB
Negligible	**51 (LOAEL)**	2,100	Beneficial	2,100	0	0	0	0
		150	Adverse	150	0	0	0	0
Very minor	**54**	250	Beneficial	250	0	0	0	0
		150	Adverse	150	0	0	0	0
Minor	**57**	80	Beneficial	80	0	0	0	0
		250	Adverse	250	0	0	0	0
Moderate	**60**	40	Beneficial	40	0	0	0	0

Subjective description of impact	Contour band dB $L_{Aeq,16h}$	Number of dwellings in band, 12 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification: Negligible 0 – 2 dB	Minor 2 – 3 dB	Moderate 3 – 6 dB	Substantial 6 – 9 dB	Very Substantial >9 dB
		80	Adverse	80	0	0	0	0
Significant Moderate	**63 (SOAEL)**	0	Beneficial	0	0	0	0	0
		10	Adverse	10	0	0	0	0
Significant Substantial	**66**	1	Beneficial	1	0	0	0	0
		0	Adverse	0	0	0	0	0
Significant Very Substantial	**69 (UAEL)**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		2,450	Beneficial	2,450	0	0	0	0
		650	Adverse	650	0	0	0	0

Table 7D.94 Dwellings exposed to absolute noise and change in noise, 2017 to 12 mppa 2026, night-time

Subjective description of impact	Contour band dB $L_{Aeq,8h}$	Number of dwellings in band, 12 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification: Negligible 0 – 2 dB	Minor 2 – 3 dB	Moderate 3 – 6 dB	Substantial 6 – 9 dB	Very Substantial >9 dB
Negligible	**45 (LOAEL)**	0	Beneficial	0	0	0	0	0
		2,050	Adverse	2,000	50	0	0	0
Very minor	**48**	0	Beneficial	0	0	0	0	0
		2,100	Adverse	2,100	3	0	0	0
Minor	**51**	0	Beneficial	0	0	0	0	0
		450	Adverse	450	0	0	0	0
Minor/ Moderate	**54**	0	Beneficial	0	0	0	0	0
		100	Adverse	100	0	0	0	0

Subjective description of impact	Contour band dB $L_{Aeq,8h}$	Number of dwellings in band, 12 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification				
				Negligible 0 – 2 dB	Minor 2 – 3 dB	Moderate 3 – 6 dB	Substantial 6 – 9 dB	Very Substantial >9 dB
Significant Moderate	**55 (SOAEL)**	0	Beneficial	0	0	0	0	0
		300	Adverse	300	0	0	0	0
Significant Substantial	**60**	0	Beneficial	0	0	0	0	0
		10	Adverse	10	0	0	0	0
Significant Very Substantial	**63**	0	Beneficial	0	0	0	0	0
		1	Adverse	1	0	0	0	0
Total		0	Beneficial	0	0	0	0	0
		5,050	Adverse	5,000	50	0	0	0

Future (10 mppa in 2021) vs Future (12 mppa in 2026)

7D.6.13 **Figure 7D.2** and **Figure 7D.3** show the daytime air noise $L_{Aeq,16h}$ noise contours for 10 mppa in 2021 and for 12 mppa in 2026 respectively. **Figure 7D.5** and **Figure 7D.6** provide the corresponding night-time air noise $L_{Aeq,8h}$ contours.

Residential Receptors

7D.6.14 The impact of air noise on receptors assuming that the Proposed Development proceeds and Bristol Airport continues to grow from 10 mppa in 2021 to 12 mppa by 2026 will give rise to the effects given in **Table 7D.95** for the daytime and **Table 7D.96** for the night-time:

Table 7D.95 Dwellings exposed to absolute noise and change in noise, 10 mppa 2021 to 12 mppa 2026, daytime

Subjective description of impact	Contour band dB $L_{Aeq,16h}$	Number of dwellings in band, 12 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification				
				Negligible 0 – 2 dB	Minor 2 – 3 dB	Moderate 3 – 6 dB	Substantial 6 – 9 dB	Very Substantial >9 dB
Negligible	**51 (LOAEL)**	1,550	Beneficial	1,550	0	0	0	0
		650	Adverse	650	0	0	0	0

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,16h}$**	**Number of dwellings in band, 12 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0 – 2 dB**	**Minor 2 – 3 dB**	**Moderate 3 – 6 dB**	**Substantial 6 – 9 dB**	**Very Substantial >9 dB**
Very minor	**54**	250	Beneficial	250	0	0	0	0
		200	Adverse	200	0	0	0	0
Minor	**57**	90	Beneficial	90	0	0	0	0
		250	Adverse	250	0	0	0	0
Moderate	**60**	40	Beneficial	40	0	0	0	0
		80	Adverse	80	0	0	0	0
Significant Moderate	**63 (SOAEL)**	0	Beneficial	0	0	0	0	0
		10	Adverse	10	0	0	0	0
Significant Substantial	**66**	1	Beneficial	1	0	0	0	0
		0	Adverse	0	0	0	0	0
Significant Very Substantial	**69 (UAEL)**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		1,950	Beneficial	1,950	0	0	0	0
		1,150	Adverse	1,150	0	0	0	0

Table 7D.96 Dwellings exposed to absolute noise and change in noise, 10 mppa 2021 to 12 mppa 2026, night-time

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,8h}$**	**Number of dwellings in band, 12 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0 – 2 dB**	**Minor 2 – 3 dB**	**Moderate 3 – 6 dB**	**Substantial 6 – 9 dB**	**Very Substantial >9 dB**
Negligible	**45 (LOAEL)**	1,700	Beneficial	1,700	0	0	0	0
		350	Adverse	350	0	0	0	0
Very minor	**48**	600	Beneficial	600	0	0	0	0

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,8h}$**	**Number of dwellings in band, 12 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0 – 2 dB**	**Minor 2 – 3 dB**	**Moderate 3 – 6 dB**	**Substantial 6 – 9 dB**	**Very Substantial >9 dB**
		1,500	Adverse	1,500	0	0	0	0
Minor	**51**	200	Beneficial	200	0	0	0	0
		250	Adverse	250	0	0	0	0
Minor/ Moderate	**54**	30	Beneficial	30	0	0	0	0
		90	Adverse	90	0	0	0	0
Significant Moderate	**55 (SOAEL)**	80	Beneficial	80	0	0	0	0
		250	Adverse	250	0	0	0	0
Significant Substantial	**60**	0	Beneficial	0	0	0	0	0
		10	Adverse	10	0	0	0	0
Significant Very Substantial	**63**	1	Beneficial	1	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		2,600	Beneficial	2,600	0	0	0	0
		2,450	Adverse	2,450	0	0	0	0

Future (10 mppa in 2026) vs Future (12 mppa in 2026)

7D.6.15 **Figure 7D.3** and **Figure 7D.26** give the daytime air noise $L_{Aeq,16h}$ noise contours for 10 mppa in 2026 (assuming the Proposed Development does not proceed) and for 12 mppa in 2026 (with the Proposed Development) respectively. **Figure 7D.6** and **Figure 7D.27** provide the corresponding night-time air noise $L_{Aeq,8h}$ contours.

Residential Receptors

7D.6.16 The impact of air noise on receptors assuming that the Proposed Development proceeds and Bristol Airport continues to grow to 12 mppa by 2026 will give rise to the effects given in **Table 7D.97** for the daytime and **Table 7D.98** for the night-time:

Table 7D.97 Dwellings exposed to absolute noise and change in noise, 10 mppa 2026 to 12 mppa 2026, daytime

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,16h}$**	**Number of dwellings in band, 12 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0 – 2 dB**	**Minor 2 – 3 dB**	**Moderate 3 – 6 dB**	**Substantial 6 – 9 dB**	**Very Substantial >9 dB**
Negligible	**51 (LOAEL)**	0	Beneficial	0	0	0	0	0
		2,200	Adverse	2,200	0	0	0	0
Very minor	**54**	0	Beneficial	0	0	0	0	0
		400	Adverse	400	0	0	0	0
Minor	**57**	0	Beneficial	0	0	0	0	0
		350	Adverse	350	0	0	0	0
Moderate	**60**	0	Beneficial	0	0	0	0	0
		100	Adverse	100	0	0	0	0
Significant Moderate	**63 (SOAEL)**	0	Beneficial	0	0	0	0	0
		10	Adverse	10	0	0	0	0
Significant Substantial	**66**	0	Beneficial	0	0	0	0	0
		1	Adverse	1	0	0	0	0
Significant Very Substantial	**69 (UAEL)**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		0	Beneficial	0	0	0	0	0
		3,100	Adverse	3,100	0	0	0	0

Table 7D.98 Dwellings exposed to absolute noise and change in noise, 10 mppa 2026 to 12 mppa 2026, night-time

Subjective description of impact	Contour band dB $L_{Aeq,8h}$	Number of dwellings in band, 12 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification: Negligible 0 – 2 dB	Minor 2 – 3 dB	Moderate 3 – 6 dB	Substantial 6 – 9 dB	Very Substantial >9 dB
Negligible	**45 (LOAEL)**	0	Beneficial	0	0	0	0	0
		2,050	Adverse	2,050	0	0	0	0
Very minor	**48**	0	Beneficial	0	0	0	0	0
		2,100	Adverse	2,100	0	0	0	0
Minor	**51**	0	Beneficial	0	0	0	0	0
		450	Adverse	450	0	0	0	0
Moderate	**54**	0	Beneficial	0	0	0	0	0
		100	Adverse	100	0	0	0	0
Significant Moderate	**55 (SOAEL)**	0	Beneficial	0	0	0	0	0
		300	Adverse	300	0	0	0	0
Significant Substantial	**60**	0	Beneficial	0	0	0	0	0
		10	Adverse	10	0	0	0	0
Significant Very Substantial	**63**	0	Beneficial	0	0	0	0	0
		1	Adverse	1	0	0	0	0
Total		0	Beneficial	0	0	0	0	0
		5,050	Adverse	5,050	0	0	0	0

Annoyance

7D.6.17 The percentage of people highly annoyed as a result of air noise associated with a given noise scenario has been determined in accordance with the procedure described in **Appendix 7B**. The resulting population is set out in **Table 7D.99**.

Table 7D.99 Annoyance, $L_{Aeq,16h}$, average mode summer day, population highly annoyed

	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
Population Highly Annoyed	750	750	750	550

Sleep Disturbance

7D.6.18 The percentage of people likely to be highly sleep disturbed as a result of air noise associated with a given noise scenario has been determined in accordance with the procedure described in **Appendix 7B**. The resulting population is set out in **Table 7D.100**.

Table 7D.100 Sleep disturbance, L_{night} average mode annual night, population highly sleep disturbed

	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
Population Highly Sleep Disturbed	450	850	800	650

Individual aircraft events – SEL and L_{ASmax}

7D.6.19 The assessment of individual events focuses on those events which occur at least once per night. **Table 7D.101** and **Table 7D.102** give details of the average number of operations per summer night by aircraft type for each scenario, for easterly and westerly operations respectively. The four most common aircraft in all scenarios are presented, these being the Airbus A320 and A320neo, and the Boeing 737-800 and B738MAX.

7D.6.20 **Table 7D.103** then gives a summary of the typical loudest aircraft which operates at least once per night for each scenario and each combination of runway and operation. The number of movements per night by that aircraft is also given in brackets.

Table 7D.101 Average aircraft movements per summer night, easterly (runway 09) operations

Aircraft type	Number of movements per summer night, rounded to 0.1							
	2017		10 mppa 2021		12 mppa 2026		10 mppa 2026	
	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep
Airbus A320	1.0	0.6	1.0	0.5	0.8	0.4	1.1	1.0
Airbus A320neo	0.0	0.0	1.6	1.2	2.1	1.5	1.9	1.3
Boeing 737-800	0.8	0.5	1.5	1.4	0.8	0.9	0.7	0.4
Boeing B738MAX	0.0	0.0	0.4	0.3	1.4	1.0	0.8	0.7
Other aircraft	1.5	1.7	0.6	1.1	0.9	1.3	0.6	1.1
Total	3.3	2.8	5.1	4.5	5.9	5.2	5.1	4.5

Table 7D.102 Average aircraft movements per summer night, westerly (runway 27) operations

Aircraft type	Number of movements per summer night, rounded to 0.1							
	2017		10 mppa 2021		12 mppa 2026		10 mppa 2026	
	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep
Airbus A320	4.2	2.1	3.6	1.7	2.9	1.6	3.9	3.6
Airbus A320neo	0.0	0.0	5.8	4.3	7.4	5.2	6.9	4.4

Aircraft type	Number of movements per summer night, rounded to 0.1							
	2017		10 mppa 2021		12 mppa 2026		10 mppa 2026	
	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep
Boeing 737-800	3.1	1.9	5.3	5.1	2.7	3.2	2.4	1.6
Boeing B738MAX	0.0	0.0	1.3	1.0	4.8	3.7	2.7	2.5
Other aircraft	6.1	6.2	2.1	3.8	3.3	4.6	2.1	3.8
Total	13.4	10.2	18.2	15.9	21.1	18.3	18.2	15.9

Table 7D.103 Typical loudest aircraft operations in different scenarios

Operation, Runway	Typical loudest aircraft (frequency per average summer night)			
	2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
Arrival, 09	Airbus A320 (1)	Boeing 737-800 (2)	Boeing B738MAX (1)	Boeing B738MAX (1)
Departure, 09	Airbus A320 (0.6)[1]	Boeing 737-800 (1)	Boeing B738MAX (1)	Boeing B738MAX (1)
Arrival, 27	Boeing 737-800 (3)	Boeing 737-800 (5)	Boeing 737-800 (3)	Boeing 737-800 (3)
Departure, 27	Boeing 737-800 (2)	Boeing 737-800 (5)	Boeing 737-800 (3)	Boeing 737-800 (3)

1. No operations occur at least once per night in this case. Instead, the most common aircraft has been presented.

7D.6.21 The number of dwellings exposed to individual events above various SEL and L_{ASmax} thresholds at least once per night is given in **Table 7D.104** for each scenario.

Table 7D.104 Air noise dwelling counts, $L_{Aeq,16h}$ average mode summer day

Contour, dB(A)	Number of Dwellings			
	Baseline 2017	10 mppa 2021	12 mppa 2026	10 mppa 2026
90 SEL	250	600	100	100
80 L_{ASmax}	250	650	100	100

7D.6.22 **Table 7D.104** demonstrates that from 2017 to the 10 mppa 2021 scenario, the number of dwellings exposed to potentially significant noise levels of individual aircraft at least once per night will increase from around 250 to around 650. Going forward to 2026, under both the 12 mppa scenario and the sensitivity scenario, this will reduce to around 100.

7D.6.23 It is noted that in **Table 7D.55** for the Boeing B738MAX on arrival, the number of dwellings is shown to rise (from 0 to 2) compared to its current day equivalent aircraft, the 737-800. This is considered to be a quirk of noise modelling as the 737-800 has a validated noise profile obtained from noise monitoring of actual operations at Bristol Airport. The B738MAX in contrast, since it does not yet operate at Bristol Airport, has a noise profile derived from the database of the noise modelling software and is unvalidated. When comparing noise certificated data for each aircraft, the B738MAX is declared to be 1 dB quieter on arrival than the 737-800 aircraft and therefore in practice it is expected that it will be quieter.

N70 and N60

7D.6.24 The N70 parameter helps to provide a little more context to how the aircraft noise environment might alter between scenarios during the daytime. People experience aircraft noise as a series of individual events over a day, rather an as a single average noise exposure level. The N70 parameter helps to illustrate how this might change between scenarios.

7D.6.25 **Table 7D.37** gives the number of dwellings lying within an N70 contour based on 10, 20, 50, 100 and 200 events per 16-hour day period. **Figure 7D.30** to **Figure 7D.33** show the N70 contours for each scenario.

7D.6.26 **Table 7D.37** can best be considered from the bottom upwards, with the highest number of events of 70 dB L_{Amax} or more occurring closest to Bristol Airport. With increasing distance from Bristol Airport, aircraft are higher and therefore only the noisiest produce a level of 70 dB L_{Amax} at a receptor on the ground.

7D.6.27 **Table 7D.37** shows that no dwellings are exposed to 200 aircraft events per day producing 70 dB L_{Amax} or more.

7D.6.28 Near Bristol Airport, for the 2017 baseline, there are 20 dwellings exposed to 100 events producing 70 dB L_{Amax} or more. In the future, this contour expands to encompass 250 dwellings under the 10 mppa scenario, both in 2021 and 2026. Under the 12 mppa 2026 scenario, due to the increased number of flights, this contour includes 350 dwellings.

7D.6.29 This pattern changes with distance from Bristol Airport, as aircraft increase in height and individual noise levels on the ground reduce. When considering 10 aircraft events, for the 2017 baseline, 2,950 dwellings lie within this contour. The number of dwellings within this contour rises by around 10% under the 10 mppa 2021 scenario but falls below current levels, to 2,800 dwellings under the 12 mppa 2026 scenario. This occurs as a result of aircraft fleet modernisation leading to the introduction of quieter aircraft. Under the sensitivity scenario of 10 mppa 2026, the number of dwellings falls to 2,500 within this contour because of the assumption that fleet modernisation occurs without any increase in aircraft activity beyond 2021.

7D.6.30 **Table 7D.40** shows the number of dwellings lying within an N60 contour based on 10, 20, 50, 100 and 200 events per 8-hour night period. **Figure 7D.34** to **Figure 7D.37** show the N60 contours for each scenario.

7D.6.31 **Table 7D.40** shows that no dwellings are exposed to 100 or more aircraft events per night at a level of 60 dB L_{Amax} or above. Under the 12 mppa in 2026 scenario, one dwelling becomes exposed to 50 events of 60 dB L_{Amax} or more.

7D.6.32 Under the 2017 baseline, there are around 30 aircraft movements per average summer night. Approximately half of these take off towards and land from the west, with the other half taking off towards and landing from the east. The 20 event contour therefore only includes the small area which is affected by both easterly and westerly operations. It contains 90 dwellings and is small in size. Under the 10 mppa 2021 scenario, there are around 44 aircraft movements per average summer night. This results in just over 20 aircraft events towards and from the west, and towards and from the east giving rise to a significant increase in this contour size. Under the 10 mppa 2021 scenario, the number of dwellings within the contour is 2,050, rising to 3,300 under the 12 mppa 2026 scenario. Under the 10 mppa 2026 scenario, despite the fleet replacement, the number of dwellings within this contour changes little from the 10 mppa 2021.

7D.6.33 The 10 event contour shows a different pattern, with 3,800 dwellings within the 2017 baseline contour, rising to 5,150 under the 10 mppa in 2021 scenario. Under the 12 mppa in 2026 scenario, increased night activity during the summer increases the dwelling count to 6,350. The sensitivity scenario shows a dwelling count of 4,400 under 10 mppa 2026. This reduction compared to the 10 mppa 2021 scenario occurs as a result of aircraft fleet modernisation.

Variation in Air Noise over a Day

7D.6.34 **Table 7D.105** shows, for each of the key scenarios, the maximum hourly deviation in noise level ($L_{Aeq,1h}$) from the average $L_{Aeq,16h}$ daytime and average $L_{Aeq,8h}$ night-time noise levels at the fourteen residential receptors during the relevant period of the 24 hours (07:00-23:00 daytime, 23:00-07:00 night-time).

Table 7D.105 Daily noise variation at residential receptors, average mode summer (dB(A))

Scenario	Receptor													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
2017														
$L_{Aeq,16h}$	53	54	62	61	60	62	55	59	54	50	53	51	59	53
$\pm L_{Aeq,1h}$	+3	+3	+4	+4	+3	+3	+3	+3	+3	+2	+2	+4	+3	+3
	-6	-8	-8	-8	-9	-8	-5	-2	-3	-3	-2	-8	-9	-7
$L_{Aeq,8h}$	48	48	57	56	54	57	50	55	50	46	49	46	53	47
$\pm L_{Aeq,1h}$	+8	+8	+8	+8	+9	+8	+7	+3	+4	+4	+5	+8	+8	+8
	-17	-20	-23	-17	-21	-19	-16	-12	-11	-12	-13	-18	-23	-18
10 mppa 2021														
$L_{Aeq,16h}$	53	53	62	60	60	62	55	59	54	50	54	51	58	53
$\pm L_{Aeq,1h}$	+3	+3	+3	+3	+3	+3	+3	+2	+2	+2	+2	+3	+3	+2
	-6	-8	-10	-9	-10	-9	-6	-3	-3	-3	-4	-9	-9	-8
$L_{Aeq,8h}$	50	50	58	57	56	58	52	56	51	47	51	48	55	49
$\pm L_{Aeq,1h}$	+7	+9	+9	+8	+9	+9	+8	+3	+4	+4	+6	+9	+9	+8
	-13	-17	-20	-15	-20	-16	-12	-7	-7	-7	-10	-17	-21	-14
12 mppa 2026														
$L_{Aeq,16h}$	53	54	62	61	60	62	55	60	55	50	54	51	58	53
$\pm L_{Aeq,1h}$	+4	+4	+5	+4	+5	+5	+4	+2	+2	+2	+2	+5	+5	+4
	-6	-10	-10	-10	-11	-10	-7	-4	-3	-3	-5	-10	-10	-8
$L_{Aeq,8h}$	50	50	58	57	56	58	52	57	52	48	51	48	55	49

Scenario	Receptor													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
$\pm L_{Aeq,1h}$	+7	+8	+9	+8	+9	+9	+7	+4	+5	+5	+5	+8	+8	+8
	-14	-18	-21	-16	-21	-17	-13	-9	-9	-9	-11	-18	-22	-15

7D.6.35 **Table 7D.106**, **Table 7D.107** and **Table 7D.108** give the variation in noise exposure at the air noise receptor locations on the average summer day, in terms of the daytime $L_{Aeq,16h}$, night-time $L_{Aeq,8h}$, and hourly $L_{Aeq,1h}$, for the following scenarios:-

- Baseline vs future scenarios (10 mppa in 2021 and 12 mppa in 2026); and
- Future 10 mppa 2021 vs future 12 mppa 2026.

Table 7D.106 Change in noise at residential receptors, average mode summer, baseline 2017 to 10 mppa 2021 (dB(A))

Hour	Receptor													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
$L_{Aeq,16h}$	0	-1	0	-1	0	0	0	0	0	0	+1	0	-1	0
$L_{Aeq,8h}$	+2	+2	+1	+1	+2	+1	+2	+1	+1	+1	+2	+2	+2	+2
00	0	-3	-4	-4	-6	-3	-1	0	0	+1	0	-5	-4	-1
01	+2	+2	+2	+2	+1	+1	+2	+1	+1	+1	+1	+2	+2	+2
02	+1	+1	0	0	-1	+1	+1	0	0	+1	0	0	0	+1
03	+1	+1	+2	+2	+1	0	0	0	+1	0	0	+1	+1	+1
04	+6	+5	+4	+3	+3	+4	+6	+6	+5	+6	+5	+3	+4	+6
05	0	-2	-1	-1	-2	-1	0	+3	+7	+6	+2	-1	-1	-1
06	+1	+3	+2	+1	+2	+2	+3	+2	+1	+2	+3	+3	+3	+2
07	-1	-1	-1	-2	-1	-1	0	-1	-1	-1	0	-1	-1	-1
08	-1	0	0	-2	0	0	-1	0	0	0	0	0	0	-1

Hour	Receptor													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
09	-1	-1	0	-2	-1	0	0	0	+1	0	+1	0	0	0
10	+1	+2	+1	+1	+1	+1	+1	0	+1	+1	+1	+1	+1	+2
11	+2	+1	+1	+1	+1	+2	+1	+1	+2	+2	+2	+1	+1	+1
12	0	0	0	0	0	+1	+1	-1	-1	0	0	0	+1	0
13	0	0	0	-1	+1	+1	+1	+1	+1	+2	+1	0	0	0
14	-1	-1	-1	-3	-1	-1	0	0	0	0	0	-2	-1	-1
15	+1	0	0	-1	-1	0	0	0	0	+1	+1	-1	0	+1
16	0	0	0	0	0	0	+1	+1	+1	+1	+1	+1	0	0
17	+2	+1	+2	+1	+2	+2	+2	0	0	0	+1	+1	+2	+1
18	-1	0	-1	-2	-1	-1	0	0	0	0	0	0	0	0
19	0	0	-1	-1	0	0	0	0	-1	+1	0	+1	0	0
20	-5	-5	-5	-6	-5	-4	-4	-2	-2	-2	-3	-5	-6	-5
21	-2	-2	-3	-3	-1	-1	-2	0	0	0	-1	-2	-2	-2
22	0	-1	-2	-2	-1	-1	-1	-1	0	0	-1	-1	-1	-1
23	+2	+1	0	+1	-1	0	+1	+1	+1	+1	+1	+1	0	+2

Table 7D.107 Change in noise at residential receptors, average mode summer, baseline 2017 to 12 mppa 2026

Hour	Receptor													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
$L_{Aeq,16h}$	0	-1	-1	-1	-1	-1	0	+1	+1	0	+1	0	-1	-1
$L_{Aeq,8h}$	+2	+2	+1	+1	+2	+1	+2	+2	+2	+1	+2	+2	+2	+2

Hour	Receptor													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
00	-1	-3	-5	-5	-7	-4	-1	0	-1	0	-1	-6	-5	-1
01	+2	+1	+2	+1	+1	+1	+1	0	+1	+1	+1	+1	+2	+1
02	+1	+1	0	0	-1	+1	+1	0	0	+1	0	0	0	+1
03	+1	+1	+2	+2	+1	0	0	0	+1	0	0	+1	+1	+1
04	+5	+4	+3	+2	+2	+3	+5	+5	+4	+5	+4	+2	+3	+5
05	-1	-2	-1	-1	-2	-1	0	+2	+5	+4	+1	-1	-1	-1
06	+1	+2	+2	+1	+2	+2	+2	+2	+2	+2	+2	+2	+2	+2
07	+1	+1	+1	0	+2	+2	+1	-1	-1	0	+1	+1	+1	+1
08	0	0	0	0	0	0	0	+2	+2	+2	+1	0	0	0
09	0	0	0	-2	0	+1	+1	+1	+2	+2	+1	0	0	0
10	0	0	-1	-1	-1	-1	-1	0	+1	0	0	-1	-1	+1
11	+3	+2	+1	+2	+1	+2	+2	+2	+3	+3	+3	+2	+1	+2
12	+1	0	+1	+1	+1	+1	+1	0	0	0	+1	+1	+1	+1
13	0	0	0	-1	0	0	+1	+1	+2	+2	+1	0	0	0
14	-2	-1	-1	-3	-2	-2	-1	0	0	0	-1	-3	-2	-2
15	0	0	0	-2	-1	-1	0	+1	+1	+1	+1	-1	-1	0
16	0	-1	-1	0	-1	-1	0	+1	+1	+1	+1	0	-1	-1
17	+1	0	+1	+1	0	0	+1	+1	+1	0	0	0	+1	+1
18	-1	-1	-2	-1	-3	-2	0	+2	+2	+2	+1	-1	-2	-1
19	0	+1	0	0	+1	+1	+1	0	-1	+1	+1	+2	+1	+1
20	-4	-5	-6	-6	-5	-5	-4	-1	0	-1	-2	-5	-6	-5
21	-4	-7	-8	-7	-8	-7	-5	-1	0	0	-2	-8	-8	-5
22	0	-2	-2	-2	-1	-1	-1	-1	0	-1	-1	-1	-1	-1
23	+4	+3	+2	+2	+1	+2	+3	+3	+3	+3	+3	+1	+2	+4

Table 7D.108 Change in noise at residential receptors, average mode summer, 10 mppa 2021 to 12 mppa 2026

Hour	Receptor													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
$L_{Aeq,16h}$	0	0	-1	0	-1	-1	0	+1	+1	0	0	0	0	-1
$L_{Aeq,8h}$	0	0	0	0	0	0	0	+1	+1	0	0	0	0	0
00	-1	0	-1	-1	-1	-1	0	0	-1	-1	-1	-1	-1	0
01	0	-1	0	-1	0	0	-1	-1	0	0	0	-1	0	-1
02	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
05	-1	0	0	0	0	0	0	-1	-2	-2	-1	0	0	0
06	0	-1	0	0	0	0	-1	0	+1	0	-1	-1	-1	0
07	+2	+2	+2	+2	+3	+3	+1	0	0	+1	+1	+2	+2	+2
08	+1	0	0	+2	0	0	+1	+2	+2	+2	+1	0	0	+1
09	+1	+1	0	0	+1	+1	+1	+1	+1	+2	0	0	0	0
10	-1	-2	-2	-2	-2	-2	-2	0	0	-1	-1	-2	-2	-1
11	+1	+1	0	+1	0	0	+1	+1	+1	+1	+1	+1	0	+1
12	+1	0	+1	+1	+1	0	0	+1	+1	0	+1	+1	0	+1
13	0	0	0	0	-1	-1	0	0	+1	0	0	0	0	0
14	-1	0	0	0	-1	-1	-1	0	0	0	-1	-1	-1	-1
15	-1	0	0	-1	0	-1	0	+1	+1	0	0	0	-1	-1
16	0	-1	-1	0	-1	-1	-1	0	0	0	0	-1	-1	-1
17	-1	-1	-1	0	-2	-2	-1	+1	+1	0	-1	-1	-1	0
18	0	-1	-1	+1	-2	-1	0	+2	+2	+2	+1	-1	-2	-1
19	0	+1	+1	+1	+1	+1	+1	0	0	0	+1	+1	+1	+1
20	+1	0	-1	0	0	-1	0	+1	+2	+1	+1	0	0	0
21	-2	-5	-5	-4	-7	-6	-3	-1	0	0	-1	-6	-6	-3

Hour	Receptor													
	1 Henley Park	2 Bishops Road	3 Fountain Treeworks	4 Cooks Bridle Path	5 Downside Road	6 School Lane	7 Hillview Gardens	8 Market Place	9 Chew Magna	10 Church Road	11 Lye Mead	12 Red Hill	13 Wrington Hill	14 Southlands Way
22	0	-1	0	0	0	0	0	0	0	-1	0	0	0	0
23	+2	+2	+2	+1	+2	+2	+2	+2	+2	+2	+2	0	+2	+2

7D.7 Assessment of vibration effects

7D.7.1 The baseline vibration conditions for most dwellings in the vicinity of Bristol Airport are generally dictated by local road traffic conditions. For dwellings along major roads, there is potential for perceptible vibration levels to be produced by passing heavy vehicles such as buses and Heavy Goods Vehicles (HGVs). For dwellings located away from busy roads, vibration levels will be low and the occupants are unlikely to be aware of any vibration within their premises from outside sources.

7D.7.2 This situation is likely to remain the same in the future as there are no aircraft types forecast to operate from Bristol Airport in the future that are louder than those currently operating.

7D.7.3 Dwellings that are situated close to Bristol Airport and are in line with the runway have the potential to experience perceptible vibration due to airborne aircraft. Some dwellings bordering Felton Common to the east of the runway fall into this category.

7D.7.4 The assessment finds that in 2017, six dwellings which border Felton Common are exposed to maximum noise levels of 97 dB L_{Cmax} or greater. This reduces to two dwellings in all future scenarios due to the introduction of more modern, quieter aircraft types. These maximum noise level instances occur less than once per day on average in all scenarios.

7D.7.5 In practice, it is appreciated that there is some variation depending on the specific characteristics of individual dwellings, and therefore it is possible that lower levels of noise may induce perceptible vibration effects. The typical aircraft operations which produce the highest L_{Cmax} noise levels currently at dwellings bordering Felton Common are departures by the Airbus A321 and Boeing 737-800 using runway 09. These two aircraft types combined carried out four runway 09 departures on an average day in 2017. Under the 10 mppa in 2021 scenario, this increases to seven, before reducing to four under the 12 mppa in 2026 scenario and three under the sensitivity scenario of 10 mppa in 2026.

7D.7.6 Therefore vibration due to airborne aircraft is expected to currently affect a small number of dwellings and this is not expected to vary significantly in the future scenarios.

7D.8 Air noise mitigation

7D.8.1 The air noise assessment has demonstrated that, both now and in the future, some receptors around Bristol Airport will be exposed to significant levels of air noise, particularly during the night-time period.

Bristol Airport – existing planning controls

7D.8.2 Bristol Airport has operated for many years under a number of planning consents and as such is already subject to planning controls and voluntary agreements relating to those consents as well as its own sustainability and noise management policies.

7D.8.3 Most recently planning permission was granted in February 2011 for expansion of Bristol Airport to handle 10 mppa[9]. The current Section 106 Agreement includes planning obligations relating to the management and control of air noise through the implementation of a noise control scheme and adoption of operational procedures and practices aimed at achieving ongoing improvements.

7D.8.4 These are each briefly described in the following section and are given in detail in Bristol Airport's current *Noise Action Plan*[10].

7D.8.5 A planning obligation required the establishment of an Airport Environmental Improvement Fund[11], the purposes of which includes the funding of initiatives to mitigate the impact of aircraft and ground noise in the local community. Bristol Airport paid an initial sum of £100,000 into the fund in 2012 with further annual payments exceeding £100,000 and increasing in line with the annual percentage increase in passenger numbers.

Air noise

7D.8.6 Air noise is currently limited by a condition which states that the area enclosed by the 57 dB $L_{Aeq,16h}$ (07:00 to 23:00) summer noise contour shall not exceed 12.42km^2 using the standardised average mode (Planning condition 30).

7D.8.7 Residential properties located within this 57 dB $L_{Aeq,16h}$ contour (which did not previously qualify for noise insulation in the A38 Diversion Scheme) are eligible for a grant under the noise insulation grant scheme (Planning condition 31). This grant scheme is on the same basis as the previous A38 Diversion Scheme and is described in more detail in paragraph 7D.8.22.

Night flying

7D.8.8 A night noise Quota Count (QC) limit is used to restrict night flying (Planning condition 36). This assigns each aircraft operation a QC score based on how loud they are. The noise classification of an aircraft is set out in a formal notice published by NATS on a regular basis.

7D.8.9 The current annual quota is 2,160 points, with 1,260 points allocated for the summer season (approx. 7 months, defined as the period from late March to late October when British Summer Time is in effect) and 900 points allocated for the winter season.

7D.8.10 Aircraft with a QC score of 4 and above shall not:

- Be scheduled to take-off or land during between the hours of 23:30 hours and 06:00 hours;
- Be permitted to take off during the period 23:00 to 06:00 except in the period 23:00 to 23:30 in circumstances where:
  - It was scheduled to take off prior to 23:00; and

[9] North Somerset Council (2011). Planning permission 09/P/1020/OT2, [Online]. Available at: https://planning.n-somerset.gov.uk/online-applications/ [Checked 6/09/2018].
[10] Bristol Airport (2014). Noise Action Plan 2014 to 2018, [Online]. Available at https://www.bristolairport.co.uk/~/media/files/brs/about-us/nap-14_18.ashx?la=en [Checked 27/04/2018].
[11] Bristol Airport (2018). Airport Environmental Improvement Fund, Guidelines for applying for a grant for noise insulation, [Online]. Available at: https://www.bristolairport.co.uk/~/media/files/brs/about-us/community/guidelines-2018_final.ashx?la=en [Checked 5/10/2018].

- Take off was delayed beyond the control of the air traffic operator.

7D.8.11 An aircraft with a QC score of 8 or 16 shall not:

- Be scheduled to take-off or land during between the hours of 23:30 and 07:00;
- Be permitted to take off during the period 23:00 to 07:00 except in the period 23:00 hours to 23:30 hours in circumstances where:
  - It was scheduled to take off prior to 23:00; and
  - Take off was delayed beyond the control of the air traffic operator.

7D.8.12 An aircraft shall not be permitted to take off or be scheduled to land during the period 23:00 to 07:00 where:

- The operator of the aircraft has not provided (prior to take-off or prior to scheduled landing time as appropriate) sufficient information to enable the airport manager to verify its noise classification and thereby its QC; or
- The operator claims that the aircraft is an exempt aircraft, but the aircraft does not appear to be an exempt aircraft.

7D.8.13 Bristol Airport reports the use of the quota at the end of every season to the Airport Consultative Committee and publishes it on Bristol Airport's website.

7D.8.14 The number of take-offs and landings between 23:30 and 06:00 are limited to 3,000 in the summer season and 1,000 in the winter season (Planning condition 38). As part of the application Bristol Airport is seeking to amend this condition to a limit of 4,000 in a calendar year.

7D.8.15 The total number of take-offs and landings between 06:00 and 07:00 and between 23:00 and 23:30 are limited to 10,500 in any calendar year (Planning condition 39).

Noise monitoring

7D.8.16 Aircraft noise is continually measured using noise monitors located at each end of the runway, near Felton and Congresbury. These monitors are positioned in accordance with ICAO standards for monitoring noise from aircraft arriving and departing using runway 27.

7D.8.17 The Felton monitor is therefore located 2,289m from the touchdown point for arriving aircraft using runway 27 and the Congresbury monitor is 6,500m from the start of roll point for departing aircraft using runway 27.

7D.8.18 A further monitor is located at Littleton Hill, 6,500m from the start of roll point for departing aircraft using runway 09.

7D.8.19 A portable noise monitor can be used to record noise at specific locations in response to queries from the local community.

7D.8.20 The monitoring system, known as the Aircraft Noise Operation Management System (ANOMS) also takes radar data from air traffic control (ATC) enabling the aircraft track to be recorded and compared with the published routes.

7D.8.21 Processed data from the noise monitors are published annually in Bristol Airport's *Operations Monitoring Report* [12] which provides a year by year comparison of noise results.

[12] Bristol Airport (2017). 2017 Operations Monitoring Report, [Online]. Available at

Noise insulation grants

7D.8.22 As part of the Bristol Airport Environmental Improvement Fund[11], grants are available from Bristol Airport to cover some or all of the costs of new glazing and ventilators for properties most closely overflown and impacted by noise from Bristol Airport flights. Depending on location a property could be eligible for a grant of 100% (up to a maximum of £5,000) or 50% (up to a maximum of £2,500).

7D.8.23 Eligible properties are within the 63 dB, 60 dB and 57 dB noise contours. If a property is within the 63 dB contour, the grant can cover 100% of new double glazed windows or ventilators up to a sum of £5,000. If a property is within the 60 dB and 57 dB contours, the grant can cover 50% of new double glazed windows or ventilators up to a sum of £2,500.

7D.8.24 As there is a limit of annual funding grant applications are prioritised according to categories based on the contour the property is in, and whether it has had a grant before. Should the fund be oversubscribed in any one category, priority is given to those living closest to the extended centreline of the runway i.e. those closest to overflying aircraft.

Bristol Airport – noise abatement procedures

7D.8.25 Details of opening hours and noise abatement procedures are given in the latest version of the UK Aeronautical Information Package (AIP) for Bristol Airport[13].

7D.8.26 Bristol Airport offers a continuous day and night service. Prior permission is required for take offs and landings between 23:00 and 07:00 (22:00 and 06:00 BST). A night surcharge applies to all landings between 22:00 and 07:00 (21:00 to 06:00 BST).

7D.8.27 The following procedures are followed to minimise the noise impact of departing and arriving aircraft around Bristol Airport unless otherwise instructed by Air Traffic Control (ATC):

- Operators of all aircraft using Bristol Airport are to ensure that their aircraft conform to the noise abatement techniques laid down for the type of aircraft and that operations are conducted in a manner calculated to cause the least disturbance practicable in areas surrounding Bristol Airport; and
- When operating IFR, any aircraft carrying out a visual approach must not join the final approach track at an altitude of less than 2,200ft (QNH[14]).

7D.8.28 Aircraft using the ILS in IMC or VMC shall not descend below the altitude specified above before intercepting the glide path nor thereafter fly below it. Aircraft approaching without assistance from ILS or radar shall follow a descent path which will not result in its being at any time lower than the approach path which would be followed by an aircraft using the ILS glide path.

7D.8.29 The Noise Preferential Routeings (NPR) given in **Table 7D.109** are compatible with ATC requirements and shall apply in both VMC and IMC. The tracks are to be flown by all departing aircraft of more than 5,700kg maximum certified weight, unless otherwise instructed by ATC or unless deviations are required in the interests of safety.

7D.8.30 The NPRs are incorporated in the ATC Standard Instrument Departure procedures (SIDs).

[13] National Air Traffic Services (2017). IAIP Bristol – EGGD Textual data and Charts related to the Airport, [Online]. Available at: http://www.nats-uk.ead-it.com/public/index.php%3Foption=com_content&task=blogcategory&id=36&Itemid=85.html [Checked 28/08/2018].

[14] QNH is a code indicating the atmospheric pressure adjusted to mean sea level. An altitude given in terms of QNH is the altitude above mean sea level, measured using atmospheric pressure.

Table 7D.109 Noise Preferential Routeings (NPRs)

Take-off runway	Details
09	Climb straight ahead to I-BON 4.7 nm DME to be no lower than 3,000ft QNH at this point before commencing the turn
27	Climb straight ahead to I-BTS 4.5 nm DME to be no lower than 3,000ft QNH at this point before commencing the turn.

7D.8.31 The obligations of NPRs cease when an altitude of 4,000ft QNH or above has been reached.

7D.8.32 Subject to ATC instructions, inbound aircraft are to maintain as high an altitude as practical and adopt a continuous descent profile, when appropriate.

7D.8.33 Every aircraft using Bristol Airport shall, after take-off or 'go around' be operated in the quietest possible manner.

7D.8.34 In order to avoid overflying Felton Village, when departing runway 09 and requiring to turn left, all aircraft shall climb ahead to 1 nm DME before commencing the left turn.

7D.8.35 Noise abatement procedures for light aircraft are given in **Table 7D.110**.

Table 7D.110 Noise Preferential Routeings (NPRs Noise abatement procedures for light aircraft

Take-off runway	Details
09	(1) Practice engine failures after take-off by single-engine aircraft are not permitted. (2) Circuit direction is normally right hand only. However, ATC may require non-standard circuit direction for traffic integration.
27	(1) All pilots should arrange their flight so as to minimise noise nuisance. (2) Circuit direction is normally left hand.

Bristol Airport – future mitigation

Enhanced noise insulation grants

7D.8.36 This assessment has shown that there are no receptors subject to significant operational noise and vibration effects due to the change between the Without Development (10 mppa) and With Development (12 mppa) scenarios. Therefore, no further mitigation is required to reduce the noise and vibration effects that are identified in this ES. However, some receptors are exposed to significant levels of noise and therefore BAL already have in place a number of mitigation measures, one of which is the noise insulation grant scheme. BAL are proposing to enhance this scheme as part of the Proposed Development.

7D.8.37 In this proposed scheme, the thresholds for insulation will remain as current (refer to paragraph 7D.8.22), i.e. daytime 57 dB $L_{Aeq,16h}$ for the 50% grant and 63 dB $L_{Aeq,16h}$ for the 100% grant. It is noted that in all scenarios the night-time 55 dB $L_{Aeq,8h}$ contour is completely enclosed within the daytime 57 dB $L_{Aeq,16h}$ contour. Therefore, people exposed to significant levels of night-time noise will also benefit from the scheme.

7D.8.38 The minimum specification of the ventilators that can be installed as part of the scheme will also be improved. These provide a benefit as with sufficient ventilation, residents are not required to open windows and therefore can experience the full acoustic benefit of the glazing.

7D.8.39 The grant amount available will increase by 50%, i.e. up to £7,500 for those properties within the 63 dB $L_{Aeq,16h}$ contour and up to £3,750 for those properties within the 57 dB $L_{Aeq,16h}$ contour.

7D.8.40 For a limited time, all properties within the 57 dB $L_{Aeq,16h}$ contour for the 12 mppa 2026 scenario will be eligible to use the grant amount towards 100% of the cost of works, rather than 50%. This is intended to incentivise uptake in the short-term in order to encourage implementation of mitigation measures prior to BAL reaching 12 mppa by 2026.

7D.8.41 BAL will also contact all properties within the forecast eligibility contour to make them aware of the scheme and the offer being provided. Furthermore BAL will advertise the scheme in the constituencies where the eligibility contour reaches twice a year in order to encourage uptake.

7. Appendix 7E Ground Noise

7E.1 Introduction

7E.1.1 This appendix of the Environmental Statement (ES) considers ground noise, defined as the operational 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 at Bristol Airport.

7E.1.2 Sources of ground noise include:

- Taxiing and manoeuvring aircraft;
- Aircraft auxiliary power units (APUs); and
- Engine running for test and maintenance purposes.

Airport ground noise is heard in the context of off-airport noise sources, termed background noise. Ground noise will be audible for locations close to the boundary of Bristol Airport and in areas beyond where background noise levels are low.

7E.1.3 The use of APUs and aircraft taxiing give rise to noticeable levels of ground noise around the vicinity of Bristol Airport. The relative impact of the different sources of ground noise is controlled by their magnitude and duration.

7E.1.4 This appendix includes:

- Criteria used to assess ground noise;
- The basis of the assessment used to assess ground noise;
- The methodology used to assess ground noise;
- Ground noise assessment results;
- Assessment of the effects of ground noise, and
- Recommended mitigation measures, where appropriate, with respect to ground noise.

7E.2 Ground noise assessment criteria

7E.2.1 This section of the appendix summarises the numerical assessment criteria used to assess ground noise. These are daytime and night-time noise levels that, if exceeded outside a noise sensitive receptor, indicate a potential adverse and significant adverse effect. Details of the background, derivation and selection of air noise assessment criteria is given in **Appendix 7B**.

7E.2.2 Detailed descriptions of all metrics are given in **Appendix 7A**.

Residential

7E.2.3 The absolute noise values corresponding to indicative *Noise Policy Statement for England* (NPSE)[1] Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL) values for ground noise are given in **Table 7E.1**.

Table 7E.1 Ground noise assessment criteria – indicative values for LOAEL and SOAEL

Action	Effect Level	Indicative daytime level $L_{Aeq,16h}$ dB(A)	Indicative night-time level $L_{Aeq,8h}$ dB(A)
Mitigate and reduce to a minimum	Lowest Observed Adverse Effect Level (LOAEL)	50	45
Avoid	Significant Observed Adverse Effect Level (SOAEL)	60	55
Prevent	Unacceptable Adverse Effect Level (UAEL)	70	65

7E.2.4 The significance of impacts from the magnitude (or absolute) noise from ground noise is given in **Table 7E.2.**

Table 7E.2 Ground noise assessment criteria – outdoor absolute level

Significance of Impact	Daytime criteria $L_{Aeq,16h}$ dB	Night-time criteria $L_{Aeq,8h}$ dB	
Negligible	50	45	LOAEL
Minor	55	50	
Significant - Moderate	60	55	SOAEL
Significant - Substantial	65	60	
Significant – Very Substantial	70	65	UAEL

7E.2.5 In addition to absolute noise level, the relative change in noise level between operational scenarios is used to assess ground noise. A potential significance rating for a change in level is given in **Table 7E.3.**

[1] Defra (2010). Noise Policy Statement for England, [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf [Checked 10/04/2018].

Table 7E.3 Ground noise impact ratings - outdoors, change in noise level

Change in noise level dB	Subjective impression	Impact classification
0 to 2	Imperceptible change	Negligible
2 to 3	Barely perceptible change	Minor
3 to 6	Perceptible change	Moderate
6 to 9	Up to a halving or a doubling of loudness	Substantial
> 9	Equal to or more than a halving or doubling of loudness	Very substantial

Non-residential receptors

Schools

7E.2.6 BB93 sets out performance standards for indoor ambient noise levels within different types of room in terms of the $L_{Aeq,30min}$ index as given in **Table 7E.4**.

Table 7E.4 Schools – Indoor Ambient Noise Levels

	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

7E.2.7 To achieve the internal ambient noise level inside a classroom using natural ventilation, external noise levels should not exceed 55 dB $L_{Aeq,30min}$.

7E.2.8 Noise levels in unoccupied playgrounds, playing fields and other outdoor areas should not exceed 55 dB $L_{Aeq,30min}$.

Healthcare facilities

7E.2.9 Guidance on recommended internal noise levels for healthcare facilities is given in HTM 08-1 (2013)[2]. For hospital wards, the criteria for noise intrusion from external sources are given in **Table 7E.5** (to be met inside the space):

[2] Department of Health (2013). Specialist Services, Health Technical Memorandum 08-01: Acoustics, [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/144248/HTM_08-01.pdf [Checked 24/08/2018].

Table 7E.5 Healthcare facilities – Indoor noise levels

Time Period	Upper limit for indoor noise levels
Daytime	40 dB $L_{Aeq,1h}$
Night	35 dB $L_{Aeq,1h}$
Night	45 dB $L_{Amax,F}$ (events that occur several times per night)

7E.2.10 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, assuming a partly open window.

Places of worship

7E.2.11 There are no specific assessment criteria for places of worship. They are however places where quiet conditions are required and, for the purposes of this assessment, the same criteria as used to rate the effects of noise on residential receptors has been adopted, for the daytime period only.

Amenity areas

7E.2.12 Amenity areas includes those external areas used by the public for their quiet enjoyment of the outdoors. This includes, for example, parks, playgrounds, sports fields and public gardens.

7E.2.13 Based on guidance in BS 8233, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$.

7E.2.14 It is recognised in BS 8233 that these guideline values are not achievable in all circumstances where development might be desirable.

7E.3 Ground noise assessment methodology

7E.3.1 The assessment of ground noise has been undertaken using the latest version of the Datakustik CadnaA[3] environmental noise prediction software model (Version 2017). This software model uses the methodology set out in ISO 9613-2:1996[4]. Predictions have been based on movements for the average summer day and night, taking account of average mode operations.

7E.3.2 Ground noise has been evaluated and expressed in the form of contours and noise levels at specific receptors, showing dB $L_{Aeq,16h}$ daytime noise levels and $L_{Aeq,8h}$ night-time noise levels for an average day during the summer period.

7E.3.3 Consideration has also been given to key receptors around Bristol Airport to illustrate how the $L_{Aeq,16h}$ and $L_{Aeq,8h}$ noise levels vary.

7E.3.4 Sensitive noise receptors considered include dwellings as well as non-residential receptors areas including:

- Schools;

[3] DataKustik GmbH (2018). CadnaA - State-of-the-art Noise Prediction Software 2017 Version, [Online]. Available at: https://www.datakustik.com/en/products/cadnaa/ [Checked 1/10/2018].
[4] International Organization for Standardization (1996). ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation, [Online]. Available at: https://www.iso.org/standard/20649.html [Checked 9/10/2018].

- Hospitals or residential healthcare facilities;
- Places of worship, and;
- Amenity areas.

7E.4 Ground noise assessment basis

7E.4.1 This section of the appendix gives details of basis of the ground noise assessment. It includes details of aircraft movements by year and/or scenario, the aircraft mix and durations of each activity on the ground.

Ground noise assessment scenarios

7E.4.2 The effects of the Proposed Development are evaluated with respect to the existing noise conditions in the Baseline Year (2017). The assessment considers the following scenarios:

- Baseline year (2017);
- 10 mppa (million passengers per annum) Without Proposed Development. This aircraft mix and number of movements corresponds to 2026 without implementation of the Proposed Development; and
- 12 mppa. This aircraft mix and number of movements corresponds to implementation of the Proposed Development in 2026.

Geographical information

7E.4.3 Geographical information about the location of the runway, taxiways and stands have been taken from the latest version of the UK Aeronautical Information Package (AIP) for Bristol Airport[5].

7E.4.4 The CadnaA model of Bristol Airport includes detailed topographical information[6] processed for use in the model.

7E.4.5 Each aircraft stand has been modelled as a separate noise source. The current location of the aircraft stands is shown in **Figure 7E.1**.

7E.4.6 The runway and taxiways have been simplified into a number of noise source locations. These locations represent segments of an aircraft's taxi route. Different sources are used for different aircraft operations, for example runway 09 arrivals have been modelled using the sources shown in **Figure 7E.2**.

Current and forecast aircraft movements

7E.4.7 Current and forecast aircraft types, numbers, mixes and movement information were provided by Bristol Airport Limited (BAL).

7E.4.8 Aircraft movement data has been processed in relation to aircraft category, and the time period that it occurred in, for each of the scenarios considered.

[5] National Air Traffic Services (2017). IAIP Bristol – EGGD Textual data and Charts related to the Airport, [Online]. Available at: http://www.nats-uk.ead-it.com/public/index.php%3Foption=com_content&task=blogcategory&id=36&Itemid=85.html [Checked 28/08/2018].
[6] eMapsite (2018). NextMap Britain 2m Contours. Available at http://www.emapsite.com/mapshop/sample.aspx?map=30 [Checked 27/06/2018].

7E.4.9 Processed current and forecast summer aircraft movements for use in the CadnaA model are summarised in **Table 7E.6**.

Table 7E.6 Number of summer aircraft movements by aircraft category

Aircraft category	Number of summer movements					
	2017		10 mppa 2026		12 mppa 2026	
	Day	Night	Day	Night	Day	Night
Small Jets	3,304	256	2,615	237	1,341	13
Medium Jets	12,252	2,422	15,088	3,706	19,241	4,547
Large Jets	40	7	145	79	145	79
Turbo-props	3,327	50	1,446	0	1,814	0
Total	18,923	2,735	19,294	4,022	22,541	4,639
	21,658		23,316		27,180	

Engine running for test and maintenance purposes

7E.4.10 Ground running of aircraft engines is necessary as part of the scheduled maintenance undertaken to ensure that aircraft are airworthy and fit for flight. All such activities are subject to strict operational procedures.

7E.4.11 At Bristol Airport, these type of activities only occur on a limited basis. Ground running occurs at idle thrust level at a frequency of around once per day, and above idle at a frequency of less than once per week. This is not expected to significantly change in the future. Detailed information on the location of these activities is not available.

7E.4.12 Due to the low frequency of these activities, it is considered that they will have no noticeable effect on the overall ground noise effect of Bristol Airport and therefore they have not been included in the model.

Runway usage

7E.4.13 The current and forecast runway usage were provided by BAL and are summarised in **Table 7E.7**. These averages have been applied equally to each aircraft category and time period.

Table 7E.7 Runway usage assumptions

Runway	Number of summer movements		
	2017	10 mppa 2026	12 mppa 2026
09	20%	22%	22%
27	80%	78%	78%

Stand usage

7E.4.14 The stand usage is used to determine the route taken by the aircraft when departing and arriving at Bristol Airport and the location where the aircraft will park and operate during the ground activities.

7E.4.15 The current and forecast stand usage was and derived from data provided by BAL and the National Air Traffic Services (NATS).

7E.4.16 The current stand usage is based on the log of actual stand usage in 2017. For the future scenarios, a percentage of stand usage on different groups of stands was provided by BAL. The distribution of stand usage within a group has been assumed to remain the same as in 2017, with the exception of in group E in the 12 mppa night-time scenario.

7E.4.17 There is currently a planning condition preventing the use of APUs on stands 38 and 39. As part of the Proposed Development, this condition will be modified to match the condition for stands 34-37 which restricts APU usage to between 06:00 and 23:00. Therefore in the 12 mppa night-time scenario, an equal distribution has been assumed between stands 37, 38 and 39.

7E.4.18 **Table 7E.8**, **Table 7E.9** and **Table 7E.10** present the stand usage during the daytime and night-time periods for each different scenario.

Table 7E.8 Summer stand usage, 2017

Group of Stands	Individual Stands	Daytime (%)	Night-time (%)	Total (%)
A	1, 2, 3, 3R, 4, 5, 6	37%	22%	35%
B	7N, 8, 9, 10, 11, 12, 13, 14, 14L, 15, 15L, 16, 16L	21%	21%	21%
C	21, 22, 23, 24, 25, 26R, 26S, 28, 29, 30	36%	38%	37%
D	31, 31R, 32L, 32, 32R, 33, 33L, 34, 35, 36, W1	5%	18%	6%
E	37, 38, 39	1%	1%	1%
F	New East Stands	0%	0%	0%
G	Southern Apron	0%	0%	0%

Table 7E.9 Summer stand usage, 10 mppa (2026) without Proposed Development

Group of Stands	Individual Stands	Daytime (%)	Night-time (%)	Total (%)
A	1, 2, 3, 3R, 4, 5, 6	30%	18%	28%
B	7N, 8, 9, 10, 11, 12, 13, 14, 14L, 15, 15L, 16, 16L	24%	23%	24%
C	21, 22, 23, 24, 25, 26R, 26S, 28, 29, 30	38%	27%	36%
D	31, 31R, 32L, 32, 32R, 33, 33L, 34, 35, 36, W1	6%	16%	8%
E	37, 38, 39	1%	7%	2%
F	New East Stands	1%	9%	2%
G	Southern Apron	0%	0%	0%

Table 7E.10 Summer stand usage, 12 mppa (2026) with Proposed Development

Group of Stands	Individual Stands	Daytime (%)	Night-time (%)	Total (%)
A	1, 2, 3, 3R, 4, 5, 6	26%	16%	24%
B	7N, 8, 9, 10, 11, 12, 13, 14, 14L, 15, 15L, 16, 16L	24%	20%	23%
C	21, 22, 23, 24, 25, 26R, 26S, 28, 29, 30	35%	28%	34%
D	31, 31R, 32L, 32, 32R, 33, 33L, 34, 35, 36, W1	11%	18%	12%
E	37, 38, 39	2%	6%	3%
F	New East Stands	2%	8%	3%
G	Southern Apron	0%	4%	1%

Future aircraft types

7E.4.19 For the future scenarios, it is forecast that there will be some new aircraft operating at Bristol Airport that do not currently operate in significant numbers, such as the Airbus A320neo and Boeing B738MAX. While detailed information in available to allow assumptions to be made about how much air noise these new aircraft will produce, there is not sufficient information available to determine the equivalent values for ground noise. Therefore, these aircraft have been categorised by size in the same way as existing aircraft and modelled using the noise levels given in **Table 7E.11**. This is likely to be a conservative assumption as in practice the newer aircraft may be slightly quieter than their existing equivalents.

Modelling assumptions

7E.4.20 A noise level has been assigned to each source representing the ground activity at that location (i.e. taxiing, manoeuvring, APU, engine start-up, hold). The noise at a given receptor is then calculated from the contribution of all these sources, taking into account propagation and any noise barriers and reflecting surfaces.

7E.4.21 For each ground activity, the sound power level used in the CadnaA model has been determined based on the associated reference noise level, L_{Aeq}, at the reference distance of 152 m. These have been based on attended measurements undertaken by Bickerdike Allen Partners LLP (BAP), both at Bristol Airport and previous surveys of similar aircraft.

7E.4.22 **Table 7E.11** shows a summary of the noise levels used in the CadnaA model.

Table 7E.11 Reference noise levels at 152 meters

Activity	Noise Level, dB L_{Aeq}			
	Large jets	**Medium jets**	**Small jets**	**Turbo-prop**
Engine start-up (idle)	74	72	67	78
Taxiing on apron	74	73	67	78
Taxiing on runway	74	73	67	78
Manoeuvre 90 degrees	79	78	72	80

Manoeuvre 180 degrees	79	78	72	80
Hold departure	74	72	67	78
APU – Arrival	63	65	65	64
APU – Departure	63	65	65	64

7E.4.23 Each source has an associated duration of activity. In practice these will vary, however for modelling purposes an average duration is assumed for each operation. For taxiing activities, the assumed speed is given, as the duration depends on the distance travelled by the aircraft. **Table 7E.12** and **Table 7E.13** set out the assumed duration or speed for each of the ground activities associated with arrivals and departures at Bristol Airport. These have been derived from observations and ground noise studies at various airports and adjusted where appropriate for operations at Bristol Airport.

Table 7E.12 Durations of arrival activities

Activity	**Details**
Auxiliary Power Unit (APU)	5 min
Manoeuvres	90 degrees: 10 s
	180 degrees: 20 s
Taxiing speed (used in conjunction with model sector length to determine sector duration)	On Apron: 10 m/s
	On Runway: 10 m/s
Engine running on stand	60 s

Table 7E.13 Durations of departure activities

Activity	**Details**
Auxiliary Power Unit (APU)	30 min
Engine start-up (idle)	60 s
Manoeuvres	90 degrees: 10 s
	180 degrees: 20 s
Hold at edge of runway (prior to getting onto runway)	60 s
Taxiing speed (used in conjunction with model sector length to determine sector duration)	On Apron: 10 m/s
	On Runway: 10 m/s
Hold at start of roll	60 s

Sensitive receptors

7E.4.24 The assessment of the ground noise effects included all noise sensitive receptors within the lowest ground noise contour bands.

Dwelling counts

7E.4.25 A database of dwellings has been compiled from the OS AddressBase Plus product, obtained on 7 September 2018. This database has been used in the dwelling counts for both the current and future scenarios.

Specific residential receptors

7E.4.26 A series of representative residential receptors have been identified for specific assessment. Details of these are given in **Section 7.7** of **Chapter 7** and they are shown on **Figure 7.2**.

Non-residential receptors

7E.4.27 A database of noise sensitive non-residential receptors, i.e., schools, healthcare facilities, places of worship and amenity areas, has been compiled from the OS AddressBase Plus product, obtained on 7 September 2018. Details of these receptors are given in **Section 7.7** of **Chapter 7** and they are shown on **Figure 7.3** to **Figure 7.5**.

7E.5 Ground noise assessment results

7E.5.1 This section presents the results of the ground noise assessment undertaken using the criteria described in **Section 7E.2**. Results are presented for each of the following scenarios:

- Baseline year (2017);
- 10 mppa Without Proposed Development. This aircraft mix and number of movements corresponds to 2026 without implementation of the Proposed Development; and
- 12 mppa. This aircraft mix and number of movements corresponds to implementation of the Proposed Development in 2026.

7E.5.2 Results are firstly introduced in terms of ground noise contour figures. To assist in finding the relevant figure, a table is provided which sets out the figure reference for a given noise indicator and scenario.

7E.5.3 Secondly, results are presented for residential receptors in terms of contour areas and dwelling counts for the L_{Aeq} index, both for daytime and night-time. Key representative residential receptors are also considered.

7E.5.4 Finally, results are presented for non-residential receptors in terms of the noise level at each receptor under each scenario.

7E.5.5 For all tables, areas are rounded to the nearest 0.1km^2. Dwelling and population counts are rounded to the nearest 50 above 100 and to the nearest 10 below 100. Below 10, the actual number is given.

Ground noise contours

7E.5.6 **Table 7E.14** denotes the relevant figure numbers for the relevant air noise contours.

Table 7E.14 Ground noise contour figure references

Contour Type	Scenario		
	Baseline 2017	10 mppa 2026	12 mppa 2026
$L_{Aeq,16h}$ summer day	7E.3	7E.4	7E.5
$L_{Aeq,16h}$ summer night	7E.6	7E.7	7E.8

Daytime

7E.5.7 The area and number of dwellings within each contour band for the three different scenarios is given in **Table 7E.15** and **Table 7E.16**. The counts include all those dwellings or people within a specified contour band so, for example, 200 dwellings within a 60 dB contour includes those within the 65 and 70 dB bands as well.

Table 7E.15 Contour areas, $L_{Aeq,16h}$ average summer day

Contour $L_{Aeq,16h}$ (dB)	Contour Areas (km^2)		
	Baseline 2017	10 mppa 2026	12 mppa 2026
50 (LOAEL)	3.3	3.4	3.3
55	1.9	1.9	1.8
60 (SOAEL)	1.1	1.2	1.1
65	0.7	0.8	0.7

Table 7E.16 Number of dwellings, $L_{Aeq,16h}$ average summer day

Contour $L_{Aeq,16h}$ (dB)	Number of Dwellings		
	Baseline 2017	10 mppa 2026	12 mppa 2026
50 (LOAEL)	70	80	70
55	20	20	4
60 (SOAEL)	1	1	1
65	0	0	0

Night-time

7E.5.8 The area and number of dwellings within each contour band for the three different scenarios is given in **Table 7E.17** and **Table 7E.18**. The counts include all those dwellings or people within a specified contour band so, for example, 200 dwellings within a 55 dB contour includes those within the 60 and 65 dB bands as well.

Table 7E.17 Contour areas, $L_{Aeq,8h}$ average summer night

Contour $L_{Aeq,8h}$ (dB)	Contour Areas (km²)		
	Baseline 2017	10 mppa 2026	12 mppa 2026
45 (LOAEL)	3.1	3.8	3.9
50	1.7	2.2	2.1
55 (SOAEL)	1.0	1.3	1.3
60	0.6	0.8	0.8

Table 7E.18 Number of dwellings, $L_{Aeq,8h}$ average summer night

Contour $L_{Aeq,8h}$ (dB)	Number of Dwellings		
	Baseline 2017	10 mppa 2026	12 mppa 2026
45 (LOAEL)	70	100	100
50	10	40	5
55 (SOAEL)	1	2	3
60	0	0	1

Specific residential receptors

Table 7E.19 gives the average summer day and night noise levels at a series of representative residential receptors for the three different scenarios.

Table 7E.19 Noise levels in 2017 and 2026 at 11 sensitive receptors around Bristol Airport

Receptor	Location	$L_{Aeq,16h}$ (dB)			$L_{Aeq,8h}$ (dB)		
		2017	10mppa (2026)	12mppa (2026)	2017	10mppa (2026)	12mppa (2026)
A	Cooks Bridle Path, Downside	61	61	63	56	59	61
B	Downside Road (West), Lulsgate Bottom	58	58	52	52	54	47
C	School Lane, Lulsgate Bottom	52	52	52	46	50	49
D	Red Hill (A38) (North), Redhill	45	45	46	39	41	41
E	Winters Lane (South), Redhill	47	47	48	42	44	44
F	Downside Road (South), Downside	53	53	54	49	50	51
G	Downside Road (North), Downside	50	50	49	45	47	46
H	Downside Road (East), Lulsgate Bottom	58	56	51	50	53	47
I	Bridgwater Road (A38), Lulsgate Bottom	50	50	49	44	47	46
J	Red Hill (A38) (South), Redhill	43	43	43	37	39	39

Receptor	Location	$L_{Aeq,16h}$ (dB)			$L_{Aeq,8h}$ (dB)		
		2017	10mppa (2026)	12mppa (2026)	2017	10mppa (2026)	12mppa (2026)
K	Winters Lane (North), Redhill	50	50	51	44	46	47

Non-residential receptors

Table 7E.20 gives the average summer day and night noise levels at the non-residential receptors closest to Bristol Airport for the three different scenarios.

Table 7E.20 Daytime noise levels at non-residential receptors around Bristol Airport

Receptor		$L_{Aeq,16h}$ (dB)		
		Baseline 2017	10 mppa 2026	12 mppa 2026
W23	St Katherine's Church, Felton	48	48	48
W28	Christ Church, Redhill	<45	<45	<45
A9	Vee Lane Play Area, Felton	<45	<45	<45
A24	Felton Common, Felton	46	46	47

7E.6 Assessment of ground noise effects

General

7E.6.1 To assess the effects of ground noise arising from the impacts that have been described in **Section 7E.5**, the assessment criteria set out in **Appendix 7B** have been applied. The effects arise because of both the absolute noise level experienced at a receptor as well as the change in noise level that occurs through the introduction of the Proposed Development.

7E.6.2 Consideration is given below to how the impacts resulting from a change in the ground noise conditions are likely to affect residential and non-residential receptors for the following scenarios:

- Baseline vs future scenarios (10 mppa in 2026 and 12 mppa in 2026); and
- Future 10 mppa in 2026 vs 12 mppa in 2026.

7E.6.3 The assessment firstly compares ground noise effects for residential receptors for each of the comparisons above, both for daytime and night-time.

7E.6.4 The ground noise levels at a series of key representative residential receptors are also compared under the different scenarios.

7E.6.5 Finally, the number of non-residential noise sensitive receptors that are likely to be significantly affected by ground noise currently and/or in the future are identified.

Baseline (2017) vs Future (10 mppa in 2026)

7E.6.6 **Figure 7E.3** and **Figure 7E.4** give the daytime ground noise $L_{Aeq,16h}$ noise contours for the baseline 2017 and 10 mppa in 2026 scenarios respectively. **Figure 7E.6** and **Figure 7E.7** provide the corresponding night-time ground noise $L_{Aeq,8h}$ contours.

7E.6.7 The impact of ground noise on residential receptors assuming that the Proposed Development does not proceed and Bristol Airport continues to grow to its current permitted capacity of 10 mppa by 2026 will give rise to the effects given in **Table 7E.21** for the daytime and **Table 7E.22** for the night-time. Those receptors that do not experience any change in noise between two scenarios are given in these tables in the "beneficial" receptor column.

Table 7E.21 Dwellings exposed to absolute noise and change in noise, 2017 to 10 mppa 2026, daytime

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,16h}$**	**Number of dwellings in band, 10 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0 – 2 dB**	**Minor 2 – 3 dB**	**Moderate 3 – 6 dB**	**Substantial 6 – 9 dB**	**Very Substantial >9 dB**
Negligible	**50 (LOAEL)**	30	Beneficial	30	0	0	0	0
		20	Adverse	20	0	0	0	0
Minor	**55**	5	Beneficial	5	0	0	0	0
		20	Adverse	20	0	0	0	0
Significant Moderate	**60 (SOAEL)**	1	Beneficial	1	0	0	0	0
		0	Adverse	0	0	0	0	0
Significant Substantial	**65**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Significant Very Substantial	**70 (UAEL)**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		40	Beneficial	40	0	0	0	0
		40	Adverse	40	0	0	0	0

Table 7E.22 Dwellings exposed to absolute noise and change in noise, 2017 to 10 mppa 2026, night-time

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,8h}$**	**Number of dwellings in band, 10 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0 – 2 dB**	**Minor 2 – 3 dB**	**Moderate 3 – 6 dB**	**Substantial 6 – 9 dB**	**Very Substantial >9 dB**
Negligible	**45 (LOAEL)**	0	Beneficial	0	0	0	0	0

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,8h}$**	**Number of dwellings in band, 10 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0 – 2 dB**	**Minor 2 – 3 dB**	**Moderate 3 – 6 dB**	**Substantial 6 – 9 dB**	**Very Substantial >9 dB**
		80	Adverse	40	20	20	0	0
Minor	**50**	0	Beneficial	0	0	0	0	0
		30	Adverse	4	30	4	0	0
Significant Moderate	**55 (SOAEL)**	0	Beneficial	0	0	0	0	0
		2	Adverse	0	1	1	0	0
Significant Substantial	**60**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Significant Very Substantial	**65 (UAEL)**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		0	Beneficial	0	0	0	0	0
		100	Adverse	40	40	30	0	0

Baseline (2017) vs Future (12 mppa in 2026)

7E.6.8 **Figure 7E.3** and **Figure 7E.5** give the daytime ground noise $L_{Aeq,16h}$ noise contours for the baseline 2017 and the 12 mppa in 2026 scenarios respectively. **Figure 7E.6** and **Figure 7E.8** provide the corresponding night-time ground noise $L_{Aeq,8h}$ contours.

7E.6.9 The impact of ground noise on residential receptors assuming that the Proposed Development proceeds and Bristol Airport continues to grow to 12 mppa by 2026 will give rise to the effects given in **Table 7E.23** for the daytime and **Table 7E.24** for the night-time. Those receptors that do not experience any change in noise between two scenarios are given in these tables in the "beneficial" receptor column.

Table 7E.23 Dwellings exposed to absolute noise and change in noise, 2017 to 12 mppa 2026, daytime

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,16h}$**	**Number of dwellings in band, 12 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0 – 2 dB**	**Minor 2 – 3 dB**	**Significant Moderate 3 – 6 dB**	**Significant Substantial 6 – 9 dB**	**Significant Very Substantial >9 dB**
Negligible	**50 (LOAEL)**	60	Beneficial	20	5	30	2	0
		10	Adverse	10	0	0	0	0
Minor	**55**	0	Beneficial	0	0	0	0	0
		3	Adverse	3	0	0	0	0
Significant Moderate	**60 (SOAEL)**	0	Beneficial	0	0	0	0	0
		1	Adverse	1	0	0	0	0
Significant Substantial	**65**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Significant Very Substantial	**70 (UAEL)**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		60	Beneficial	20	5	30	4	0
		20	Adverse	20	0	0	0	0

Table 7E.24 Dwellings exposed to absolute noise and change in noise, 2017 to 12 mppa 2026, night-time

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,8h}$**	**Number of dwellings in band, 10 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0 – 2 dB**	**Minor 2 – 3 dB**	**Significant Moderate 3 – 6 dB**	**Significant Substantial 6 – 9 dB**	**Significant Very Substantial >9 dB**
Negligible	**45 (LOAEL)**	40	Beneficial	20	10	10	0	0
		70	Adverse	30	30	6	0	0
Minor	**50**	0	Beneficial	0	0	0	0	0
		2	Adverse	0	2	0	0	0
Significant Moderate	**55 (SOAEL)**	0	Beneficial	0	0	0	0	0

Subjective description of impact	Contour band dB $L_{Aeq,8h}$	Number of dwellings in band, 10 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification Negligible 0 – 2 dB	Minor 2 – 3 dB	Significant Moderate 3 – 6 dB	Significant Substantial 6 – 9 dB	Significant Very Substantial >9 dB
		2	Adverse	0	0	2	0	0
Significant Substantial	**60**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	1	0	0
Significant Very Substantial	**65 (UAEL)**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		40	Beneficial	20	10	10	0	0
		70	Adverse	30	30	9	0	0

Future (10 mppa in 2026) vs Future (12 mppa in 2026)

7E.6.10 **Figure 7E.4** and **Figure 7E.5** give the daytime ground noise $L_{Aeq,16h}$ noise contours for the 10 mppa in 2026 and the 12 mppa in 2026 scenarios respectively. **Figure 7E.7** and **Figure 7E.8** provide the corresponding night-time ground noise $L_{Aeq,8h}$ contours.

7E.6.11 The impact of ground noise on residential receptors assuming that the Proposed Development proceeds and Bristol Airport continues to grow to 12 mppa by 2026 will give rise to the effects given in **Table 7E.25** for the daytime and **Table 7E.26** for the night-time. Those receptors that do not experience any change in noise between two scenarios are given in these tables in the "beneficial" receptor column.

Table 7E.25 Dwellings exposed to absolute noise and change in noise, 10 mppa 2026 to 12 mppa 2026, daytime

Subjective description of impact	Contour band dB $L_{Aeq,16h}$	Number of dwellings in band, 12 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification Negligible 0 – 2 dB	Minor 2 – 3 dB	Significant Moderate 3 – 6 dB	Significant Substantial 6 – 9 dB	Significant Very Substantial >9 dB
Negligible	**50 (LOAEL)**	60	Beneficial	20	5	30	3	0
		10	Adverse	10	0	0	0	0
Minor	**55**	0	Beneficial	0	0	0	0	0
		3	Adverse	3	0	0	0	0

Subjective description of impact	Contour band dB $L_{Aeq,16h}$	Number of dwellings in band, 12 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification Negligible 0 – 2 dB	Minor 2 – 3 dB	Significant Moderate 3 – 6 dB	Significant Substantial 6 – 9 dB	Significant Very Substantial >9 dB
Significant Moderate	**60 (SOAEL)**	0	Beneficial	0	0	0	0	0
		1	Adverse	1	0	0	0	0
Significant Substantial	**65**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Significant Very Substantial	**70 (UAEL)**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		60	Beneficial	20	5	30	3	0
		10	Adverse	10	0	0	0	0

Table 7E.26 Dwellings exposed to absolute noise and change in noise, 10 mppa 2026 to 12 mppa 2026, night-time

Subjective description of impact	Contour band dB $L_{Aeq,8h}$	Number of dwellings in band, 10 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification Negligible 0 – 2 dB	Minor 2 – 3 dB	Significant Moderate 3 – 6 dB	Significant Substantial 6 – 9 dB	Significant Very Substantial >9 dB
Negligible	**45 (LOAEL)**	80	Beneficial	40	9	30	4	0
		30	Adverse	30	0	0	0	0
Minor	**50**	0	Beneficial	0	0	0	0	0
		2	Adverse	2	0	0	0	0
Significant Moderate	**55 (SOAEL)**	0	Beneficial	0	0	0	0	0
		2	Adverse	2	0	0	0	0
Significant Substantial	**60**	0	Beneficial	0	0	0	0	0
		1	Adverse	1	0	0	0	0

				Change in Noise Level, dB Potential Impact Classification				
Subjective description of impact	**Contour band dB $L_{Aeq,8h}$**	**Number of dwellings in band, 10 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0 – 2 dB**	**Minor 2 – 3 dB**	**Significant Moderate 3 – 6 dB**	**Significant Substantial 6 – 9 dB**	**Significant Very Substantial >9 dB**
Significant Very Substantial	**65 (UAEL)**	0	Beneficial	0	0	0	0	0
		0	Adverse	0	0	0	0	0
Total		80	Beneficial	40	9	30	4	0
		30	Adverse	30	0	0	0	0

Specific residential receptors

7E.6.12 Eight of the 11 assessed specific residential receptors are exposed to daytime ground noise levels at or above the LOAEL in 2017, with one of those being exposed to a level above the SOAEL. This situation remains the same under the 10 mppa scenario, and under to 12 mppa scenario improves to six receptors exposed to the LOAEL or above.

7E.6.13 Six of the 11 assessed specific residential receptors are exposed to night-time ground noise levels at or above the LOAEL in 2017, with one of those being exposed to a level above the SOAEL. This increases to nine exposed to the LOAEL or above under both future scenarios.

7E.6.14 Changes in noise levels are generally small. Some receptors experience an increase in noise due to the increased aircraft traffic in the future scenarios, however in the 12 mppa scenario some receptors, in particular those in Lulsgate Bottom, see a benefit of the additional screening resulting from the Proposed Development being built out and ground noise levels reduce to lower than in 2017. This screening is due to the new walkway being constructed to the north of the existing eastern apron.

Non-residential receptors

7E.6.15 None of the assessed non-residential receptors are exposed to significant levels of ground noise in any of the three scenarios.

7E.7 Ground noise mitigation

7E.7.1 The ground noise assessment has demonstrated that, both now and in the future, a small number of receptors around Bristol Airport will be exposed to significant levels of ground noise, particularly during the night-time period.

Bristol Airport – existing planning controls

7E.7.2 Bristol Airport has operated for many years under a number of planning consents and as such is already subject to planning controls and voluntary agreements relating to those consents as well as its own sustainability and noise management policies.

7E.7.3 Most recently planning permission was granted in February 2011 for expansion of Bristol Airport to handle 10 mppa[7]. The current Section 106 Agreement includes planning obligations relating to the management and control of ground noise through the implementation of a noise control scheme and adoption of operational procedures and practices aimed at achieving ongoing improvements.

7E.7.4 These are each briefly described in the following section and are given in detail in Bristol Airport's current *Noise Action Plan*[8].

7E.7.5 A planning obligation required the establishment of an Airport Environmental Improvement Fund[9], the purposes of which includes the funding of initiatives to mitigate the impact of aircraft and ground noise in the local community. Bristol Airport paid an initial sum of £100,000 into the fund in 2012 with further annual payments exceeding £100,000 and increasing in line with the annual percentage increase in passenger numbers.

Ground noise

7E.7.6 Bristol Airport has procedures in place to limit the use of Auxiliary Power Units (APUs).

7E.7.7 These include requirements for the installation and availability of Fixed Electrical Ground Power (FEGP) before the use of stands for live aircraft movements (Planning condition 32) and for FEGP to be used in preference to APUs (Planning condition 33) on areas cited in these conditions. Mobile diesel ground power generators and aircraft APUs cannot be used on stands 38 and 39 (Planning condition 34).

7E.7.8 APUs cannot be used on stands 34 to 37 between 23:00 and 06:00 hours (Planning condition 35).

7E.7.9 Planning conditions 4, 5 and 69 require the erection of 5m high noise attenuation walls around the western and eastern apron extensions, and a 3m high timber fence around the northern boundary of the north side car park.

Noise insulation grants

7E.7.10 As part of the Bristol Airport Environmental Improvement Fund[10], grants are available from Bristol Airport to cover some or all of the costs of new double glazing and ventilators for properties exposed to air noise levels of 57 dB $L_{Aeq,16h}$ or above. Further details of this scheme are outlined in **Appendix 7D**.

7E.7.11 Although eligibility for these grants are not based on ground noise criteria, all dwellings exposed to significant levels of ground noise under any of the assessed scenariosare eligible for grants.

Bristol Airport – future mitigation

7E.7.12 Bristol Airport are proposing to enhance their existing noise insulation grants. Although eligibility for these grants are not based on ground noise criteria, all dwellings exposed to significant levels of

[7] North Somerset Council (2011). Planning permission 09/P/1020/OT2, [Online]. Available at: https://planning.n-somerset.gov.uk/online-applications/ [Checked 6/09/2018].
[8] Bristol Airport (2014). Noise Action Plan 2014 to 2018, [Online]. Available at https://www.bristolairport.co.uk/~/media/files/brs/about-us/nap-14_18.ashx?la=en [Checked 27/04/2018].
[9] Bristol Airport (2018). Airport Environmental Improvement Fund, Guidelines for applying for a grant for noise insulation, [Online]. Available at: https://www.bristolairport.co.uk/~/media/files/brs/about-us/community/guidelines-2018_final.ashx?la=en [Checked 5/10/2018].
[10] Bristol Airport (2018). Airport Environmental Improvement Fund, Guidelines for applying for a grant for noise insulation, [Online]. Available at: https://www.bristolairport.co.uk/~/media/files/brs/about-us/community/guidelines-2018_final.ashx?la=en [Checked 5/10/2018].

ground noise under any of the assessed scenarios will be eligible for grants under the enhanced scheme.

7E.7.13 As part of the Proposed Development a new walkway will be constructed to the north of the existing eastern apron. This will offer screening from ground noise for receptors to the north of this location, in particular those on Downside Road.

7E.7.14 No additional specific mitigation is proposed based on ground noise effects.

Appendix 7F
Road Traffic Noise

7F.1 Introduction

7F.1.1 This appendix of the Environmental Statement (ES) considers road traffic noise in the vicinity of Bristol Airport.

7F.1.2 This appendix includes:

- Criteria used to assess road traffic noise;
- The methodology used to assess road traffic noise;
- The basis of the assessment of road traffic noise;
- Road traffic noise assessment results;
- Assessment of the effects of road traffic noise; and
- Recommended mitigation measures, where appropriate, with respect to road traffic noise.

7F.2 Road traffic noise assessment criteria

7F.2.1 This section of the appendix summarises the assessment criteria used to assess road traffic noise. These are outdoor noise levels that, if exceeded outside a residential or noise sensitive non-residential receptor, indicate a potential adverse or significant adverse effect.

7F.2.2 Details of the background, derivation and selection of road traffic noise assessment criteria are given in **Appendix 7B**.

7F.2.3 Detailed descriptions of all metrics are given in **Appendix 7A**.

7F.2.4 The absolute noise values corresponding to indicative *Noise Policy Statement for England* (NPSE)[1] Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL) values are given in **Table 7F.1**.

[1] Defra (2010). Noise Policy Statement for England, [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf [Checked 10/04/2018].

Table 7F.1 Road traffic noise assessment criteria – indicative values for LOAEL and SOAEL

Action	Effect Level	Indicative daytime façade level $L_{A10,18h}$ (dB)
Mitigate and reduce to a minimum	Lowest Observed Adverse Effect Level (LOAEL)	55
Avoid	Significant Observed Adverse Effect Level (SOAEL)	68
Prevent	Unacceptable Adverse Effect Level (UAEL)	75

7F.2.5 The significance of impacts from the absolute noise level from road traffic is given in **Table 7F.2**.

Table 7F.2 Road traffic noise assessment criteria – outdoor absolute level

Significance of impact	Daytime criteria facade level $L_{A10,18h}$ (dB)
Negligible	55 (LOAEL)
Minor	60
Significant - Moderate	68 (SOAEL)
Significant - Substantial	70
Significant – Very Substantial	75 (UAEL)

7F.2.6 In addition to absolute noise level, the relative change in noise level between operational scenarios is used to assess road traffic noise. Potential significance ratings for a change in level are given in **Table 7F.3** for short term and long term impacts, derived from Highways England's *Design Manual for Roads and Bridges* (DMRB)[2].

Table 7F.3 Road traffic noise impact ratings – outdoor change in noise level

Significance of impact	Long Term Change in Noise Level $L_{A10,18h}$ (dB)
No change	0.0
Negligible	0.1 to 2.9
Significant Minor	3.0 to 4.9
Significant Moderate	5.0 to 9.9
Significant Substantial	≥ 10.0

[2] Highways England (2018). Design Manual for Roads and Bridges, [Online]. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/index.htm [Checked 24/04/ 2018].

7F.3 Road traffic assessment methodology

7F.3.1 The assessment of road traffic noise has been undertaken using the calculation method given in the Department of Transport *Calculation of Road Traffic Noise* (CRTN)[3]. Noise levels due to road traffic have been determined using the latest version of the Datakustik CadnaA[4] environmental noise prediction software model (Version 2017). This software model uses CRTN and the methodology set out in *ISO 9613-2:1996*[5] to determine the extent of current and future road traffic noise around Bristol Airport.

7F.3.2 Road traffic noise levels have been evaluated and expressed in the form of contours and noise levels at representative residential receptors, showing dB $L_{A10, 18h}$ noise levels for an annual average weekday, as is the convention in the UK. $L_{A10,18h}$ is the noise level exceeded for 10% of the time over the period 06:00 to 24:00.

7F.4 Road traffic assessment basis

7F.4.1 This section of the appendix gives details of basis of the road traffic noise assessment. It includes details of traffic movements and also gives details of the assumptions made and the data used in the assessment.

Road traffic noise assessment scenarios

7F.4.2 The effects of the Proposed Development are evaluated with respect to the existing noise conditions in the Baseline Year (2017). The assessment considers the following scenarios:

- Baseline year (2017);
- 10 mppa without Proposed Development. This scenario corresponds to 2026 without implementation of the Proposed Development; and
- 12 mppa. This scenario corresponds to implementation of the Proposed Development in 2026.

Geographical information

7F.4.1 The CadnaA model of Bristol Airport includes detailed topographical information[6] processed for use in the model.

7F.4.2 Bristol Airport Limited (BAL) have supplied details of roads, and the location and layout of buildings and other man-made features in and around the Proposed Development.

7F.4.3 The roads around Bristol Airport used for this assessment are shown in **Figure 7F.1**.

Current and forecast road traffic movements

7F.4.4 Traffic flow information for the current (2017), and future scenarios have been provided by BAL and are given in **Table 7F.4**. These are given in terms of 18 hour Annual Average Weekday Traffic

[3] Department of Transport Welsh Office (1988). Calculation of Road Traffic Noise. London: HMSO.
[4] DataKustik GmbH (2018). CadnaA - State-of-the-art Noise Prediction Software 2017 Version, [Online]. Available at: https://www.datakustik.com/en/products/cadnaa/ [Checked 1/10/2018].
[5] International Organization for Standardization (1996). ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation, [Online]. Available at: https://www.iso.org/standard/20649.html [Checked 9/10/2018].
[6] eMapsite (2018). NextMap Britain 2m Contours. Available at http://www.emapsite.com/mapshop/sample.aspx?map=30 [Checked 27/06/2018].

(AAWT) flows and includes the total motor vehicles, percentage of heavy vehicles and maximum traffic speed.

Table 7F.4 Road traffic flows around the proposed development provided by Bristol Airport

Roads	18 hours AAWT flows Total (%HGVs)			Max. traffic speed (km/h)
	Baseline 2018	10 mppa 2026	12 mppa 2026	
R1 Downside Road	5,705 (3%)	7,303 (3%)	8,131 (3%)	64
R2 A38 (North of airport access)	22,503 (3%)	31,290 (4%)	37,317 (2%)	80
R3 Roundabout airport access	17,938 (2%)	23,589 (3%)	27,143 (2%)	32
R4 A38 (South of airport access)	16,756 (3%)	21,310 (4%)	23,585 (4%)	80
West Lane	5,261 (1%)	7,292 (1%)	8,676 (1%)	64
North Side Road (airport access)	14,557 (1%)	18,167 (1%)	20,525 (1%)	32

Validation of CadnaA model

7F.4.5 Validation of the CadnaA model for Bristol Airport has been carried out by comparison of predicted noise levels with the measured noise levels obtained at the road traffic noise monitoring locations.

7F.4.6 **Table 7F.5** shows a comparison between measured and the predicted $L_{A10,18h}$ noise levels at positions R1 to R4. The measured $L_{A10,5min}$ noise levels have been converted to $L_{A10,18h}$ using the method given in CRTN[3]. CadnaA has then been used to predict the noise levels at the measurement locations using the actual traffic counts taken during the measurements.

Table 7F.5 Comparison of measured and CadnaA road traffic noise levels

Location	Average measured $L_{A10,18h}$ (dB)	CadnaA Predicted $L_{A10,18h}$ (dB)	Difference between CadnaA model and measured noise levels, dB
R1	71	69	-2
R2	77	75	-2
R3	69	69	0
R4	75	72	-3

7F.4.7 An average difference of less than 2 dB between measured and predicted noise levels at the measurement positions indicates that the CadnaA model is sufficiently accurate.

Sensitive receptors

7F.4.8 Receptors for the road traffic assessment have been identified from details of the location and layout of buildings around Bristol Airport supplied by BAL. These are shown in **Figure 7F.2**.

7F.4.9 These receptors include those in the Noise Important Area[7] in Lulsgate Bottom, as defined by the Department for Environment, Food and Rural Affairs (Defra) as part of the Noise Action Planning process.

7F.5 Road traffic assessment results

General

7F.5.1 This section presents the results of the road traffic noise assessment undertaken using indicators described in **Section 7F.2**. Results are presented for each of the following scenarios:

- Baseline year (2017);
- 10 mppa (million passengers per annum) in 2021; and
- 12 mppa with implementation of the Proposed Development in 2026.

7F.5.2 Results are given in terms of road traffic noise contour figures, and the number of residential receptors within each contour. To assist in finding the relevant figure, a table is provided which sets out the figure reference for a given noise indicator and scenario.

7F.5.3 For all tables, receptor counts are rounded to the nearest 50 above 100 and to the nearest 10 below 100. Below 10, the actual number is given.

Road Traffic Noise Contours

7F.5.4 **Table 7F.6** denotes the relevant figure numbers for the relevant road traffic noise contours.

Table 7F.6 Road traffic noise contour figure references

Contour Type	**Scenario**		
	Baseline 2017	**10 mppa 2026**	**12 mppa 2026**
$L_{A10,18h}$	7F.3	7F.4	7F.5

7F.5.5 The number of residential receptors within each contour band for the three different scenarios is shown in **Table 0F.7.** The counts include all those dwellings or people within a specified contour band so, for example, 20 dwellings within a 55 dB contour includes those within the 68 and 75 dB bands as well.

[7] Noise Important Areas in England are available to view at http://www.extrium.co.uk/noiseviewer.html [Checked 28/11/2018]

Table 0F.7 Numbers of residential receptors, $L_{A10,18h}$

Contour $L_{A18,18h}$ dB(A)	Number of receptors		
	Baseline 2017	10 mppa 2026	12 mppa 2026
55 (LOAEL)	100	100	100
60	70	80	80
68 (SOAEL)	20	30	30
70	10	20	20
75 (UAEL)	2	4	4

7F.6 Assessment of road traffic effects

General

7F.6.1 To assess the effects of road traffic noise arising from the impacts that have been described in **Section 7F.5**, the assessment criteria set out in **Appendix 7B** have been applied. The effects arise because of both the absolute noise level experienced at a receptor as well as the change in noise level that occurs through the introduction of the Proposed Development.

7F.6.2 Consideration is given below to how the impacts resulting from a change in the road traffic noise conditions are likely to affect residential and non-residential receptors for the following scenarios:

- Baseline vs future scenarios (10 mppa in 2026 and 12 mppa in 2026); and
- Future 10 mppa in 2026 vs 12 mppa in 2026.

7F.6.3 The assessment compares road traffic noise effects for residential receptors for each of the comparisons above.

Baseline (2017) vs Future (10 mppa in 2026)

7F.6.4 **Figure 7F.3** and **Figure 7F.4** give the road traffic noise $L_{A10,18h}$ noise contours for the baseline 2017 and 10 mppa in 2026 scenarios respectively.

7F.6.5 The impact of road traffic noise on residential receptors assuming that the Proposed Development does not proceed and Bristol Airport continues to grow to its current permitted capacity of 10 mppa by 2026 will give rise to the effects given in **Table 7F.8**. Those receptors that do not experience any change in noise between two scenarios are given in this table in the “beneficial” receptor column.

Table 7F.8 Dwellings exposed to absolute noise and change in noise, 2017 to 10 mppa 2026

Subjective description of impact	Contour band dB $L_{A10,18h}$	Number of receptors in band, 10 mppa (2026)	Beneficial or adverse change	Change in Noise Level, dB Potential Impact Classification: Negligible 0.0 – 2.9 dB	Significant Minor 3.0 – 4.9 dB	Significant Moderate 5.0 – 9.9 dB	Significant Substantial >10.0 dB
Negligible	**55 (LOAEL)**	0	Beneficial	0	0	0	0
		40	Adverse	40	0	0	0
Minor	**60**	0	Beneficial	0	0	0	0
		50	Adverse	50	0	0	0
Significant Moderate	**68 (SOAEL)**	0	Beneficial	0	0	0	0
		20	Adverse	20	0	0	0
Significant Substantial	**70**	0	Beneficial	0	0	0	0
		10	Adverse	10	0	0	0
Significant Very Substantial	**75 (UAEL)**	0	Beneficial	0	0	0	0
		4	Adverse	4	0	0	0
Total		0	Beneficial	0	0	0	0
		100	Adverse	100	0	0	0

Baseline (2017) vs Future (12 mppa in 2026)

7F.6.6 **Figure 7F.3** and **Figure 7F.5** give the daytime ground noise $L_{A10,18h}$ noise contours for the baseline 2017 and the 12 mppa in 2026 scenarios respectively.

7F.6.7 The impact of road traffic noise on residential receptors assuming that the Proposed Development proceeds and Bristol Airport continues to grow to 12 mppa by 2026 will give rise to the effects given in **Table 7F.9**. Those receptors that do not experience any change in noise between two scenarios are given in this table in the "beneficial" receptor column.

Table 7F.9 Dwellings exposed to absolute noise and change in noise, 2017 to 12 mppa 2026

				Change in Noise Level, dB Potential Impact Classification			
Subjective description of impact	**Contour band dB $L_{A10,18h}$**	**Number of receptors in band, 12 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0.0 – 2.9 dB**	**Significant Minor 3.0 – 4.9 dB**	**Significant Moderate 5.0 – 9.9 dB**	**Significant Substantial >10.0 dB**
Negligible	**55 (LOAEL)**	0	Beneficial	0	0	0	0
		40	Adverse	40	0	0	0
Minor	**60**	0	Beneficial	0	0	0	0
		50	Adverse	50	0	0	0
Significant Moderate	**68 (SOAEL)**	0	Beneficial	0	0	0	0
		20	Adverse	20	0	0	0
Significant Substantial	**70**	0	Beneficial	0	0	0	0
		10	Adverse	10	0	0	0
Significant Very Substantial	**75 (UAEL)**	0	Beneficial	0	0	0	0
		4	Adverse	4	0	0	0
Total		0	Beneficial	0	0	0	0
		100	Adverse	100	0	0	0

Future (10 mppa in 2026) vs Future (12 mppa in 2026)

7F.6.8 **Figure 7F.4** and **Figure 7F.5** give the road traffic noise $L_{A10,18h}$ noise contours for the 10 mppa in 2026 and the 12 mppa in 2026 scenarios respectively.

7F.6.9 The impact of road traffic noise on residential receptors assuming that the Proposed Development proceeds and Bristol Airport continues to grow to 12 mppa by 2026 will give rise to the effects given in **Table 7E.10.** Those receptors that do not experience any change in noise between two scenarios are given in these tables in the “beneficial” receptor column.

Table 7E.10 Dwellings exposed to absolute noise and change in noise, 10 mppa 2026 to 12 mppa 2026

					Change in Noise Level, dB Potential Impact Classification		
Subjective description of impact	**Contour band dB $L_{A10,18h}$**	**Number of receptors in band, 12 mppa (2026)**	**Beneficial or adverse change**	**Negligible 0.0 – 2.9 dB**	**Significant Minor 3.0 – 4.9 dB**	**Significant Moderate 5.0 – 9.9 dB**	**Significant Substantial >10.0 dB**
Negligible	**55 (LOAEL)**	4	Beneficial	4	0	0	0
		40	Adverse	40	0	0	0
Minor	**60**	0	Beneficial	0	0	0	0
		50	Adverse	50	0	0	0
Significant Moderate	**68 (SOAEL)**	0	Beneficial	0	0	0	0
		10	Adverse	10	0	0	0
Significant Substantial	**70**	0	Beneficial	0	0	0	0
		20	Adverse	20	0	0	0
Significant Very Substantial	**75 (UAEL)**	0	Beneficial	0	0	0	0
		4	Adverse	4	0	0	0
Total		4	Beneficial	4	0	0	0
		100	Adverse	100	0	0	0

Car parking noise

7F.6.10 The existing multi storey car park (MSCP) was assessed prior to construction as part of the 10 mppa application[8]. This found that the noise levels at the nearest affected dwellings were between 41 and 43 dB $L_{Aeq,1h}$ during the peak hours. This is approximately equivalent to between 43 and 45 $L_{A10,18h}$, although this conservatively assumes that the peak hours are representative of the 18-hour assessment period.

7F.6.11 As part of the Proposed Development, an additional MSCP is planned. This is adjacent to the existing MSCP, and a similar distance from dwellings on Downside Road. Noise levels at dwellings would therefore be expected to be similar.

7F.6.12 The dwellings on Downside Road are exposed to levels in excess of 60 dB $L_{A10,18h}$ due to road traffic. The results presented in the 10 mppa application suggest that car parking noise levels are likely to be in the region of 45 dB $L_{A10,18h}$ and therefore not contribute significantly to the overall noise level.

[8] North Somerset Council (2011). Planning permission 09/P/1020/OT2, [Online]. Available at: https://planning.n-somerset.gov.uk/online-applications/ [Checked 6/09/2018].

7F.7 Road traffic noise mitigation

7F.7.1 The road traffic noise assessment has demonstrated that, both now and in the future, a small number of receptors around Bristol Airport will be exposed to significant levels of road traffic noise.

Bristol Airport – existing mitigation

7F.7.2 As part of the Bristol Airport Environmental Improvement Fund[9], grants are available from Bristol Airport to cover some or all of the costs of new double glazing and ventilators for properties exposed to air noise levels of 57 dB $L_{Aeq,16h}$ or above. Further details of this scheme are outlined in **Appendix 7D**. Although eligibility for these grants are not based on road traffic noise criteria, some of the dwellings currently exposed to significant levels of road traffic noise are eligible for grants, for example in Lulsgate Bottom.

7F.7.3 No specific mitigation is currently in place based on road traffic noise effects.

Bristol Airport – future mitigation

7F.7.4 Bristol Airport are proposing to enhance their existing noise insulation grants. Although eligibility for these grants are not based on road traffic noise criteria, some of the dwellings exposed to significant levels of road traffic noise are eligible for grants, for example in Lulsgate Bottom.

7F.7.5 No specific mitigation is proposed based on road traffic noise effects.

[9] Bristol Airport (2018). Airport Environmental Improvement Fund, Guidelines for applying for a grant for noise insulation, [Online]. Available at: https://www.bristolairport.co.uk/~/media/files/brs/about-us/community/guidelines-2018_final.ashx?la=en [Checked 5/10/2018].

Appendix 7G
Construction Noise and Vibration

7G.1 Introduction

7G.1.1 This appendix considers noise and vibration associated with the construction works of the Proposed Development.

7G.1.2 This appendix includes:

- The criteria used to assess construction noise and vibration;
- The methodology used to assess construction noise and vibration;
- The basis of the construction noise and vibration assessment;
- The results of the construction noise and vibration assessment;
- Assessment of the effects of construction noise and vibration; and
- Recommended mitigation measures, where appropriate, with respect to construction noise and vibration.

7G.1.3 The construction works that have been assessed make up the key elements of the infrastructure of the Proposed Development and are listed in **Table 7G.3** in **Section 7G.4**.

7G.1.4 Construction will take place at different times over a period of up to seven years. Some works will occur in isolation while others will occur in phases, some of which might overlap in time. This raises the possibility of a noise sensitive receptor being affected simultaneously by different types of operations at a given site. In addition, works at multiple sites might take place at the same time. To assess this risk, consideration has been given to the current programme of works provided by Bristol Airport Limited (BAL) and presented in **Chapter 2: Description of the Proposed Development**. Construction noise levels likely to arise at a series of representative noise sensitive receptors have been determined based on a single phase of works, for overlapping phases of works (where relevant) as well as in conjunction with any works packages programmed to occur at a similar time.

7G.2 Construction noise and vibration assessment criteria

7G.2.1 This section summarises the numerical assessment criteria used to assess construction noise and vibration. Details of the background, derivation and selection of construction noise and vibration assessment criteria are given in **Appendix 7B**.

Construction noise

7G.2.2 The criteria adopted to rate construction noise are summarised in **Table 7G.1**. These are noise levels that, if exceeded outside a noise sensitive receptor, indicate a potential adverse and significant adverse effect, derived from guidance given in BS 5228-1:2009+A1:2014. **Table 7G.1** also provides an indication of the Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL) values as referred to in the *Noise Policy Statement for*

England[1], as well as the Unacceptable Adverse Effect Level (UAEL) as referred to in the *Planning Practice Guidance*[2].

Table 7G.1 Construction noise assessment criteria – outdoor absolute level

Significance of impact	Daytime noise criteria, $L_{Aeq,12h}$ dB	Night-time noise criteria, $L_{Aeq,8h}$ dB	Effect level
Negligible	55	45	LOAEL
Minor	60	50	
Significant - Moderate	65	55	SOAEL
Significant - Substantial	75	65	
Significant – Very Substantial	85	75	UAEL

7G.2.3 In summary, the threshold for a potentially significant effect from construction noise adopted in this assessment is 65 dB $L_{Aeq,12h}$ for the daytime (07.00-19.00) and 55 dB $L_{Aeq,8h}$ for the night-time (23.00-07.00).

Construction vibration

7G.2.4 The absolute value vibration assessment criteria used are given in **Table 7G.2**. These relate to both human and building response, where human response criteria are more stringent.

[1] Defra (2010). Noise Policy Statement for England, [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf [Checked 31/10/2018].

[2] Department of Communities & Local Government (2014). Planning Practice Guidance 2014.

Table 7G.2 Construction vibration assessment criteria for human response and building damage

Significance of impact	Vibration criteria, PPV mms^{-1}	Effect
None	< 0.14	Vibration unlikely to be perceptible.
Negligible	0.14	*Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.*
Minor	0.3	*Vibration might be just perceptible in residential environments.*
Significant - Moderate	1.0	*It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.*
Significant - Substantial	7.5	Guide value for cosmetic damage of residential buildings where dynamic loading may lead to resonance.
Significant - Very Substantial	10.0	*Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.*

7G.2.5 On the basis of the above table, the threshold for a potentially significant effect from construction vibration adopted in this assessment is 1.0 mms^{-1} PPV during the daytime (07.00-23.00) and 0.3 mms^{-1} during the night-time.

7G.3 Construction noise and vibration assessment methodology

Construction noise

7G.3.1 Predictions of construction noise values have been made using the methods described in *BS 5228-1:2009+A1:2014*[3] (*BS 5228-1*). Assumptions used for these calculations are described in **Section 7G.4**.

7G.3.2 Noise has been predicted at representative noise sensitive receptors for each construction site of the Proposed Development and for each phase of construction activity. Where phases of construction activity at a site are expected to be concurrent, a worst-case value has been predicted alongside noise estimates for each phase. Worst-case values have also been predicted where work is provisionally scheduled to occur concurrently at different construction sites.

Construction vibration

7G.3.3 Construction sites where piling and vibratory compaction will take place have been identified. The vibration impact on the identified noise sensitive receptors has been considered with reference to guidance given in *BS 5228-2:2009+A1:2014*[4] (*BS5228-2*).

[3] British Standards Institution (2009). BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise. Available at: https://shop.bsigroup.com/ProductDetail?pid=000000000030258086 [checked 24 August 2018].

[4] British Standards Institution (2009). BS5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration. Available at: https://shop.bsigroup.com/ProductDetail/?pid=000000000030258089 [checked 28 September 2018].

7G.4 Construction noise and vibration assessment basis

7G.4.1 The Proposed Development includes a number of buildings, structures and surface works, which are summarised in **Table 7G.3**. Alongside this, the provisional dates at which the works are programmed to be undertaken are indicated. A plan of the Proposed Development can be seen in **Figure 2.3**.

7G.4.2 The construction programme for the Proposed Development assumes a six-day working week, with daytime construction confined to the hours of 07:30 to 18:00 Monday to Friday and Saturday 08:00 to 13:00. There is no planned working on Sundays or Bank Holidays.

7G.4.3 Work on the east taxiway link and taxiway widening and fillets is scheduled to occur between 23:00 and 06:00 over a 6-month period. This is the only night-time construction work scheduled.

7G.4.4 The above hours may be subject to seasonal variations and dictated by the construction activity being undertaken and prevailing weather conditions. For example, the typical working day in the summer months could be 07:00 to 19:00, while during the winter months this may shift to 08:00 to 16:00.

7G.4.5 A standard daytime assessment period of 12 hours, 07:00 to 19:00, has been used to encompass the scheduled works including any seasonal variations.

7G.4.6 For the night-time assessment, while BS 5228 provides guideline criteria based on an assessment over 8 hours, construction work has been assessed over a one hour period as this is more stringent than a standard 8 hour, 23:00 to 07:00, assessment. This is because all plant has been assumed to operate continuously over a one hour period whereas over a full night, this would not arise for every item of plant. As a worst-case, these resulting one hour noise values are assumed to occur over the 8 hour night although in practice, noise levels over a full night period at any given receptor will be lower than this.

Table 7G.3 Construction sites of the Proposed Development

Development	Access route	Provisional dates	Notes
New Arrivals Area with Vertical Circulation Cores	North Side Road	11/2019 – 04/2020	
South Terminal Extension	North Side Road	11/2019 – 04/2021	
West terminal extension (Phase 2A)	North Side Road	09/2020 – 06/2021	
West terminal extension (Phase 2B)	North Side Road	11/2024 – 03/2026	
New service yard	North Side Road	11/2025 – 03/2026	
Walkway to East Pier with Circulation Cores and One Pre-Board Zone	North Side Road	09/2025 – 06/2026	
East Pier with Vertical Circulation Cores and Five Pre-Board Zones	North Side Road	09/2025 – 06/2026	
New canopy to front of existing terminal	North Side Road	09/2022 – 05/2023	
Multi-storey car park (MSCP)	North Side Road	09/2024 – 07/2025	
Gyratory road with internal surface car parking	North Side Road	10/2020 – 05/2021	
Eastern taxiway link	North Side Road	01/2024 – 06/2024	Night-time
Extension to Silver Zone Car Park (Phase 2)	Silver Zone Parking	01/2020 – 04/2020	
Highway improvements (A38)	A38	10/2019 – 04/2020	
Taxiway widening and fillets	North Side Road	01/2024 – 06/2024	Night-time
Operational extension to the Silver Zone Car Park (Phase 1)	Silver Zone Parking	04/2019 – 06/2019	

Sensitive receptors

7G.4.7 Construction noise and vibration impacts likely to arise as a result of the Proposed Development have been assessed having regard to representative sensitive receptors in the vicinity of the proposed works. These eleven receptors, A to K, can be seen in **Figure 7.2** and are described in **Table 7G.4**.

7G.4.8 Baseline noise levels for receptors A to D, used in determining the noise assessment criteria, have been taken from the baseline measurements carried out at these locations, as described in **Appendix 7C**.

7G.4.9 Baseline noise levels for receptors E to K have been adopted from the baseline measurements based on closest proximity.

Table 7G.4 Construction noise and vibration sensitive receptors

Receptor	Location	Daytime baseline, $L_{Aeq,12h}$ dB (to nearest 5dB)	Night-time baseline, $L_{Aeq,8h}$ dB (to nearest 5dB)
A	Cooks Bridle Path, Downside	55 (A)	50 (A)
B	Downside Road (West), Lulsgate Bottom	60 (B)	55 (B)
C	School Lane, Lulsgate Bottom	60 (C)	55 (C)
D	Red Hill (A38) (North), Redhill	60 (D)	50 (D)
E	Winters Lane (South), Redhill	60 (D)	50 (D)
F	Downside Road (South), Downside	55 (A)	50 (A)
G	Downside Road (North), Downside	55 (A)	50 (A)
H	Downside Road (East), Lulsgate Bottom	60 (B)	55 (B)
I	Bridgwater Road (A38), Lulsgate Bottom	60 (C)	55 (C)
J	Red Hill (A38) (South), Redhill	60 (D)	50 (D)
K	Winters Lane (North), Redhill	60 (D)	50 (D)

Construction noise

7G.4.10 Construction activities at each construction site have been grouped into phases and construction plant for each site and phase have been assumed for a typical working day based on information provided by Bristol Airport Limited (BAL).

7G.4.11 The assumed construction plant for each construction site and phase are described in detail in **Table 7G.5** to **Table 7G.18**.

7G.4.12 Construction haulage traffic has been assumed to access sites via fixed haulage routes. These are North Side Road and Silver Zone Parking, for north side and south side sites respectively. It has been assumed that construction traffic will adhere to current traffic restrictions, such as the 20mph speed limit on North Side Road.

7G.4.13 The degree of disturbance to the local community due to noise produced by construction will be greatly dependent on location relative to the particular construction site. Construction noise levels will also vary considerably throughout the build depending on on-site plant activity and location.

7G.4.14 To obtain an indication of the typical long-term average noise level likely to arise at a given receptor, plant activities have been assumed to take place towards the centre of a given site. On site mobile plant has also been assumed to be quasi-stationary, primarily active at the centre of a given site. In practice noise levels at a given receptor could at times be both higher and lower than the values presented, due to the variability of how plant might be used throughout a working day. The assumptions adopted err on the conservative side as all plant items listed are assumed to be operating over the day, with many items operating at the same time. As a result, predictions represent noise levels likely to arise at the top end of the potential range.

7G.4.15 The predicted values represent outdoor free-field values. Calculations take no account of any screening, such as might be provided from solid timber site hoarding, nor do they take account of any special mitigation measures. Other factors such as meteorological conditions and atmospheric absorption can also influence the level of noise, however, these have not been considered in this assessment. This is due to the fact that at short distances, any effects arising from these factors will be small, while at long distances there will be a strong tendency towards an increase in sound attenuation.

7G.4.16 The runway construction works scheduled to be undertaken at night have been grouped into sequential phases of activity. It has been assumed that, in a particular hour, work will be focused on a particular location on site and only one of these phases may be progressed at a time. For each phase of activity it has also been assumed that all relevant plant will be active for the entire duration and the results should therefore be taken as a worst-case.

Table 7G.5 Assumed construction phases and plant –new arrivals area

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Substructure	Steel Pile Casing by Vibration	C.3.8	88	10
11/2019 – 12/2019	Gas Cutters for Pile Steel Casing	C.3.34	68	10
	Piling Rig-Rotary Bored	C.3.21	79	75
	Tracked Excavator	C.2.5	76	100
	Articulated Dump Truck (2 No.)	C.1.11	80	10
	Mobile Telescopic Crane	C.4.38	78	75
	Concrete Mixer Trucks	C.4.20	80	10
	Truck Mounted Concrete	C.3.25	78	75
	Poker Vibrators	C.4.33	78	50
	Air Compressors	C.5.5	65	50
	Hand-Held Pneumatic Breaker	C.1.6	83	10
	Mobile Generators	C.4.86	65	100
	Diesel Generator	C.4.76	61	100
	Lorry (2/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Envelope & Fit	Tracked Mobile Crane	C.3.28	67	75
12/2019 – 04/2020	Mobile Telescopic Crane	C.4.38	78	75
	Core Drill (Electric)	C.4.70	85	10
	Hand-Held Saw	C.4.71	85	10
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Lorry (2/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

wood.

Table 7G.6 Assumed construction phases and plant –south terminal extension

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Site Strip & Drainage	Tracked Excavator (2 No.)	C.2.5	76	100
12/2019 – 01/2020	Articulated Dump Truck	C.1.11	80	10
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Diesel Generator	C.4.76	61	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Piling	Steel Pile Casing by Vibration	C.3.8	88	10
01/2020 – 03/2020	Gas Cutters for Pile Steel Casing	C.3.34	68	10
	Piling Rig-Rotary Bored	C.3.21	79	75
	Tracked Excavator	C.2.5	76	100
	Articulated Dump Truck	C.1.11	80	10
	Hand-Held Pneumatic Breaker	C.1.6	83	10
	Disc Cutter	D.6.53	84	10
	Water Pump	C.2.45	65	100
	Mobile Generators	C.4.86	65	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
3. Sub- & Superstructure	Articulated Dump Truck	C.1.11	80	10
12/2019 – 11/2020	Tracked Mobile Crane	C.3.28	67	75
	Mobile Telescopic Crane	C.4.38	78	75
	Site Lift for Workers	C.4.62	66	50
	Concrete Placing Boom	C.3.7	65	75
	Concrete Mixer Trucks	C.4.20	80	10
	Truck Mounted Concrete	C.3.25	78	75
	Poker Vibrators	C.4.33	78	50
	Air Compressors	C.5.5	65	50
	Diesel Generator	C.4.76	61	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
4. Envelope & Fit	Tracked Mobile Crane	C.3.28	67	75
03/2020 – 03/2021	Mobile Telescopic Crane	C.4.38	78	75
	Site Lift for Workers	C.4.62	66	50

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
	Concrete Placing Boom	C.3.37	65	75
	Compactor Rammer	D.3.118	80	50
	Core Drill (Electric)	C.4.70	85	10
	Hand-Held Saw	C.4.71	85	10
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Diesel Generator	C.4.76	61	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

Table 7G.7 Assumed construction phases and plant –west terminal extension phase 2A

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Site Strip & Drainage	Tracked Excavator (2 No.)	C.2.5	76	100
09/2020 – 10/2020	Articulated Dump Truck	C.1.11	80	10
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Diesel Generator	C.4.76	61	100
	Lorry (2/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Piling	Steel Pile Casing by Vibration	C.3.8	88	10
09/2020 – 10/2020	Gas Cutters for Pile Steel Casing	C.3.34	68	10
	Piling Rig-Rotary Bored	C.3.21	79	75
	Tracked Excavator	C.2.5	76	100
	Articulated Dump Truck	C.1.11	80	10
	Hand-Held Pneumatic Breaker	C.1.6	83	10
	Disc Cutter	D.6.53	84	10
	Water Pump	C.2.45	65	100
	Mobile Generators	C.4.86	65	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
3. Sub- & Superstructure	Articulated Dump Truck	C.1.11	80	10
10/2020 – 03/2021	Tracked Mobile Crane	C.3.28	67	75
	Mobile Telescopic Crane	C.4.38	78	75
	Site Lift for Workers	C.4.62	66	50

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
	Concrete Placing Boom	C.3.7	65	75
	Concrete Mixer Trucks	C.4.20	80	10
	Truck Mounted Concrete	C.3.25	78	75
	Poker Vibrators	C.4.33	78	50
	Air Compressors	C.5.5	65	50
	Diesel Generator	C.4.76	61	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
4. Envelope & Fit	Tracked Mobile Crane	C.3.28	67	75
03/2021 – 06/2021	Mobile Telescopic Crane	C.4.38	78	75
	Site Lift for Workers	C.4.62	66	50
	Concrete Placing Boom	C.3.37	65	75
	Compactor Rammer	D.3.118	80	50
	Core Drill (Electric)	C.4.70	85	10
	Hand-Held Saw	C.4.71	85	10
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Diesel Generator	C.4.76	61	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

Table 7G.8 Assumed construction phases and plant –west terminal extension phase 2B

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Site Strip & Drainage	Tracked Excavator (2 No.)	C.2.5	76	100
11/2024 – 01/2025	Articulated Dump Truck	C.1.11	80	10
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Diesel Generator	C.4.76	61	100
	Lorry (6/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Piling	Steel Pile Casing by Vibration	C.3.8	88	10
12/2024 – 03/2025	Gas Cutters for Pile Steel Casing	C.3.34	68	10
	Piling Rig-Rotary Bored	C.3.21	79	75
	Tracked Excavator	C.2.5	76	100

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
	Articulated Dump Truck	C.1.11	80	10
	Hand-Held Pneumatic Breaker	C.1.6	83	10
	Disc Cutter	D.6.53	84	10
	Water Pump	C.2.45	65	100
	Mobile Generators	C.4.86	65	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
3. Sub- & Superstructure	Articulated Dump Truck	C.1.11	80	10
12/2024 – 11/2025	Tracked Mobile Crane	C.3.28	67	75
	Mobile Telescopic Crane	C.4.38	78	75
	Site Lift for Workers	C.4.62	66	50
	Concrete Placing Boom	C.3.7	65	75
	Concrete Mixer Trucks	C.4.20	80	10
	Truck Mounted Concrete	C.3.25	78	75
	Poker Vibrators	C.4.33	78	50
	Air Compressors	C.5.5	65	50
	Diesel Generator	C.4.76	61	100
	Lorry (2/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
4. Envelope & Fit	Tracked Mobile Crane	C.3.28	67	75
09/2025 – 03/2026	Mobile Telescopic Crane	C.4.38	78	75
	Site Lift for Workers	C.4.62	66	50
	Concrete Placing Boom	C.3.37	65	75
	Compactor Rammer	D.3.118	80	50
	Core Drill (Electric)	C.4.70	85	10
	Hand-Held Saw	C.4.71	85	10
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Diesel Generator	C.4.76	61	100
	Lorry (2/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

Table 7G.9 Assumed construction phases and plant –new service yard

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Site Strip & Drainage	Tracked Excavator (3 No.)	C.2.5	76	100
11/2025 – 01/2026	Articulated Dump Truck (4 No.)	C.1.11	80	10
	Dozer	C.5.13	82	100
	Tracked Mobile Crane	C.3.28	67	75
	Mobile Telescopic Crane	C.4.38	78	75
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Diesel Generator	C.4.76	61	100
	Lorry (2/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Service Yard Formation	Articulated Dump Truck	C.1.11	80	10
	Dozer	C.5.13	82	100
	Compactor Rammer	D.3.118	80	50
	Mobile Telescopic Crane	C.4.38	78	75
	Concrete Placing Boom	C.3.7	65	75
	Concrete Mixer Truck	C.4.20	80	10
	Truck Mounted Concrete	C.3.25	78	75
	Poker Vibrators	C.4.33	78	50
	Air Compressors	C.5.5	65	50
	Diesel Generator	C.4.76	61	100
	Lorry (2/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
Table 7G.10 Assumed construction phases and plant – walkway and east pierPhase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Site Strip & Drainage	Tracked Excavator (2 No.)	C.2.5	76	100
09/2025 – 10/2025	Articulated Dump Truck	C.1.11	80	10
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Diesel Generator	C.4.76	61	100
	Lorry (2/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Piling	Steel Pile Casing by Vibration	C.3.8	88	10
09/2025 – 10/2025	Gas Cutters for Pile Steel Casing	C.3.34	68	10
	Piling Rig-Rotary Bored	C.3.21	79	75
	Tracked Excavator	C.2.5	76	100

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
	Articulated Dump Truck	C.1.11	80	10
	Hand-Held Pneumatic Breaker	C.1.6	83	10
	Disc Cutter	D.6.53	84	10
	Water Pump	C.2.45	65	100
	Mobile Generators	C.4.86	65	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
3. Sub- & Superstructure	Articulated Dump Truck	C.1.11	80	10
10/2025 – 03/2026	Tracked Mobile Crane (2 No.)	C.3.28	67	75
	Mobile Telescopic Crane	C.4.38	78	75
	Site Lift for Workers	C.4.62	66	50
	Concrete Placing Boom	C.3.7	65	75
	Concrete Mixer Trucks	C.4.20	80	10
	Truck Mounted Concrete	C.3.25	78	75
	Poker Vibrators	C.4.33	78	50
	Air Compressors	C.5.5	65	50
	Diesel Generator	C.4.76	61	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
4. Envelope & Fit	Tracked Mobile Crane	C.3.28	67	75
03/2026 – 06/2026	Mobile Telescopic Crane	C.4.38	78	75
	Site Lift for Workers	C.4.62	66	50
	Concrete Placing Boom	C.3.37	65	75
	Compactor Rammer	D.3.118	80	50
	Core Drill (Electric)	C.4.70	85	10
	Hand-Held Saw	C.4.71	85	10
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Diesel Generator	C.4.76	61	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

Table 7G.11 Assumed construction phases and plant –new canopy to front of existing terminal

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Substructure	Steel Pile Casing by Vibration	C.3.8	88	10
09/2022 – 10/2022	Gas Cutters for Pile Steel Casing	C.3.34	68	10
	Piling Rig-Rotary Bored	C.3.21	79	75
	Tracked Excavator	C.2.5	76	100
	Articulated Dump Truck (2 No.)	C.1.11	80	10
	Mobile Telescopic Crane	C.4.38	78	75
	Concrete Mixer Trucks	C.4.20	80	10
	Truck Mounted Concrete	C.3.25	78	75
	Poker Vibrators	C.4.33	78	50
	Air Compressors	C.5.5	65	50
	Hand-Held Pneumatic Breaker	C.1.6	83	10
	Disc Cutter	D.6.53	84	10
	Water Pump	C.2.45	65	100
	Mobile Generators	C.4.86	65	100
	Diesel Generator	C.4.76	81	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Envelope & Fit	Tracked Mobile Crane	C.3.28	67	75
10/2022 – 05/2023	Mobile Telescopic Crane	C.4.38	78	75
	Concrete Placing Boom	C.3.37	65	75
	Site Lift for Workers	C.4.62	66	50
	Core Drill (Electric)	C.4.70	85	10
	Hand-Held Saw	C.4.71	85	10
	Angle Grinder (Grinding Steel)	C.4.93	80	10
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
3. External Works	Mobile Telescopic Crane	C.4.38	78	75
04/2023 – 05/2023	Compactor Rammer	D.3.118	80	100
	Diesel Generator	C.4.76	61	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

wood.

Table 7G.12 Assumed construction phases and plant –multi-storey car park

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Excavation	Tracked Excavator (2 No.)	C.2.5	76	100
09/2024 – 09/2024	Articulated Dump Truck (2 No.)	C.1.11	80	10
	Diesel Generator	C.4.76	81	100
	Lorry (3/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Sub- & Superstructure	Tracked Mobile Crane	C.3.28	67	75
09/2024 – 03/2025	Mobile Telescopic Crane	C.4.38	78	75
	Concrete Placing Boom	C.3.7	65	75
	Concrete Mixer Trucks	C.4.20	80	10
	Truck Mounted Concrete	C.3.25	78	75
	Articulated Dump Truck	C.1.11	80	10
	Dozer	C.5.13	82	100
	Poker Vibrators	C.4.33	78	50
	Air Compressors	C.5.5	65	50
	Disc Cutter	D.6.53	84	10
	Diesel Generator	C.4.76	81	100
	Lorry (3/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

Table 7G.13 Assumed construction phases and plant –gyratory road with internal surface parking

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Site Clearance	Tracked Excavator	C.5.18	80	100
10/2020 – 10/2020	Dump Truck	C.5.17	81	100
	Compressor	C.5.5	65	25
	Road Breaker (Hand-Held)	C.5.4	86	25
	Lorry (3/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Earthworks & Fill	Tracked Excavator (4 No.)	C.5.18	80	100
10/2020 – 11/2020	Dump Truck (4 No.)	C.5.17	81	100
	Vibratory Roller (2 No.)	C.5.20	75	100
	Dozer	C.5.13	82	100
	Lorry (3/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
3. Access Roads & Parking Bays	Tracked Excavator (2 No.)	C.5.18	80	100
12/2020 – 03/2021	Dump Truck (3 No.)	C.5.17	81	100
	Vibratory Roller (3 No.)	C.5.20	75	100
	Dozer (2 No.)	C.5.13	82	100
	Lorry (3/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
4. Paving	Asphalt Paver	C.5.31	77	100
01/2021 – 05/2021	Dump Truck (2 No.)	C.5.17	81	100
	Dozer (2 No.)	C.5.13	82	100
	Vibratory Roller (2 No.)	C.5.20	75	100
	Lorry (3/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

Table 7G.14 Assumed construction phases and plant –east taxiway link (night-time)

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Earthworks	Tracked Excavator (2 No.)	C.5.18	80	100
01/2024 – 03/2024	Articulated Dump Truck (2 No.)	C.5.17	81	100
	Vibratory Roller	C.5.20	75	100
	Dozer	C.5.13	82	100
	Lorry (6/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Drainage & Lights	Tracked Excavator	C.2.5	76	100
03/2024 – 05/2024	Articulated Dump Truck	C.1.11	80	100
	Compressor	C.5.5	65	100
	Road Breaker (Hand-Held)	C.5.4	86	100
	Angle Grinder (Grinding Steel)	C.4.93	80	100
	Diesel Generator	C.4.76	61	100
	Lorry (2/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
3. Taxiway Sub-Base	Wheeled Excavator	C.5.11	73	100
03/2024 – 03/2024	Dump Truck	C.5.17	81	100
	Vibratory Roller	C.5.20	75	100
	Dozer	C.5.13	82	100
	Diesel Generator	C.4.76	61	100
	Lorry (6/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
4. Taxiway Concrete	Articulated Dump Truck	C.1.11	80	100
04/2024 – 05/2024	Mobile Telescopic Crane	C.4.38	78	100
	Truck Mounted Concrete	C.3.25	78	100
	Poker Vibrators	C.4.33	78	100
	Air Compressors	C.5.5	65	100
	Diesel Generator	C.4.76	61	100
	Lorry (6/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
5. Taxiway Asphalt	Asphalt Paver	C.5.31	77	100
05/2024 – 06/2024	Vibratory Roller (2 No.)	C.5.20	75	100
	Lorry (4/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

wood.

Table 7G.15 Assumed construction phases and plant –extension to Silver Zone Parking (phase 2)

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Site Clearance & Earthworks	Tracked Excavator (4 No.)	C.5.18	80	100
04/2019 – 05/2019	Articulated Dump Truck (4 No.)	C.5.17	81	100
	Lorry (10/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Access Road Formation	Tracked Excavator (2 No.)	C.5.18	80	100
04/2019 – 05/2019	Articulated Dump Truck (4 No.)	C.5.17	81	100
	Vibratory Roller (4 No.)	C.5.20	75	100
	Dozer	C.5.13	82	100
	Lorry (5/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
3. Access Road Wearing Course	Asphalt Paver	C.5.31	77	100
07/2019 – 07/2019	Articulated Dump Truck (2 No.)	C.5.17	81	100
	Vibratory Roller (2 No.)	C.5.20	75	100
	Dozer (2 No.)	C.5.13	82	100
	Lorry (6/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
4. Car Parking Bays	Tracked Excavator (2 No.)	C.5.18	80	100
05/2019 – 07/2019	Articulated Dump Truck (4 No.)	C.5.17	81	100
	Vibratory Roller (4 No.)	C.5.20	75	100
	Compactor Rammer (4 No.)	D.3.118	80	50
	Dozer	C.5.13	82	100
	Mobile Telescopic Crane (3 No.)	C.4.38	78	75
	Lorry (10/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

Table 7G.16 Assumed construction phases and plant –highway improvements (A38)

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Site Set Up	Wheeled Excavator	C.5.11	73	50
10/2019 – 11/2019	Articulated Dump Truck	C.5.17	81	100
	Compressor	C.5.5	65	25
	Disc Cutter	D.6.53	84	10
	Road Breaker (Hand-Held)	C.5.4	86	25
	Diesel Generator	C.4.76	81	100
	Lorry (3/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Widening Works	Wheeled Excavator	C.5.11	73	50
11/2019 – 03/2020	Articulated Dump Truck	C.5.17	81	100
	Compressor	C.5.5	65	25
	Compactor Rammer	D.3.118	80	25
	Vibratory Roller	C.5.20	75	100
	Asphalt Paver	C.5.31	77	100
	Disc Cutter (2 No.)	D.6.53	84	10
	Road Breaker (Hand-Held)	C.5.4	86	25
	Diesel Generator	C.4.76	81	100
	Lorry (3/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
3. Install Splitter Islands	Wheeled Excavator	C.5.11	73	50
11/2019 – 03/2020	Articulated Dump Truck	C.5.17	81	100
	Vibratory Roller	C.5.20	75	100
	Compactor Rammer	D.3.118	80	25
	Disc Cutter	D.6.53	84	10
	Diesel Generator	C.4.76	61	100
	Lorry (3/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
4. Final Surfacing	Asphalt Paver	C.5.31	77	100
03/2025 – 04/2025	Vibratory Roller (2 No.)	C.5.20	75	100
	Lorry (4/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

Table 7G.17 Assumed construction phases and plant –taxiway widening and fillets (night-time)

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Earthworks	Tracked Excavator (2 No.)	C.5.18	80	100
01/2024 – 03/2024	Articulated Dump Truck (2 No.)	C.5.17	81	100
	Vibratory Roller	C.5.20	75	100
	Dozer	C.5.13	82	100
	Lorry (13/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Drainage & Lights	Tracked Excavator	C.2.5	76	100
01/2024 – 04/2024	Articulated Dump Truck	C.1.11	80	100
	Compressor	C.5.5	65	100
	Angle Grinder (Grinding Steel)	C.4.93	80	100
	Road Breaker (Hand-Held)	C.5.4	86	100
	Diesel Generator	C.4.76	61	100
	Lorry (2/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
3. Taxiway Sub-Base	Wheeled Excavator	C.5.11	73	100
03/2024 – 03/2024	Dump Truck	C.5.17	81	100
	Vibratory Roller	C.5.20	75	100
	Dozer	C.5.13	82	100
	Diesel Generator	C.4.76	61	100
	Lorry (12/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
4. Taxiway Concrete	Articulated Dump Truck	C.1.11	80	100
04/2024 – 05/2024	Mobile Telescopic Crane	C.4.38	78	100
	Truck Mounted Concrete	C.3.25	78	100
	Poker Vibrators	C.4.33	78	100
	Air Compressors	C.5.5	65	100
	Diesel Generator	C.4.76	61	100
	Lorry (12/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
5. Taxiway Asphalt	Asphalt Paver	C.5.31	77	100
05/2024 – 06/2024	Vibratory Roller (2 No.)	C.5.20	75	100
	Lorry (4/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

Table 7G.18 Assumed construction phases and plant –extension to Silver Zone Parking (phase 1)

Phase	Plant	*BS 5228-1* ref.	$L_{Aeq,T}$ dB at 10m	%-On Time
1. Earthworks	Dozer (3 No.)	C.5.13	82	100
10/2019 – 11/2019	Mobile Telescopic Crane	C.4.38	78	75
	Articulated Dump Truck	C.5.17	81	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100
2. Make Good to Existing Surface	Dozer	C.5.13	82	100
11/2019 – 11/2019	Articulated Dump Truck	C.5.17	81	100
	Vibratory Roller	C.5.20	75	100
	Lorry (1/hour at up to 30 km/h)	C.2.34	108 L_{WA}	100

Construction vibration

7G.4.17 Vibration levels resulting from typical piling methods at various distances are given in **Table 7G.19** and have been reproduced from *BS 5228-2*. The exact level of vibration resulting from piling activities will depend on a number of factors such as soil conditions; however, the resultant vibration would usually be expected to attenuate with distance.

Table 7G.19 Typical piling vibration levels

Piling method	*BS 5228-2* ref.	Distance from piling rig (m)	PPV (mms^{-1})
Pressed-in steel sheet piles	C.1.1	4.8	2.5 – 4.3
	C.1.1	24	< 0.5
	C.1.2	7.1	0.3 – 0.7
Driven steel tubular piles	C.1.3	5	12.32 – 13.91
	C.1.3	10	8.45 – 8.76
	C.1.3	20	4.32 – 5.4
Driven precast concrete square piles	C.1.4	5	10.16 – 11.4
	C.1.4	10	6.41
	C.1.4	20	4.32 – 5.6

7G.4.18 Piling is expected to occur during the daytime construction works on the new arrivals area, south terminal extension, west terminal extension phases 2A and 2B, walkway and east pier and the new canopy to front of existing terminal.. The closest receptor to piling activity is receptor H (Downside Road (East), Lulsgate Bottom) at a distance of 170m from the walkway and east pier site.

7G.4.19 Vibration resulting from vibratory compaction has been estimated using empirical formulae given in *BS5228-2*, where use of a typical 98kW single drum vibratory roller with drum length 1.7m and displacement amplitude 0.7mm has been assumed.

7G.4.20 Vibratory compaction is expected to occur during the daytime construction works on the gyratory road, surface parking on cogloop 2 land, A38 roadworks and extension to Silver Zone Parking phase 1. The closest receptor to this activity is receptor I (Bridgwater Road (A38), Lulsgate Bottom) during the A38 roadworks where the minimum distance to the road is approximately 20m.

7G.4.21 Vibratory compaction will take place primarily during the daytime hours. Some vibratory compaction will, however, take place during the construction of the east taxiway link and the taxiway widening and fillets. The closest receptors to these works are C (School Lane, Lulsgate Bottom) and H (Downside Road (East), Lulsgate Bottom), both at a distance of approximately 400m.

7G.5 Construction noise and vibration assessment results

Construction noise - daytime

7G.5.1 The predicted daytime construction noise levels for each site and phase are provided in **Table 7G.20** to **Table 7G.31**.

Table 7G.20 Predicted construction noise –new arrivals area

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Substructure 11/2019 – 12/2019	41	46	42	36	36	44	46	44	41	34	36
2. Envelope & Fit 12/2019 – 04/2020	37	42	38	32	32	40	41	40	37	30	32

Table 7G.21 Predicted construction noise –south terminal extension

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Site Strip & Drainage 12/2019 – 01/2020	36	42	37	32	31	39	41	41	37	30	32
2. Piling 01/2020 – 03/2020	38	45	40	34	33	42	44	43	39	32	34
3. Sub- & Superstructure 12/2019 – 11/2020	37	44	39	33	32	41	43	42	38	31	33
4. Envelope & Fit 03/2020 – 03/2021	38	44	39	33	33	41	43	43	38	31	33

Table 7G.22 Predicted construction noise –west terminal extension phase 2A

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Site Strip & Drainage 09/2020 – 10/2020	38	42	38	33	33	43	43	41	37	32	34
2. Piling 09/2020 – 10/2020	40	43	38	34	34	46	46	41	38	32	34
3. Sub- & Superstructure 10/2020 – 03/2021	39	42	37	33	33	44	44	40	37	31	33
4. Envelope & Fit 03/2021 – 06/2021	39	42	38	33	33	45	45	41	37	31	34

Table 7G.23 Predicted construction noise –west terminal extension phase 2B

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Site Strip & Drainage 11/2024 – 01/2025	40	45	41	37	37	44	45	44	41	36	37
2. Piling 12/2024 – 03/2025	40	43	38	34	34	46	46	41	38	32	34
3. Sub- & Superstructure 12/2024 – 11/2025	39	43	39	34	34	44	45	41	38	33	34
4. Envelope & Fit 09/2025 – 03/2026	40	43	39	34	34	45	45	42	39	33	35

Table 7G.24 Predicted construction noise –new service yard

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Site Strip & Drainage 11/2025 – 01/2026	43	45	41	36	36	48	48	44	40	34	37
2. Service Yard Formation 01/2026 – 03/2026	42	45	41	36	36	48	48	44	40	34	37

Table 7G.25 Predicted construction noise –walkway and east pier

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Site Strip & Drainage 09/2025 – 10/2025	34	50	45	33	32	36	38	52	43	32	32
2. Piling 09/2025 – 10/2025	35	53	47	33	32	38	40	55	45	31	32
3. Sub- & Superstructure 10/2025 – 03/2026	34	52	46	32	31	36	38	53	44	30	31
4. Envelope & Fit 03/2026 – 06/2026	34	52	46	32	31	37	39	54	44	31	32

Table 7G.26 Predicted construction noise –new canopy to front of existing terminal

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Substructure 09/2022 – 10/2022	41	49	43	36	36	47	49	47	42	34	36
2. Envelope & Fit 10/2022 – 05/2023	36	43	38	32	32	41	44	42	37	30	32
3. External Works 04/2023 – 05/2023	37	44	38	32	32	42	44	42	38	31	32

Table 7G.27 Predicted construction noise –multi-storey car park

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Excavation 09/2024 – 09/2024	42	44	40	35	35	51	56	43	40	34	36
2. Sub- & Superstructure 09/2024 – 03/2025	44	46	41	36	37	54	59	44	41	35	38

Table 7G.28 Predicted construction noise –gyratory road with internal surface parking

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Site Clearance 10/2020 – 10/2020	38	58	49	36	35	40	43	58	47	34	35
2. Earthworks & Fill 10/2020 – 11/2020	41	63	54	39	38	45	47	63	52	37	38
3. Access Roads & Parking Bays 12/2020 – 03/2021	41	63	53	39	38	44	47	63	51	37	38
4. Paving 01/2021 – 05/2021	40	61	52	37	37	43	45	61	50	36	37

Table 7G.29 Predicted construction noise –extension to Silver Zone Parking (phase 2)

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Site Clearance & Earthworks 04/2019 – 05/2019	45	42	41	48	53	43	42	42	41	46	51
2. Access Road Formation 04/2019 – 05/2019	45	40	40	48	53	42	41	40	39	45	51
3. Access Road Wearing Course 07/2019 – 07/2019	43	40	39	47	51	42	40	40	39	44	50
4. Car Parking Bays 05/2019 – 07/2019	46	42	42	49	54	44	43	42	41	47	53

Table 7G.30 Predicted construction noise –highway improvements (A38)

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Site Set Up 10/2019 – 11/2019	36	50	63	35	34	38	40	54	70	34	34
2. Widening Works 11/2019 – 03/2020	37	51	64	36	35	39	41	55	72	34	35
3. Install Splitter Islands 11/2019 – 03/2020	35	48	61	34	33	37	38	52	68	33	33
4. Final Surfacing 03/2020 – 04/2020	35	46	58	34	34	37	38	50	65	33	34

Table 7G.31 Predicted construction noise –extension to Silver Zone Parking (phase 1)

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Earthworks 10/2019 – 11/2019	44	47	42	37	38	50	50	45	42	35	38
2. Make Good to Existing Surface 11/2019 – 11/2019	42	44	39	35	35	47	47	43	39	33	35

Construction noise – night-time

7G.5.2 The predicted night-time construction noise levels for each site and phase are provided in **Table 7G.32** to **Table 7G.33**.

Table 7G.32 Predicted construction noise – east taxiway link

Phase	$L_{Aeq,8h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Earthworks 01/2024 – 03/2024	40	50	51	40	38	42	43	52	48	38	38
2. Drainage & Lights 03/2024 – 05/2024	38	49	50	38	36	40	42	51	47	36	36
3. Taxiway Sub-Base 03/2024 – 03/2024	39	48	49	38	37	40	41	50	47	37	37
4. Taxiway Concrete 04/2024 – 05/2024	39	48	49	38	37	40	41	50	46	37	37
5. Taxiway Asphalt 05/2024 – 06/2024	36	45	45	36	35	38	39	47	43	34	35

Table 7G.33 Predicted construction noise – taxiway widening and fillets

Phase	$L_{Aeq,8h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
1. Earthworks 01/2024 – 03/2024	46	49	46	42	42	48	48	48	45	40	42
2. Drainage & Lights 01/2024 – 04/2024	44	46	42	39	39	47	46	45	42	37	40
3. Taxiway Sub-Base 03/2024 – 03/2024	44	48	45	41	41	46	46	47	44	39	41
4. Taxiway Concrete 04/2024 – 05/2024	44	48	45	41	40	46	46	47	44	39	41
5. Taxiway Asphalt 05/2024 – 06/2024	39	43	40	36	36	41	42	42	40	35	36

Construction vibration

7G.5.3 With reference to **Table 7G.19**, a worst-case of piling vibration would be 4.32 – 5.6mms^{-1} PPV at 20m, with driven precast concrete square piles. At 5m this would be 10.16 – 11.4mms^{-1} PPV which, when compared with the level at 20m, indicates the significant attenuation with distance expected. At a distance of 170m, where the closest receptor is located, the vibration would be expected to attenuate to levels well below 1mms^{-1} PPV.

7G.5.4 In practice, piling is planned to involve use of a rotary bored piling rig along with the insertion of steel casings using a vibratory technique. These methods produce less vibration than that arising from driven piles which have been assessed above.

7G.5.5 For daytime vibratory compaction, using the assumptions outlined in **Section 7G.4** at a distance of 20m, the closest distance between site and receptor for this activity (receptor I during the A38 works), a vibration level of 0.4mms^{-1} PPV would be expected with 50% probability of this value being exceeded. This is equivalent to a vibration level of 0.8mms^{-1} PPV with 33% chance of exceedance or 1.6mms^{-1} PPV with 5% chance of exceedance.

7G.5.6 For vibratory compaction during the night-time runway works, the closest receptors are approximately 400m away (receptors C and H on School Lane and Downside Road respectively). At this distance a vibration level of 0.02mms^{-1} PPV would be expected with 5% probability of exceedance.

7G.6 Assessment of construction noise and vibration effects

Construction noise - daytime

7G.6.1 On an individual site and phase basis, no significant effects from daytime construction noise, are expected, with one exception.

7G.6.2 Noise sensitive receptors adjacent to the A38 are predicted to be exposed to construction noise levels above the adopted daytime SOAEL and threshold for a potentially significant effect from the A38 highway improvements due to their close proximity to the site. The predictions indicate that this threshold is likely to be exceeded for all phases of work associated with this works package during the six-month programme at this site, with daytime noise levels lying in the range 68 to 72 dB $L_{Aeq,12h}$. As a result, a significant effect is predicted in the absence of any mitigation.

7G.6.3 Certain phases of daytime construction activity are scheduled to occur concurrently at the sites of the Proposed Development. For these cases a worst-case value has been predicted for each site, assuming all construction activities for concurrent phases are to be carried out simultaneously. These are presented in **Table 7G.34**.

Table 7G.34 Worst case construction noise scenarios, individual construction sites, daytime

Site, concurrent phases and month of schedule overlap	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
New arrivals area Phases 1. & 2. 12/2019	42	48	43	38	37	46	47	46	43	36	38
South terminal extension Phases 2. & 3. & 4. 03/2020	43	49	44	38	38	46	48	48	43	36	38

Site, concurrent phases and month of schedule overlap	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
West terminal extension phase 2A **Phases 1. & 2. & 3.** **10/2020**	44	47	43	38	38	49	50	46	42	36	39
West terminal extension phase 2B **Phases 1. & 2. & 3.** **12/2024 – 01/2025**	45	48	45	40	40	50	50	47	44	39	40
New service yard **Phases 1. & 2.** **01/2026**	45	48	44	39	39	51	51	47	43	37	40
Walkway and east pier **Phases 1. & 2. & 3.** **10/2025**	39	57	51	37	37	42	44	58	49	36	37
New canopy to front of existing terminal **Phases 1. & 2.** **10/2022**	43	50	44	37	37	48	50	48	43	36	38
Multi-storey car park **Phases 1. & 2.** **09/2024**	46	48	44	39	39	56	61	47	44	38	40
Gyratory road with internal surface parking **Phases 3. & 4.** **01/2021 – 03/2021**	43	65	55	41	40	47	49	65	54	39	41
Extension to Silver Zone Parking (phase 2) **Phases 1. & 2. & 4.** **05/2019**	50	46	46	53	58	48	47	46	45	51	57
Highway improvements (A38) **Phases 1. & 2. & 3.** **11/2019**	41	55	68	40	39	43	45	59	75	38	39
Extension to Silver Zone Parking (phase 1) **Phases 1. & 2.** **11/2019**	46	49	44	39	40	52	52	47	44	37	40

7G.6.4 On this worst-case basis, residential receptors at the east end of Downside Road are predicted to experience construction noise levels at the daytime threshold level of 65dB from the construction works on the gyratory road (construction site O). A potentially significant effect is therefore predicted from concurrent activity on the gyratory road.

7G.6.5 For the case of the A38 highway improvements, residential receptors in the vicinity of the A38 are expected to be exposed to construction noise levels greater than 65dB. A predicted significant effect is therefore indicated. Receptors immediately adjacent to the roadworks are predicted to experience construction noise levels of up to 75dB and a substantial significant effect is indicated from concurrent activity on the A38 roadworks.

7G.6.6 Consideration has also been given to the cumulative effects of daytime noise from multiple construction sites where the schedule of works is expected to overlap. Worst-case values have been predicted for these periods, where all construction activities for concurrent phases have been assumed to be carried out simultaneously in a given month. These are presented in **Table 7G.35**.

7G.6.7 With reference to the criteria given in **Table 7G.1**, no significant effects are predicted due to cumulative noise from multiple construction sites, aside from at those receptors already identified to be close to the A38 roadworks and those close to the new gyratory roadworks. The level of noise at these significantly affected receptors in this instance does not differ materially from the worst case scenarios presented in **Table 7G.34** when the roadworks are considered in isolation. The roadworks are the dominant factor.

Table 7G.35 Worst case construction noise scenarios, concurrent construction sites, daytime

Sites, concurrent phases and month of schedule overlap	$L_{Aeq,12h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
New arrivals area Phase 1. Highway Improvements (A38) Phases 1. & 2. & 3. Extension to Silver Zone Parking (Phase 1) Phases 1. & 2. 11/2019	48	56	68	43	43	53	54	59	75	42	44
South terminal extension Phases 4. West terminal extension phase 2A Phases 3. & 4. Gyratory road with internal surface parking Phases 3. & 4. 03/2021	46	65	56	43	42	51	52	65	54	41	43
West terminal extension phase 2B Phases 1. & 2. & 3. Multi-storey car park Phase 2. 12/2024 – 01/2025	47	50	46	42	42	55	59	49	46	40	42
West terminal extension phase 2B Phases 3. & 4. Walkway and east pier Phase 1. & 2. & 3. 10/2025	44	57	51	40	40	49	49	59	50	39	40

Construction noise – night-time

7G.6.8 On an individual site and phase basis, no significant effects from night-time construction noise are expected.

7G.6.9 Due to the sequential phasing of activity of the runway construction works, no concurrent activity at individual sites is expected during the night. However, work on the east taxiway link and taxiway widening and fillets sites is provisionally scheduled to be concurrent. In this scenario, if the noisiest phase of activity (earthworks) is assumed to take place at both sites simultaneously in a given hour then construction levels will remain below the threshold above which any potential significant effects could arise. This is shown in **Table 7G.36**.

Table 7G.36 Worst case construction noise scenarios, concurrent construction sites, night-time

Sites, concurrent phases and month of schedule overlap	$L_{Aeq,1h}$ dB at noise sensitive receptor										
	A	B	C	D	E	F	G	H	I	J	K
East taxiway link Phase 1. Taxiway widening and fillets Phase 1. 03/2024	47	53	52	44	43	49	49	53	50	42	44

Construction vibration

7G.6.10 As stated in paragraph 7G.5.3, vibration from piling would be expected to attenuate below the criteria for a potential significant effect over the distances to the nearest receptors and therefore no significant effects are predicted from piling vibration.

7G.6.11 Based on the results for vibratory compaction during the daytime, vibration is most likely to remain below the limit for a possible significant effect to be indicated (1mms^{-1} PPV), although there is a slim chance of levels rising to a potential moderate significant effect but remaining below a potential substantial significant effect. Considering the low probability and context that only a few residential receptors could be affected for a short duration and assuming that Best Practicable Means, including forewarning the few receptors that could be affected, are followed it is not expected that a significant effect would occur due to vibratory compaction during the A38 works.

7G.6.12 Vibratory compaction during the night-time, during the east taxiway works and taxiway widening and fillets works, will take place at large distances from the nearest noise sensitive residential receptors. As a result, vibration levels at these receptors are predicted to lie well below the threshold at which any potential significant effects might be expected.

7G.7 Construction noise and vibration mitigation

7G.7.1 The assessment of construction noise effects has shown that daytime construction works in the north-east area of Bristol Airport, specifically the roadworks required for the new gyratory road with internal surface parking may have a significant effect on residential properties located at the east end of Downside Road.

7G.7.2 *BS5228-1* suggests that site hoardings may provide a noise reduction from 5 dB, when plant is just visible over the noise barrier, to 10 dB, when the plant is not visible over the noise barrier. On the assumption that a conventional solid timber site hoarding is installed along the northern edge of the gyratory road site, near Downside Road, with a minimum height of 2.4m, then noise at the most affected receptors is predicted to be mitigated to below the threshold for a potentially significant effect to be indicated. This is shown in **Table 7G.37**.

Table 7G.37 Predicted construction noise with screening – gyratory road with internal surface parking

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor	
	B	**H**
Gyratory Road – Single Phasing		
1. Site Clearance **10/2020 – 10/2020**	50	50
2. Earthworks & Fill **10/2020 – 11/2020**	56	56
3. Access Roads & Parking Bays **12/2020 – 03/2021**	55	55
4. Paving **01/2021 – 05/2021**	53	54
Gyratory Road – Multiple Phasing		
Phases 3. & 4. **01/2021 – 03/2021**	57	57
Gyratory Road – Cumulative Sites		
South terminal extension **Phases 4.** **West terminal extension phase 2A** **Phases 3. & 4.** **Gyratory road with internal surface parking** **Phases 3. & 4.** **03/2021**	58	58

7G.7.3 Further roadworks constituting the A38 highway improvements also pose a risk to the amenity of residential properties situated close to the road, with noise levels predicted to reach up to 75 dB in the worst-case, where there is concentrated activity on site.

7G.7.4 Using the same assumptions for screening as for the gyratory road, temporary barriers surrounding stationary plant such as hand-held road breakers would be predicted to mitigate noise at receptors situated slightly away from the A38to below the threshold for a significant effect. However, further mitigation would be required for those residences directly adjacent to the road due to their close proximity to the works. Additional temporary solid road-side site hoardings to screen these receptors would be predicted to mitigate noise levels below the threshold for a potentially significant effect for these receptors as well. This is shown in **Table 7G.38**.

Table 7G.38 Predicted construction noise with screening – highway improvements (A38)

Phase	$L_{Aeq,12h}$ dB at noise sensitive receptor	
	C	I
Highway improvements (A38) – Single Phasing		
1. Site Set Up 10/2019 – 11/2019	57	60
2. Widening Works 11/2019 – 03/2020	59	61
3. Install Splitter Islands 11/2019 – 03/2020	58	57
4. Final Surfacing 03/2020 – 04/2020	56	54
Highway improvements (A38) – Multiple Phasing		
Phases 1. & 2. & 3. 11/2019	63	63
Highway improvements (A38) – Cumulative Sites		
New arrivals area Phase 1. Highway Improvements (A38) Phases 1. & 2. & 3. Extension to Silver Zone Parking (Phase 1) Phases 1. & 2. 11/2019	63	64

7G.7.5 No significant effects are expected to arise from construction vibration and no vibration mitigation will be required.

7G.7.6 At some sites, construction activities will temporarily have the potential to cause adverse effects on residents. Best Practicable Means (as defined under Section 72 of the *1974 Control of Pollution Act*[5]) will be deployed by the contractor to achieve compliance set out within relevant legislation and standards.

7G.7.7 Measures to be considered in implementing Best Practicable Means, adopted as part of the Construction Environmental Management Plan (CEMP) in **Appendix 2B.** will be consistent with the recommendations in *BS5228-1*, including:

- Project supervision – The Proposed Development will include the designation of a Project Environmental Manager to supervise the implementation of the works;
- Community Relations – keeping local people informed of progress and treating complaints fairly and expediently;

[5] Control of Pollution Act (1974), c.40. [Online]. Available at: http://www.legislation.gov.uk/ukpga/1974/40/pdfs/ukpga_19740040_en.pdf [Checked 21/08/2018].

- Site Personnel Training – informing site personnel about the need to minimise noise and advising on the proper use and maintenance of tools and equipment and the positioning of machinery to reduce noise emission to the neighbourhood;
- Site Location – setting noise emission limits with due regard to the proximity of noise sensitive premises;
- Noise Monitoring – to ensure compliance with noise emission limits applicable to relevant items of plant or around the boundary of a site;
- Programme - Details of operations with an indication of the expected duration of each phase and key dates. Local residents may be willing to accept higher levels of noise if they know that the activity causing the noise will only last for a short time; and
- Type of Plant – consideration will be given to using quiet techniques taking account of practical site constraints and best practicable means. Where reasonably practicable, quiet working methods will be employed, including use of the most suitable plant, reasonable hours of working for noisy operations, and economy and speed of operations.

7G.7.8 Many of the work sites relating to the Proposed Development are located at a reasonable distance from the nearest residential receptor and the effects of construction noise and vibration will therefore be negligible. For some sites however, such as for the highway improvements to the A38, works will take place at times very close to dwellings. In such cases, it will be particularly important to establish a procedure by which consultation between the contractor and local residents can take place regularly, to keep them informed of progress and steps being taken to protect them from any significant effects of noise and vibration.