Assessment of the Noise Impact of a Reduction in Air Departure Tax in Scotland

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CONTENTS

ACRONYMS

Acronym	Meaning
ADT	Air Departure Tax
ANCON	Aircraft Noise Contour
APD	Air Passenger Duty
APF	Aviation Policy Framework
ATM	Air Traffic Movement
CAA	Civil Aviation Authority
ECAC	European Civil Aviation Conference
END	Environmental Noise Directive
GIS	Geographic Information System
ICAO	International Civil Aviation Organization
INM	Integrated Noise Model
LDP	Local Development Plan
PAX	Passenger Movements
SID	Standard Instrument Departure

1. EXECUTIVE SUMMARY

1.1.1. This report presents the findings of an assessment of the potential impact on noise levels of the Scottish Government's plans to reduce the overall burden of Air Departure Tax (ADT) by 50%.

1.1.2. The assessment covers the five largest airports in Scotland (in terms of passenger numbers)[1] and considered six[2] alternative scenarios for a reduction in ADT. The hypothetical scenarios differ in terms of the bands (based on distance to destination with Band A representing short haul flights (from 0 to 2,000 miles) and Band B representing long haul (over 2,000 miles))[3] to which the tax reductions are applied. The extent to which the reduced taxes will be passed on to passengers by airlines in the form of lower air fares are reflected by what the report refers to as "Full Pass Through" or "Zero Pass Through" scenarios.

1.1.3. The six scenarios (not including the baseline scenario of 'Do nothing'/existing tax levels option) considered in the assessment are as follows:

- Scenario 1a – 100% cut in Band A (Full Pass Through);
- Scenario 1c – 100% cut in Band A (Zero Pass Through);
- Scenario 2a – 100% cut in Band B (Full Pass Through);
- Scenario 2c – 100% cut in Band B (Zero Pass Through);
- Scenario 3a – 50% cut in Band A & Band B (Full Pass Through); and
- Scenario 3c – 50% cut in Band A & Band B (Zero Pass Through).

1.1.4. Departures from the Highlands and Islands are currently exempt from UK Air Passenger Duty (APD). The potential noise impact at Inverness Airport was excluded from the assessment on the working assumption that this exemption will continue when APD is replaced by ADT in Scotland and so Inverness is included in the baselines for 2018 and 2022 but not in the forecasts.

1.1.5. The likely changes to air traffic movements at the remaining four airports were estimated for each ADT scenario for the year 2022. These were then used to forecast the changes in the aircraft noise levels in the vicinity of each of the airports and compared to a 'no-change' scenario in which no changes were

[1] The five included airports are Aberdeen, Edinburgh, Glasgow, Prestwick and Inverness.
[2] These six scenarios are consistent with the Scottish Government's **Air Departure Tax in Scotland: An Economic Assessment** publication http://www.gov.scot/Publications/2017/12/2270. Three additional scenarios; 1b, 2b, 3b (Partial Pass Through) were included in that work which have not been modelled here. We have sought to identify the range of potential noise impacts and noise impacts from those scenarios would likely fall within that range.
[3] https://www.gov.uk/government/publications/rates-and-allowances-excise-duty-air-passenger-duty

made to ADT and increases in passengers occur only from underlying market growth rather than tax reductions.

1.1.6. The predicted aircraft noise levels were then combined with population projections within the vicinity of the airports to estimate the likely change in the numbers of people exposed to different levels of aircraft noise.

Noise level changes

1.1.7. The changes in aircraft noise levels in the vicinity of the airports are best demonstrated by noise contours. These are a series of lines which link geographical points experiencing equal noise similar to the way in which relief contours link areas of equal elevation on a topographic map. Each noise contour joins areas within which noise levels are above a specified value and areas between two contour lines represent defined intervals, e.g. 45 dB[4] to 47.9 dB, 48 dB to 51.9 dB, etc. The larger the area enclosed by the contours, the wider the spread (and typically higher the number) of properties and people likely to be affected by noise.

1.1.8. Based on the total area covered by the contours, the scenarios resulting in the largest noise impacts have been identified to be: **Scenario 3c (50% cut in Band A & B and B with Zero Pass Through) for Aberdeen Airport and Scenario 1c (100% cut in Band A with Zero Pass Through) for Edinburgh, Glasgow and Prestwick Airports.**

1.1.9. These results, as expected, correspond with the economic assessment's passenger movement forecasts from which forecast changes in air traffic movements (ATMs) have been derived. The largest increase in overall passenger movements from all airports was forecast to occur under **Scenario 1c** – where airlines do not lower air fares as a result of a tax reduction but instead invest in the development of routes applicable for Band A UK APD rates. Aberdeen Airport is the exception, where the demand response to lower air fares from an ADT cut (**Scenario 3c**) is expected to lead to greater increases in passengers (and subsequently ATMs) than from the supply side effect of route development.

[4] Sound is pressure fluctuations in the air, typically measured in pascals (Pa). Between the quietest audible sound and the loudest tolerable sound there is a million to one ratio in the pressure level. Because of this wide range a noise level scale based on logarithms is used in noise measurement called the decibel (dB) scale. The human ear system does not respond uniformly to sound across the detectable frequency range and consequently instrumentation used to measure noise is weighted to represent the performance of the ear. This is known as the 'A weighting' and annotated as dB (A).

Impacts of additional noise exposure

1.1.10. **Scenario 2a** (100% cut in Band B, Full Pass Through) results in the smallest aggregate impact on noise exposure across all airports which is estimated to result in an increase in population exposed to $L_{Aeq,16h}$[5] noise levels above 51 dB(A) of approximately 1,274, and an increase in population of approximately 1,577 people exposed to night-time noise (L_{night}) levels in excess of 45 dB(A)[6]. This follows directly from the prediction that Scenario 2a would result in the smallest increase in both daily ATMs and the area covered by the 51 dB $L_{Aeq,16h}$ and 45 dB L_{night} noise contour.

1.1.11. The highest aggregate impact across all Scottish airports is observed under **Scenario 1c** (100% cut in Band B with Zero Pass Through), which is estimated to result in an increase in population exposed to $L_{Aeq,16h}$ noise levels above 51 dB(A) of approximately 10,902, and an increase in population of approximately 11,875 people exposed to night-time noise (L_{night}) levels in excess of 45 dB.

1.1.12. Predicted noise level increases may be at least partly offset by the potential impacts of improvements in the noise-efficiency of aircraft over time. These potential improvements are not considered in the assessment and are likely to result in a decrease in exposure to adverse levels of noise by 2022. However, these reductions would also be present in the no-change scenario and would therefore make no difference to the overall ranking of the tax and Pass Through scenarios.

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[5] $L_{Aeq,16h}$ is the average equivalent continuous A-weighted sound pressure level over a 16-hour period from 07:00 to 23:00 accounting for the daily average of aircraft movements during the 92-day summer period from 19 June to 15 September.
[6] L_{night} is the average sound level over an 8-hour night-time period (23:00hrs to 07:00hrs) using the average daily aircraft movements during the 92-day summer period from 19 June to 15 September.

2. INTRODUCTION

2.1. Background

2.1.1. The devolution of powers over Air Passenger Duty (APD) to the Scottish Parliament was recommended by the Smith Commission in November 2014. Following the passage of the Scotland Act 2016, the Scottish Parliament now has the power to legislate for Air Departure Tax, which will replace APD in Scotland. The Air Departure Tax (Scotland) Bill[7] was introduced to the Scottish Parliament to provide for the replacement of UK APD with Air Departure Tax (ADT). The strategic objectives of the Bill were to:

- design and structure ADT in a way which boosts Scotland's air connectivity and economic competitiveness, encouraging the establishment of new routes which will enhance business connectivity and tourism;
- create an environment which encourages airlines to base more aircraft in Scotland, which not only creates new routes but creates new jobs, including flight crew, cabin crew, engineering and ancillary support roles; and
- reduce the overall tax burden of ADT by 50% and to abolish the tax when resources allow.

2.1.2. The Scottish Parliament passed the Bill in June 2017 and the Air Departure Tax (Scotland) Act 2017[8] has since been enacted. The Scottish Government is undertaking a range of assessments to develop an evidence base on the potential environmental impacts of an overall 50% reduction in ADT, which it will consider when determining rate amounts and bands to be included in the secondary legislation (Regulations) which will be created under the Act.

2.1.3. This report describes the nature and significance of one such environmental impact, namely the potential changes in air traffic noise as a result of the reduction in the burden of air taxation. This assessment demonstrates that the Scottish Government is fully committed to quantifying the potential noise impacts of the proposed policy.

2.2. Environmental Noise Directive

2.2.1. In order to fulfil its obligations under the European Parliament and Council Directive for Assessment and Management of Environmental Noise 2002/49/EC (commonly referred to as the Environmental Noise Directive (END)), the Scottish Government published the Environmental Noise

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[7] http://www.parliament.scot/Air%20Departure%20Tax%20Scotland%20Bill/SPBill03PMS052016.pdf
[8] http://www.legislation.gov.uk/asp/2017/2/contents

(Scotland) Regulations 2006. Under these Regulations, strategic noise maps must be produced for major roads, rail, airports and industry.

2.2.2. The competent authorities (for airports, this is the airport operator[9]) are then required to establish Noise Action Plans (NAPs) based on the mapping results. NAPs are intended to provide a framework to manage environmental noise and its effects. They also aim to protect quiet areas in agglomerations (large urban areas) where the noise quality is good[10].

2.2.3. Under Round 1 of the END (submitted to the European Commission in 2007), noise maps were produced for the following airports: Aberdeen, Edinburgh, Glasgow and Prestwick. Aberdeen, Edinburgh and Glasgow airports each produced a NAP. Under Round 2 of the END (2012), Prestwick was omitted, and Dundee was introduced. Edinburgh and Glasgow airports both published NAPs in 2014[11,12] Aberdeen International Airport published in 2013[13]. Each of these documents contained the 2011 L_{den}[14] and 2011 $L_{Aeq,16h}$ noise contours for the airport. The Scottish Government published a NAP for Dundee Airport in 2014[15]. Further noise mapping and NAPs were produced in 2018 by Aberdeen International, Edinburgh and Glasgow airports as required by END Round 3 (2017).

2.2.4. The need for major airports to provide NAPs highlights the ongoing commitment to protect communities from being impacted by adverse levels of noise. Any change in infrastructure or policy that is likely to result in changes in airport operations may further impact on these communities and, if significant changes are proposed, may result in noise impacts on previously unaffected communities. As the proposed reduction in ADT has the potential to result in a significant increase in activity in and around airports, it was considered that there should be an understanding of the potential noise impacts that may arise. This understanding of potential noise impacts will inform decisions on whether, when and at what pace to proceed with a reduction in ADT.

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[9] Airport operators are as follows: Aberdeen – Aberdeen International Airport Ltd; Edinburgh – Edinburgh Airport Ltd; Glasgow – Glasgow Airport Ltd; Inverness – Highlands and Islands Airports Limited; and Prestwick – Prestwick Aviation Holdings Ltd.

[10] The Environmental Noise (Scotland) Regulations 2006, para. 13. Available at http://www.legislation.gov.uk/ssi/2006/465/pdfs/ssi_20060465_en.pdf

[11] Edinburgh Airport (2014) Edinburgh Airport Noise Action Plan 2013 – 2018 [online] available at https://www.aberdeenairport.com/media/377333/FINAL-Noise-Action-Plan-2018-Compressed-.pdf

[12] Glasgow Airport (2014) Glasgow Airport Noise Action Plan 2013 – 2018 [online] available at https://www.glasgowairport.com/media/2492/gla-noise-action-plane-25-oct-2018.pdf

[13] Aberdeen International Airport (2013) Aberdeen International Airport Noise Action Plan [online] available at https://noise.environment.gov.scot/pdf/Aberdeen-International-Airport-Noise-Action-Plan.pdf

[14] L_{den} is the average of the day, evening and night sound levels, weighted for the sensitivity of the different time periods.

[15] The Scottish Government (2014) Dundee Airport Noise Action Plan [online] available at https://www.gov.scot/publications/dundee-airport-noise-action-plan/

Sources of Noise

2.2.5. The proposed reduction in ADT has the potential to increase the number of sources of noise. The introduction of, or changes to, these noise sources may result in short and/or long-term impacts on sensitive receptors [16]. The significance of these impacts will depend on the absolute level of noise and change in noise level, the sensitivity of the receptor and the effectiveness of any mitigation measures that are implemented.

2.2.6. The noise sources that have been included in this study are directly related to aircraft take-off and landing. These have the biggest potential to result in noise impacts due to the number of people living near flight paths that may be affected. Noise sources that may change but have been excluded from the assessment are as follows:

- Aircraft taxiing and engine testing – Depending on the proximity of taxi-routes and engine test areas to sensitive receptors, noise from aircraft taxiing and ground running may be audible at sensitive receptors. However, in general, noise from these activities tends to be confined within the boundaries of the aerodrome. Additionally, the land surrounding aerodromes tends to be used for non-noise sensitive uses. Consequently, it is considered that any intensification of these activities as a result of a reduction in ADT is unlikely to result in overall noise impacts.

- Airport vehicular traffic – increases in passengers may result in increases in airport vehicular traffic. As this traffic is confined to within the aerodrome boundaries, potential increases in noise are unlikely to breakout and impact on sensitive receptors. Consequently, impacts from airport vehicular traffic have been excluded.

- Road and rail traffic to and from the airports – it is considered that, although there is likely to be increases in road and rail traffic to accommodate increases in passengers, these increases are likely to occur on transport routes that currently experience a high volume of movements, and hence percentage changes in traffic volumes, and corresponding changes in noise, would be small. However, any increases in operating hours (e.g. to accommodate delivery of supplies to service an increase in passenger numbers) could potentially have an impact on night-time traffic noise. It is unknown at this stage of the assessment if changes in infrastructure and operations would be required to accommodate additional passengers. Consequently, impacts due to road and rail traffic have been excluded.

- As with road and rail infrastructure, it is unknown at this stage of the assessment if airports will require additional infrastructure to cope with

[16] A receptor is a technical term which refers to any premises (e.g. residential or non-residential premises such as schools, hospitals, theatres etc.) or area that is sensitive to noise.

potential increases in passengers. Consequently, potential impacts from construction noise due to new airport infrastructure have been excluded.

2.3. Aims and Objectives

2.3.1. The primary aim of this research is to assess the potential impact on noise levels at Scottish airports of the Scottish Government's plans to reduce the overall burden of ADT by 50%. The specific objectives were to:

a) *Establish the current situation with regard to the production of noise maps within the NAPs at Scotland's airports and specifically Aberdeen (ABZ), Glasgow (GLA), Prestwick (PIK), Edinburgh (EDI), and Inverness (INV) airports.*

b) *Assess the extent to which the current outputs (or soon to be outputs) under the END noise mapping exercise will be sufficient in terms of content and coverage to stand as a baseline against which to measure the impact of the expected reduction in ADT.*

c) *Develop additional (appropriate) baseline noise maps where it is considered that the existing or proposed noise maps for Scottish airports are insufficient, incomplete in their coverage or are unlikely to be available to fit in with the research timings of this project.*

d) *Develop appropriate noise impact assessments for each affected airport based on scenarios to be provided by Scottish Government and, where necessary, take account of exogenous changes such as housing growth in the vicinity of the affected airports.*

e) *Produce a national aggregate impact assessment relative to baseline of the noise impact resulting from the plans to reduce the overall burden of ADT by 50%.*

f) *Produce an accompanying narrative setting out the approach, the key uncertainties and the sensitivity of the results to the development of Scottish airports in terms of passenger numbers, air traffic movements and extent of the operational day, considering the potential impact from a change in the number of night time movements.*

2.4. Report structure

2.4.1. The remainder of this report is structured as follows:

- **Section 3** sets out the approach to the impact assessment.
- **Section 4** sets out the noise impact prediction methodology, which details the noise modelling methodology, the methodology for determining baseline and future ATMs and the methodology for identifying receptors within noise contour predictions.

- **Section 5** presents the results of modelling and examines the potential impacts resulting from changes in noise levels.

- **Section 6** concludes with a summary of the main findings.

2.4.2. This is primarily a technical report, though we have sought to present it in as accessible form as possible allowing for the subject matter. If readers wish to focus on the tax reduction impacts, then **Sections 5 and 6** are the most relevant. As **Sections 3 and 4** (along with Annex A) are more technical in nature and deal with the noise methodology itself, they may be of less interest to those interested in the tax reduction impacts. However, we feel it is important to lay out in detail the methodology underpinning the conclusions of the tax reduction impacts. Those who wish to learn about the methodology, and therefore fully understand the impact of tax reductions on airport noise levels, should also read **Sections 3 and 4**.

2.4.3. The detailed methodology for noise mapping is provided in Appendix A.

3. APPROACH TO THE IMPACT ASSESSMENT

3.1.1. This section sets out the rationale for the levels of noise that were chosen as the criteria for assessing the impact of aircraft noise in this report.

3.1.2. The UK Government formally published the Aviation Policy Framework[17] (APF) in March 2013, defining what it believes is a balanced approach to securing the benefits of aviation. Its stated objective is that the aviation industry needs to grow to benefit the UK economy while respecting the quality of life of people affected by aviation activity.

3.1.3. The overall objective of the APF is to: *'…limit and where possible reduce the number of people in the UK significantly affected by aircraft noise'*.

3.1.4. Changes in aircraft movements as a result of the proposed reduction in ADT need to be assessed against the policy set out within the APF. Key noise criteria relating to the onset of annoyance and when properties become eligible for compensation are set out in the APF as follows:

- 57 dB $L_{Aeq,16h}$ – considered to be the average level of aircraft noise marking the onset of significant community annoyance.
- 63 dB $L_{Aeq,16h}$ – the level above which airport operators are expected to offer acoustic insulation to noise-sensitive buildings.
- 69 dB $L_{Aeq,16h}$ – the level above which airport operators are expected to offer assistance with the costs of moving[18].

3.1.5. The $L_{Aeq,16h}$ noise metric was adopted by the UK Government in 1990 and is commonly used in the UK to describe the average daytime noise levels of aircraft. The concept of assessment criteria for aviation noise was expanded on during the appraisal for increasing UK airport capacity in the Appraisal Framework Consultation[19] (AFC) document. The document recommends the use of the $L_{Aeq,16h}$ and L_{night} for assessing aircraft noise impacts.

3.1.6. In 2002 the European Commission published Directive 2002/49/EC[20], which established the L_{den} as a common environmental noise indicator for the European Union. Consequently, all noise mapping undertaken for the END is required to present contours using the L_{den} noise metric.

[17] The Stationery Office Limited (2013) Aviation Policy Framework [online] available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/153776/aviation-policy-framework.pdf
[18] The level of assistance to be provided for moving house is not defined in the APF. The level of assistance is defined by individual airports and tends to consist of either a percentage of the property sale price or a lump sum.
[19] Airports Commission (2014); Appraisal Framework.
[20] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0049&from=EN

3.1.7. Studies undertaken by the Civil Aviation Authority (CAA) show that the $L_{Aeq,16h}$ and L_{den}[21] noise metrics show a strong degree of correlation at larger UK airports with the L_{den} approximately 1.5 dB higher than the corresponding $L_{Aeq,16h}$. Consequently, it was considered that there would be no substantial benefit to model both the $L_{Aeq,16h}$ and L_{den} noise metrics for the purposes of this report and, in line with UK aviation policy, the $L_{Aeq,16h}$ has been used to represent daytime aircraft noise levels.

3.1.8. The following range of contours that should be used to assess potential aviation noise impacts are identified in the AFC document:

- $L_{Aeq,16h}$ – average summer's day: 54 dB and above in 3 dB increments; and
- L_{night} – average summer's night: 48 dB and above in 3 dB increments.

3.1.9. The 57 dB $L_{Aeq,16h}$ was identified as an indicator of community annoyance based on the findings of the 1982 Aircraft Noise Index Study (ANIS)[22].Since the publication of these criteria listed above, the Civil Aviation Authority's (CAA) Survey of Noise Attitudes[23] identified that the sensitivity of people to aircraft noise had increased. The study found that the same percentage of people annoyed by aircraft noise in the 1982 ANIS study at 57 dB $L_{Aeq,16h}$ now occurs at approximately 54 dB $L_{Aeq,16h}$. To account for the increased sensitivity to noise, the range of criteria $L_{Aeq,T}$ stated in the AFC document has been expanded to include the 51 dB $L_{Aeq,16h}$ noise contour and the 45 dB L_{night} noise contour. Consequently, the range of noise contours considered in this assessment are as follows:

- $L_{Aeq,16h}$ – average summer's day: 51 and above in 3 dB increments; and
- L_{night} – average summer's night: 45 and above in 3 dB increments.

3.1.10. This approach is in line with the developing UK aviation strategy (which is due to be published in the middle of 2019) as discussed in the Consultation Response on UK Airspace Policy[24] that identifies 51 dB $L_{Aeq,16h}$ and 45 dB L_{night} as the onset of adverse levels of aircraft noise. As such, the discussion of the noise prediction results that account for the proposed ADT reduction scenarios has been undertaken with reference to area of land and population covered by the 51 dB $L_{Aeq,16h}$ and the 45 dB L_{night} noise contours.

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[21] Civil Aviation Authority (2017); CAP 1506, Survey of noise attitudes 2014: Aircraft.
[22] Brooker P, Critchley J B, Monkman D J & Richmond C (1985); DR Report 8402: United Kingdom Aircraft Noise Study: Main Report.
[23] Civil Aviation Authority (2017); CAP 1506, Survey of noise attitudes 2014: Aircraft.
[24] Department for Transport (2017), UK Airspace Policy: A framework for balanced decisions on the design and use of airspace. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/588186/uk-airspace-policy-a-framework-for-balanced-decisions-on-the-design-and-use-of-airspace-web-version.pdf

3.1.11. The assessment of aircraft noise has traditionally been undertaken through the area of land covered by noise contours. However, the Airport Commission introduced the concept of assessing population affected by aircraft noise as being more relevant to the assessment of aircraft noise impacts. Consequently, the assessment has been undertaken with reference to both the area of land and the population affected by changes in aircraft noise.

4. NOISE IMPACT PREDICTION METHODOLOGY

4.1. Overview

4.1.1. This section describes the technical approach to the forecasting of changes in noise levels. The methods applied to determine potential noise impacts as a result of proposed reductions in ADT are as follows:

- Noise modelling methodology – sets out the methodology to predict aircraft noise contours.
- Determination of baseline Air Traffic Movements (ATM) – sets out how baseline ATMs were derived from 2016 flight logs.
- Determination of future scenario ATMs – sets out the method how ATMs for future assessment scenarios were determined from forecast passenger numbers.
- Application of noise mitigation in predictions – sets out the consideration of potential future reductions in aircraft noise in predictions.
- Population mapping – sets out the methodology for identifying receptors within aircraft noise contour bands.

4.2. Noise modelling methodology

4.2.1. Noise modelling was undertaken using commercially available software called Integrated Noise Model (INM). INM calculates aircraft noise from ATM data which is applied to approach and departure flight paths. Further details on INM are presented in Appendix A.

4.2.2. INM has the capacity to output a variety of noise level parameters depending on the input information. As described in Section 1.1.10, the following parameters are used to describe aircraft noise levels:

- $L_{Aeq,16h}$ – average sound level over a 16-hour daytime period (07:00hrs to 23:00hrs) using the average daily aircraft movements from the 92-day summer period;
- L_{night} – average sound level over an 8-hour night-time period (23:00hrs to 07:00hrs) using the average daily aircraft movements from the 92-day summer period.

4.2.3. The output of the noise model is a series of contour lines which link geographical points experiencing equal noise in a similar way to isobars link points of equal barometric pressure or relief contours link areas of equal elevation on a topographic map. These noise contours define areas within which noise levels are above the specified value. For example a contour labelled 51 dB $L_{Aeq,16h}$ indicates that all areas within that contour will be exposed to daily average aircraft noise levels of 51 dB $L_{Aeq,16h}$ or above.

4.3. Determination of baseline air traffic movements

4.3.1. A study of 2016 ATMs was undertaken using 2016 ATM data that were sourced from each airport. Although 2016 noise contours would be provided by each airport as part of Round 3 of the END, it was considered preferable to model 2016 ATMs as part of this assessment to ensure that a consistent methodology was applied when modelling baseline and future scenario noise contours. This study covers objective (b) set out in paragraph 2.3.1.

4.3.2. Due to the potential for discrepancies in how 2016 ATM data could be analysed and differences in aircraft noise data in INM and the Civil Aviation Authority's Aircraft Noise Contour (ANCON) noise modelling software, the baseline noise contours presented in this report should not be considered comparable with those provided for Round 3 of the END. As Round 3 mapping has not been publicised at the time of undertaking this assessment, there was no way of mitigating this; so the reader is reminded of the technical differences. A detailed methodology of how 2016 ATM data was analysed is presented in Appendix A.

4.3.3. Flight paths were input into the noise model using information obtained from the National Air Traffic Services website[25]. Where detailed information about Standard Instrument Departure (SIDs) routes was not available, END Round 2 noise contour maps were referred to for provision of SID information. Flight paths for each airport are presented in Figures A.1 to A.5 of Appendix A.

4.3.4. Military and rotary wing aircraft contribute to noise at Aberdeen and Prestwick airports. These movements would be unaffected by changes to ADT as they are non-chargeable aircraft, so have been omitted from predictions.

4.4. Determination of future scenario ATMs

4.4.1. The future assessment year has been taken as 2022 as it was considered that the effect of a reduction in ADT will be in a steady state by this point. Passenger data was provided by Peter Brett Associates (PBA) under three different ADT scenarios with different Pass Through (the extent to which an ADT change is reflected in lower air fares) assumptions. PBA have conducted a separate study[26] into the economic impact of potential reductions in ADT and every effort has been made to ensure that this study is consistent with the PBA work. The nine scenarios (not including the baseline scenario or 'Do nothing'/existing tax levels option) provided in the PBA study are as follows:

- Scenario 1a – 100% cut in Band A (Full Pass Through);
- Scenario 1b – 100% cut in Band A (Partial Pass Through);

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[25] http://www.nats-uk.ead-it.com/public/index.php%3Foption=com_content&task=blogcategory&id=1&Itemid=2.html
[26] http://www.gov.scot/Resource/0052/00528693.pdf

- Scenario 1c – 100% cut in Band A (Zero Pass Through);
- Scenario 2a – 100% cut in Band B (Full Pass Through);
- Scenario 2b – 100% cut in Band B (Partial Pass Through);
- Scenario 2c – 100% cut in Band B (Zero Pass Through);
- Scenario 3a – 50% cut in Band A & Band B (Full Pass Through);
- Scenario 3b – 50% cut in Band A & Band B (Partial Pass Through);
- Scenario 3c – 50% cut in Band A & Band B (Zero Pass Through).

4.4.2. Although there may be changes to flight paths and airport infrastructure (i.e. new runways) in the future, no such changes have been made at the time of issue of this report. Consequently, no information is available on potential future operational conditions and noise modelling of future scenarios uses existing flight paths and airport layouts as the best possible basis.

4.4.3. Future ATMs have been calculated with reference to the baseline 2016 ATM data. Forecast passenger data provided by PBA covers the years from 2017 to 2022. The forecast passenger data were simplified into groups defined by operator type to provide a means of correlating passenger numbers with ATMs:

- UK scheduled operators;
- EU scheduled operators;
- Overseas (non-EU) scheduled operators;
- UK charter operators; and
- EU charter operators.

4.4.4. Scheduled services are defined as those performing to a published timetable with charter services referring to all air traffic movements other than scheduled services.

4.4.5. The change in passengers broadly affects ATMs depending on the operator category they are assigned to. UK and EU scheduled operators tend to operate Code C aircraft (e.g. A320, B737) that are medium sized. Overseas scheduled operators tend to operate long haul Code E aircraft (e.g. A330, B777) that can carry a greater number of passengers. Charter operators tend to operate small aircraft that carry a low number of passengers. Consequently, a large increase in charter passengers will have a large increase in ATMs compared to a corresponding large increase in overseas scheduled passengers that can be handled by a smaller increase in ATMs.

4.4.6. ATM data was provided from each airport for 2016 whereas PBA passenger forecasts started from 2017. It was assumed that the ATM data from 2016 would broadly correlate with the 2017 passenger forecasts. Consequently, representative ATMs for the 2022 assessment scenarios were generated from the 2016 ATM data based on the change in passengers between 2017 and 2022. The methodology applied for calculating future scenario ATMs is presented in Appendix B.

4.4.7. The scenarios that have been considered in this assessment are: 1a, 1c, 2a, 2c, 3a, and 3c (as described in Section 4.4.1). These scenarios represent the 'Full Pass Through' and the 'Zero Pass Through' scenarios. This enables an understanding of the potential range of changes in noise contours at each airport as a result of each ADT change option. A summary of the total projected yearly passengers (PAX) and annual average ATMs for each scenario are presented in Table 1.

4.4.8. It should be noted that, as the current APD exemption for all passengers flying on aircraft departing from airports within the Highlands & Islands is expected to remain in place under ADT, passenger forecasts have not been undertaken for Inverness Airport. However, baseline 2022 noise contours have been calculated for Inverness Airport using a combination of DfT ATM forecasts[27] and historical CAA ATM data[28]. A discussion on how changes in passenger numbers affect the summer average ATMs at each airport along with full details of summer average ATMs for each aircraft variant are presented in Appendix B.

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[27] Department for Transport (2013); UK Aviation Forecasts.
[28] https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-airport-data/

Table 1 Projected Passengers and ATMs for Each Tax/Pass Through Scenario

Scenario	ABZ		EDI		GLA		INV	PIK	
	Yearly[29] PAX	Average Daily ATMs	Yearly PAX	Average Daily ATMs	Yearly PAX	Average Daily ATMs	Average Daily ATMs	Yearly PAX	Average Daily ATMs
Baseline 2017	2,943,686	178.6	12,558,738	379.1	9,305,969	309.6	72.6	682,964	152.3
Baseline 2022	3,049,512	184.8	13,987,106	405.2	9,600,513	319.2	83.1	693,731	153.2
1a	3,130,663	189.5	14,702,412	425.6	10,019,302	342.5	-	770,733	159.3
1c	3,138,205	191.6	15,664,092	449.6	10,588,591	352.3	-	870,042	167.3
2a	3,070,868	185.8	14,050,224	407.0	9,687,174	327.3	-	693,731	153.2
2c	3,142,359	189.2	14,267,537	415.6	10,036,505	333.2	-	693,731	153.2
3a	3,100,766	187.7	14,376,318	416.3	9,853,238	327.9	-	732,232	156.3
3c	3,153,249	191.2	15,105,630	434.6	10,414,268	346.1	-	794,480	161.2

4.5. Application of noise mitigation in predictions

4.5.1. Mitigation of aircraft noise is covered by the International Civil Aviation Organisation's (ICAO) Balanced Approach to Aircraft Noise Management[30]. The Balanced Approach explores various measures to address noise problems at airports through consideration of four principal elements:

- Reduction of noise at source.
- Land use planning and noise management.
- Noise abatement and operational procedures.
- Operating restrictions.

4.5.2. The most effective means of reducing aircraft noise is through reduction of noise at source.

[29] Yearly PAX data supplied by Peter Brett Associates
[30] https://www.icao.int/environmental-protection/Pages/noise.aspx

4.5.3. There is a continued drive in the aircraft industry to reduce noise generated by aircraft movements. In 2017, ICAO Chapter 14[31] standard of aircraft were introduced which included noise criteria which all new civil aircraft should achieve. Consequently, aircraft fleets in the 2022 future assessment year are likely to generate lower levels of noise than current aircraft fleets. As no information is available on how flight operators may phase into service new aircraft variants, assumptions cannot easily be made as to the percentage of fleet that may be upgraded. Thus, for the purposes of the analysis, aircraft fleets in the 2022 scenarios are considered equivalent to the fleets operating in 2016.

4.5.4. Aircraft noise may also be mitigated through optimisation of operational procedures. Improvements in aircraft technology allow aircraft noise to be managed through measures such as steeper aircraft approach angles and management of approach/ departure profiles (flap settings, speed and reverse thrust). Airports may or may not adopt optimised operational procedures in future. However, as no information is available on how they may be implemented at each airport, this study assumes that operational procedures will remain consistent for future scenarios.

4.5.5. As no potential future mitigation measures have been included in the predictions of future aircraft noise, the noise impacts forecast in this work are likely to be over-estimates. However, it is not possible to say to what extent these values are over-estimated.

4.6. Population mapping

Baseline mapping

4.6.1. The receptors considered in the assessment of noise impacts are exclusively residential in character. Although other types of receptors (e.g. schools, hospitals, theatres etc.) may be similarly affected by changes in aircraft noise, it was considered reasonable for this study to only consider residential receptors as they make up the majority of the affected sensitive receptors around airfields.

4.6.2. The baseline population mapping was undertaken using the baseline noise contours which were created for each airport. Ordnance Survey building footprints were identified where they intersected the noise contours. Using Ordnance Survey (OS) AddressBase Premium data, residential buildings were selected and address data that were located within these building footprints were identified.

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[31] Aircraft noise has been controlled since the 1970s by the setting of design noise limits for aircraft in the form Standards and Recommended Practices, which are contained in Volume I of Annex 16 to the Convention on International Civil Aviation. Chapter 14 replaces the Chapter 4 design standard and contains more stringent noise limits for new aircraft to comply with.

4.6.3. Noise levels from the noise contour bands described above were assigned to each residential property (or household) within each noise contour. Based on household occupation projections undertaken by National Records for Scotland[32] (NRS), a figure of 2.14 persons was taken as the average population for a Scottish household in 2017. Aggregate scores for total population currently affected by noise levels within the noise bands were then calculated.

Future mapping

4.6.4. For each airport, research was carried out to identify future housing developments in the vicinity. Housing development data was collated from Local Authorities where possible, and digitised from their Local Development Plans (LDPs) in a small number of cases where data could not be provided. A maximum development capacity number was taken from the LDPs if this was not already provided and attributed to each housing development area. A Geographic Information System (GIS) assessment was then made to identify where residential properties had already been built (and were already contained within the OS AddressBase Premium data) and the difference between this number and the capacity number was used to identify how many additional properties should be added. Points were generated in a random pattern within these development areas, to represent the future property locations.

4.6.5. A GIS model was created to run the population assessment for the future scenarios, and this identified residential properties within the contours as per the baseline process, and additionally future housing locations within the noise contours. The model also attributed a noise level to each point.

4.6.6. As per the baseline, the noise level was aggregated to provide a count for each noise level for each airport. A 2022 average household size figure of 2.07 referenced from NRS household projections[33] was applied as a factor to each property to calculate the total number of people forecast to be affected within each noise band.

[32] https://www.nrscotland.gov.uk/files//statistics/household-projections/2012-based/2012-house-proj-publication.pdf
[33] https://www.nrscotland.gov.uk/files//statistics/household-projections/2012-based/2012-house-proj-publication.pdf

5. MODELLING RESULTS AND POTENTIAL IMPACTS

5.1. Noise Prediction Results

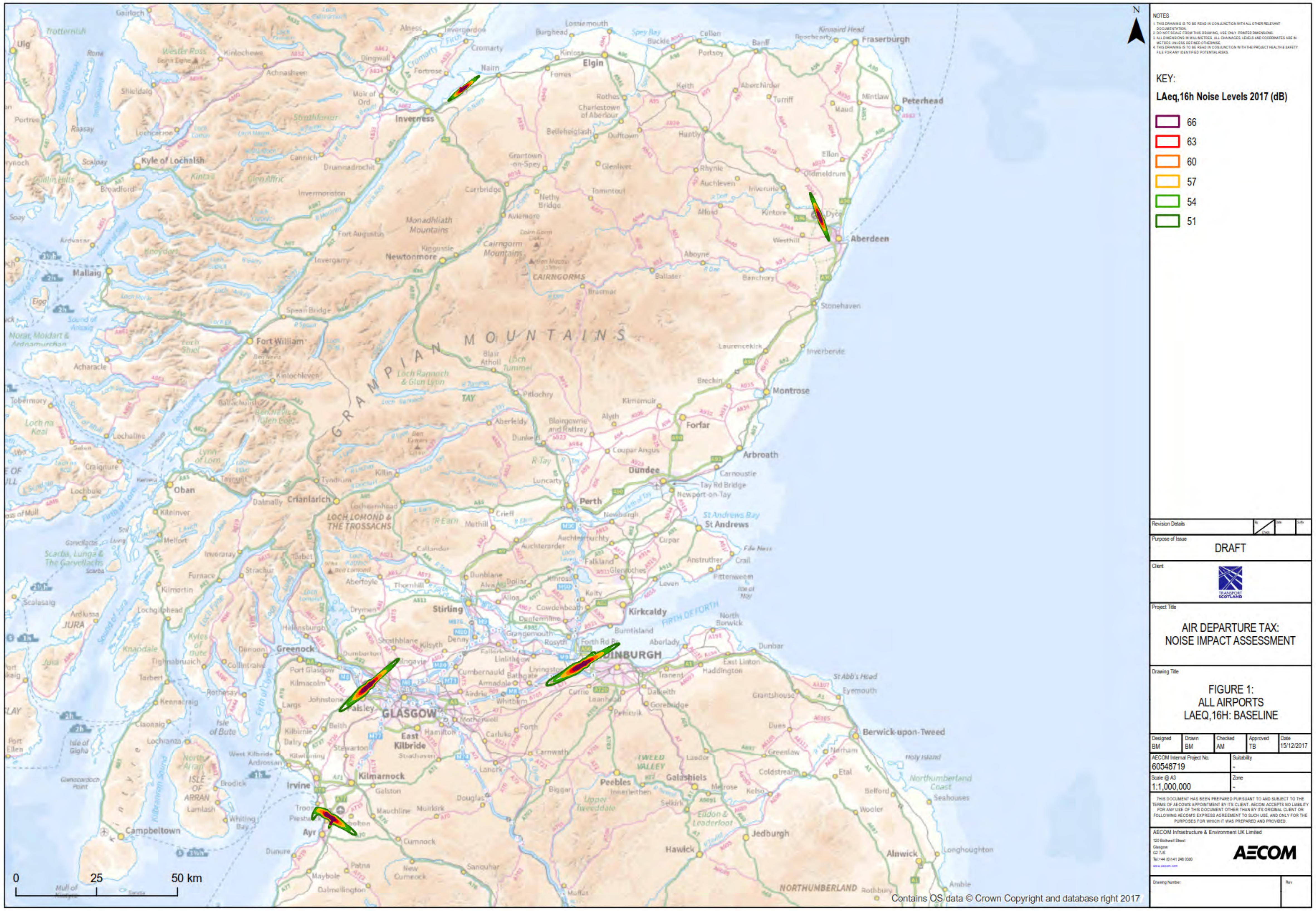
5.1.1. Baseline 2017 $L_{Aeq,16h}$ contours for all airports in Scotland are shown in Figure 1. The comparison between the 2017 and 2022 baselines ($L_{Aeq,16h}$ and L_{night}) for the all airports are shown in Figures C.1 to C.10 in Appendix C. These figures also show the population per ward and additional residential developments identified within the future population mapping exercise.

5.1.2. For each of the future scenarios that have been assessed, $L_{Aeq,16h}$ and L_{night} contours have been produced. In order to demonstrate the relative noise impact of the changes, the areas covered by $L_{Aeq,16h}$ and L_{night} contours have been presented for each scenario with the respective 2022 baseline contours along with the population per ward and additional residential developments. These noise contour plots are shown in Figures C.11 to C.58 in Appendix C. Table 2 presents a summary guide to the layout of each noise scenario and the individual airport mappings in Appendix C.

Table 2: Reference Guide to Appendix C Noise Contour Maps

Scenario	Aberdeen	Edinburgh	Glasgow	Inverness	Prestwick
Baseline 2017 v Baseline 2022	Figures C.1-C.2	Figures C.3-C.4	Figures C.5-C.6	Figures C.7-C.8	Figures C.9-C.10
Scenario 1a	Figures C.11-C.12	Figures C.23-C.24	Figures C.35-C.36	-	Figures C.47-C.48
Scenario 1c	Figures C.13-C.14	Figures C.25-C.26	Figures C.37-C.38	-	Figures C.49-C.50
Scenario 2a	Figures C.15-C.16	Figures C.27-C.28	Figures C.39-C.40	-	Figures C.51-C.52
Scenario 2c	Figures C.17-C.18	Figures C.29-C.30	Figures C.41-C.42	-	Figures C.53-C.54
Scenario 3a	Figures C.19-C.20	Figures C.31-C.32	Figures C.43-C.44	-	Figures C.55-C.56
Scenario 3c	Figures C.21-C.22	Figures C.33-C.34	Figures C.45-C.46	-	Figures C.57-C.58

Figure 1 Baseline $L_{Aeq,16h}$ dB Noise Contours for All Airports, 2017



5.2. Results by individual airport

Aberdeen Airport

5.2.1. The results of noise predictions for each scenario along with the population distribution around Aberdeen Airport are presented in Figure C.11 to Figure C.22 of Appendix C. The results of noise predictions showing the area covered by each contour band at Aberdeen Airport are presented in Table 3. The cells showing the scenarios with the largest and smallest noise impacts at Aberdeen Airport are shaded dark grey and light grey respectively for easy identification. The discussion of noise predictions takes into account the lowest noise contour level for day and night periods as they are considered to represent the onset of adverse levels of aircraft noise.

Table 3: Aberdeen Airport Contour Area Coverage (km²)

Noise Level (dB(A))	Scenario							
	2017 Baseline	2022 Baseline	100% cut in Band A		100% cut in Band B		50% cut in Band A & Band B	
			1a Full Pass Through	1c Zero Pass Through	2a Full Pass Through	2c Zero Pass Through	3a Full Pass Through	3c Zero Pass Through
Daytime $L_{Aeq,16h}$								
≥51	14.7	15.2	15.5	15.5	15.2	15.5	15.4	15.6
≥54	8.3	8.5	8.7	8.7	8.6	8.7	8.6	8.8
≥57	4.5	4.6	4.7	4.7	4.6	4.7	4.7	4.7
≥60	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5
≥63	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.1
≥66	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
≥69	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
>72	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Night-time L_{night}								
≥45	17.2	17.7	18.1	18.1	17.8	18.1	17.9	18.2
≥48	9.8	10.0	10.2	10.2	10.1	10.2	10.1	10.3
≥51	5.4	5.5	5.6	5.7	5.5	5.7	5.6	5.7
≥54	2.9	2.9	3.0	3.0	2.9	3.0	2.9	3.0
≥57	1.5	1.5	1.6	1.6	1.5	1.6	1.5	1.6
≥60	0.8	0.8	0.9	0.7	0.9	0.9	0.9	0.9
≥63	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
≥66	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
≥69	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
>72	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

5.2.2. Noise predictions indicate that the increase in 51 dB $L_{Aeq,16h}$ noise contour will range from no change for Scenario 2a to +0.4 km^2 for Scenario 3c. The change in 45 dB L_{night} noise contour area will range from +0.1 km^2 for Scenario 2a to +0.5 km^2 for Scenario 3c.

5.2.3. Scenario 3c gives the largest increase in 51 dB $L_{Aeq,16h}$ noise contour area. This represents a 3% increase in contour size and the 45 dB L_{night} noise contour also represents a 3% increase in contour size.

5.2.4. The results of analysis to identify population exposed to aircraft noise in each contour band are presented in Table 4.

Table 4: Aberdeen Airport Population Exposure

Noise Level (dB(A))	**Scenario**							
	2017 Baseline	2022 Baseline	100% cut in Band A		100% cut in Band B		50% cut in Band A & Band B	
			1a Full Pass Through	1c Zero Pass Through	2a Full Pass Through	2c Zero Pass Through	3a Full Pass Through	3c Zero Pass Through
Daytime $L_{Aeq,16h}$								
≥51	16,810	17,766	18,263	18,342	17,961	18,314	18,141	18,380
≥54	6,174	6,711	7,124	7,195	6,857	7,169	7,006	7,212
≥57	1,791	1,911	2,033	2,052	1,924	2,037	1,954	2,054
≥60	486	578	627	636	584	631	603	640
≥63	15	15	17	17	15	17	17	17
≥66	0	0	0	0	0	0	0	0
≥69	0	0	0	0	0	0	0	0
>72	0	0	0	0	0	0	0	0
Night-time L_{night}								
≥45	22,740	24,114	24,856	24,946	24,330	24,946	24,571	25,036
≥48	10,060	9,885	10,233	10,281	10,013	10,272	10,118	10,313
≥51	2,919	2,955	3,090	3,101	2,987	3,097	3,030	3,116
≥54	1,036	967	1,064	1,079	980	1,079	1,044	1,081
≥57	71	47	60	60	47	60	60	60
≥60	0	0	0	0	0	0	0	0
≥63	0	0	0	0	0	0	0	0
≥66	0	0	0	0	0	0	0	0
≥69	0	0	0	0	0	0	0	0
>72	0	0	0	0	0	0	0	0

5.2.5. The population analysis indicates that the increase in population within the 51 dB $L_{Aeq,16h}$ noise contour will range from 195 people (i.e. 17,961 minus the 2022 baseline of 17,766) for Scenario 2a to 614 people for Scenario 3c. The increase in population within the 45 dB L_{night} contour area will range from 216 people for Scenario 2a to 922 people for Scenario 3c.

5.2.6. The highest increase in population within the 51 dB $L_{Aeq,16h}$ represents a 3% increase in population in Scenario 3C. The highest increase in noise 45 dB L_{night} represents a 4% increase in population in Scenario 3C. Comparison of the area covered by noise contours shows a proportional increase in area and population for the 51 dB $L_{Aeq,16h}$ noise contour. Although the percentage increase in area covered by the 45 dB L_{night} noise contour is greater than the daytime, the percentage increase in population does not show a similar proportional increase as the 51 dB $L_{Aeq,16h}$. This indicates the additional noise contour coverage accounts for less densely populated areas than the 45 dB L_{night} 2022 baseline noise contour.

5.2.7. A summary of the changes in area (referenced from Table 3) and population (referenced from Table 4) exposed to noise within the 51 dB $L_{Aeq,16h}$ and 45 dB $L_{Aeq,8h}$ noise contours for each scenario in comparison with the 2022 baseline scenario are summarised in Table 5.

Table 5: Aberdeen Airport Increase in Area and Population Summary

Scenario	Population Increase		Area Increase / km^2	
	51 dB $L_{Aeq,16h}$	45 dB L_{night}	51 dB $L_{Aeq,16h}$	45 dB L_{night}
1a	496	743	0.3	0.4
1c	576	832	0.4	0.4
2a	195	216	0.1	0.1
2c	548	832	0.4	0.4
3a	375	458	0.2	0.2
3c	614	922	0.4	0.5

5.2.8. The results in Table 5 of the assessment of increase in area and population exposed to noise indicate that Scenario 3c (50% cut in Band A & Band B and Zero Pass Through) represents the highest impact in terms of noise at Aberdeen International Airport. The day period sees an increase in the area affected of 0.4 km^2 and in the population affected of 614 people whereas the night period sees an increase in the area affected of 0.5 km^2 and the affected population of 922 people.

5.2.9. Scenario 2a (100% cut in Band B and Full Pass Through) represents the smallest impact in terms of noise. The day period sees an increase in area of 0.1 km^2 and population of 195 people whereas the night period sees an increase in area of 0.1 km^2 and population of 216 people.

5.2.10. The noise contour plots for the highest impact scenario (Scenario 3c) are presented in Figure C.21 (daytime) and Figure C.22 (night-time) of Appendix C. The noise contour plots for the lowest impact scenario (Scenario 2a) are presented in Figure C.15 (daytime) and Figure C.16 (night-time) of Appendix C.

Edinburgh Airport

5.2.11. The results of noise predictions for each scenario along with the population distribution around Edinburgh Airport are presented in Figure C.23 to Figure C.34 of Appendix C. The results of noise predictions showing the area covered by each contour band at Edinburgh Airport are presented in Table 6. The cells showing the scenario with the largest and smallest noise impact at Edinburgh Airport are shaded dark grey and light grey respectively for easy identification. The discussion of noise predictions takes into account the lowest noise contour level for day and night periods as they are considered to represent the onset of adverse levels of aircraft noise.

Table 6: Edinburgh Airport Contour Area Coverage (km^2)

Noise Level (dB(A))	Scenario							
	2017 Baseline	2022 Baseline	100% cut in Band A		100% cut in Band B		50% cut in Band A & Band B	
			1a Full Pass Through	1c Zero Pass Through	2a Full Pass Through	2c Zero Pass Through	3a Full Pass Through	3c Zero Pass Through
Daytime $L_{Aeq,16h}$								
≥51	49.0	49.7	51.7	54.5	49.9	50.6	50.8	52.8
≥54	28.4	28.8	30.1	32.0	28.9	29.4	29.5	30.9
≥57	15.7	15.8	16.5	17.5	15.9	16.1	16.2	16.9
≥60	9.0	9.0	9.4	9.9	9.1	9.2	9.2	9.6
≥63	5.0	5.0	5.2	5.5	5.0	5.1	5.1	5.4
≥66	2.6	2.6	2.8	3.0	2.7	2.7	2.7	2.8
≥69	1.4	1.4	1.5	1.5	1.4	1.4	1.4	1.5
>72	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.8
Night-time L_{night}								
≥45	52.9	54.6	56.6	59.5	54.8	56.0	55.7	58.1
≥48	30.3	31.6	32.8	34.7	31.7	32.4	32.3	33.8
≥51	16.9	17.5	18.2	19.2	17.6	18.0	17.9	18.8
≥54	9.5	9.8	10.2	10.8	9.9	10.1	10.0	10.5
≥57	5.0	5.2	5.5	5.8	5.2	5.4	5.3	5.6
≥60	2.6	2.7	2.8	3.0	2.7	2.8	2.8	2.9
≥63	1.4	1.4	1.5	1.6	1.5	1.5	1.5	1.6
≥66	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.9
≥69	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
>72	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

5.2.12. Noise predictions indicate that the increase in 51 dB $L_{Aeq,16h}$ noise contour will range from +0.2 km^2 for Scenario 2a to +4.8 km^2 for Scenario 1c. The change in 45 dB L_{night} noise contour area will range from +0.2 km^2 for Scenario 2a to +4.9 km^2 for Scenario 1c.

5.2.13. The Scenario 1c increase in 51 dB $L_{Aeq,16h}$ noise contour area represents a 9% increase in contour size. The highest increase in the 45 dB L_{night} noise contour represents a 9% increase in contour size. The results of analysis to identify population exposed to aircraft noise in each contour band are presented in Table 7.

Table 7: Edinburgh Airport Population Exposure

Noise Level (dB(A))	Scenario							
	2017 Baseline	2022 Baseline	100% cut in Band A		100% cut in Band B		50% cut in Band A & Band B	
			1a Full Pass Through	1c Zero Pass Through	2a Full Pass Through	2c Zero Pass Through	3a Full Pass Through	3c Zero Pass Through
Daytime $L_{Aeq,16h}$								
≥51	22,331	24,897	27,206	30,653	25,106	25,977	26,129	28,468
≥54	5,680	6,138	6,390	6,726	6,148	6,289	6,296	6,491
≥57	3,745	3,784	3,850	3,944	3,792	3,816	3,820	3,880
≥60	1,866	2,067	2,313	2,570	2,078	2,176	2,191	2,416
≥63	430	430	441	464	430	437	437	456
≥66	199	180	218	259	186	199	201	242
≥69	4	4	6	11	4	6	6	9
>72	0	0	0	0	0	0	0	0
Night-time L_{night}								
≥45	15,322	20,578	22,667	25,999	20,807	21,819	21,789	24,285
≥48	5,042	6,170	6,632	6,964	6,221	6,461	6,343	6,788
≥51	3,828	3,933	3,998	4,092	3,938	3,974	3,965	4,036
≥54	2,868	2,930	2,983	3,052	2,932	2,966	2,960	3,015
≥57	732	803	895	1,209	813	892	841	1,046
≥60	109	126	169	225	131	148	143	195
≥63	2	2	2	6	2	2	2	2
≥66	0	0	0	0	0	0	0	0
≥69	0	0	0	0	0	0	0	0
>72	0	0	0	0	0	0	0	0

5.2.14. The population analysis indicates that the increase in population within the 51 dB $L_{Aeq,16h}$ noise contour will range from 210 people for Scenario 2a to 5,757 people for Scenario 1c. The increase in population within the 45 dB L_{night} contour area will range from 229 people for Scenario 2a to 5,421 people for Scenario 1c.

5.2.15. The Scenario 1c increase in population within the 51 dB $L_{Aeq,16h}$ represents a 23% increase in population. The highest increase in noise 45 dB L_{night} represents a 26% increase in population.

5.2.16. Comparison of the area covered by noise contours shows an approximate similar proportional increase in area and population for the 51 dB $L_{Aeq,16h}$ and 45 dB L_{night} noise contours. However, the marginally higher percentage increase in 45 dB L_{night} indicates that the increased area is more densely populated than the increased area covered by the 51 dB $L_{Aeq,16h}$ noise contour.Table 8.

Table 8: Edinburgh Airport Increase in Area and Population Summary

Scenario	Population Increase		Area Increase / km^2	
	51 dB $L_{Aeq,16h}$	45 dB L_{night}	51 dB $L_{Aeq,16h}$	45 dB L_{night}
1a	2,309	2,089	2.0	2.0
1c	5,757	5,421	4.7	4.9

2a	210	229	0.2	0.2
2c	1,081	1,241	0.9	1.3
3a	1,233	1,211	1.1	1.1
3c	3,572	3,706	3.1	3.5

5.2.17. The results of the assessment of increase in area and population exposed to noise indicate that Scenario 1c (100% cut in Band A , Zero Pass Through) represents the highest impact in terms of noise and Scenario 2a (100% cut in Band B and Full Pass Through) represents the smallest impact. The day period sees an increase in area of 4.7 km^2 and population affected of 5,757 people whereas the night period sees an increase in area of 4.9 km^2 and population of 5,421 people affected.

5.2.18. Scenario 2a (100% cut in Band B and Full Pass Through) represents the smallest impact in terms of noise. The day period sees an increase in area of 0.2 km^2 and population of 210 people whereas the night period sees an increase in area of 0.2 km^2 and population of 229 people.

5.2.19. The noise contour plots for the highest impact scenario (Scenario 1c) are presented in Figure C.25 (daytime) and Figure C.26 (night-time) of Appendix C. The noise contour plots for the lowest impact scenario (Scenario 2a) are presented in Figure C.27 (daytime) and Figure C.28 (night-time) of Appendix C.

Glasgow Airport

5.2.20. The results of noise predictions for each scenario along with the population distribution around Glasgow Airport are presented in Figure C.35 to Figure C.46 of Appendix C. The results of noise predictions showing the area covered by each contour band at Glasgow Airport are presented in Table 9. The cells showing the scenario with the largest and smallest noise impact at Glasgow Airport are shaded dark grey and light grey respectively for easy identification. The discussion of noise predictions takes into account the lowest noise contour level for day and night periods as they are considered to represent the onset of adverse levels of aircraft noise.

Table 9: Glasgow Airport Contour Area Coverage (km^2)

Noise Level (dB(A))	Scenario							
	2017 Baseline	2022 Baseline	100% cut in Band A		100% cut in Band B		50% cut in Band A & Band B	
			1a Full Pass Through	1c Zero Pass Through	2a Full Pass Through	2c Zero Pass Through	3a Full Pass Through	3c Zero Pass Through

Daytime $L_{Aeq,16h}$								
≥51	38.9	39.9	41.3	43.3	40.2	41.5	40.7	42.8
≥54	21.8	22.4	23.3	24.5	22.6	23.5	22.9	24.2
≥57	12.2	12.5	13.0	13.6	12.6	13.1	12.8	13.5
≥60	7.0	7.2	7.5	7.8	7.2	7.5	7.3	7.7
≥63	3.8	3.9	4.1	4.3	4.0	4.1	4.0	4.3
≥66	2.0	2.1	2.2	2.3	2.1	2.2	2.1	2.3
≥69	1.1	1.2	1.2	1.3	1.2	1.2	1.2	1.3
>72	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Night-time L_{night}								
≥45	54.9	56.2	58.1	60.7	56.6	57.9	57.3	59.7
≥48	32.2	33.0	34.2	35.8	33.2	34.1	33.7	35.3
≥51	18.2	18.7	19.4	20.4	18.8	19.4	19.1	20.0
≥54	10.4	10.6	11.0	11.5	10.7	11.0	10.9	11.4
≥57	5.9	6.0	6.3	6.6	6.1	6.2	6.2	6.5
≥60	3.2	3.3	3.4	3.6	3.3	3.4	3.3	3.5
≥63	1.7	1.8	1.8	1.9	1.8	1.8	1.8	1.9
≥66	1.0	1.0	1.1	1.1	1.0	1.1	1.0	1.1
≥69	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.7
>72	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

5.2.21. Noise predictions indicate that the increase in 51 dB $L_{Aeq,16h}$ noise contour will range from +0.4 km^2 for Scenario 2a to +4.5 km^2 for Scenario 1c. The change in 45 dB L_{night} noise contour area will range from +0.3 km^2 for Scenario 2a to +3.4 km^2 for Scenario 1c.

5.2.22. The highest increase in 51 dB $L_{Aeq,16h}$ noise contour area represents an 11% increase in contour size. The highest increase in the 45 dB L_{night} noise contour represents a 6% increase in contour size.

5.2.23. The results of analysis to identify population exposed to aircraft noise in each contour band are presented in Table 10.

Table 10: Glasgow Airport Population Exposure

Noise Level (dB(A))	**Scenario**							
	2017 Baseline	2022 Baseline	100% cut in Band A		100% cut in Band B		50% cut in Band A & Band B	
			1a Full Pass Through	1c Zero Pass Through	2a Full Pass Through	2c Zero Pass Through	3a Full Pass Through	3c Zero Pass Through
Daytime $L_{Aeq,16h}$								
≥51	63,139	68,275	70,487	72,308	69,143	70,181	69,805	71,630
≥54	29,838	32,684	35,423	37,951	33,587	35,316	34,373	37,193
≥57	8,894	10,174	10,997	12,119	10,353	11,152	10,642	11,821

≥60	2,679	2,793	2,923	3,114	2,827	2,949	2,878	3,069
≥63	576	668	837	1,027	704	852	768	974
≥66	0	0	0	0	0	0	0	0
≥69	0	0	0	0	0	0	0	0
>72	0	0	0	0	0	0	0	0
Night-time L_{night}								
≥45	52,351	87,004	89,461	91,254	88,136	88,493	88,686	90,252
≥48	22,446	56,517	59,717	61,814	57,938	58,874	58,734	60,889
≥51	6,953	24,711	26,649	28,747	25,184	26,551	25,870	28,102
≥54	2,059	7,389	7,918	8,603	7,490	7,843	7,719	8,318
≥57	96	2,131	2,337	2,523	2,179	2,305	2,228	2,457
≥60	0	148	227	383	158	199	184	321
≥63	0	0	0	0	0	0	0	0
≥66	0	0	0	0	0	0	0	0
≥69	0	0	0	0	0	0	0	0
>72	0	0	0	0	0	0	0	0

5.2.24. The population analysis indicates that the increase in population within the 51 dB $L_{Aeq,16h}$ noise contour will range from 869 people for Scenario 2a to 4,034 people for Scenario 1c. The increase in population within the 45 dB L_{night} contour area will range from 1,132 people for Scenario 2a to 4,250 people for Scenario 1c.

5.2.25. The highest increase in population within the 51 dB $L_{Aeq,16h}$ represents a 6% increase in population. The highest increase in noise 45 dB L_{night} represents a 5% increase in population.

5.2.26. Comparison of the area covered by noise contours shows a higher percentage increase in area than population for the 51 dB $L_{Aeq,16h}$. However, the 45 dB L_{night} noise contour show an approximately similar percentage increase in area and population. Consequently, it can be concluded that the area covered by increases in 51 dB $L_{Aeq,16h}$ is more densely populated that the increase in area covered by the 45 dB L_{night} noise contour.

5.2.27. A summary of the changes in area (referenced from Table 9) and population (referenced from Table 10) exposed to noise within the 51 dB $L_{Aeq,16h}$ and 45 dB $L_{Aeq,8h}$ noise contours for each scenario in comparison with the 2022 baseline scenario are summarised in Table 11.

Table 11: Glasgow Airport Increase in Area and Population Summary

Scenario	Population Increase		Area Increase / km^2	
	51 dB $L_{Aeq,16h}$	45 dB L_{night}	51 dB $L_{Aeq,16h}$	45 dB L_{night}
1a	2,213	2,457	1.9	1.4
1c	4,034	4,250	4.5	3.4
2a	869	1,132	0.4	0.3
2c	1,907	1,489	1.7	1.6
3a	1,530	1,682	1.1	0.8
3c	3,356	3,249	3.6	2.9

5.2.28. The results of the assessment of increase in area and population exposed to noise indicate that Scenario 1c (100% cut in Band A, Zero Pass Through) represents the highest impact in terms of noise and Scenario 2a (100% cut in Band B and Full Pass Through) represents the smallest impact.

5.2.29. For Scenario 1c, representing the highest impact in terms of noise, the day period sees an increase in the area affected of 4.5 km^2 and the population affected of 4,034 whereas the night period sees an increase in area of 3.4 km^2 and population of 4,250.

5.2.30. Scenario 2a represents the smallest impact in terms of noise. The day period sees an increase in the area affected of 0.4 km^2 and the population affected of 869 whereas the night period sees an increase in area of 0.3 km^2 and population of 1,132.

5.2.31. The noise contour plots for the highest impact scenario (Scenario 1c) are presented in Figure C.37 (daytime) and Figure C.38 (night-time) of Appendix C. The noise contour plots for the lowest impact scenario (Scenario 2a) are presented in Figure C.39 (daytime) and Figure C.40 (night-time) of Appendix C.

Prestwick Airport

5.2.32. The results of noise predictions for each scenario along with the population distribution around Prestwick Airport are presented in Figure C.47 to Figure C.58 of Appendix C. The results of noise predictions showing the area covered by each contour band at Prestwick Airport are presented in Table 12. The cells showing the scenario with the largest and smallest noise impact at Prestwick Airport are shaded dark grey and light grey respectively for easy identification. The discussion of noise predictions takes into account the lowest noise contour level for day and night periods as they are considered to represent the onset of adverse levels of aircraft noise.

Table 12: Prestwick Airport Contour Area Coverage (km^2)

Noise Level (dB(A))	Scenario							
	2017 Baseline	2022 Baseline	100% cut in Band A		100% cut in Band B		50% cut in Band A & Band B	
			1a Full Pass Through	1c Zero Pass Through	2a Full Pass Through	2c Zero Pass Through	3a Full Pass Through	3c Zero Pass Through
Daytime $L_{Aeq,16h}$								
≥51	30.0	30.2	31.8	33.9	30.2	30.2	31.0	32.3
≥54	17.1	17.3	18.2	19.4	17.3	17.3	17.7	18.5

≥57	10.1	10.2	10.7	11.4	10.2	10.2	10.4	10.9
≥60	5.6	5.7	6.0	6.5	5.7	5.7	5.9	6.2
≥63	3.0	3.0	3.2	3.4	3.0	3.0	3.1	3.2
≥66	1.7	1.7	1.8	1.9	1.7	1.7	1.7	1.8
≥69	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.1
>72	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.8
Night-time L_{night}								
≥45	38.4	38.8	42.1	46.3	38.8	38.8	40.4	43.1
≥48	22.2	22.4	24.3	26.6	22.4	22.4	23.4	24.9
≥51	12.6	12.8	13.7	15.0	12.8	12.8	13.2	14.0
≥54	7.6	7.7	8.3	9.0	7.7	7.7	8.0	8.4
≥57	4.1	4.2	4.6	5.1	4.2	4.2	4.4	4.7
≥60	2.3	2.3	2.5	2.7	2.3	2.3	2.4	2.5
≥63	1.3	1.3	1.4	1.6	1.3	1.3	1.4	1.5
≥66	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9
≥69	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6
>72	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4

5.2.33. Noise predictions indicate that the increase in 51 dB $L_{Aeq,16h}$ noise contour will range from no change for Scenarios 2a and 2c to +3.7 km^2 for Scenario 1c. The change in 45 dB L_{night} noise contour area will range from +0.3 km^2 for Scenarios 2a and 2c to +7.5 km^2 for Scenario 1c.

5.2.34. The highest increase in 51 dB $L_{Aeq,16h}$ noise contour area represents a 12% increase in contour size. The highest increase in the 45 dB L_{night} noise contour represents a 19% increase in contour size.

5.2.35. The results of analysis to identify population exposed to aircraft noise in each contour band are presented in Table 13.

Table 13: Prestwick Airport Population Exposure

Noise Level (dB(A))	**Scenario**							
	2017 Baseline	2022 Baseline	100% cut in Band A		100% cut in Band B		50% cut in Band A & Band B	
			1a Full Pass Through	1c Zero Pass Through	2a Full Pass Through	2c Zero Pass Through	3a Full Pass Through	3c Zero Pass Through
Daytime $L_{Aeq,16h}$								
≥51	4,901	5,408	5,645	5,943	5,408	5,408	5,515	5,744
≥54	2,992	3,150	3,268	3,426	3,150	3,150	3,219	3,326
≥57	1,299	1,350	1,519	1,785	1,350	1,350	1,451	1,596
≥60	261	295	349	407	295	295	317	362
≥63	90	103	109	113	103	103	107	109
≥66	47	49	54	60	49	49	54	54

≥69	6	6	15	15	6	6	11	15
>72	0	0	0	0	0	0	0	0
Night-time L_{night}								
≥45	6,739	7,584	8,171	8,956	7,584	7,584	7,875	8,316
≥48	3,918	4,334	4,663	5,164	4,334	4,334	4,500	4,785
≥51	2,666	2,810	2,983	3,163	2,810	2,810	2,883	3,022
≥54	1,055	1,128	1,357	1,577	1,128	1,128	1,235	1,406
≥57	154	182	214	259	182	182	205	225
≥60	75	83	90	94	83	83	88	90
≥63	26	28	34	47	28	28	30	36
≥66	0	2	9	13	2	2	4	11
≥69	0	0	0	0	0	0	0	0
>72	0	0	0	0	0	0	0	0

5.2.36. The population analysis indicates that the increase in population within the 51 dB $L_{Aeq,16h}$ noise contour will range from no change for Scenarios 2a and 2c to 535 people for Scenario 1c. The increase in population within the 45 dB L_{night} contour area will range from no change for Scenarios 2a and 2c to 1,372 people for Scenario 1c.

5.2.37. The highest increase in population within the 51 dB $L_{Aeq,16h}$ represents a 10% increase in population. The highest increase in noise 45 dB L_{night} represents a 19% increase in population.

5.2.38. Comparison of the area covered by noise contours shows an approximate similar proportional increase in area and population for the 51 dB $L_{Aeq,16h}$ and 45 dB L_{night} noise contours. However, the higher percentage increase in 45 dB L_{night} indicates that the increased area is more densely populated than the increased area covered by the 51 dB $L_{Aeq,16h}$ noise contour.

5.2.39. A summary of the changes in area (referenced from Table 12) and population (referenced from Table 13) exposed to noise within the 51 dB $L_{Aeq,16h}$ and 45 dB $L_{Aeq,8h}$ noise contours for each scenario in comparison with the 2022 baseline scenario are summarised in Table 14.

Table 14: Prestwick Airport Increase in Area and Population Summary

Scenario	Population Increase		Area Increase / km^2	
	51 dB $L_{Aeq,16h}$	45 dB L_{night}	51 dB $L_{Aeq,16h}$	45 dB L_{night}
1a	238	586	1.6	3.3
1c	535	1372	3.7	7.5
2a	0	0	0.0	0.0
2c	0	0	0.0	0.0
3a	107	291	0.8	1.6
3c	336	732	2.1	4.3

5.2.40. The results of the assessment of increase in area and population exposed to noise indicate that Scenario 1c (100% cut in Band A, Zero Pass Through) represents the highest impact in terms of noise and Scenario 2a (100% cut in Band B and Full Pass Through) represents the smallest impact.

5.2.41. For Scenario 2c representing the highest impact, the day period sees an increase in area of 3.7 km^2 and population of 535 people whereas the night period sees an increase in area of 7.5 km^2 and population of 732 people.

5.2.42. Scenario 2a (100% cut in Band B and Full Pass Through) and 2c (100% cut in Band B and Zero Pass Through) represents the smallest impact in terms of noise as the changes to ADT do not result in any additional passengers.

5.2.43. The noise contour plots for the highest impact scenario (Scenario 1c) are presented in Figure C.49 (daytime) and Figure C.50 (night-time) of Appendix C. The noise contour plots for the lowest impact scenario (Scenario 2a) are presented in Figure C.52 (daytime) and Figure C.51 (night-time) of Appendix C.

5.3. Summary of Results

5.3.1. A summary of the increase in the population exposed to increased noise as a result of changes in ADT at all airports considered in the assessment are presented in Table 15. The changes in population exposure are calculated through comparison with the 2022 baseline scenario with the largest and smallest impact scenarios shaded dark grey and light grey respectively for easy identification.

Table 15: Increase in Population Affected by Noise

Airport	Noise Contour	Change in Population Affected					
		1a Full Pass Through	1c Zero Pass Through	2a Full Pass Through	2c Zero Pass Through	3a Full Pass Through	3c Zero Pass Through
Aberdeen	51 dB $L_{Aeq,16h}$	496	576	195	548	375	614
	45 dB L_{night}	743	832	216	832	458	922
Edinburgh	51 dB $L_{Aeq,16h}$	2,309	5,757	210	1,081	1,233	3,572
	45 dB L_{night}	2,089	5,421	229	1,241	1,211	3,706
Glasgow	51 dB $L_{Aeq,16h}$	2,213	4,034	869	1,907	1,530	3,356
	45 dB L_{night}	2,457	4,250	1,132	1,489	1,682	3,249
Prestwick	51 dB $L_{Aeq,16h}$	238	535	0	0	107	336
	45 dB L_{night}	586	1,372	0	0	291	732

Airport	Noise Contour	Change in Population Affected					
		1a Full Pass Through	1c Zero Pass Through	2a Full Pass Through	2c Zero Pass Through	3a Full Pass Through	3c Zero Pass Through
Total Change in Affected Population	51 dB $L_{Aeq,16h}$	5,256	10,902	1,274	3,536	3,245	7,878
	45 dB L_{night}	5,875	11,875	1,577	3,562	3,642	8,609

5.3.2. Based on the total area covered by the contours, the largest impact scenarios have been identified to be: 3c (50% cut in Band A & Band B with Zero Pass Through) for Aberdeen and 1c (100% cut in Band A with Zero Pass Through) for Edinburgh, Glasgow and Prestwick.

5.3.3. The increase in population affected under Scenario 1c, identified as having the highest overall impact across all modelled airports, is 10,902 people during daytime and 11,875 people during night-time. This is consistent with the conclusions of the economic assessment which identified Scenario 1c as the scenario likely to generate the greatest economic impact by virtue of the fact that it involved the greatest supply-side response to a reduction in ADT.

5.3.4. The overall increase in population affected during Scenario 2a, identified as having the smallest impact, is 1,274 people during daytime and 1,577 people during night-time.

5.3.5. As expected, these results correspond with PBA's passenger movement forecasts, from which forecast changes in ATMs have been derived. PBA forecast the largest increase in overall passenger movements from all airports under Scenario 1c – where airlines do not lower air fares but instead invest in the development of routes applicable for Band A UK APD rates. Aberdeen Airport is the exception, where the economic analysis identifies that the demand response to lower air fares from an ADT cut (Scenario 3c) is expected to lead to greater increases in passengers (and subsequently ATMs) than from the supply side effect of route development.

6. SUMMARY OF MAIN FINDINGS

6.1.1. The primary aim of this research is to assess the potential impact on noise levels at Scottish airports of the Scottish Government's plans to reduce the overall burden of ADT by 50%. The specific objectives a) to f) can be found in Section 2.3. The following section provides a summary of main findings for each objective.

a) *Establish the current situation with regard to the production of noise maps within the NAPs at Scotland's airports and specifically Aberdeen (ABZ), Glasgow (GLA), Prestwick (PIK), Edinburgh (EDI), and Inverness (INV) airports.*

b) *Assess the extent to which the current outputs (or soon to be outputs) under the END noise mapping exercise will be sufficient in terms of content and coverage to stand as a baseline against which to measure the impact of the expected reduction in ADT.*

c) *Develop additional (appropriate) baseline noise maps where it is considered that the existing or proposed noise maps for Scottish airports are insufficient, incomplete in their coverage or are unlikely to be available to fit in with the research timings of this project.*

6.1.2. Taking a), b) and c) together, this study contains analysis of NAPs and END noise mapping for each of five Scottish airports. At the time of undertaking this study, Round 3 of END mapping was not publicly available and there was subsequent uncertainty over Round 3 noise modelling methodologies. Consequently, it was determined that it would be appropriate to undertake a noise modelling exercise that included the current baseline scenario (based on underlying air traffic growth to 2022) in addition to future scenarios involving different patterns of air traffic determined by potential reductions in ADT for four Scottish airports. The maps are outlined in Figure C.1 to C.10 of Appendix C.

d) *Develop appropriate noise impact assessments for each affected airport based on scenarios to be provided by Scottish Government and, where necessary, take account of exogenous changes such as housing growth in the vicinity of the affected airports.*

6.1.3. Analysis of 2016 ATM data were undertaken for each of the four airports – Aberdeen, Edinburgh, Glasgow and Prestwick. The results of this analysis were extrapolated using future passenger forecasts to provide representative ATM data for a future baseline scenario and six future ADT reduction scenarios. These passenger forecasts were made available from a related study from Peter Brett Associates (see 4.4.1 above) which calculated the net economic impacts of each of the scenarios. Noise modelling of each scenario was undertaken and the anticipated change in the population that would become exposed to aircraft noise under each scenario was identified. The key results of predicted changes in noise levels are presented in Chapter 5.

e) *Produce a national aggregate impact assessment relative to baseline of the noise impact resulting from the plans to reduce the overall burden of ADT by 50%.*

6.1.4. A sum of the total change in affected population for all airports and the results of the sister study (the economic impact assessment of ADT reductions) from which the noise results are generated, are summarised in Table 16 below but are presented in full in Table 15 of Chapter 5.

Table 16: Summary of Noise Assessment and Economic Impact Assessment

Factor		Scenario					
		1a (100% cut in Band A and Full Pass Through)	1c (100% cut in Band A and Zero Pass Through)	2a (100% cut in Band B and Full Pass Through)	2c (100% cut in Band B and Zero Pass Through)	3a (50% cut in Band A & Band B and Full Pass Through)	3c (50% cut in Band A & Band B and Zero Pass Through)
Net economic impact 2017-22 (£m)		252	721	-453	-91	-92	504
Total Change in Affected Population	51 dB $L_{Aeq,16h}$	5,256	10,902	1,274	3,536	3,245	7,878
	45 dB $L_{Aeq,8h}$	5,875	11,875	1,577	3,562	3,642	8,609

6.1.5. The main conclusion is that Scenario 1c (100% cut in Band A and Zero Pass Through, shaded dark grey) is the scenario that generates the greatest economic benefit (£721 million) to Scotland but also generates the largest increase in population affected by aircraft noise both during the day (10,902 people) and at night (11,875 people). This conclusion was expected given that a scenario involving Zero Pass Through is logically one which involves the greatest supply-side response from airlines which in turn would generate greater aircraft noise. Conversely, Scenario 2a (100% cut in Band B and Full Pass Through, shaded light grey) is the scenario that generates the least (in fact, negative) economic benefit (-£453 million) to Scotland but also generates the lowest increase in population affected by aircraft noise both during the day (1,274 people) and at night (1,577 people).

f) *Produce an accompanying narrative setting out the approach, the key uncertainties and the sensitivity of the results to the development of Scottish airports in terms of passenger numbers, air traffic movements and extent of the operational day, considering the potential impact from a change in the number of night time movements.*

6.1.6. The results of this assessment can be seen as an indication of the potential impacts at each airport that may result due to changes in ADT. The noise modelling methodology applied in this assessment was adopted for the purposes of maintaining consistency with the economic assessment of reductions in ADT (as mentioned in 1.1.2 and 6.1.3). Due to the potential different approaches in noise modelling methodology, the results of this assessment should not be directly compared with information contained in individual airport Noise Management Plans which were compiled for purposes other than potential changes in ADT.

6.1.7. It should be noted that the noise assessment does not consider potential changes in the character of the aircraft fleet leaving from and arriving at Scotland's airports. With the introduction of ICAO Chapter 14 (standards of aircraft) in 2017, there is a current trend in the industry to upgrade aircraft types with new, quieter aircraft. The rate at which new aircraft will be introduced into service at each airport is dependent on the respective airline operators. Consequently, due to the uncertainty regarding future fleets, this assessment has not considered the potential introduction of new aircraft variants. As such, increases in affected properties as a result of changes in ADT may potentially be smaller than shown in the results presented in this report, though it is not possible to describe the (unknown) extent of the over-estimation for the precise reason outlined above.

APPENDIX A. NOISE MODELLING METHODOLOGY

A.1. Aircraft Noise Modelling Software

A.1.1. The US Federal Aviation Authority produces the Integrated Noise Model (INM) which was developed by the US Federal Aviation Administration and is approved for use in producing strategic noise maps for compliance with the END. The INM is a computer model that generates data on aircraft noise levels in the vicinity of airports. It is developed from the algorithms and frameworks for calculation of aircraft noise outlined in the SAE-AIR-1845 document[34,] which complies with the calculation method set out in ECAC Doc 29, 3rd Edition[35] and ICAO Doc 9911[36] which set out a standard method for computing aircraft noise.

A.1.2. The INM uses Noise-Power-Distance (aircraft noise level at ground height as a function of distance) data to estimate noise levels, accounting for the typical operational mode, engine thrust setting, source-to-receiver geometry, acoustic directivity and other environmental factors. The INM can calculate exposure, maximum-level and time-based noise contours, as well as levels at pre-selected locations. The INM contains an extensive database of the noise attributes of aircraft, and is flexible enough to allow data from new aircraft or aircraft types to be inserted.

A.2. Aerodrome Layouts and Flight Paths

A.2.1. The National Air Traffic Services website[37] provides information on aerodrome layouts and flight paths. Figures showing flight paths for each airport are presented in Figures A.1 to A.5.

A.3. Method for Determining Baseline Air Traffic Movements

A.3.1. Aircraft flight logs for the 2016 baseline year were obtained for each airport. Analysis of flight logs was undertaken to define representative baseline fleets. The analysis provided the number of annual Air Traffic Movements (ATMs) for each aircraft variant attributed to each runway at the respective airports. The exception to this was for Inverness Airport where 2016 ATM data did not contain specific variants of aircraft but contained information on aircraft type (e.g. twin engine turbo-prop, twin engine business jet, twin engine business jet

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[34] Society of Automotive Engineers, (1995); Aerospace Information Report 1845, Procedure for the Calculation of Airplane Noise in the Vicinity of Airports.
[35] European Civil Aviation Conference, (2005); Doc 29, 3rd Edition, Report on Standard Method of Computing Noise Contours around Civil Airports.
[36] International Civil Aviation Organisation, (2008); Doc 9911 Recommended Method for Computing Noise Contours Around Airports Edition 1.
[37] http://www.nats-uk.ead-it.com/public/index.php%3Foption=com_content&task=blogcategory&id=1&Itemid=2.html

etc.), movement type (e.g. scheduled service, freight/cargo, military etc.), flight number and aircraft registration.

A.3.2. To obtain a representative fleet for Inverness Airport, analysis of 2016 ATM data was undertaken by identifying each aircraft type within each movement type group. Flight numbers and aircraft registration information were used to identify the most common aircraft variants for each aircraft type. To simplify the process for piston aircraft, it was considered all types of these aircraft were comparable to a Cessna 172.

A.3.3. To simplify 2016 ATM data for all airports, it was considered that aircraft variants that had movements on any runway that were less than an average of 0.25 per day were discarded from the list of aircraft variants operational at each airport as, in terms of daily movements, these aircraft were not considered significant. For Prestwick Airport, the significance level was reduced to an average of 0.1 movements on a runway per day as, due to the comparatively low number of daily ATMs, it was found that using an average of 0.25 movements per day resulted in the omission of a significant number of aircraft. The ATM data for discarded aircraft was distributed among the study fleet so the baseline of the total movements for the representative fleet corresponded with the total movements for all aircraft.

A.3.4. In the 2016 ATM data for Aberdeen and Prestwick airports there was a contribution from military and rotary wing aircraft (relating to the oil industry at Aberdeen and search and rescue at Prestwick). It was agreed that for the purposes of this study these types of movements would not be modelled as military and rotary wing aircraft are non-chargeable under ADT.

A.4. Future Scenario Passenger Forecasts

A.4.1. Passenger forecasts with and without the proposed ADT reduction scenarios have been provided by Peter Brett Associates (PBA). Forecast passenger data covers the years from 2017 to 2022 and was simplified into groups defined by the nationality of the operator to provide a means of correlating passenger numbers with ATMs:

- UK scheduled operators;
- EU scheduled operators;
- Overseas (non-EU) scheduled operators;
- UK charter operators;
- EU charter operators; and
- Cargo/ aeroclub.

A.5. Method for Determining Future Scenario INM Input Data

A.5.1. Future ATMs for each scenario have been calculated with reference to the baseline 2016 ATM data. Aircraft fleets for each airport have been summarised into the operator classes from the 2016 ATM data. This was achieved differently for each airport depending on the format of the baseline data.

A.5.2. Aberdeen Airport provided information on aircraft origin and destinations so, depending on the aircraft variant, the applicable aircraft group has been assumed.

A.5.3. The aircraft types for Edinburgh and Glasgow Airport have been derived through study of 2016 baseline data and identification of the type of aircraft that fleet operators use. Edinburgh and Glasgow Airports provided aircraft call signs in the baseline ATM data which enabled identification of aircraft groups that are operated by significant carriers.

A.5.4. For Inverness Airport, the 2022 baseline was derived from Department for Transport forecasts[38] with different corrections applied to scheduled and non-scheduled services, which were derived using CAA data for 2016[39].

A.5.5. For Prestwick Airport, all aircraft are operated by Ryanair, who use only Boeing 737-800 aircraft[40]. This meant that all changes in passenger numbers could be assumed to directly affect numbers of this type of aircraft, with no change to the fleet mix.

A.5.6. The stage length represents the assumed distance an aircraft travels when departing an airport. The higher the stage length, the more fuel is required for the aircraft to reach its destination. An aircraft with more fuel is heavier and so requires increased thrust to take-off and the climb-rate will be lower. Consequently, the higher the aircraft stage length, the noisier the aircraft is on departure. It should be noted that on arrival, all aircraft will be low on fuel so all aircraft have a single setting for approach weight. Stage length settings in nautical miles (nmi) for aircraft departures are presented in Table 17.

[38] https://www.gov.uk/government/publications/uk-aviation-forecasts-2013
[39] https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-airport-data/
[40] https://www.ryanair.com/gb/en/useful-info/about-ryanair/fleet

Table 17 Aircraft Departure Stage Length (Nautical miles, nmi)

Stage	Stage Length
1	0 to 500 nmi
2	501 to 1000 nmi
3	1001 to 1500 nmi
4	1501 to 2500 nmi
5	2501 to 3500 nmi
6	3501 to 4500 nmi
7	4501 to 5500 nmi
8	5501 to 6500 nmi
9	over 6500 nmi

A.5.7. Stage lengths for each aircraft have been estimated based on the destinations for aircraft at each airport. For example, aircraft from Edinburgh and Glasgow airports may fly to destinations in the Americas and Middle East so the larger aircraft required have been assigned a higher stage length to account for longer flights. In comparison, destinations from Aberdeen and Prestwick airports that are short-haul flights to domestic or EU locations were assigned lower stage lengths. It is assumed that the destinations that aircraft operators will provide services to will remain consistent for future scenarios. Consequently, the stage length is consistent for all scenarios and only the change in daily average ATMs affects the extent of noise contours.

Figure A.1 Aberdeen Airport Flight Paths

Figure A.2 Edinburgh Airport Flight Paths

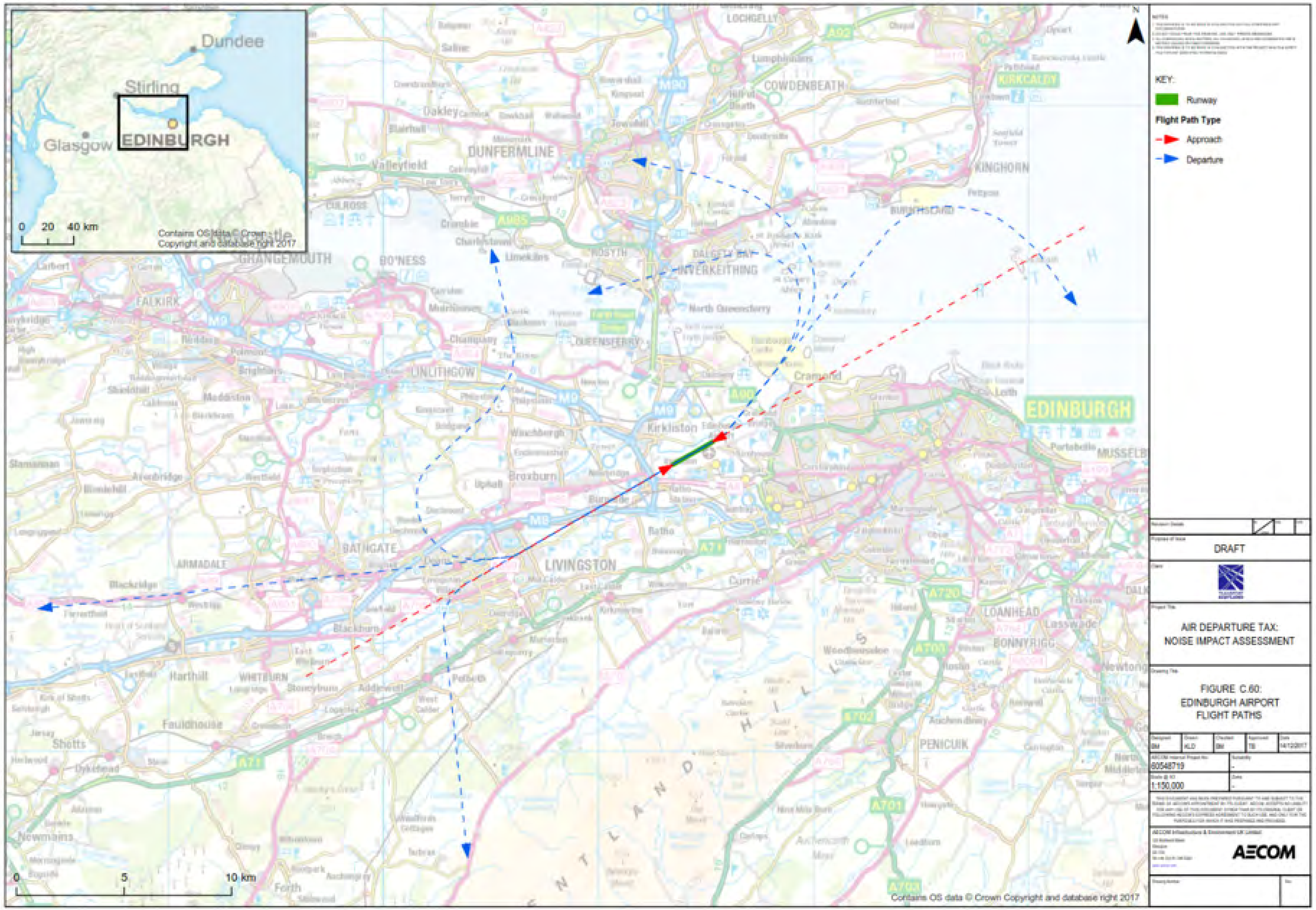


Figure A.3 Glasgow Airport Flight Paths

Figure A.4 Inverness Airport Flight Paths

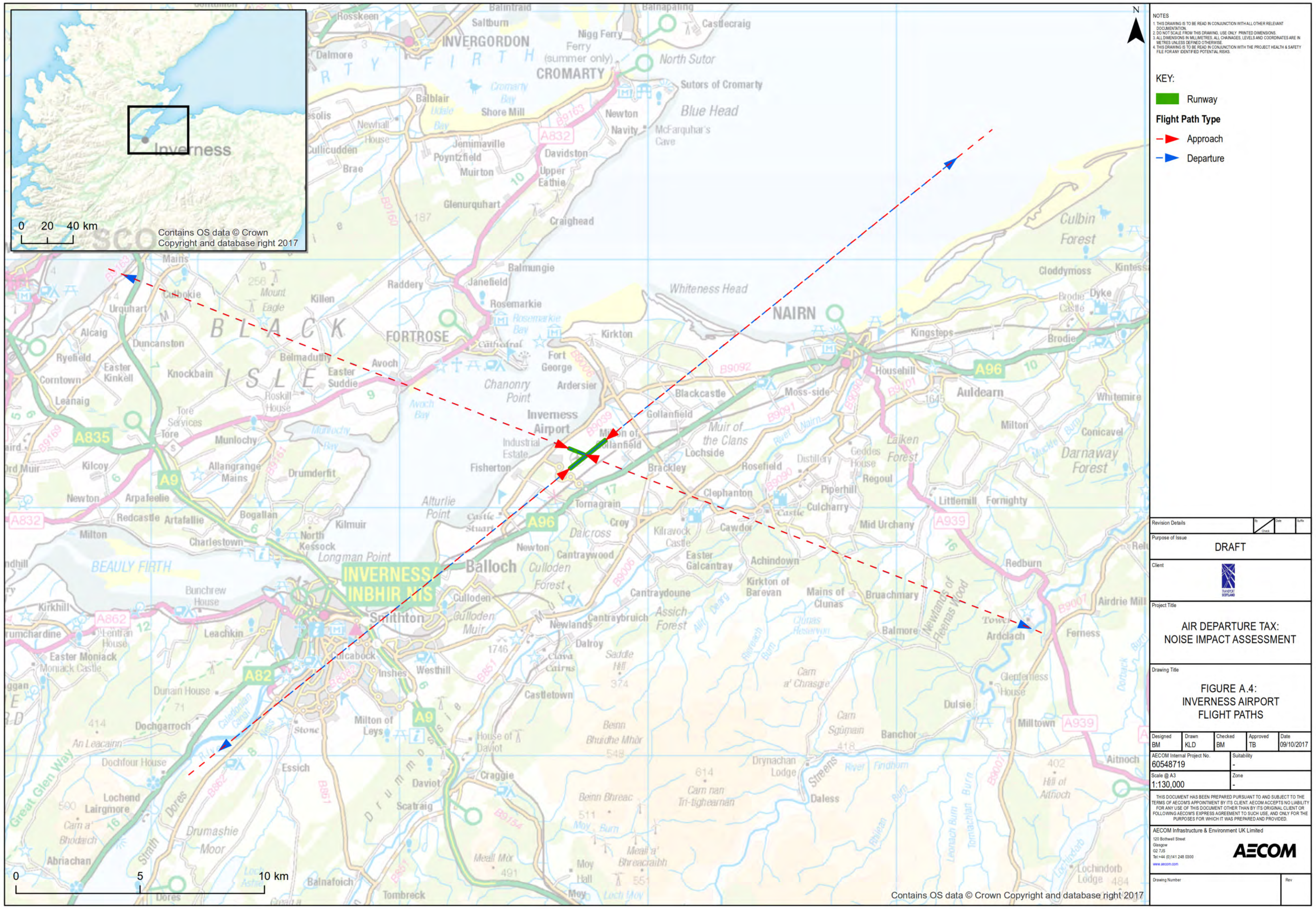
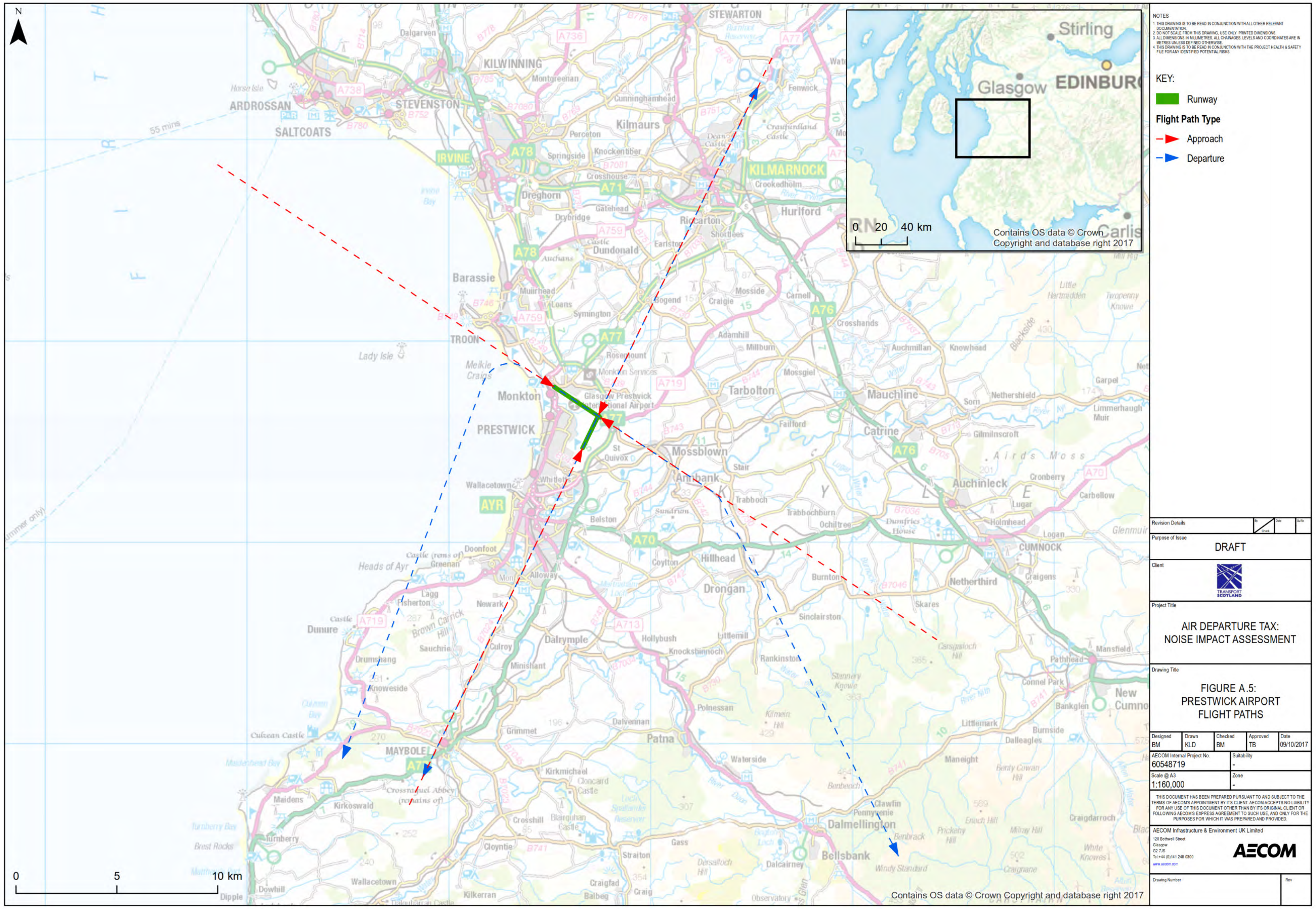


Figure A.5 Prestwick Airport Flight Paths



APPENDIX B. FORECAST AIR TRAFFIC MOVEMENTS

B.1. Forecast Changes at Aberdeen Airport

B.1.1. The majority of passengers from the 2017 baseline scenario at Aberdeen Airport are associated with UK scheduled operators (approximately 62%). Approximately 28% of passengers are from EU operators, with the remaining 10% split between overseas operators and UK charter operators. A minor amount of passengers (less than 1%) are attributed to EU charter operators. The total number of Air Traffic Movements (ATMs) for the 2017 baseline scenario is approximately 179 ATMs per day.

B.1.2. The natural growth in passenger numbers (assuming no changes in ADT) is forecast to see Aberdeen Airport increase from 2.94 million passengers per annum (mppa) in 2017 to 3.05 mppa in 2022, with a split between operators approximately equivalent to the 2017 baseline scenario. The overall increase in passengers has been calculated to be equivalent to an increase in daily ATMs of approximately 6.3.

B.1.3. Scenario 1a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 81,000 mppa, with a split between operators approximately equivalent to the 2022 baseline scenario. The overall increase in passengers for Scenario 1a equates to an increase in daily ATMs from the 2022 baseline scenario of 4.6.

B.1.4. Scenario 1c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 89,000 mppa. The majority of additional passengers are assigned to scheduled UK operators with a smaller amount assigned to UK charter operators; however, due to the high number of scheduled UK operator flights, the increase in passengers is approximately 4% whereas the increase in UK charter operator passengers is approximately 9%. The increase overall in passengers for Scenario 1c equates to an increase in daily ATMs from the 2022 baseline scenario of 6.7.

B.1.5. Scenario 2a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 21,000 mppa. The majority of additional passengers are assigned to scheduled UK operators with a smaller amount assigned to scheduled overseas operators and a minor amount assigned to scheduled EU operators. The increase in UK scheduled operator passengers is approximately 1% whereas the increase in overseas scheduled operator passengers is approximately 4%. The overall increase in passengers for Scenario 2a equates to an increase in daily ATMs from the 2022 baseline scenario of 1.0.

B.1.6. Scenario 2c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 93,000 mppa. The majority of additional passengers are assigned to scheduled UK operators with a smaller amount assigned to scheduled overseas operators and a minor amount assigned to scheduled EU operators. The increase in UK scheduled operator passengers is approximately 3% whereas the increase in overseas scheduled operator passengers is approximately 24%. The overall increase in passengers for Scenario 2c equates to an increase in daily ATMs from the 2022 baseline scenario of 4.4.

B.1.7. Scenario 3a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 51,000 mppa. The additional passengers are mostly assigned to scheduled UK and EU operators with a minor amount of passengers shared between scheduled overseas, and UK and EU charter operators. These changes are equivalent to an increase in passengers of approximately 1-2% for all aircraft operator categories. The overall increase in passengers for Scenario 3a equates to an increase in daily ATMs from the 2022 baseline scenario of 2.8.

B.1.8. Scenario 3c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 104,000 mppa. The additional passengers are mostly assigned to scheduled UK operators with moderate amounts of passengers assigned to overseas scheduled and UK charter operators. The percentage increase in passengers for each operator category is most notable in the UK charter category, which increases by approximately 14%. Other categories increase by approximately 4-5% with the exception of EU scheduled operators, which do not increase. The overall increase in passengers for Scenario 3c equates to an increase in daily ATMs from the 2022 baseline scenario of 6.3.

B.1.9. The daily averages of ATMs per aircraft variant for each scenario at Aberdeen Airport are presented in Table 18. In addition to ATM data, Table 18 also presents the estimated stage length for each aircraft variant along with the associated aircraft type for each variant that was used to distribute passenger forecasts onto aircraft.

Table 18 Aberdeen Daily Average ATMs

Aircraft type (INM Code)	Departure Stage Length	Average Daily ATMs per Scenario							
		2017 baseline	2022 baseline	1a	1c	2a	2c	3a	3c
737300	2	5.82	6.03	6.21	6.27	6.08	6.23	6.14	6.28
737400	2	1.19	1.77	1.77	1.77	1.77	1.77	1.77	1.77
A319-131	2	14.17	14.68	15.10	15.25	14.80	15.16	14.95	15.28
A320-232	2	6.69	6.93	7.13	7.20	6.99	7.16	7.06	7.22
A321-232	2	2.46	2.55	2.61	2.55	2.57	2.63	2.59	2.60
ATR72	1	2.22	2.30	2.35	2.30	2.31	2.37	2.33	2.34
BEC200	1	39.16	40.57	41.59	44.01	40.57	40.57	41.08	42.53
CRJ900	1	7.37	7.64	7.81	7.64	7.68	7.88	7.75	7.77
DHC830	1	30.40	31.49	32.20	31.49	31.69	32.49	31.95	32.06
DO228	1	1.42	1.48	1.51	1.60	1.48	1.48	1.49	1.55
EMB135	2	4.52	4.68	4.82	4.86	4.72	4.84	4.77	4.87
EMB145	2	5.31	5.50	5.66	5.71	5.54	5.68	5.60	5.72
EMB170	2	7.10	7.36	7.52	7.36	7.40	7.59	7.46	7.49
EMB190	2	7.69	7.97	8.15	7.97	8.02	8.22	8.08	8.11
FK70	2	2.21	2.29	2.32	2.48	2.29	2.29	2.30	2.40
HS748A	1	1.77	1.19	1.19	1.19	1.19	1.19	1.19	1.19
PA30	1	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68
SAAB20	1	22.94	23.77	24.45	24.68	23.96	24.55	24.20	24.74
SF340	2	14.47	14.99	15.42	15.57	15.11	15.48	15.26	15.60
Total Passengers (mppa)		**2.94**	**3.05**	**3.13**	**3.14**	**3.07**	**3.14**	**3.10**	**3.15**
Total ATMs		**178.6**	**184.9**	**189.5**	**191.6**	**185.9**	**189.3**	**187.7**	**191.2**

B.2. Forecast Changes at Edinburgh Airport

B.2.1. The majority of passengers from the 2017 baseline scenario at Edinburgh Airport are associated with UK scheduled operators (approximately 43%) and EU scheduled operators (approximately 44%). Approximately 6% of passengers are associated with both overseas operators and UK charter operators. A minor amount of passengers (approximately 2%) are attributed to EU charter operators. The total number of ATMs for the 2017 baseline scenario is approximately 379 per day.

B.2.2. Natural growth in passenger numbers is forecast to see Edinburgh Airport increase from 12.56 mppa in 2017 to 13.99 mppa in 2022. The split of passengers between operators shows an increase in UK and EU scheduled passengers and a decrease in overseas scheduled, UK charter and EU charter passengers from the 2017 baseline scenario. This has been calculated to be equivalent to an increase in daily ATMs of approximately 26.

B.2.3. Scenario 1a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 715,000 mppa; which are approximately equally split between UK and EU scheduled operators with minor amounts of passengers assigned to scheduled overseas, UK charter and EU charter operators. The percentage increase in UK and EU scheduled passengers is approximately 2-3% for each category, with other categories experiencing no appreciable increase in passengers. The overall increase in passengers for Scenario 1a equate to an increase in daily ATMs from the 2022 baseline scenario of 20.5.

B.2.4. Scenario 1c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 1,677,000 mppa. The majority of additional passengers are assigned to scheduled EU scheduled operators with approximately half the amount assigned to UK scheduled operators. A minor amount of passengers are assigned to UK and EU charter operators. The percentage increase in EU scheduled passengers is approximately 7% and, for UK scheduled passengers, the increase is approximately 3%. Other categories experience no appreciable increase in passengers. The overall increase in passengers for Scenario 1c equates to an increase in daily ATMs from the 2022 baseline scenario of 44.4.

B.2.5. Scenario 2a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 63,000 mppa. Passengers are split approximately equally between UK, EU and overseas scheduled operators assigned to scheduled UK operators with a minor amount assigned to UK charter operators. The low number of passengers for this scenario results in an increase in passengers for all categories of no more than 0.2%. The overall increase in passengers for Scenario 2a equates to an increase in daily ATMs from the 2022 baseline scenario of 1.8.

B.2.6. Scenario 2c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 280,000 mppa. The majority of additional passengers are assigned to scheduled UK and overseas operators with a minor amount assigned to scheduled EU and UK charter operators. These increases are equivalent to an approximately 1% increase in UK and overseas scheduled passengers with all other affected categories having no appreciable increase. The overall increase in passengers for Scenario 2c equates to an increase in daily ATMs from the 2022 baseline scenario of 10.5.

B.2.7. Scenario 3a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 389,000 mppa. The additional passengers are mostly assigned to scheduled UK and EU operators with smaller amounts assigned to overseas scheduled, and UK and EU charter operators. The increases in passengers are equivalent to an approximate 1% increase in both UK and EU scheduled passengers, with all other categories experiencing no appreciable increase. The overall increase in passengers for Scenario 3a equates to an increase in daily ATMs from the 2022 baseline scenario of 11.5.

B.2.8. Scenario 3c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 1,119,000 mppa. Passengers are mostly assigned to scheduled operators with the largest increase being assigned to scheduled EU operators. A minor amount of passengers are assigned to UK and EU charter operators. The percentage increase in passengers is equivalent to approximately 3% for UK scheduled operators, 4% for EU scheduled operators and 1% for overseas scheduled operators. All other categories experience no appreciable increase in passengers. The overall increase in passengers for Scenario 3c equates to an increase in daily ATMs from the 2022 baseline scenario of 29.4.

B.2.9. The daily averages of ATMs per aircraft variant for each scenario at Edinburgh Airport are presented in Table 19. In addition to ATM data, Table 19 also presents the estimated stage length for each aircraft variant along with the associated aircraft type for each variant that was used to distribute passenger forecasts onto aircraft.

Table 19 Edinburgh Daily Average ATMs

Aircraft type (INM Code)	Departure Stage Length	Average Daily ATMs per Scenario							
		2017 baseline	2022 baseline	1a	1c	2a	2c	3a	3c
A319-131	2	58.12	64.59	67.79	70.22	64.87	65.89	66.33	68.55
A320-232	2	53.73	59.56	62.55	65.13	59.81	60.68	61.18	63.38
A321-232	2	6.06	6.60	6.96	7.49	6.62	6.67	6.79	7.15
A330-301	6	2.23	1.55	1.55	1.55	1.59	1.90	1.57	1.75
737300	3	19.26	20.22	21.18	21.91	20.32	20.73	20.75	21.48
737700	4	5.24	5.70	6.01	6.48	5.72	5.76	5.87	6.18
737800	4	77.48	83.33	88.14	97.23	83.57	83.69	85.86	91.48
737900	4	0.97	1.02	1.07	1.11	1.03	1.05	1.05	1.09
757PW	6	5.65	0.99	0.99	0.99	1.00	1.12	0.99	1.06
767300	6	1.25	3.93	3.93	3.93	4.04	4.81	3.98	4.43
7878R	6	2.52	1.75	1.76	1.75	1.80	2.15	1.78	1.98
ATR72	1	14.73	15.80	16.73	18.54	15.85	15.85	16.29	17.40
BAE146	1	5.53	5.37	5.62	6.12	5.41	5.61	5.52	5.94
BEC200	1	1.31	0.73	0.76	0.78	0.73	0.74	0.75	0.77
CNA421	1	0.95	0.53	0.55	0.57	0.53	0.54	0.54	0.56
CNA650	1	3.34	1.86	1.94	2.00	1.87	1.88	1.91	1.95
CRJ900	2	0.84	0.90	0.95	1.05	0.90	0.90	0.92	0.99
DHC830	1	62.87	70.03	73.46	75.78	70.33	71.50	71.89	74.16
DO328	1	4.44	4.94	5.18	5.35	4.96	5.05	5.07	5.23
EMB170	2	3.61	4.02	4.21	4.35	4.03	4.10	4.12	4.26
EMB175	2	1.13	1.25	1.31	1.36	1.26	1.28	1.29	1.33
EMB190	2	22.83	23.57	24.76	25.77	23.65	25.78	24.20	25.02
EMB195	2	3.78	4.22	4.42	4.56	4.23	4.30	4.33	4.46
GV	1	0.88	0.49	0.51	0.53	0.49	0.50	0.50	0.52
SF340	2	20.36	22.21	23.30	25.03	22.30	23.15	22.80	23.50
Total Passengerse (mppa)		12.56	13.99	14.70	15.66	14.05	14.27	14.38	15.11
Total ATMs		379.1	405.2	425.6	449.6	407	415.6	416.3	434.6

B.3. Forecast Changes at Glasgow Airport

B.3.1. The majority of passengers from the 2017 baseline scenario at Glasgow airport are associated with UK scheduled operators (approximately 54%). Approximately 25% of passengers are from EU operators, 5% associated with overseas operators and 16% from UK charter operators. A minor amount of passengers are attributed to EU and overseas charter operators, which are considered approximate to a 0% contribution to total passengers. The total number of ATMs for the 2017 baseline scenario is approximately 310 per day.

B.3.2. The natural growth in passenger numbers is forecast to see Glasgow Airport increase from 9.31 mppa in 2017 to 9.60 mppa in 2022, with a split between operators approximately equivalent to the 2017 baseline scenario. The overall increase in passengers has been calculated to be equivalent to an increase in daily ATMs of approximately 10 per day.

B.3.3. Scenario 1a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 419,000 mppa. The majority of additional passengers are assigned to scheduled UK operators with a smaller amount assigned to EU scheduled and UK charter operators. The increase in UK scheduled passengers is approximately 5%, EU scheduled passengers increase by approximately 2% and UK charter passengers by approximately 1%. Other operator groups experience no appreciable increase in passenger numbers. The overall increase in passengers for Scenario 1a equate to an increase in daily ATMs from the 2022 baseline scenario of 24.3.

B.3.4. Scenario 1c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 988,000 mppa. The majority of additional passengers are assigned to scheduled UK and EU scheduled operators with a smaller, but significant, number of passengers assigned to UK charter operators. The increase in UK scheduled passengers is approximately 9%, EU scheduled passengers increase by approximately 7% and UK charter passengers by approximately 2%. Other operator groups experience minor increases in passengers such that there is no appreciable change. The overall increase in passengers for Scenario 1c equates to an increase in daily ATMs from the 2022 baseline scenario of 33.0.

B.3.5. Scenario 2a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 87,000 mppa. Passengers are mainly assigned to UK scheduled operators with a smaller amounts assigned to overseas scheduled and UK charter operators. The increase in passengers corresponds to an approximate increase of up to 1% for UK scheduled, overseas scheduled and UK charter operators. The overall increase in passengers for Scenario 2a equates to an increase in daily ATMs from the 2022 baseline scenario of 12.8.

B.3.6. Scenario 2c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 436,000 mppa. The majority of additional passengers are assigned to UK and overseas scheduled operators with a minor amount assigned to UK charter operators. The increase in UK scheduled passengers is approximately 5%, EU scheduled passengers increase by approximately 3% and UK charter passengers by approximately 1%. The increase in passengers equates to an increase in daily ATMs from the 2022 baseline scenario of 23.6.

B.3.7. Scenario 3a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 253,000 mppa. The additional passengers are split between all aircraft groups with the majority being assigned to UK scheduled operators and smaller amounts assigned to EU and overseas scheduled, and UK charter operators. The increase in UK scheduled passengers is approximately 3%, whereas other operator groups experience forecast passenger increases of up to 1%. The overall increase in passengers for Scenario 3a equates to an increase in daily ATMs from the 2022 baseline scenario of 18.3.

B.3.8. Scenario 3c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 814,000 mppa. The majority of additional passengers are assigned UK scheduled flights with approximately half the amount assigned to EU scheduled operators. Passenger increases of approximately half that applied to EU scheduled flights are assigned to both overseas scheduled and UK charter flights. The increase in UK scheduled passengers is approximately 8%, EU scheduled passengers increase by approximately 4% and both overseas scheduled and UK charter passengers by approximately 2%. The overall increase in passengers for Scenario 2c equates to an increase in daily ATMs from the 2022 baseline scenario of 36.5.

B.3.9. The daily averages of ATMs per aircraft variant for each scenario at Glasgow Airport are presented in Table 20. In addition to ATM data, Table 20 also presents the estimated stage length for each aircraft variant along with the associated aircraft type for each variant that was used to distribute passenger forecasts onto aircraft.

Table 20 Glasgow Daily Average ATMs

Aircraft type (INM Code)	Departure Stage Length	Average Daily ATMs per Scenario							
		2017 baseline	2022 baseline	1a	1c	2a	2c	3a	3c
737300	2	2.14	2.21	2.31	2.37	2.44	2.23	2.26	2.29
737400	2	1.04	1.07	1.12	1.16	1.20	1.08	1.07	1.07
737700	4	10.23	10.55	11.00	11.32	11.69	10.66	10.90	11.19
737800	4	46.55	48.02	50.40	52.39	54.65	48.50	48.52	48.87
737900	4	1.48	1.52	1.60	1.68	1.77	1.54	1.52	1.52
747400	2	1.03	1.06	1.12	1.14	1.16	1.07	1.09	1.11
767300	5	0.94	0.97	1.00	1.02	1.03	0.98	1.03	1.09
777300	6	4.23	4.36	4.36	4.36	4.36	4.41	5.01	5.61
757PW	6	15.30	15.78	16.42	16.81	17.26	15.94	16.48	17.07
787R	2	1.39	1.43	1.50	1.53	1.57	1.45	1.47	1.50
A310-304	2	1.40	1.44	1.44	1.44	1.44	1.46	1.66	1.86
A319-131	2	44.04	45.44	47.70	48.66	49.79	45.90	46.71	47.64
A320-232	2	24.01	24.77	26.00	26.54	27.16	25.02	25.46	25.96
A321-232	2	16.76	17.29	18.15	18.51	18.93	17.47	17.78	18.14
A330-301	6	3.08	3.17	3.33	3.40	3.48	3.20	3.26	3.33
ATR42	1	2.83	2.92	3.06	3.17	3.29	2.95	2.92	2.92
ATR72	1	10.49	10.82	11.36	11.93	12.57	10.93	10.83	10.83
BEC200	1	4.05	4.18	4.23	4.31	4.40	4.22	4.36	4.46
BEC300	1	2.07	2.13	2.19	2.24	2.29	2.15	2.16	2.17
CNA152	1	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
CNA172	1	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58
CNA510	1	0.81	0.84	0.86	0.88	0.90	0.84	0.85	0.85
CNA560XL	1	0.73	0.76	0.78	0.79	0.81	0.76	0.77	0.77
CRJ900	1	1.81	1.86	1.95	2.05	2.16	1.88	1.86	1.86
DHC6	1	10.74	11.08	11.63	12.22	12.87	11.19	11.08	11.08
DHC830	1	40.13	41.40	43.46	44.32	45.33	41.82	42.58	43.43
DO228	1	3.01	3.11	3.23	3.30	3.37	3.14	3.11	3.11
EMB120	1	1.21	1.25	1.30	1.32	1.35	1.26	1.25	1.25
EMB170	2	2.78	2.87	3.01	3.07	3.14	2.90	2.95	3.01
EMB190	2	14.65	15.11	15.86	16.21	16.62	15.26	15.51	15.79
GROB15	1	4.80	4.95	5.09	5.21	5.32	5.00	5.03	5.05
PA28	1	2.29	2.29	2.29	2.29	2.29	2.29	2.29	2.29
PA38	1	1.65	1.70	1.75	1.79	1.83	1.71	1.72	1.73
SAAB20	1	6.83	7.04	7.40	7.54	7.71	7.12	7.25	7.39
SF340	2	22.43	23.14	24.29	24.77	25.33	23.37	23.80	24.27
Total Passengers (mppa)		**9.31**	**9.60**	**10.02**	**10.59**	**9.69**	**10.04**	**9.85**	**10.41**
Total ATMs		**309.6**	**319.2**	**342.5**	**352.3**	**327.3**	**333.2**	**327.9**	**346.1**

B.4. Forecast Changes at Inverness Airport

B.4.1. The baseline and future baseline ATM data for Inverness Airport are presented in Table 21. The 2022 future baseline has been estimated based on ATM trends from previous years referenced from the Civil Aviation Authority (CAA) website and future projections referenced from the Department for Transport (DfT). The total number of ATMs for the 2017 baseline scenario is approximately 73 per day, which is forecast to increase to approximately 83 per day in 2022.

Table 21 Inverness Daily Average ATMs

Aircraft type (INM Code)	Departure Stage Length	Scenario	
		2017 baseline	2022 baseline
A320-232	2	13.98	16.00
BEC200	1	0.48	0.55
BEC300	1	1.03	1.18
BN2A	1	0.93	1.07
CNA172	1	20.68	23.68
CNA208	1	0.21	0.24
CNA510	1	1.91	2.19
CNA550	1	0.03	0.04
CNA560XL	1	2.97	3.40
DA42	1	0.09	0.10
DO228	1	0.01	0.01
EMB190	2	0.08	0.09
LEAR35	1	0.07	0.07
PC12	1	0.03	0.04
SAAB20	1	24.71	28.28
SF340	2	5.36	6.13
Total ATMs		72.6	83.1

B.5. Forecast Changes at Prestwick Airport

B.5.1. Passenger numbers at Prestwick Airport are forecast to increase in number from 0.68 mppa in 2017 to 0.69 mppa in 2022. This has been calculated to be equivalent to an increase in daily ATMs of approximately 0.9 per day.

B.5.2. It should be noted that all passengers at Prestwick Airport use scheduled EU operator services. The Boeing 737-800 aircraft is the only commercial aircraft in use at Prestwick Airport so increases in ATMs can only (at the moment) occur for this single type of aircraft. At other airports, with a wider variety of aircraft types, changes in ATMs are distributed amongst a range of aircraft which ultimately generate a more complex range of effects between noise outputs and noise contours.

B.5.3. Scenario 1a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 77,000 mppa. The increase in passengers equates to an increase in daily ATMs from the 2022 baseline scenario of 6.1.

B.5.4. Scenario 1c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 176,000 mppa. The increase in passengers equates to an increase in daily ATMs from the 2022 baseline scenario of 14.1.

B.5.5. Scenario 2a and Scenario 2c are forecast to result in no changes to the 2022 baseline passenger numbers or ATMs, since no Band B applicable flights are projected to depart from or land at Prestwick Airport.

B.5.6. Scenario 3a forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 38,000 mppa. The increase in passengers equates to an increase in daily ATMs from the 2022 baseline scenario of 3.1.

B.5.7. Scenario 3c forecasts an increase in annual passengers from the 2022 baseline scenario of approximately 101,000 mppa. The increase in passengers equates to an increase in daily ATMs from the 2022 baseline scenario of 8.0.

B.5.8. The daily averages of ATMs per aircraft variant for each scenario at Prestwick Airport are presented in Table 22. In addition to ATM data, Table 22 also presents the estimated stage length for each aircraft variant along with the associated aircraft type for each variant that was used to distribute passenger forecasts onto aircraft.

Table 22 Prestwick Daily Average ATMs

Aircraft type (INM Code)	Departure Stage Length	Scenario							
		2017 baseline	2022 baseline	1a	1c	2a	2c	3a	3c
7478	3	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45
737300	3	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
737800	4	54.70	55.56	61.73	69.68	55.56	55.56	58.65	63.63
747400	3	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
757PW	6	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39
A319-131	2	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14
A320-232	2	4.73	4.73	4.73	4.73	4.73	4.73	4.73	4.73
A321-232	2	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35
A330-301	6	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
AA5A	1	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40
BAE146	2	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73
BEC200	1	3.91	3.91	3.91	3.91	3.91	3.91	3.91	3.91
CNA152	1	10.43	10.43	10.43	10.43	10.43	10.43	10.43	10.43
CNA172	1	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
CNA182	1	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77
CNA404	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CNA750	1	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
DHC6	1	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
DHC8	1	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.34
FAL20	1	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
GROB15	1	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
PA28AR	1	20.37	20.37	20.37	20.37	20.37	20.37	20.37	20.37
PA30	1	7.19	7.19	7.19	7.19	7.19	7.19	7.19	7.19
PA32C6	1	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
PC6	1	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
PITTS S1	1	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
SD330	1	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52
SF340	2	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
Total Passengers (mppa)		**0.68**	**0.69**	**0.77**	**0.87**	**0.69**	**0.69**	**0.73**	**0.79**
Total ATMs		**152.3**	**153.2**	**159.3**	**167.3**	**153.2**	**153.2**	**156.3**	**161.2**

APPENDIX C. NOISE CONTOUR PLOTS

C.1.1. Noise contour plots showing the results of aircraft noise modelling along with the distribution of population in the area around each airport are presented within this appendix. There are two noise contour plots presented for each modelled scenario to account for daytime $L_{Aeq,16h}$ and night-time $L_{Aeq,8h}$ aircraft noise. The noise contour plots are listed as follows:

- Figure C.1 to C.10 (pages 61 to 70) compare baseline 2017 to baseline 2022 for each of the five airports;
- Figure C.11 to Figure C.22 (pages 71 to 82) present each of the future modelled scenarios at Aberdeen Airport;
- Figure C.23 to Figure C.34 (pages 83 to 94) present each of the future modelled scenarios at Edinburgh Airport;
- Figure C.35 to Figure C.46 (pages 95 to 106) present each of the future modelled scenarios at Glasgow Airport; and
- Figure C.47 to Figure C.58 (pages 107 to 118) present each of the future modelled scenarios at Prestwick Airport.

Figure C.1 Aberdeen Airport Baseline 2017 v Baseline 2022 $L_{Aeq,16h}$ dB Noise Contours

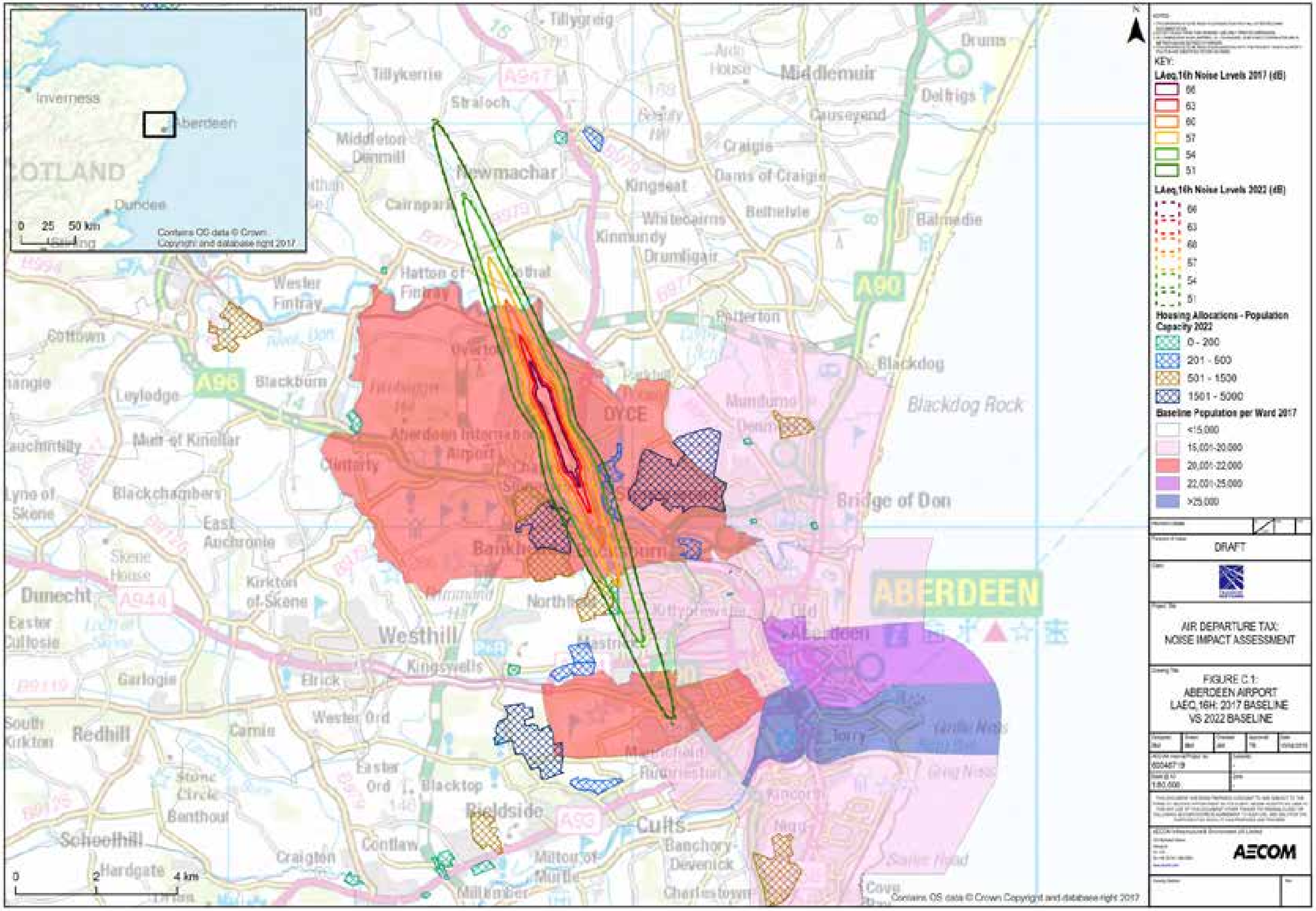


Figure C.2 Aberdeen Airport Baseline 2017 v Baseline 2022 L_{night} dB Noise Contours

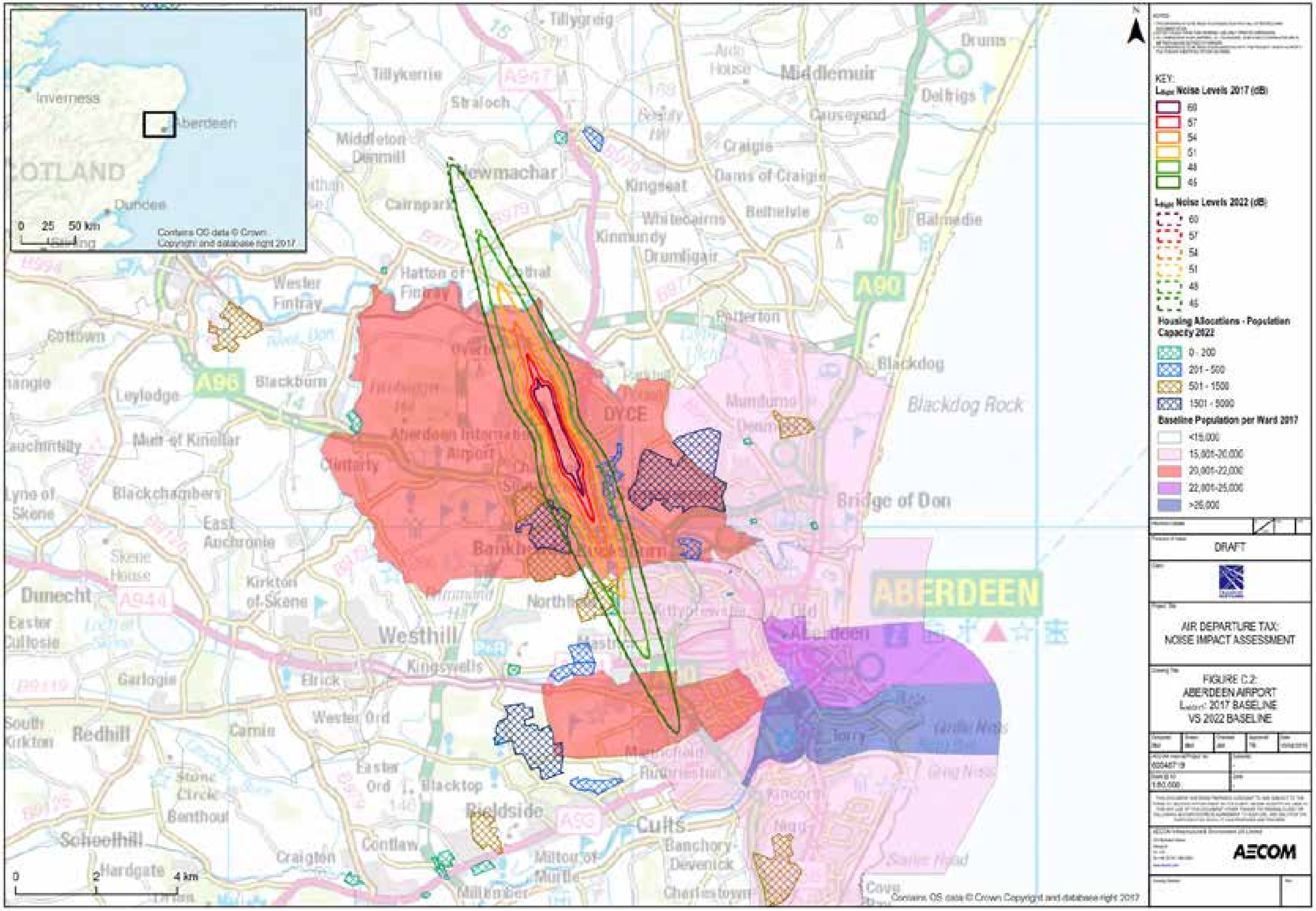


Figure C.3 Edinburgh Airport Baseline 2017 v Baseline 2022 $L_{Aeq,16h}$ dB Noise Contours

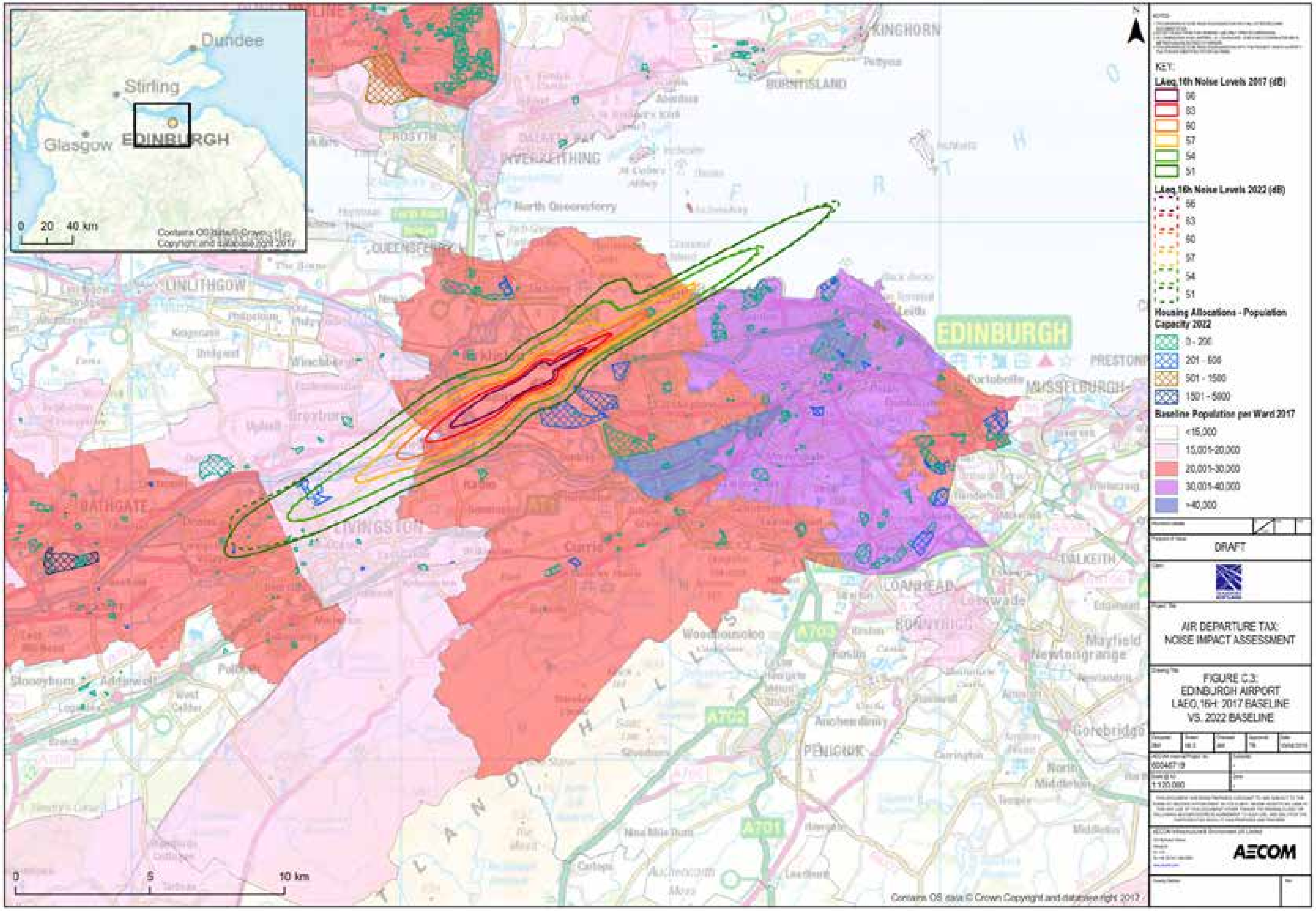


Figure C.4 Edinburgh Airport Baseline 2017 v Baseline 2022 L_{night} dB Noise Contours

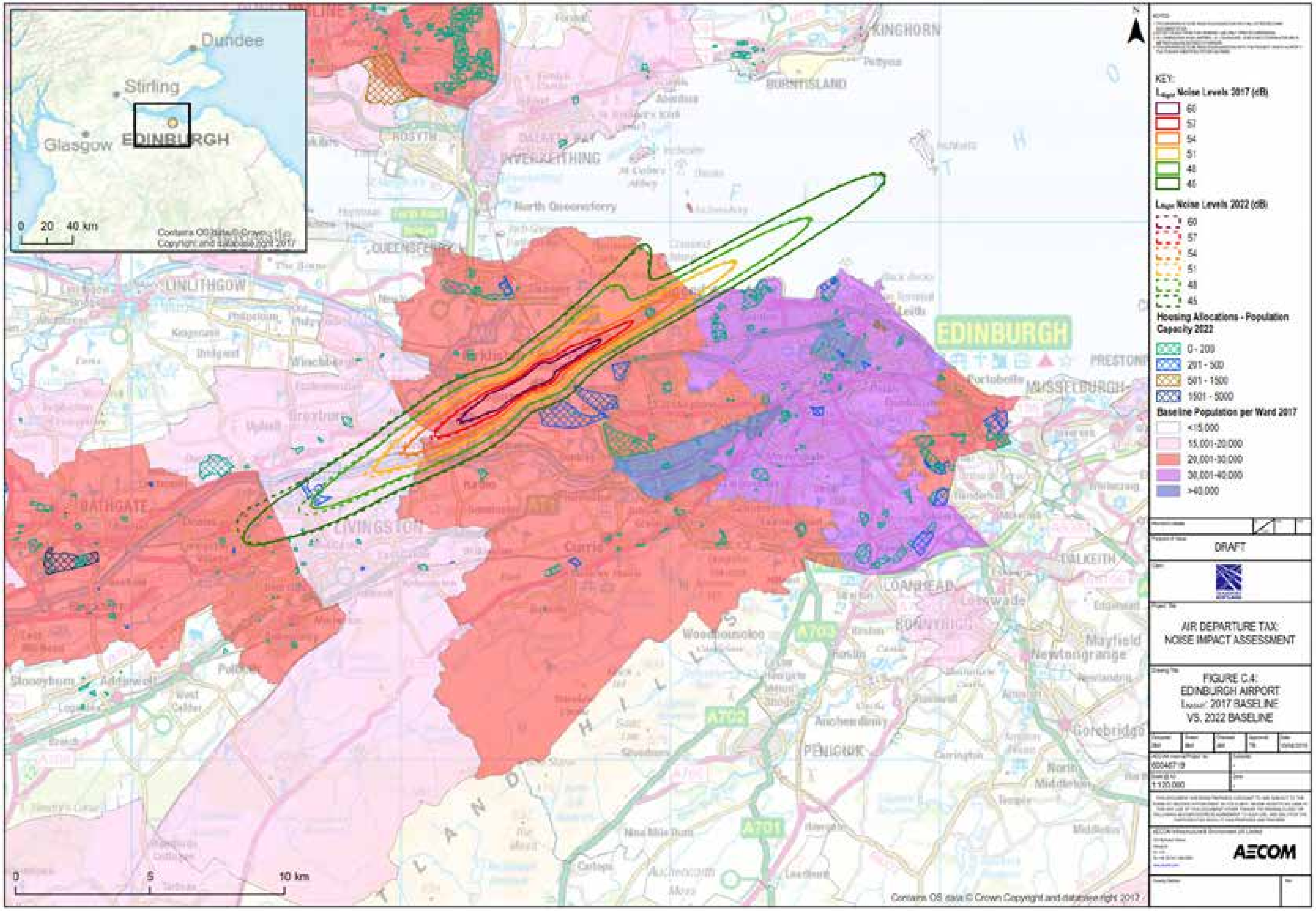


Figure C.5 Glasgow Airport Baseline 2017 V Baseline 2022 $L_{Aeq,16h}$ dB Noise Contours

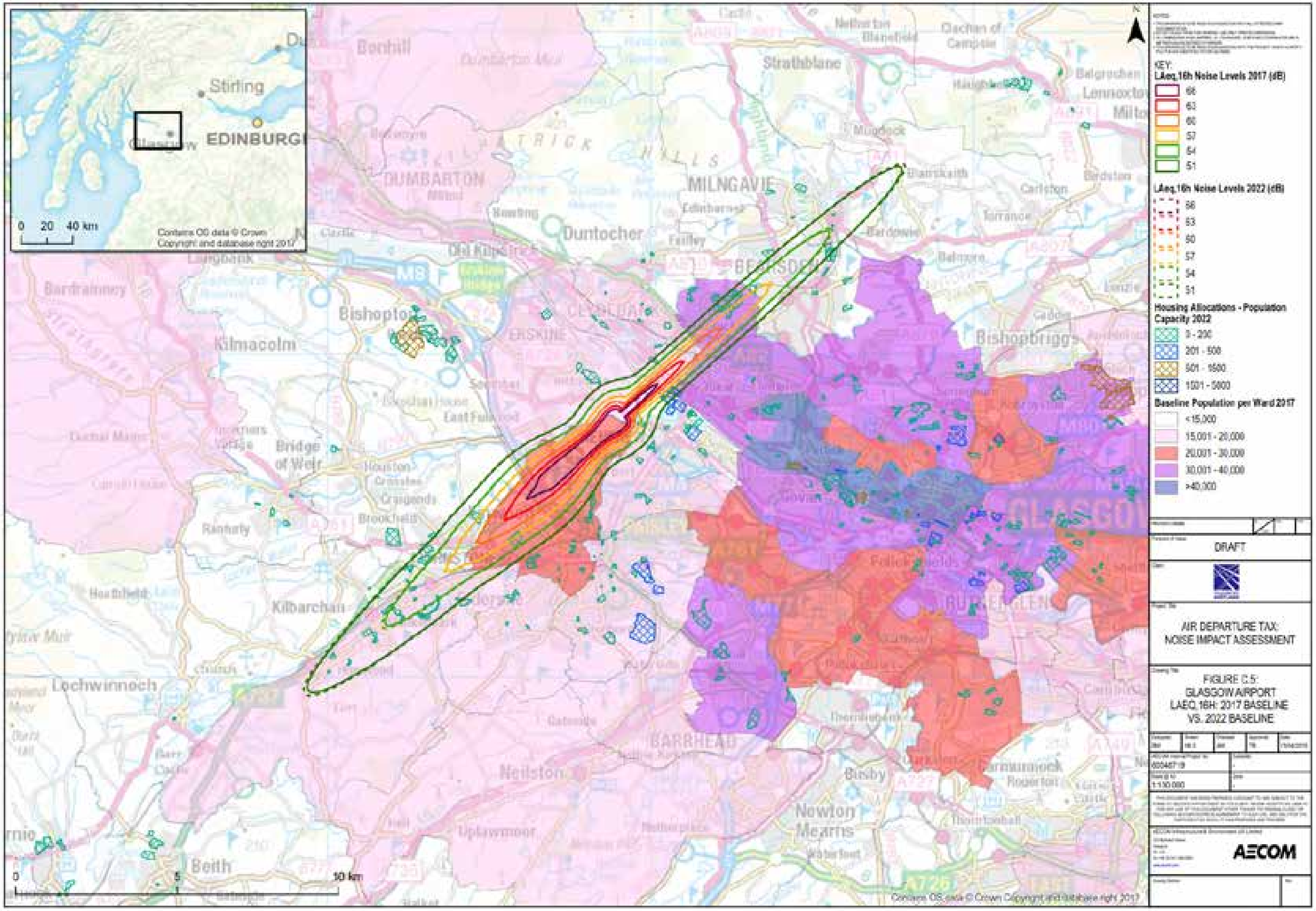


Figure C.6 Glasgow Airport Baseline 2017 v Baseline 2022 L_{night} dB Noise Contours

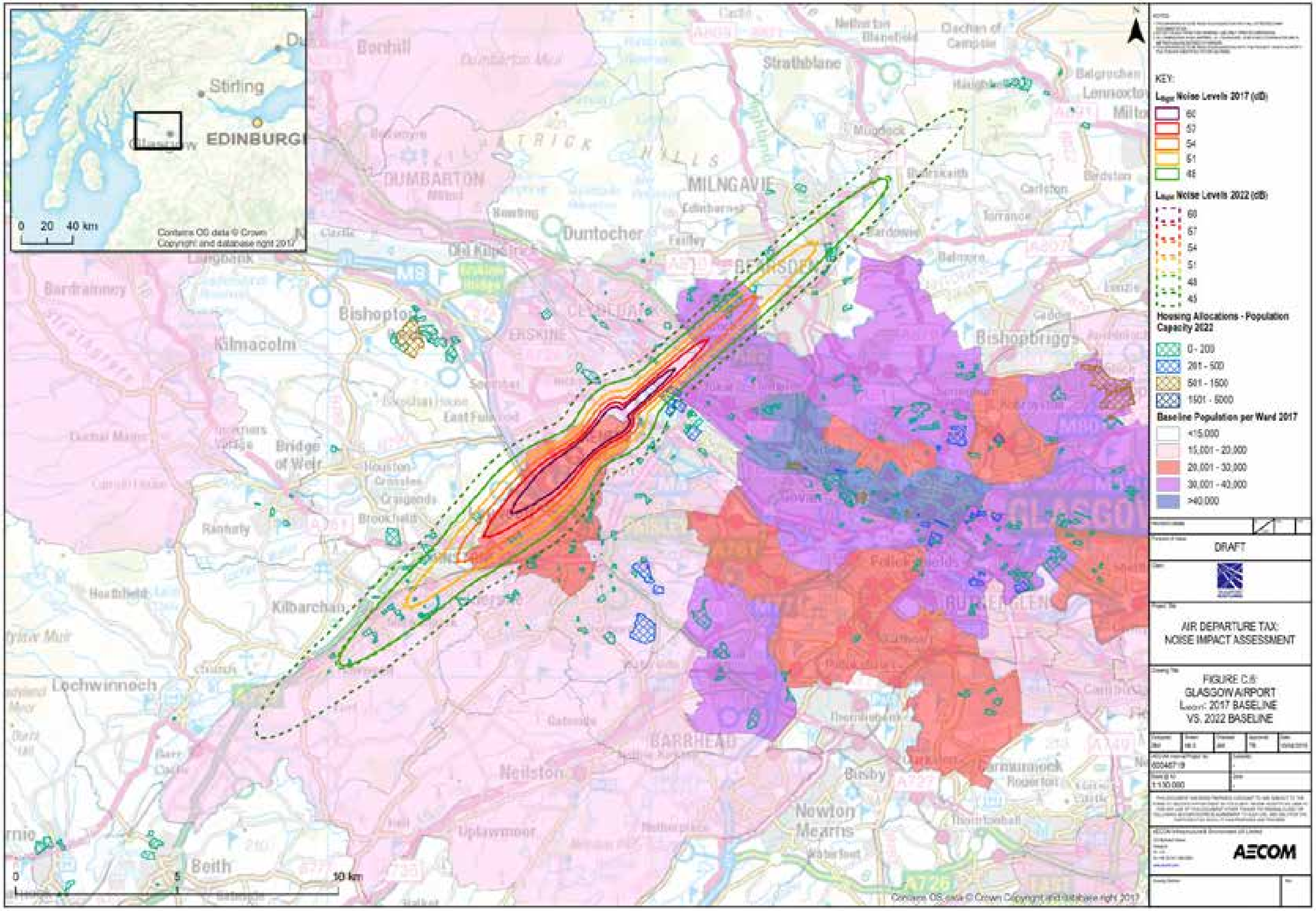


Figure C.7 Inverness Airport Baseline 2017 v Baseline 2022 $L_{Aeq,16h}$ dB Noise Contours

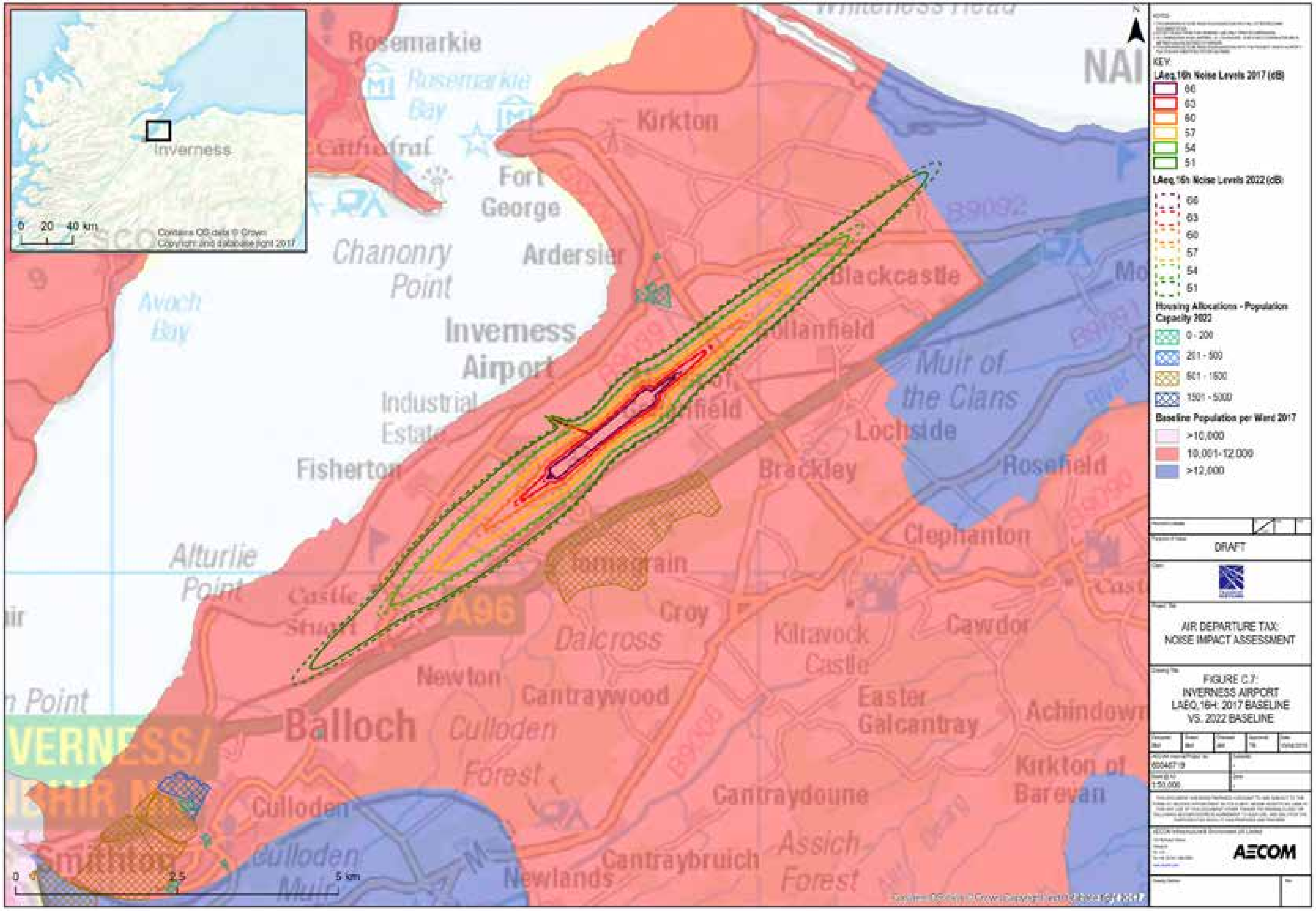


Figure C.8 Inverness Airport Baseline 2017 v Baseline 2022 L_{night} dB Noise Contours

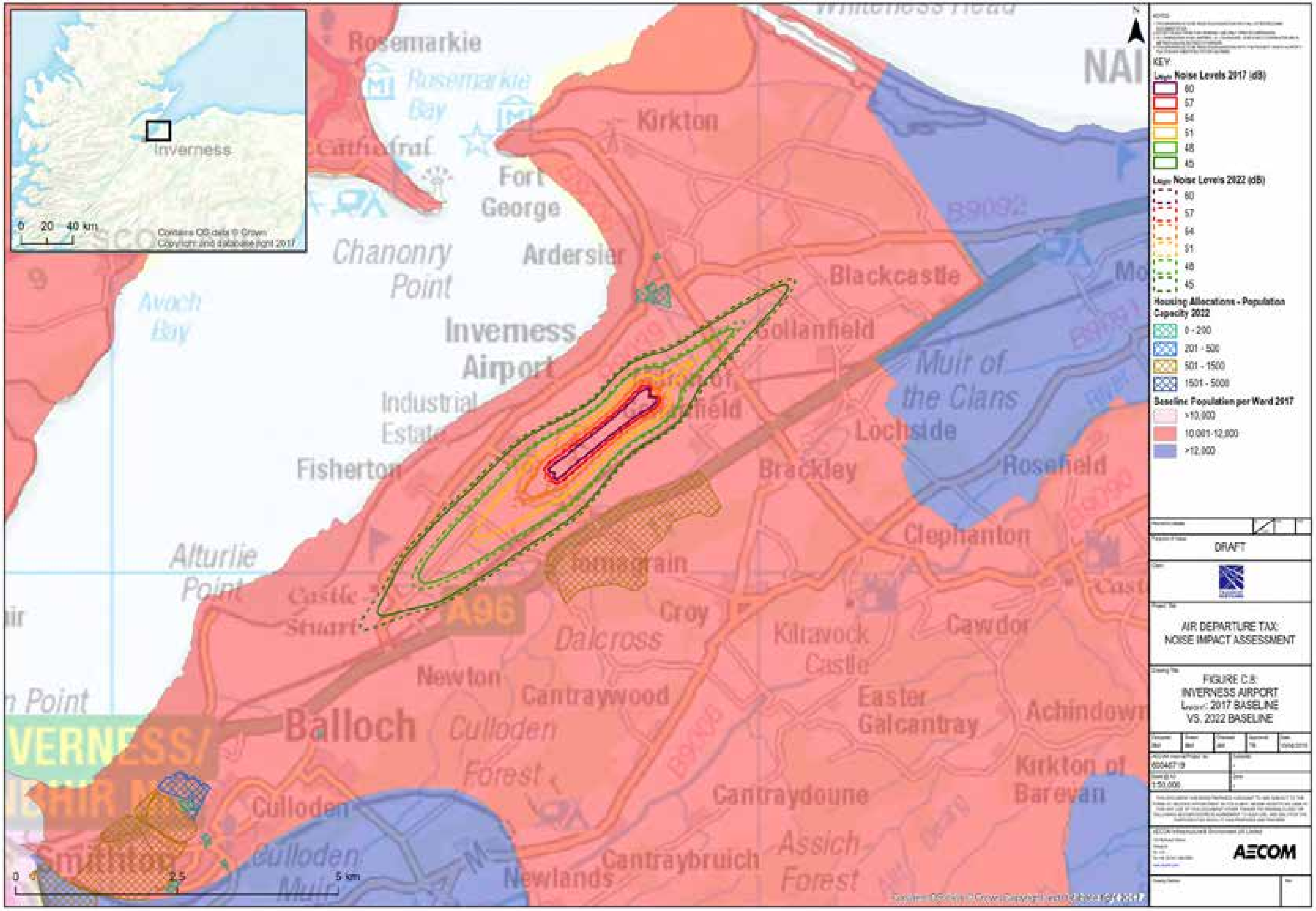


Figure C.9 Prestwick Airport Baseline 2017 v Baseline 2022 $L_{Aeq,16h}$ dB Noise Contours

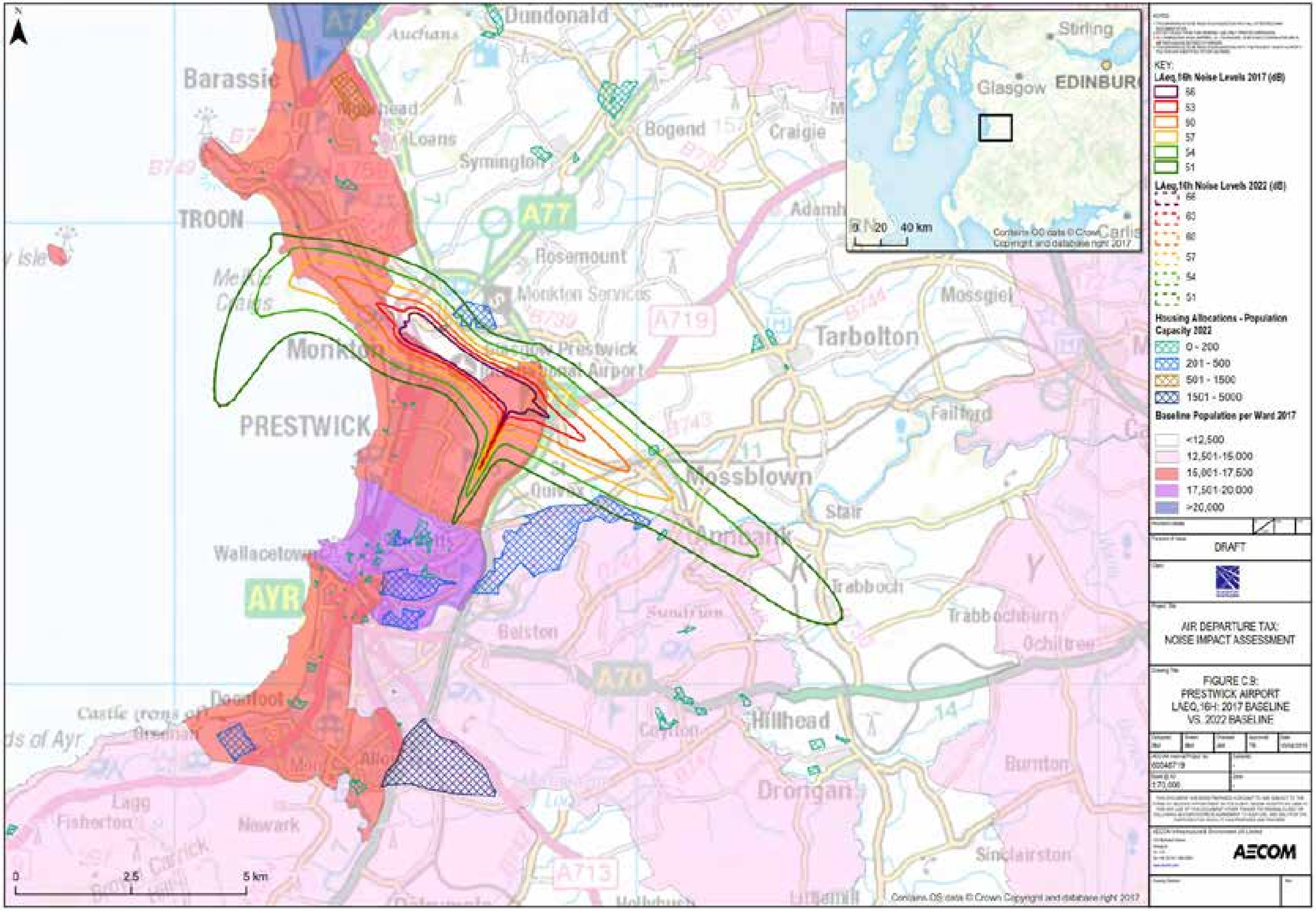


Figure C.10 Prestwick Airport Baseline 2017 v Baseline 2022 L_{night} dB Noise Contours

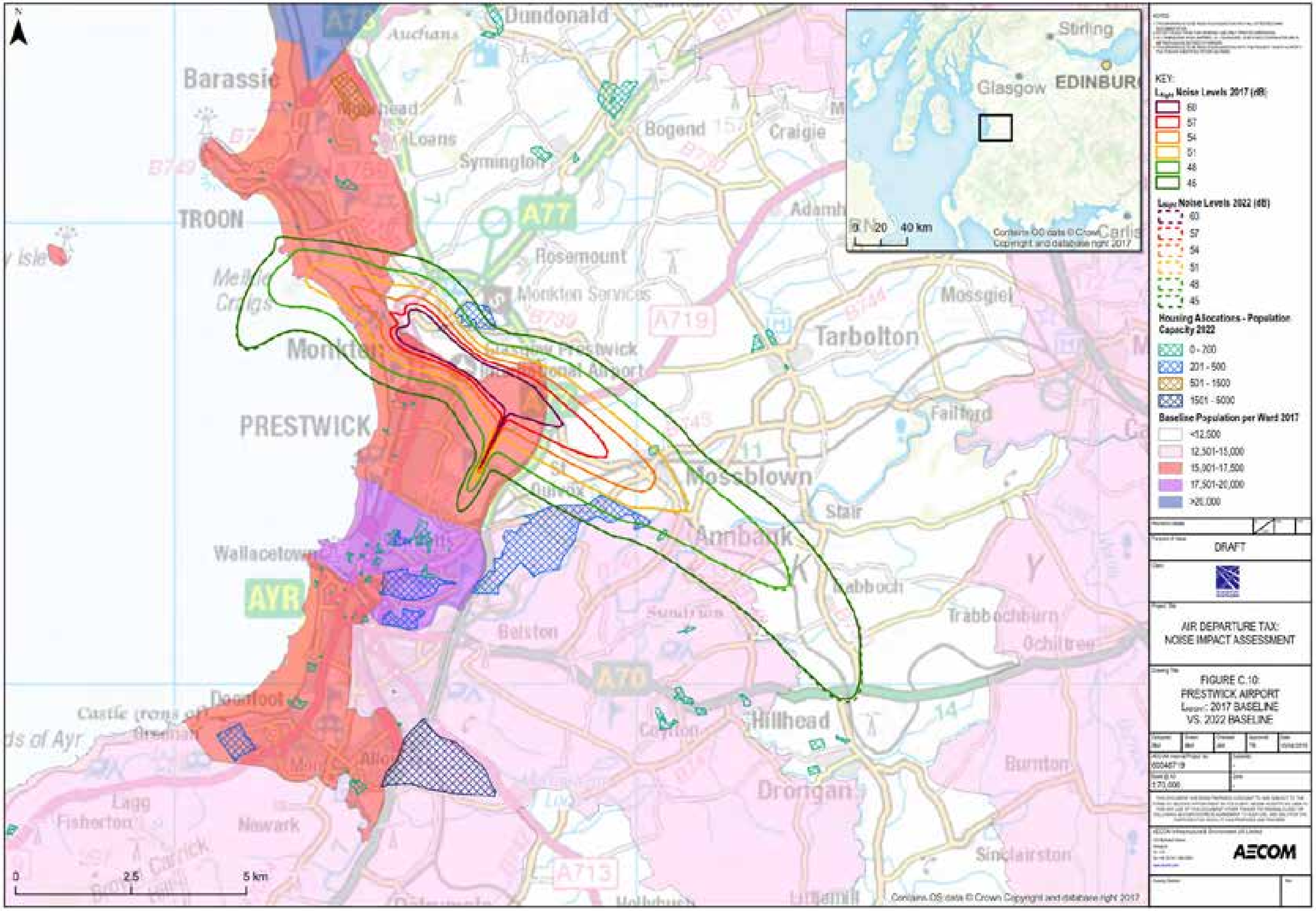


Figure C.11 Aberdeen Airport Baseline 2022 v Scenario 1a $L_{Aeq,16h}$ dB Noise Contours

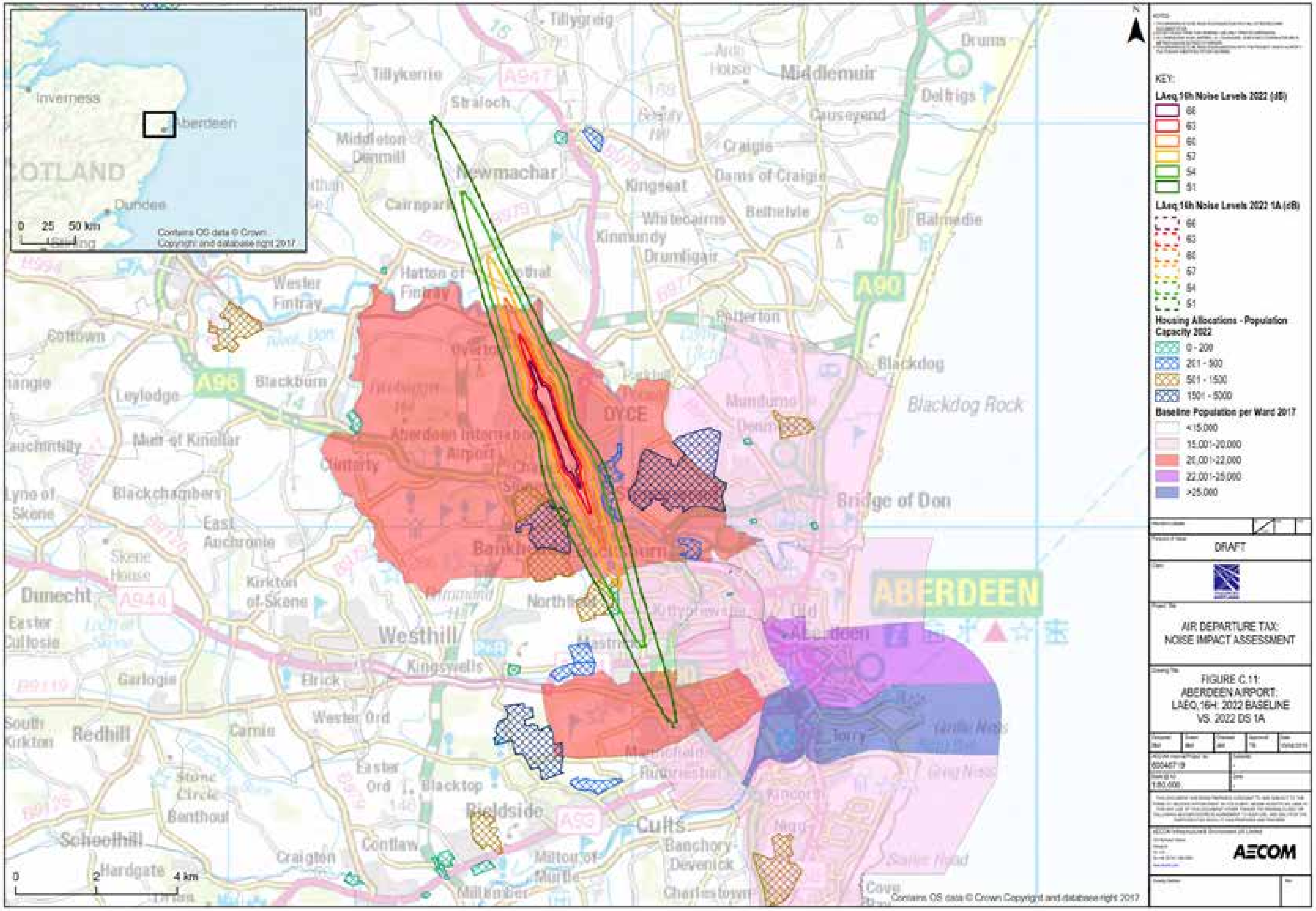


Figure C.12 Aberdeen Airport Baseline 2022 v Scenario 1a L_{night} dB Noise Contours

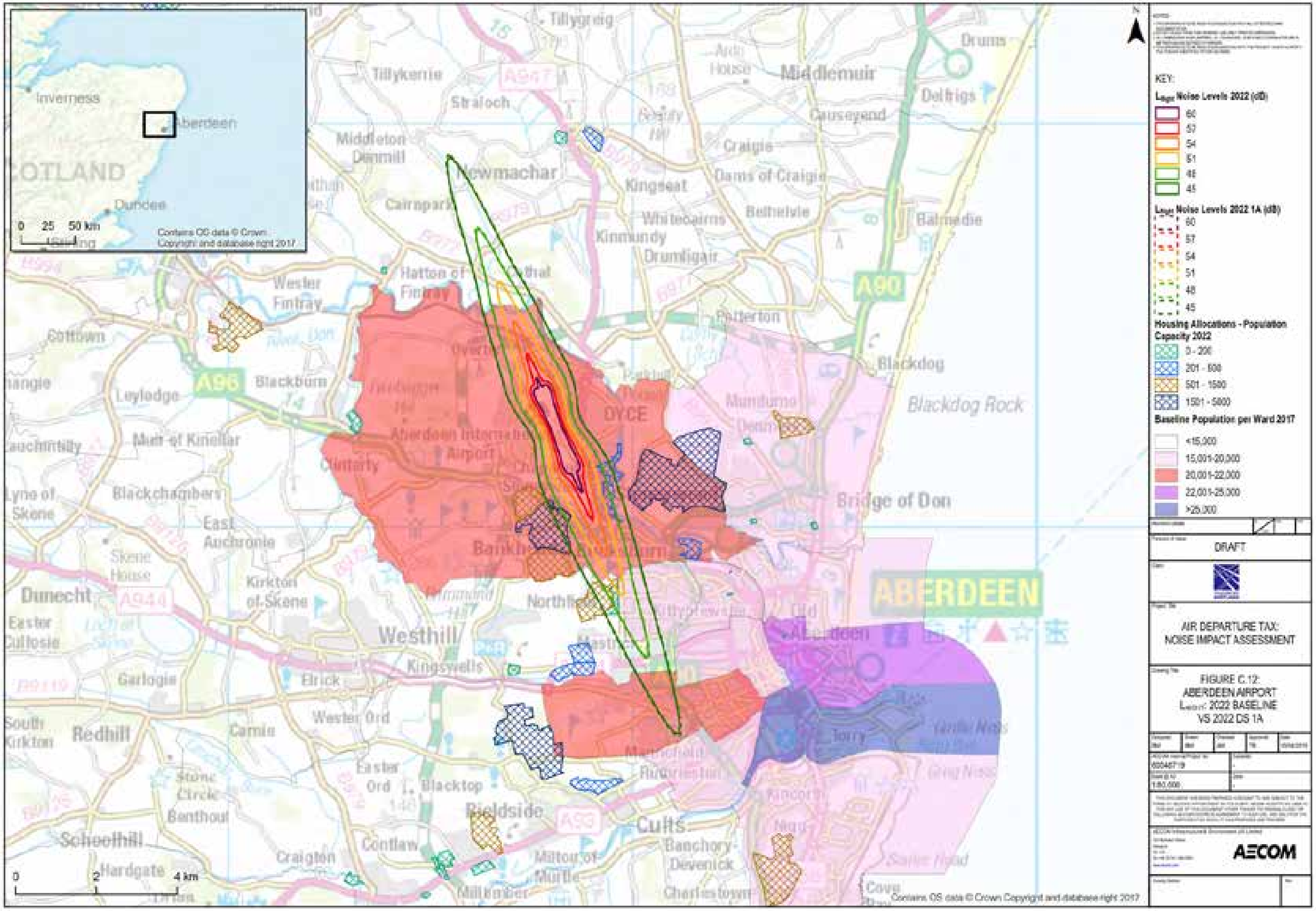


Figure C.13 Aberdeen Airport Baseline 2022 v Scenario 1c $L_{Aeq,16h}$ dB Noise Contours

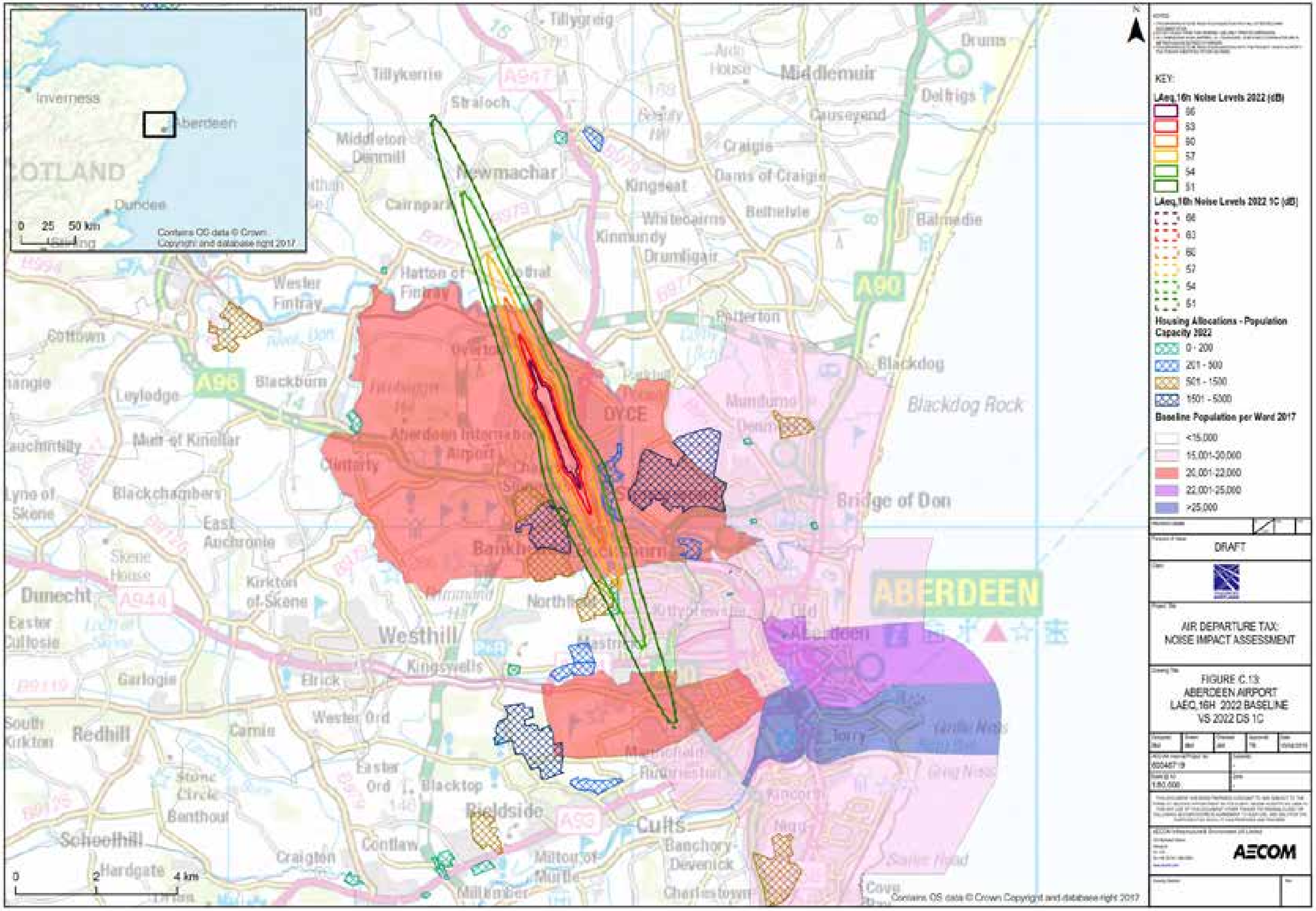


Figure C.14 Aberdeen Airport Baseline 2022 v Scenario 1c L_{night} dB Noise Contours

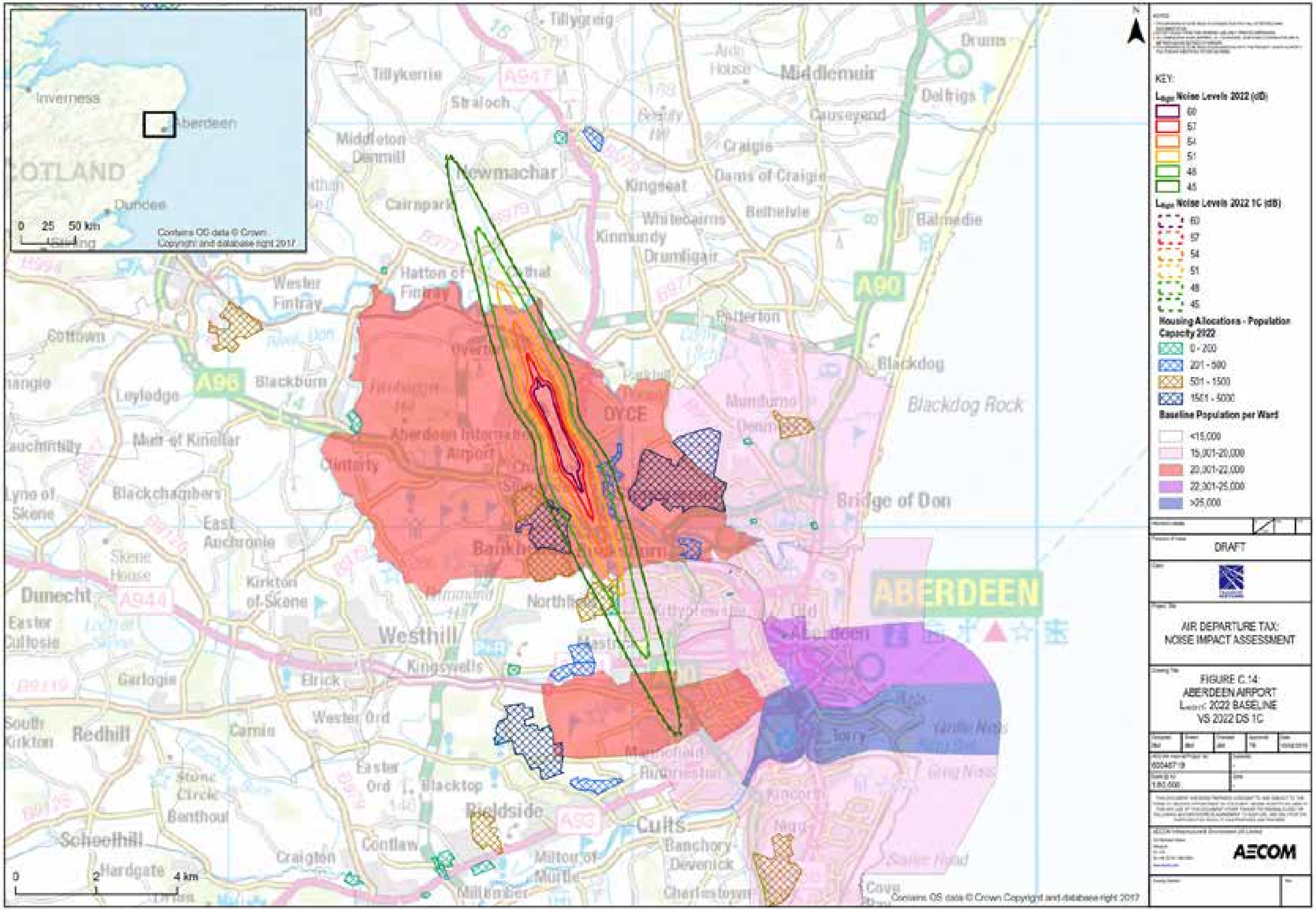


Figure C.15 Aberdeen Airport Baseline 2022 v Scenario 2a $L_{Aeq,16h}$ dB Noise Contours

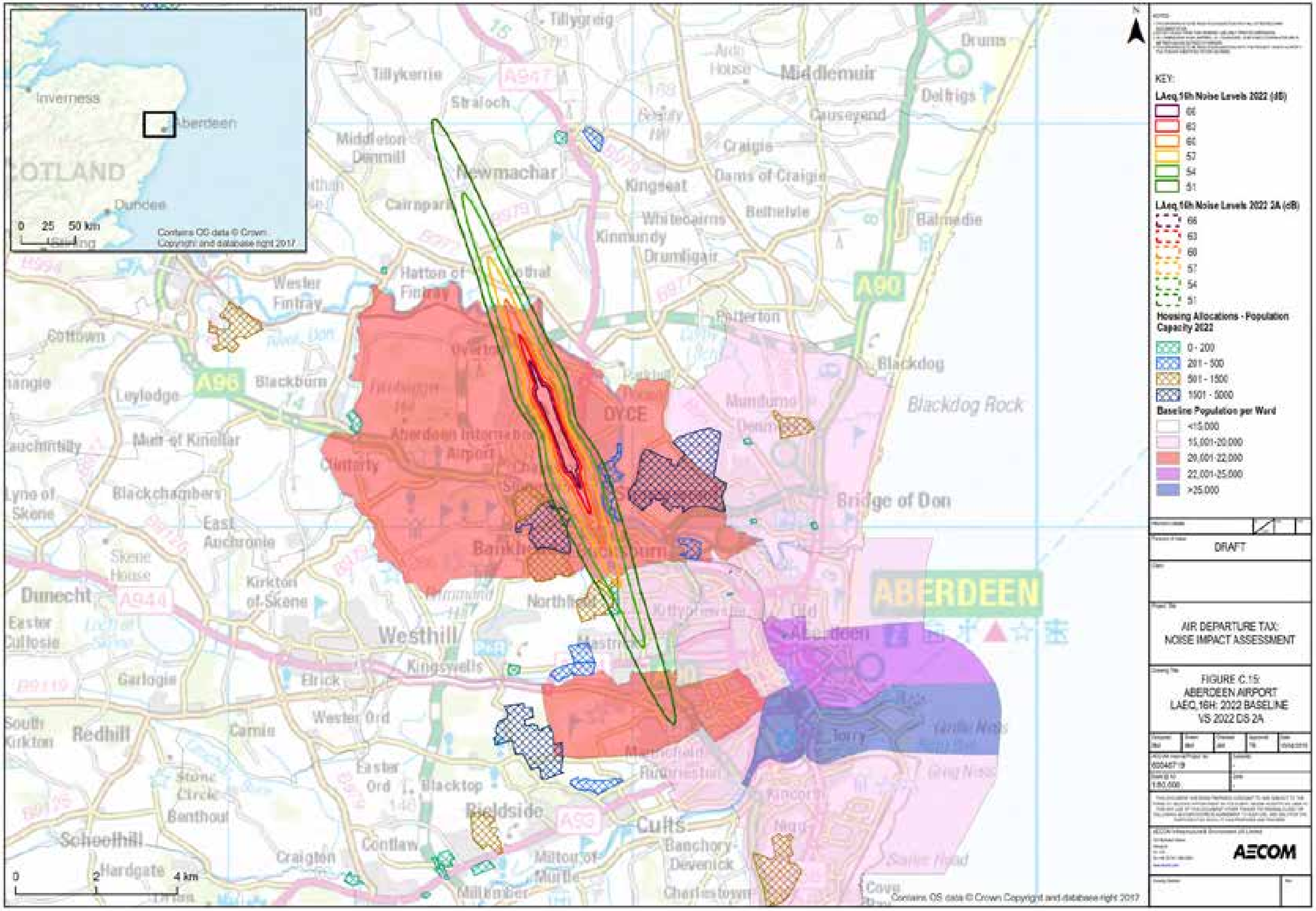


Figure C.16 Aberdeen Airport Baseline 2022 v Scenario 2a L_{night} dB Noise Contours

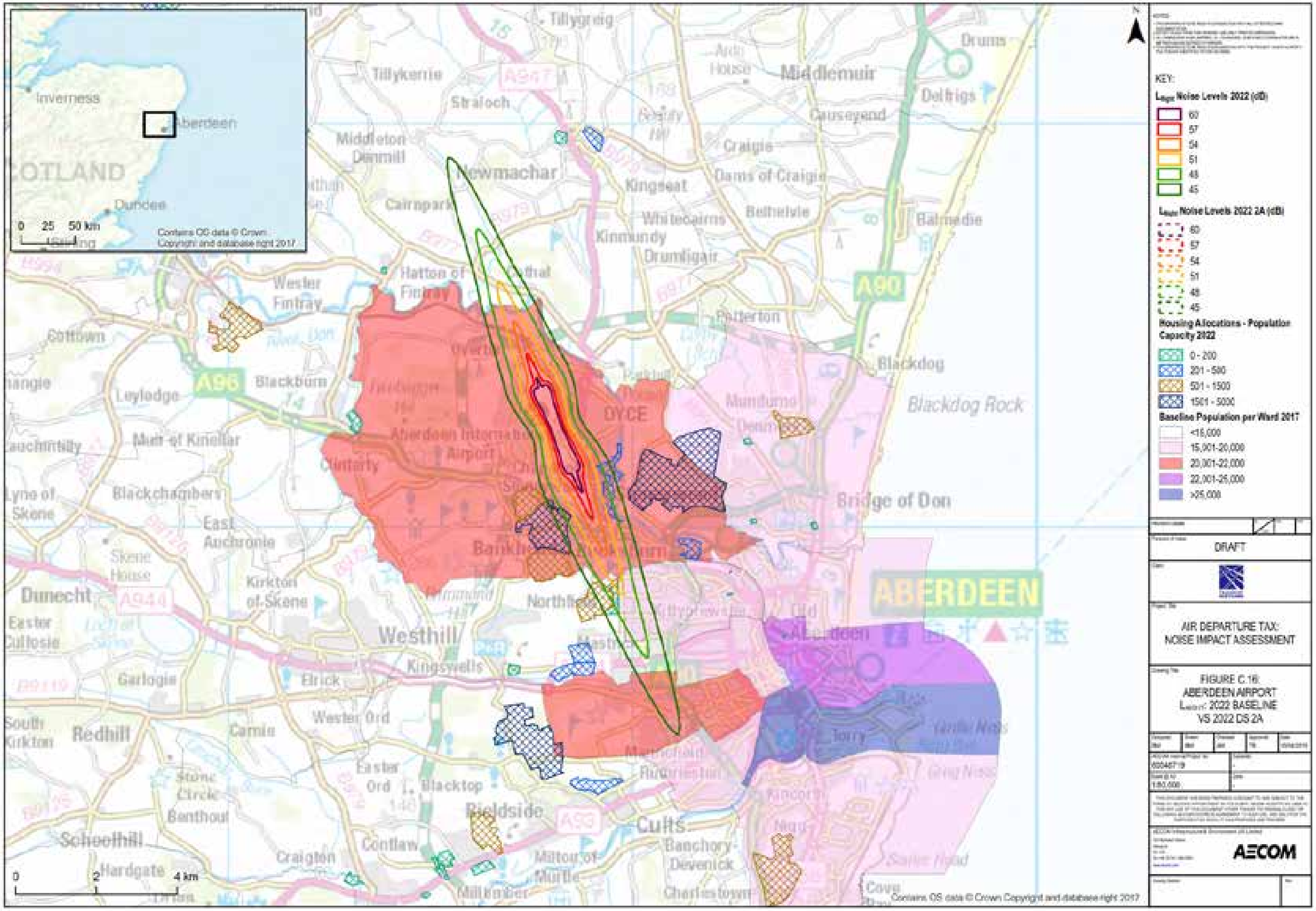


Figure C.17 Aberdeen Airport Baseline 2022 v Scenario 2c $L_{Aeq,16h}$ dB Noise Contours

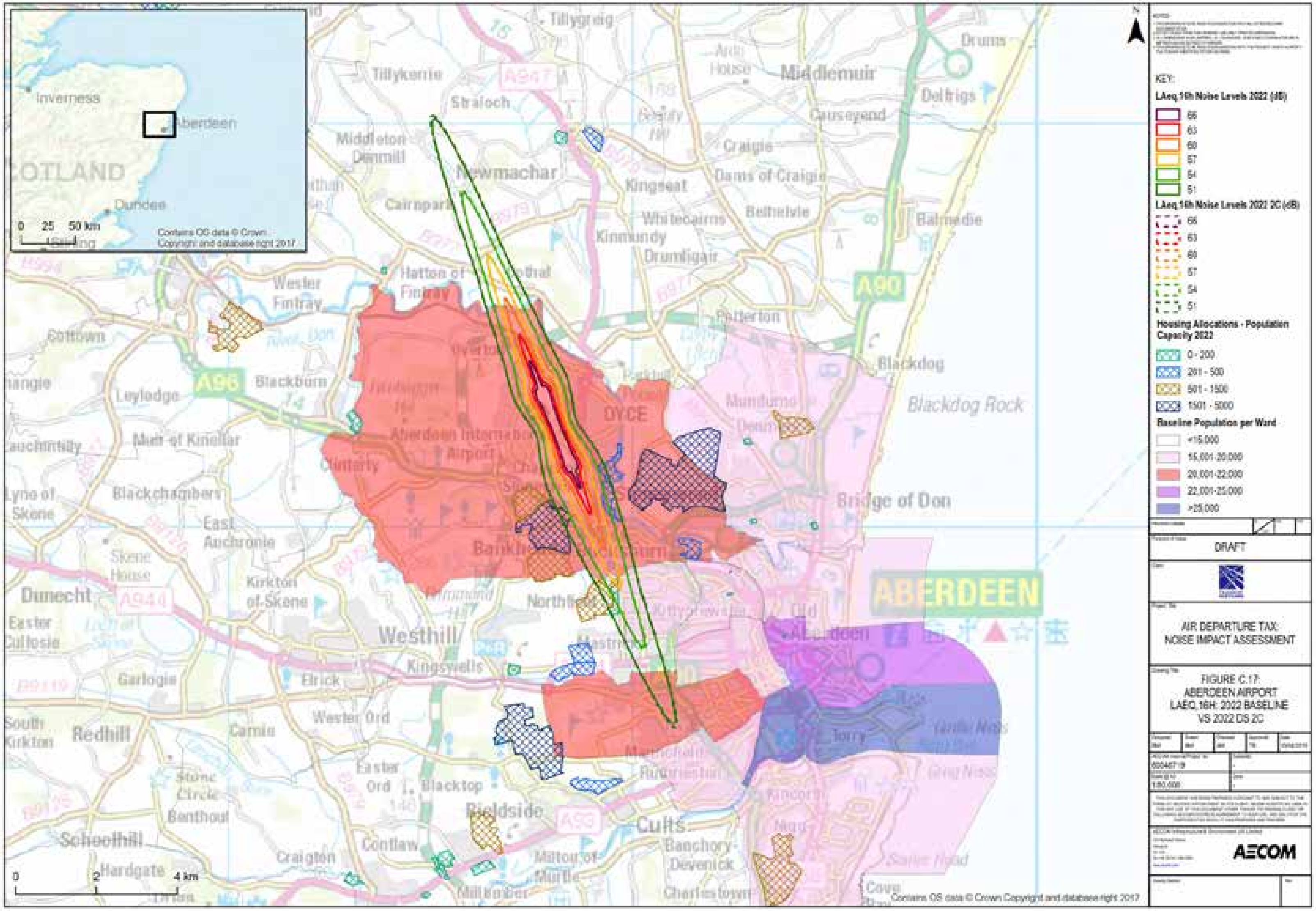


Figure C.18 Aberdeen Airport Baseline 2022 v Scenario 2c L_{night} dB Noise Contours

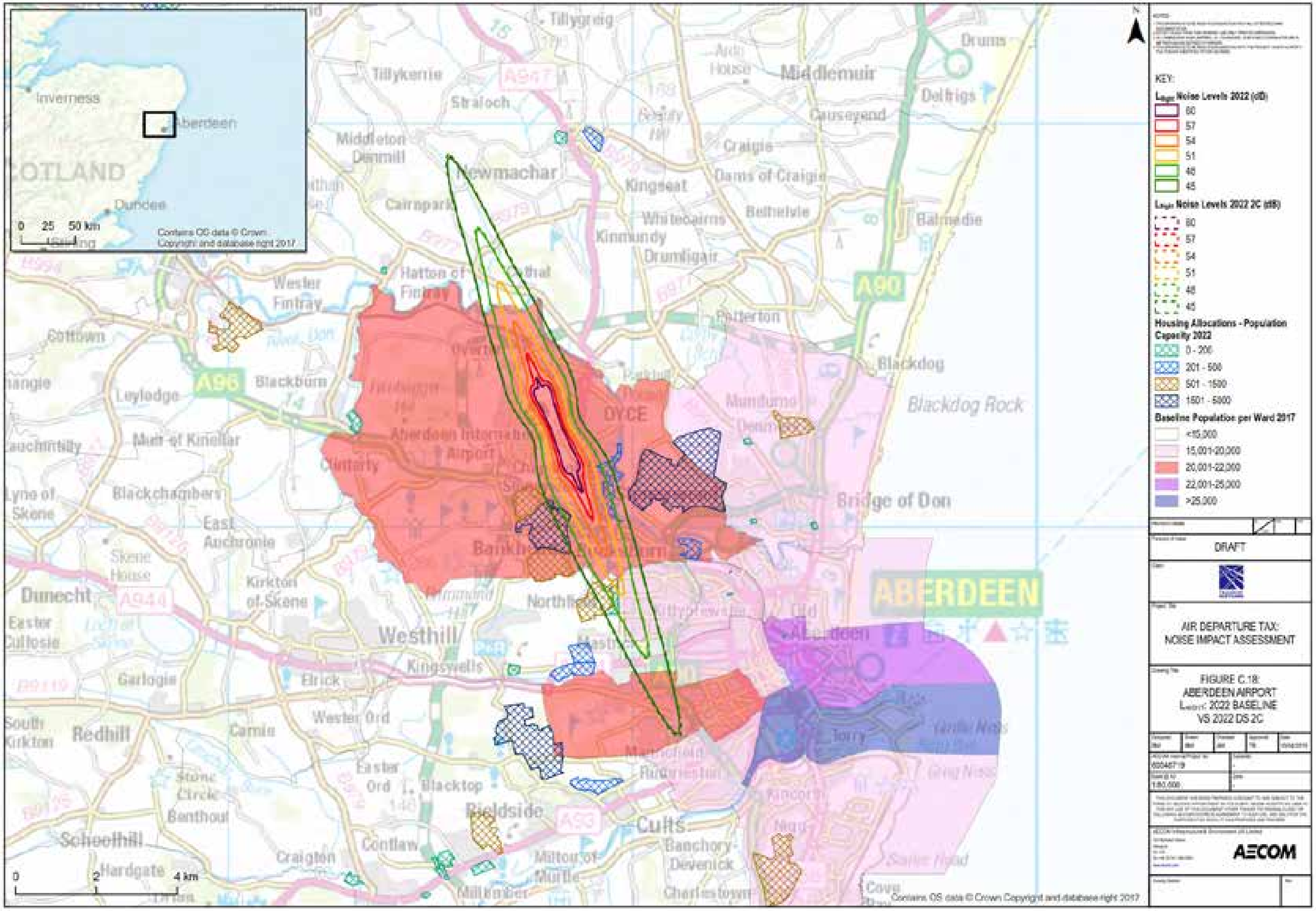


Figure C.19 Aberdeen Airport Baseline 2022 v Scenario 3a $L_{Aeq,16h}$ dB Noise Contours

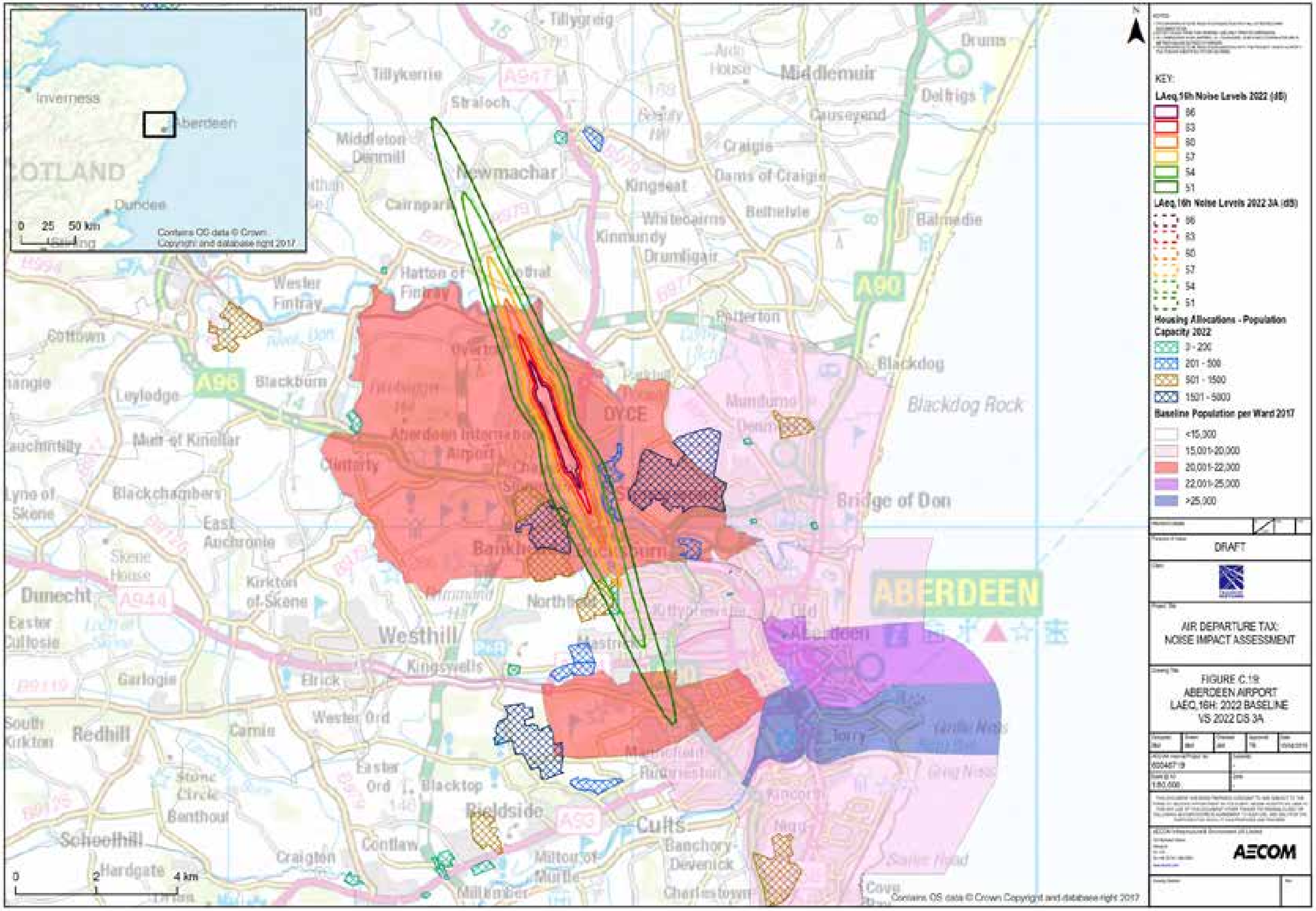


Figure C.20 Aberdeen Airport Baseline 2022 v Scenario 3a L_{night} dB Noise Contours

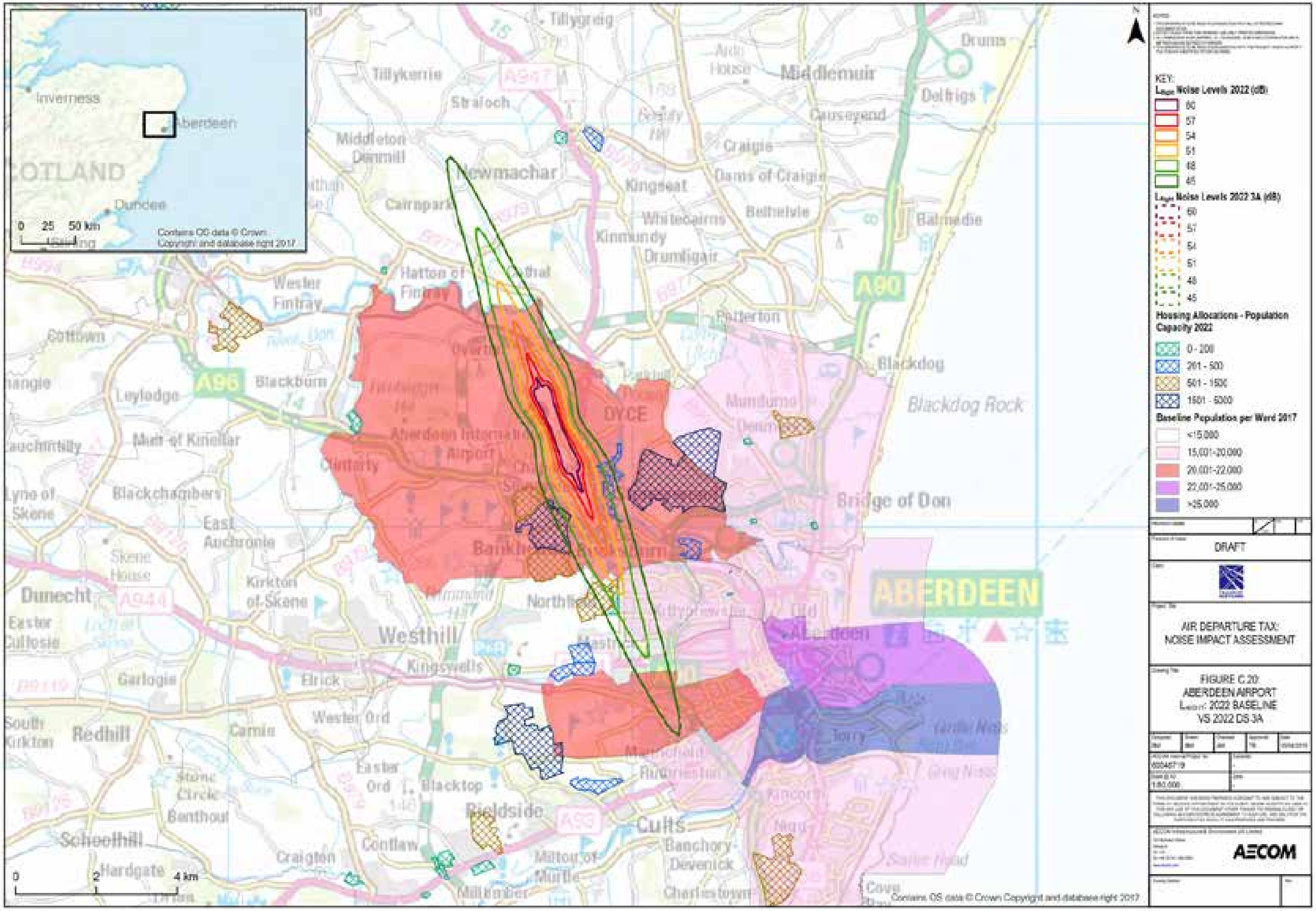


Figure C.21 Aberdeen Airport Baseline 2022 v Scenario 3c $L_{Aeq,16h}$ dB Noise Contours

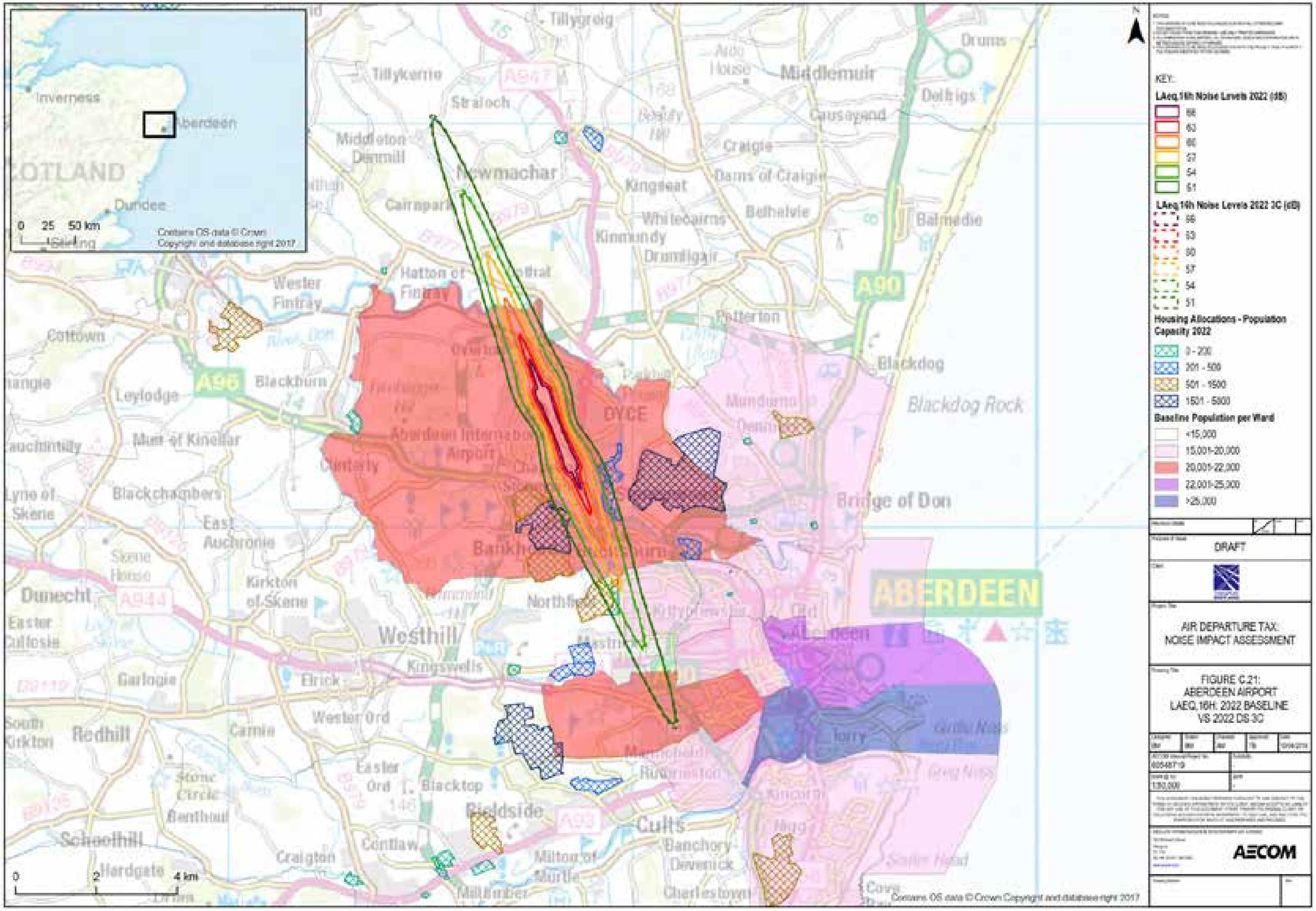


Figure C.22 Aberdeen Airport Baseline 2022 v Scenario 3c L_{night} dB Noise Contours

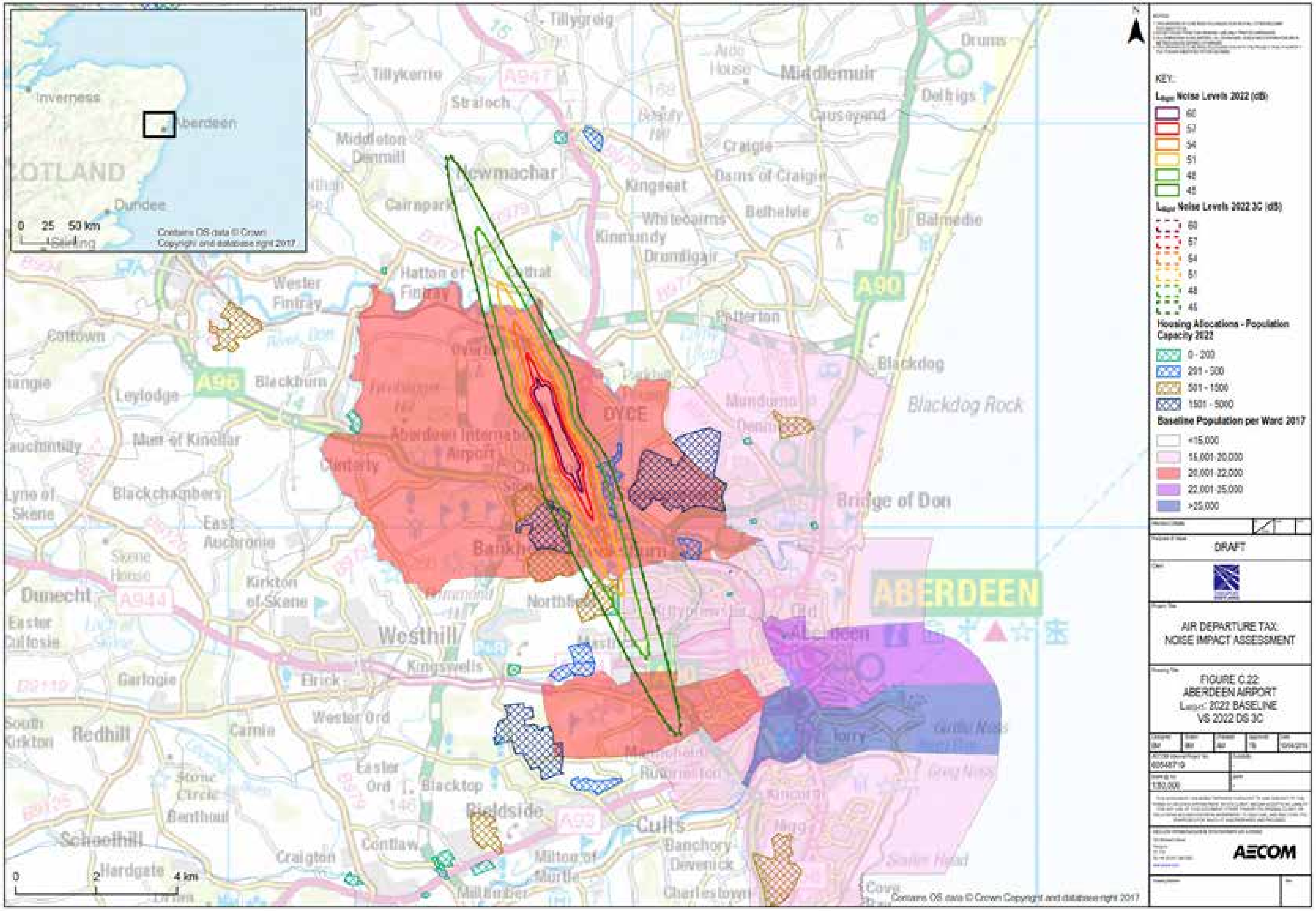


Figure C.23 Edinburgh Airport Baseline 2022 v Scenario 1a $L_{Aeq,16h}$ dB Noise Contours

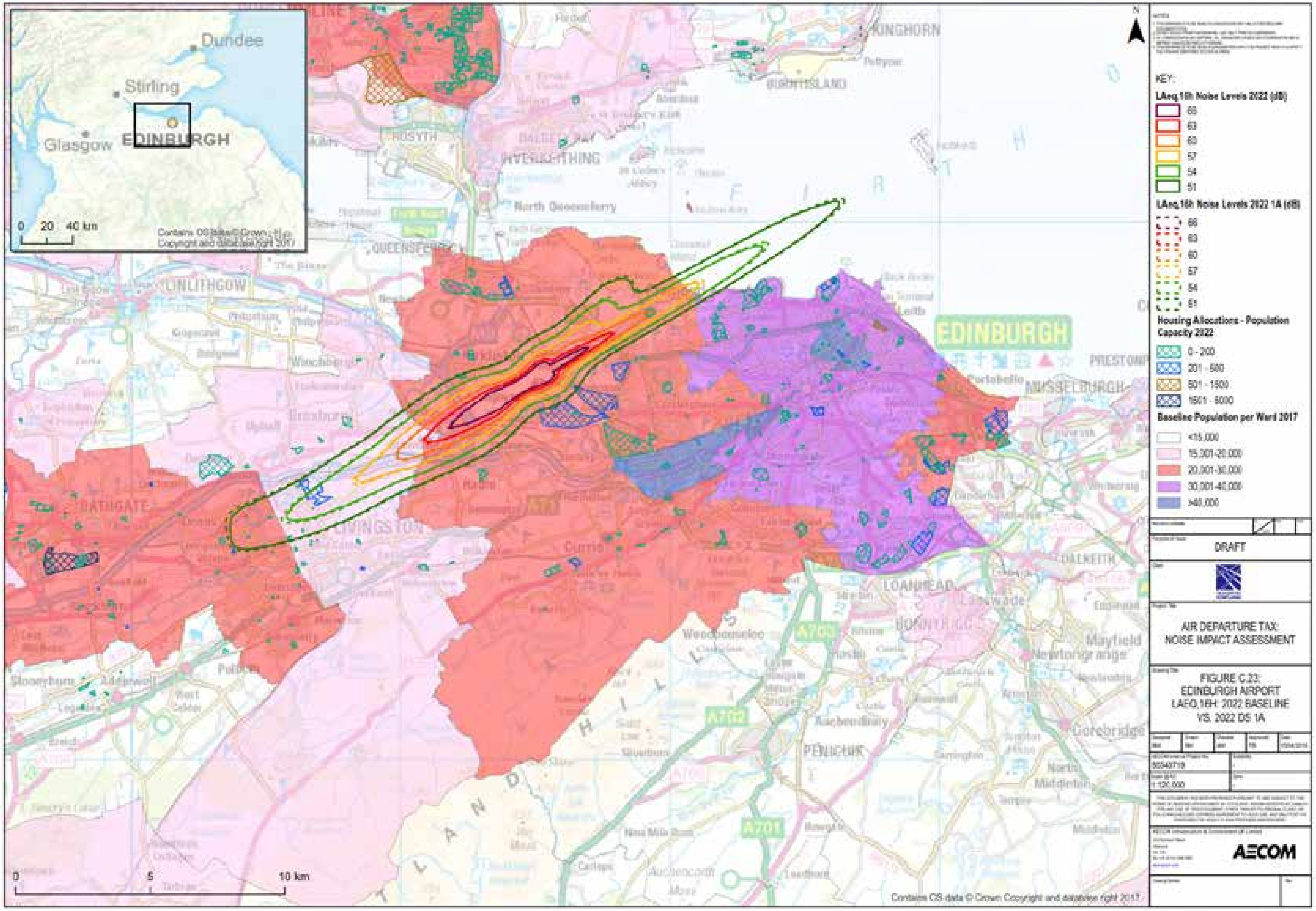


Figure C.24 Edinburgh Airport Baseline 2022 v Scenario 1a L_{night} dB Noise Contours

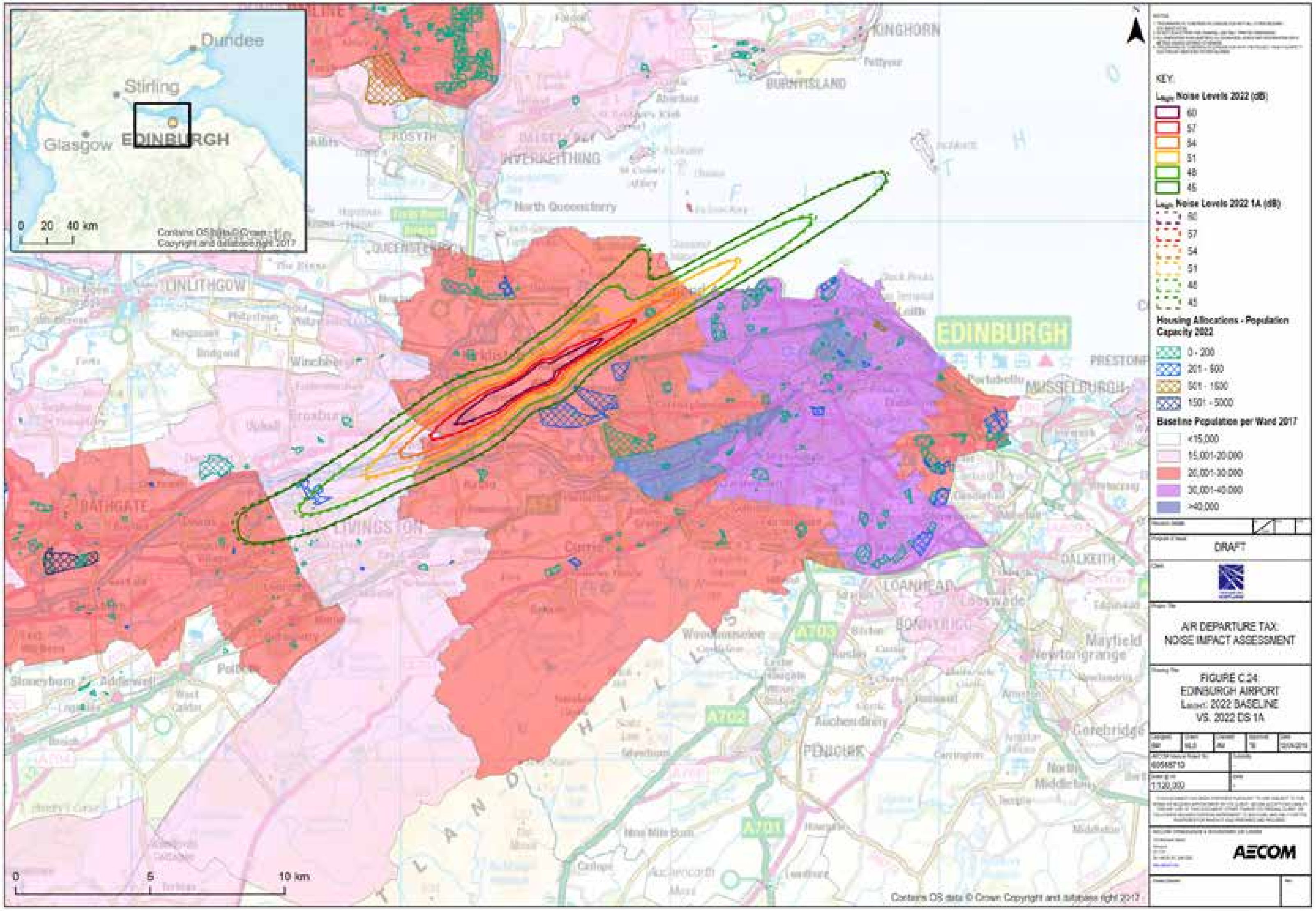


Figure C.25 Edinburgh Airport Baseline 2022 v Scenario 1c $L_{Aeq,16h}$ dB Noise Contours

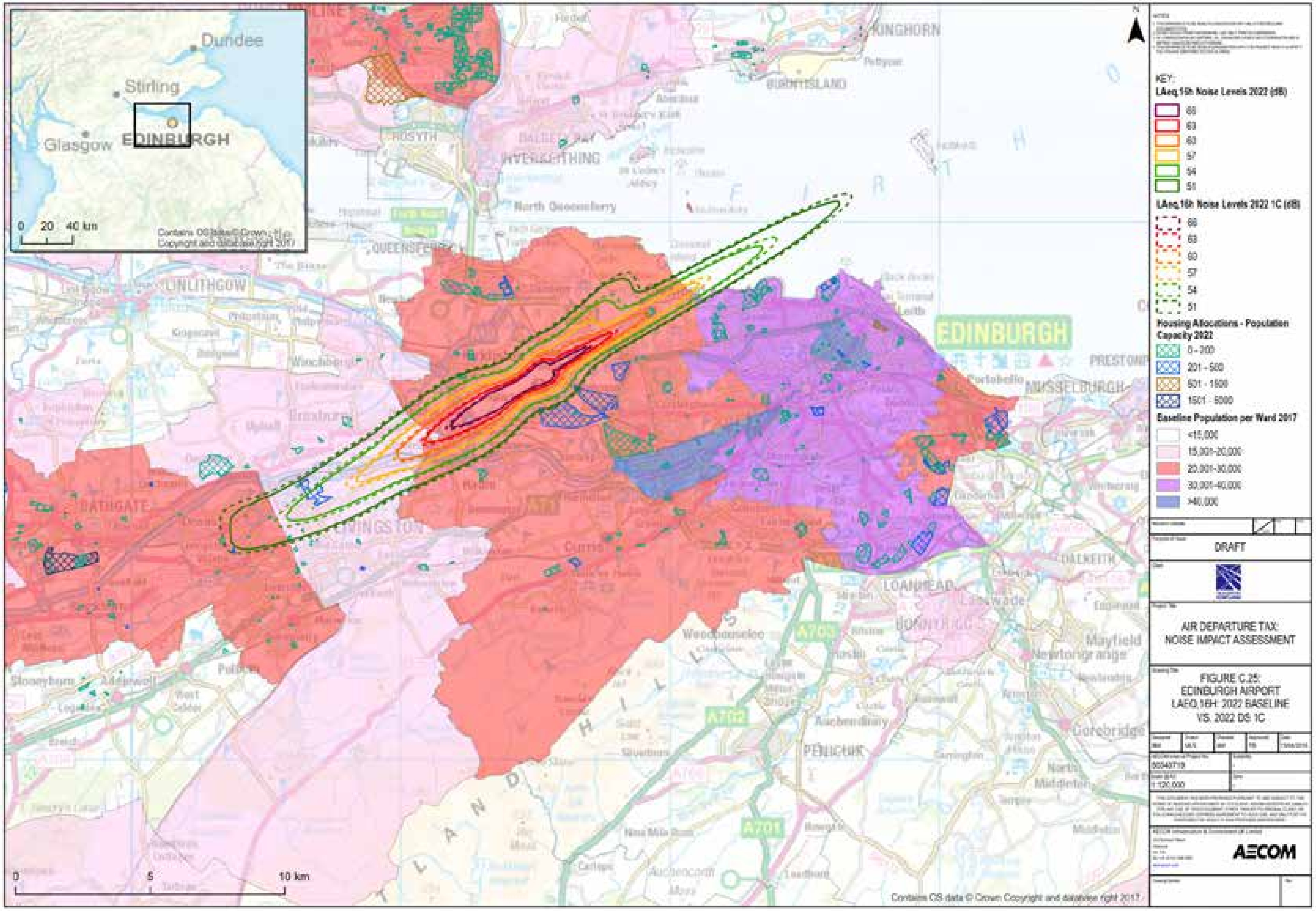


Figure C.26 Edinburgh Airport Baseline 2022 v Scenario 1c L_{night} dB Noise Contours

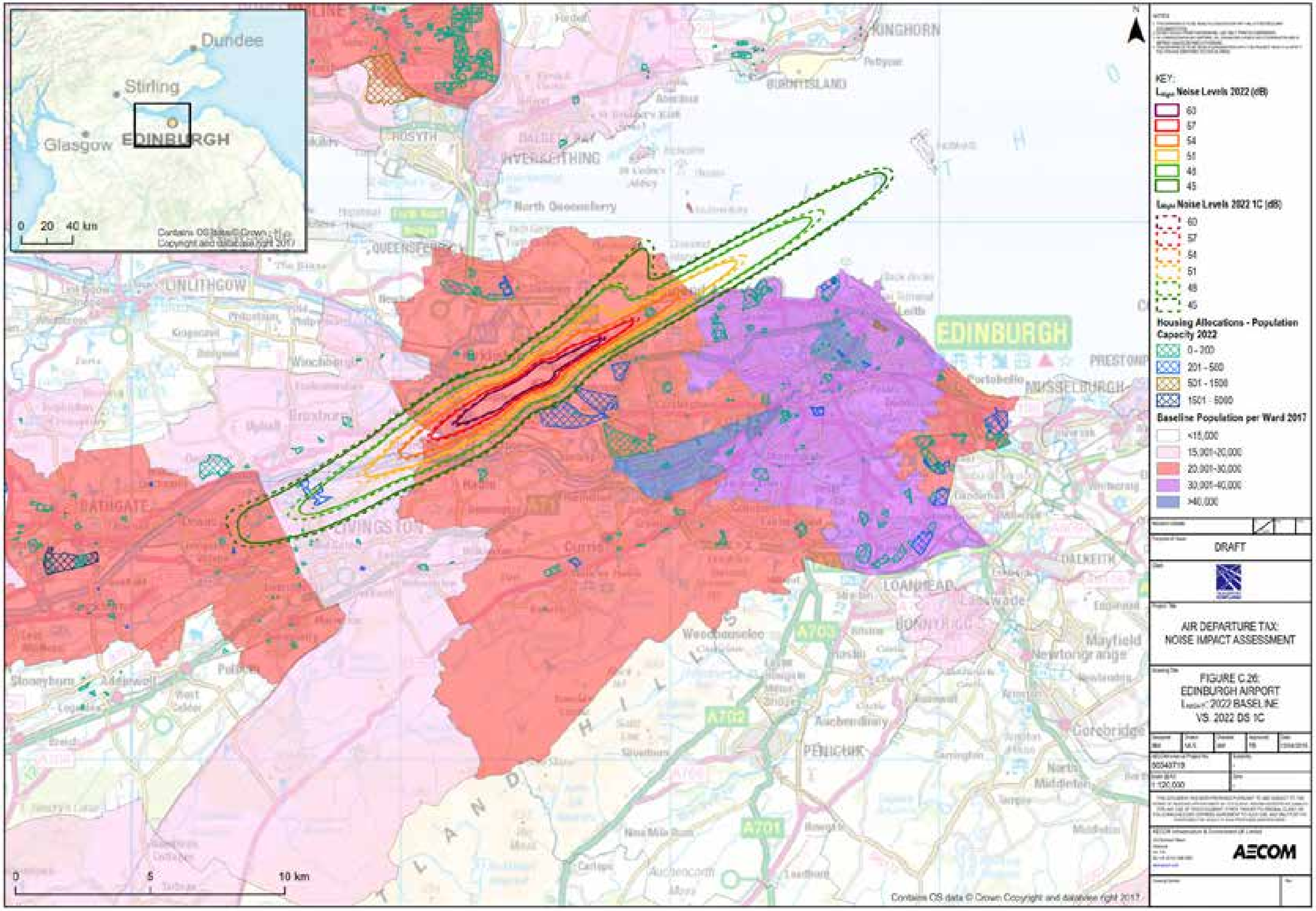


Figure C.27 Edinburgh Airport Baseline 2022 v Scenario 2a $L_{Aeq,16h}$ dB Noise Contours

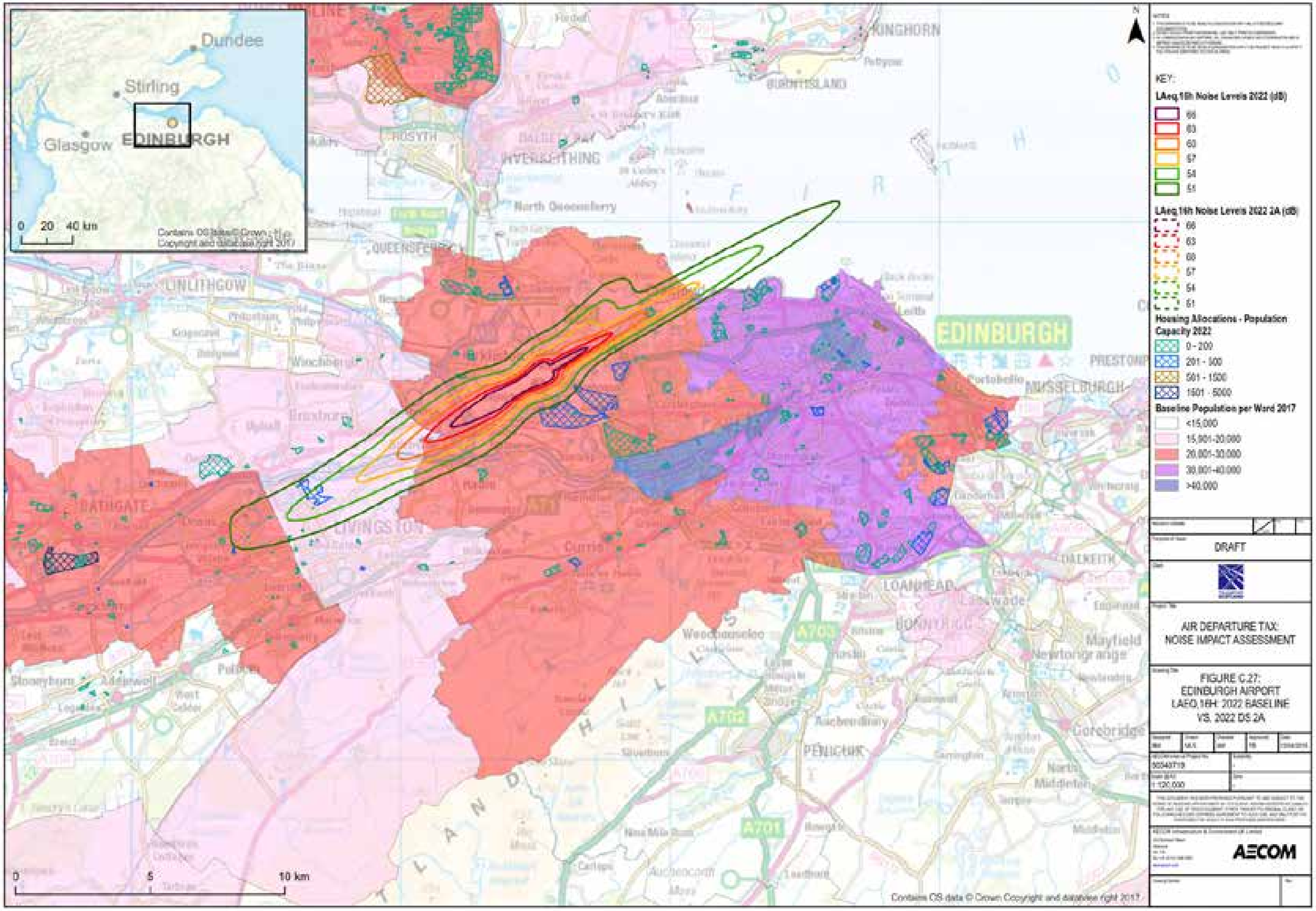


Figure C.28 Edinburgh Airport Baseline 2022 v Scenario 2a L_{night} dB Noise Contours

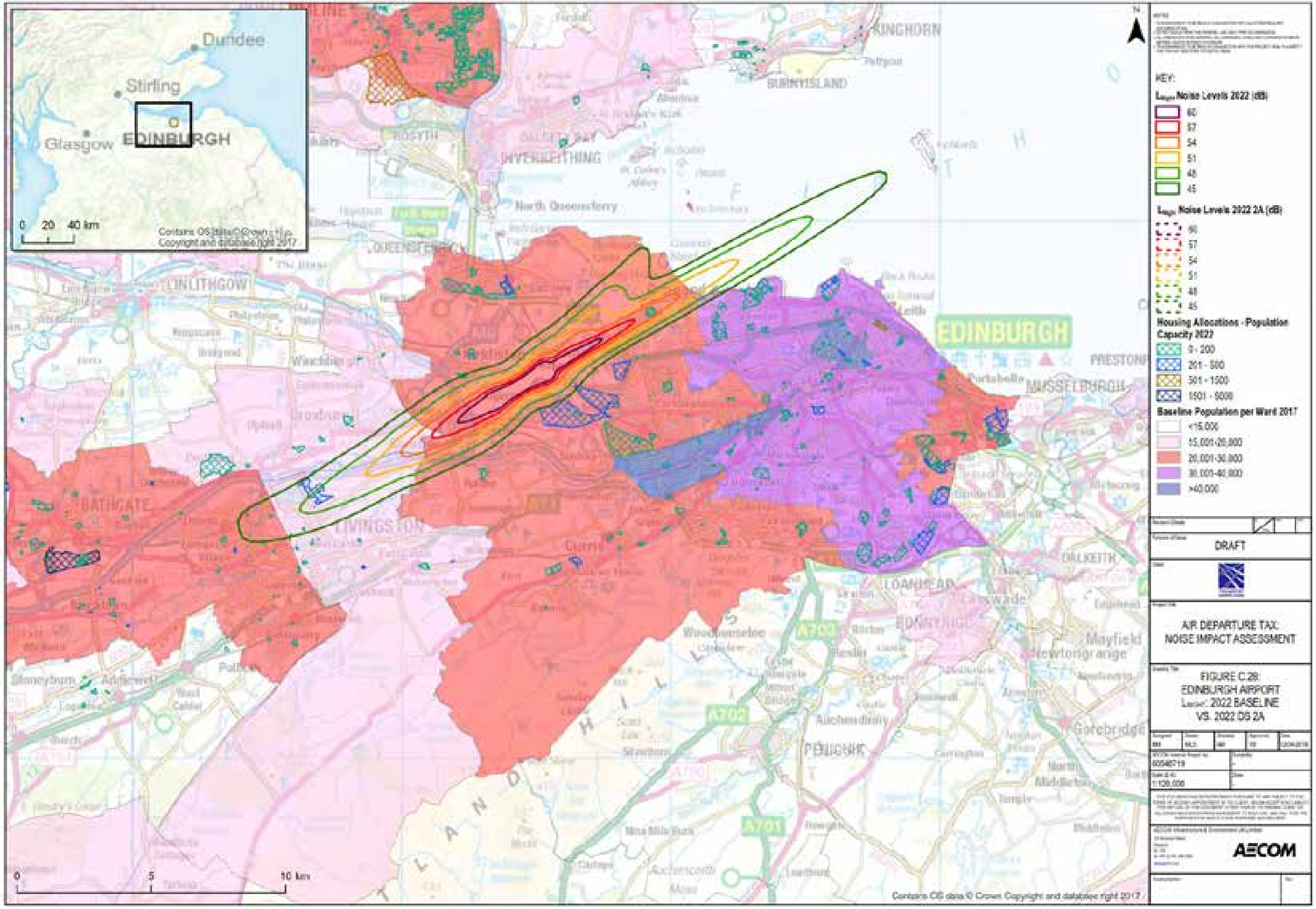


Figure C.29 Edinburgh Airport Baseline 2022 v Scenario 2c $L_{Aeq,16h}$ dB Noise Contours

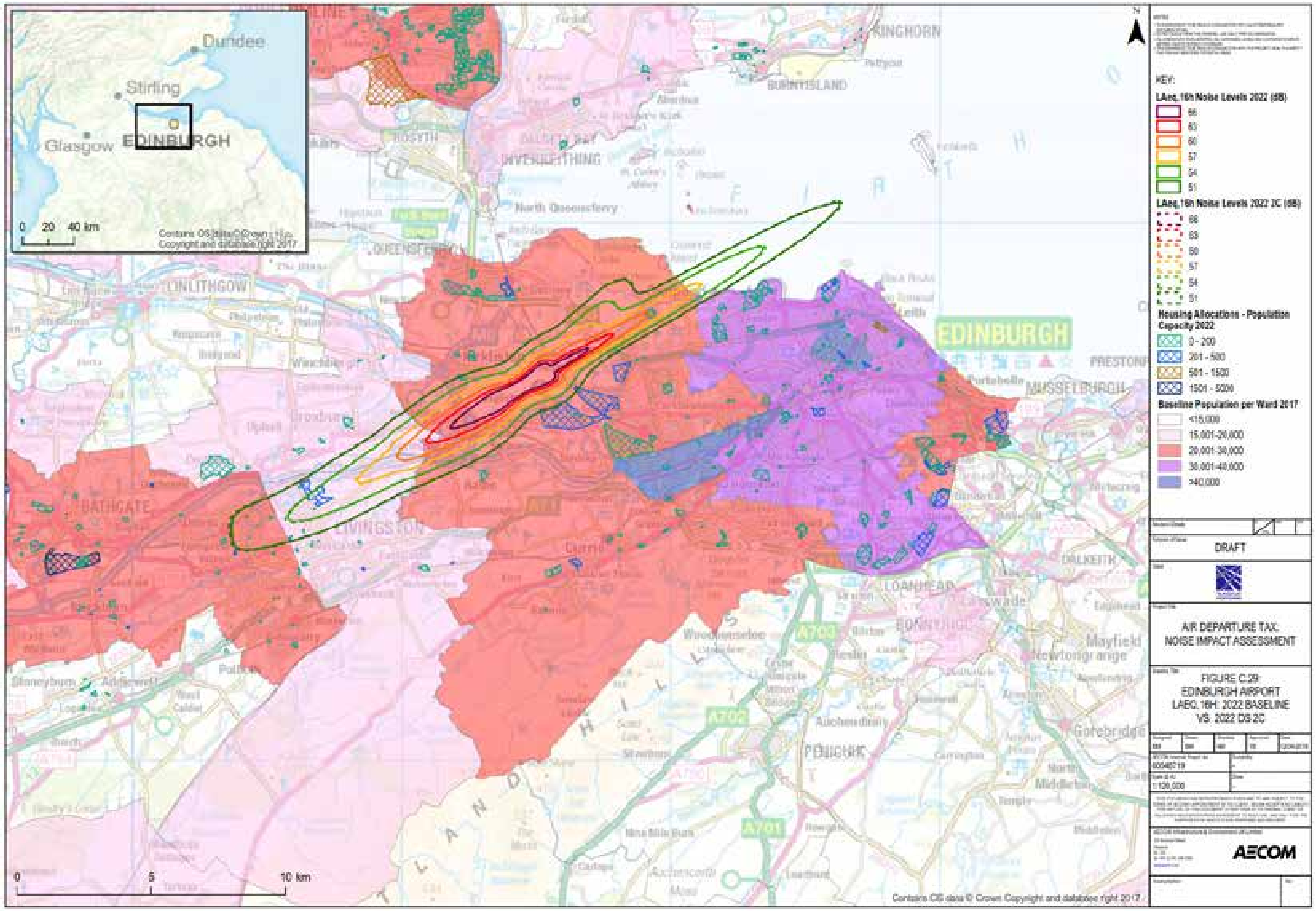


Figure C.30 Edinburgh Airport Baseline 2022 v Scenario 2c L_{night} dB Noise Contours

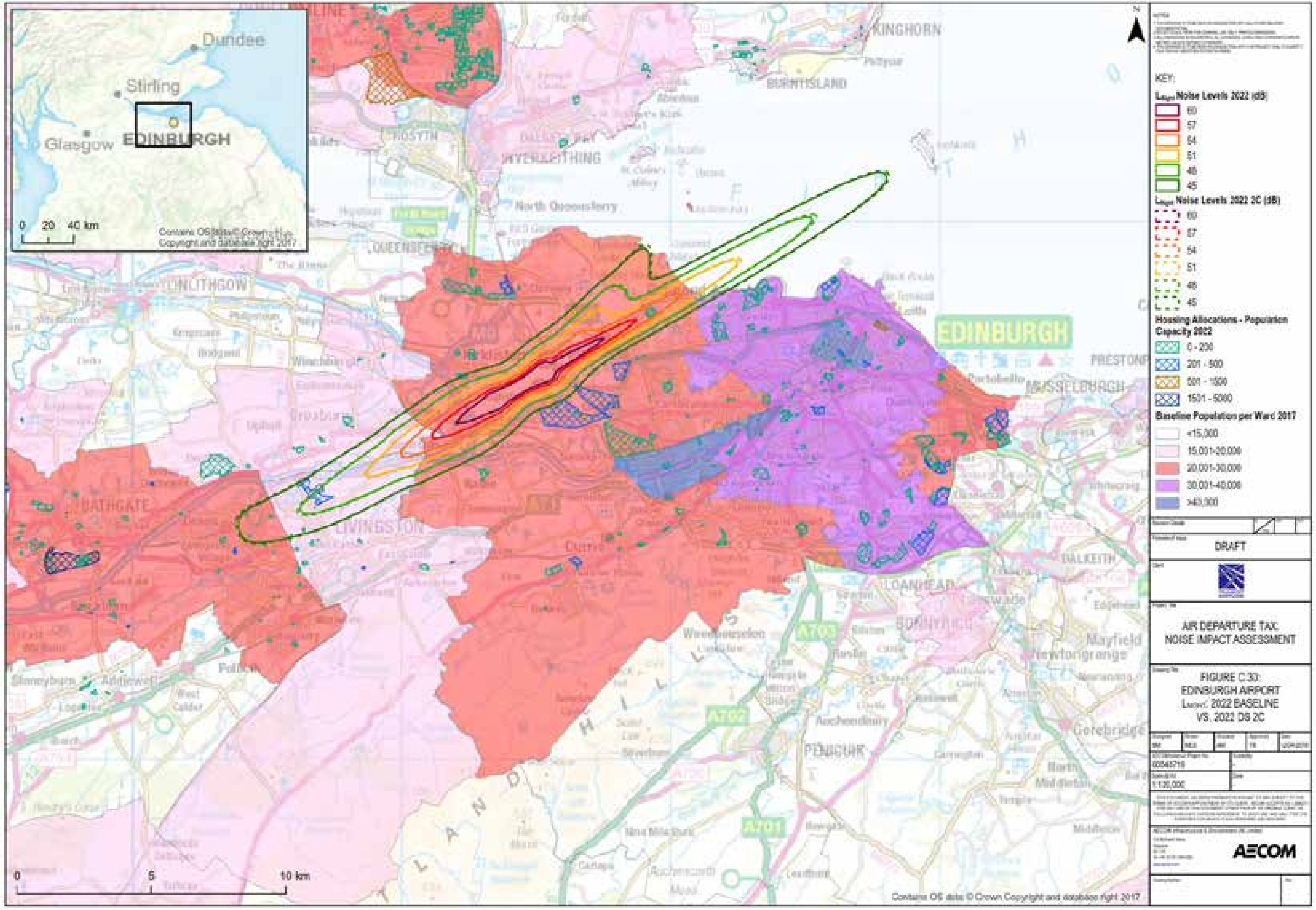


Figure C.31 Edinburgh Airport Baseline 2022 v Scenario 3a $L_{Aeq,16h}$ dB Noise Contours

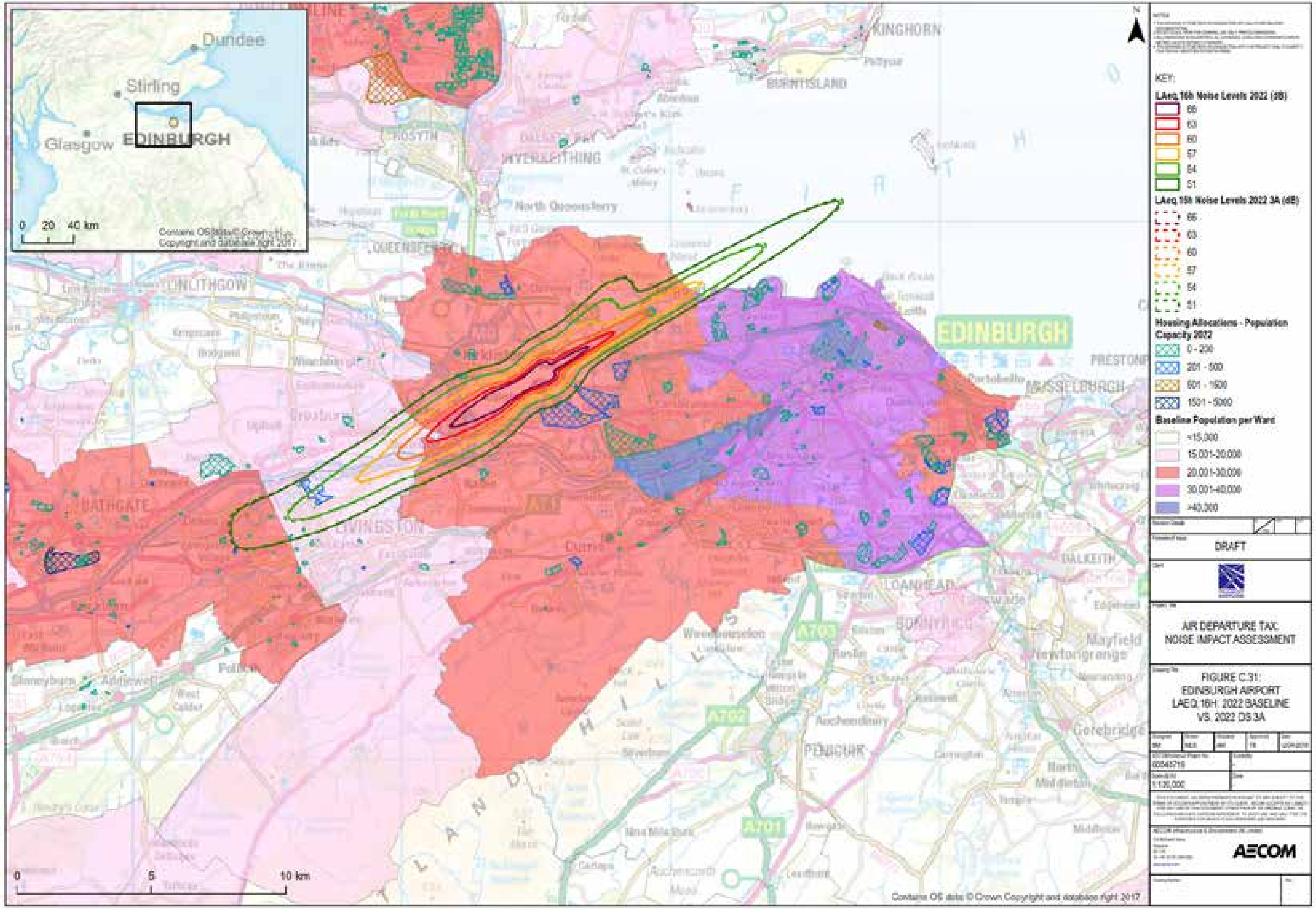


Figure C.32 Edinburgh Airport Baseline 2022 v Scenario 3a L_{night} dB Noise Contours

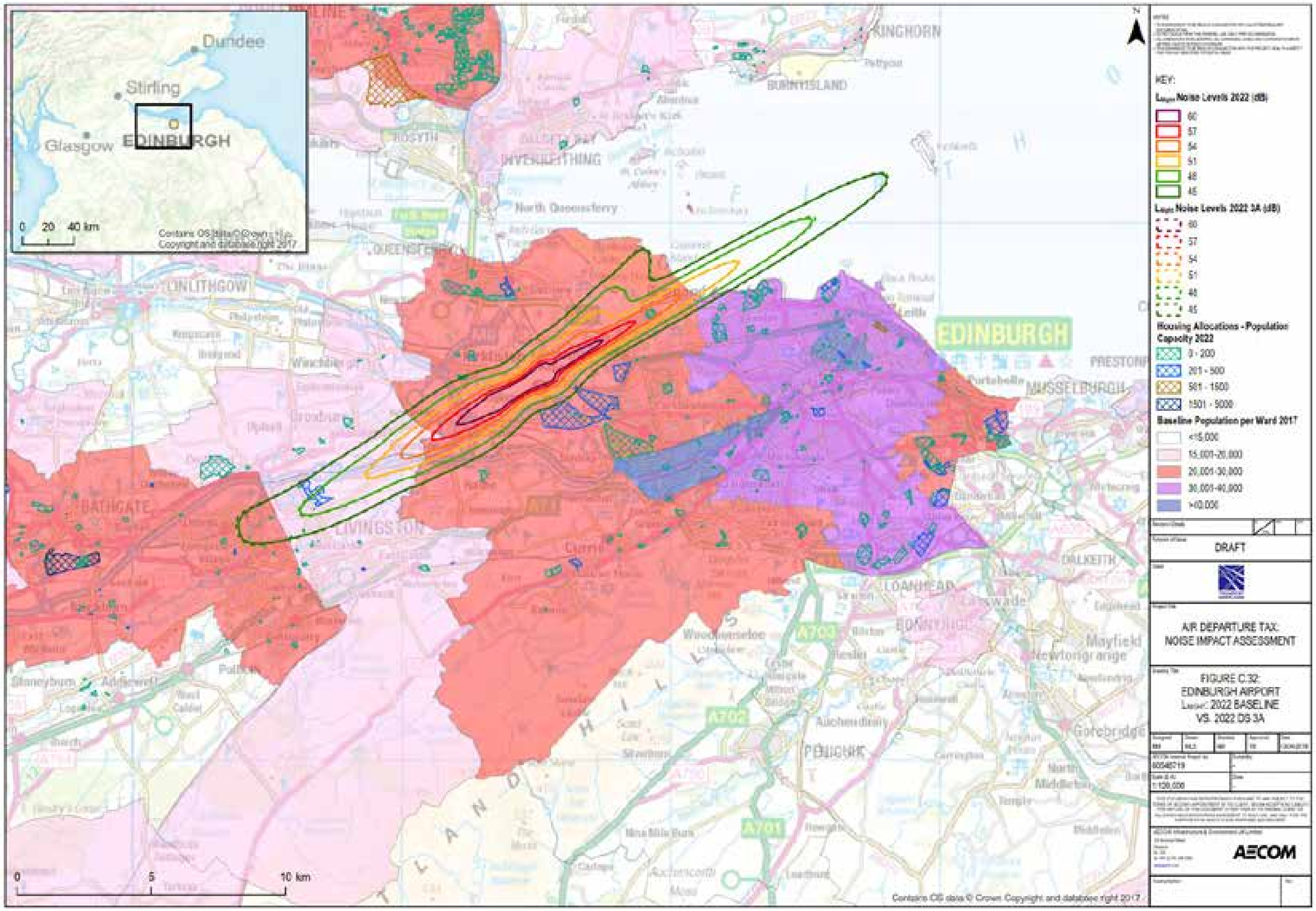


Figure C.33 Edinburgh Airport Baseline 2022 v Scenario 3c $L_{Aeq,16h}$ dB Noise Contours

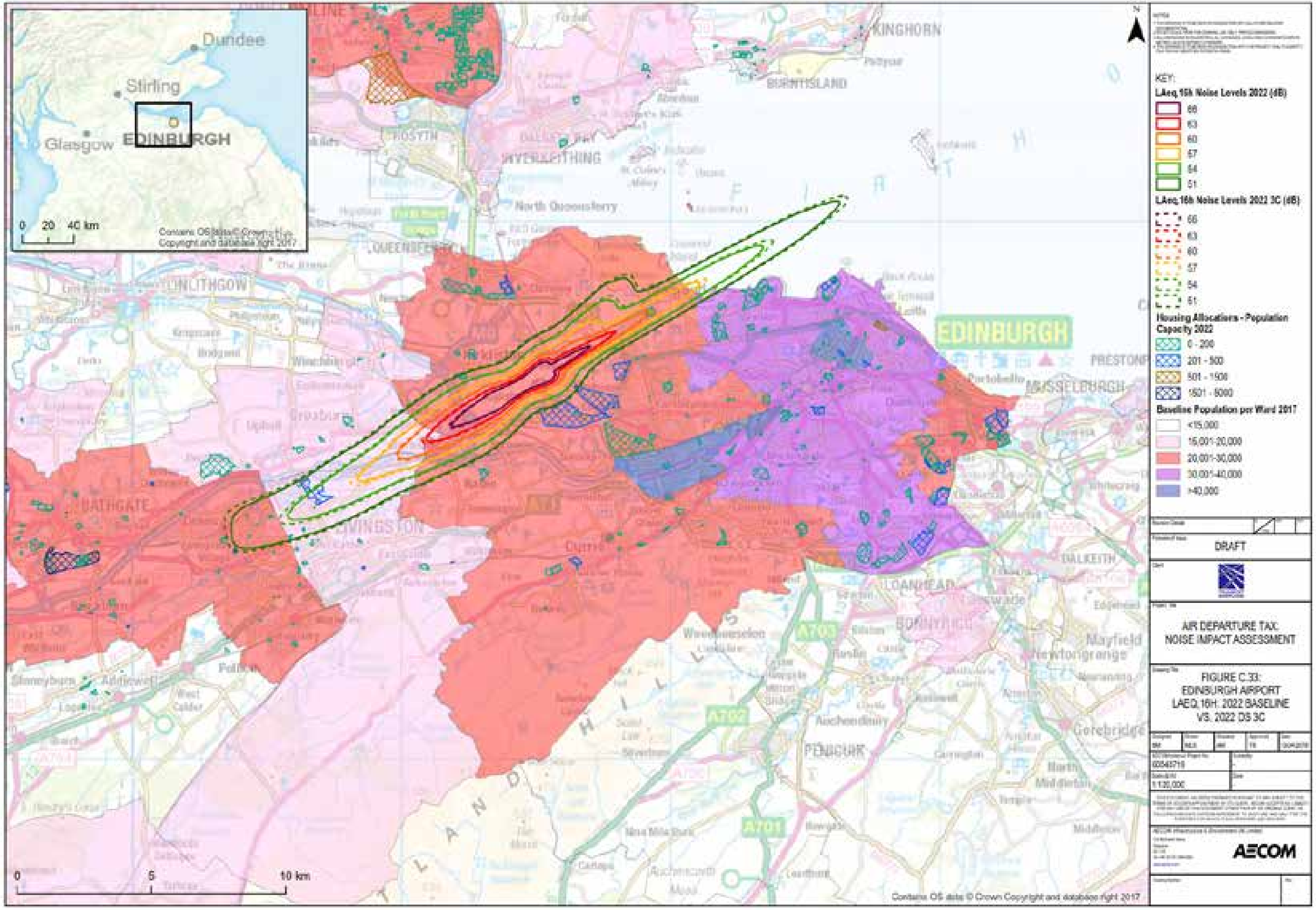


Figure C.34 Edinburgh Airport Baseline 2022 v Scenario 3c L_{night} dB Noise Contours

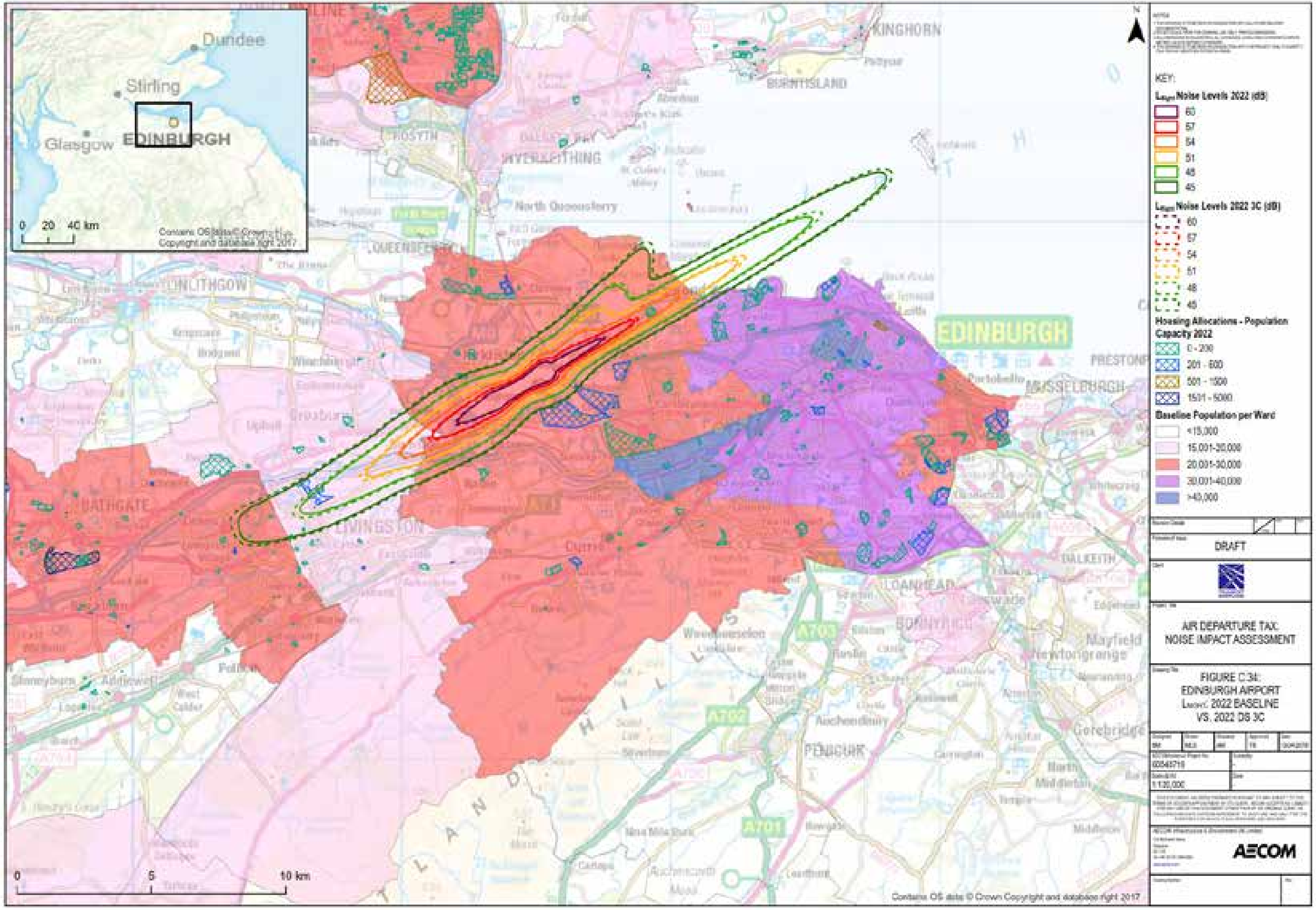


Figure C.35 Glasgow Airport Baseline 2022 v Scenario 1a $L_{Aeq,16h}$ dB Noise Contours

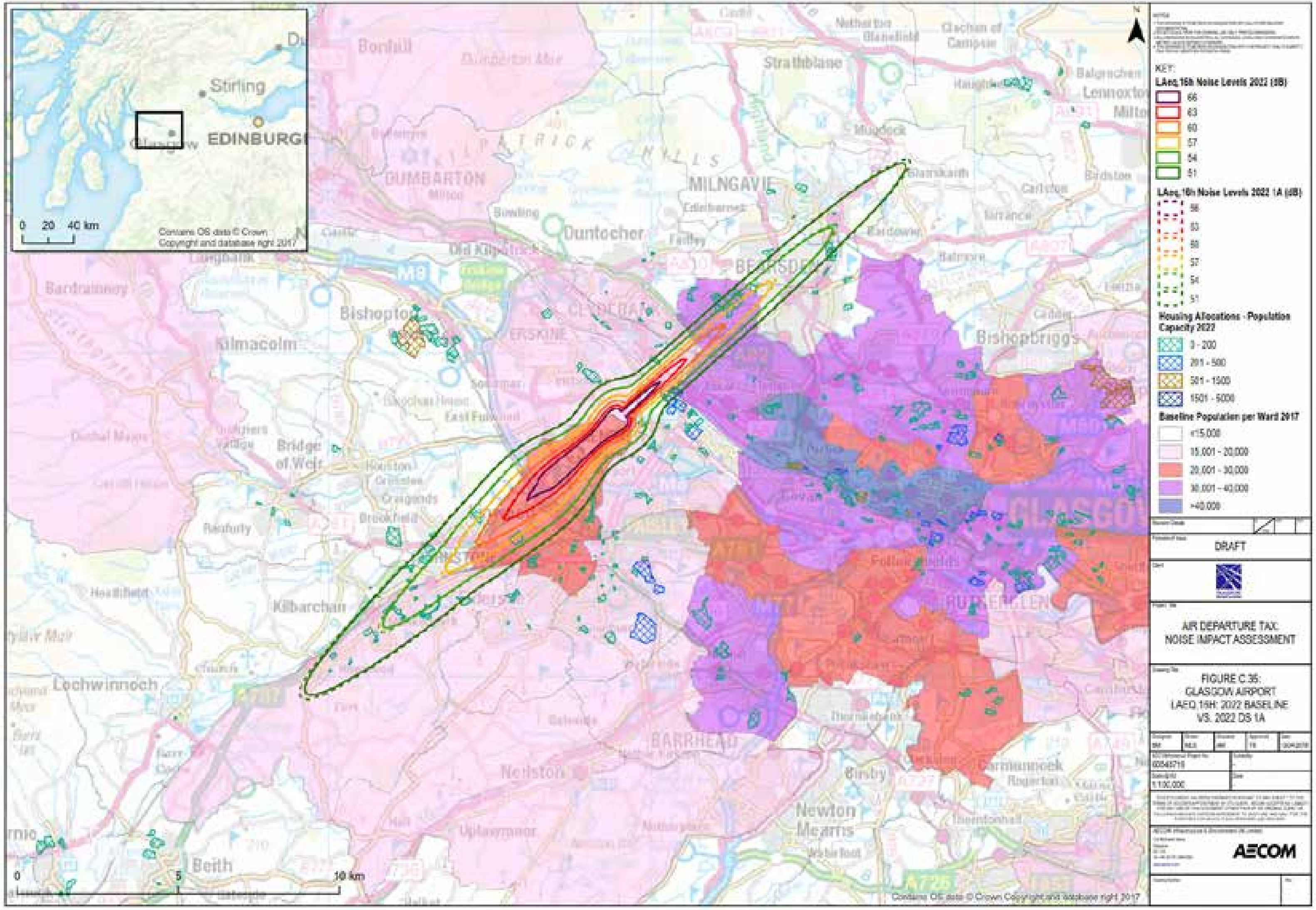


Figure C.36 Glasgow Airport Baseline 2022 v Scenario 1a L_{night} dB Noise Contours

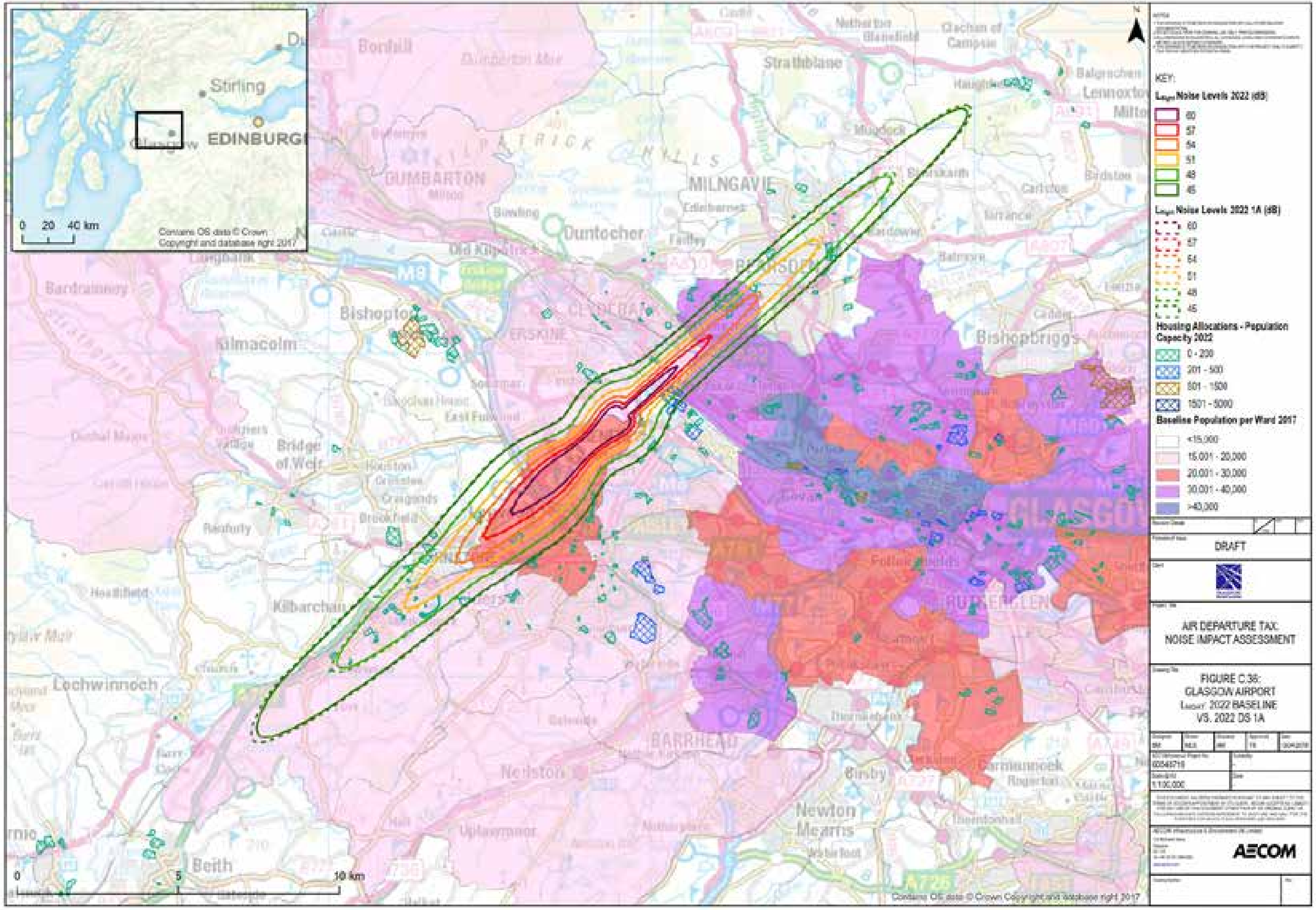


Figure C.37 Glasgow Airport Baseline 2022 v Scenario 1c $L_{Aeq,16h}$ dB Noise Contours

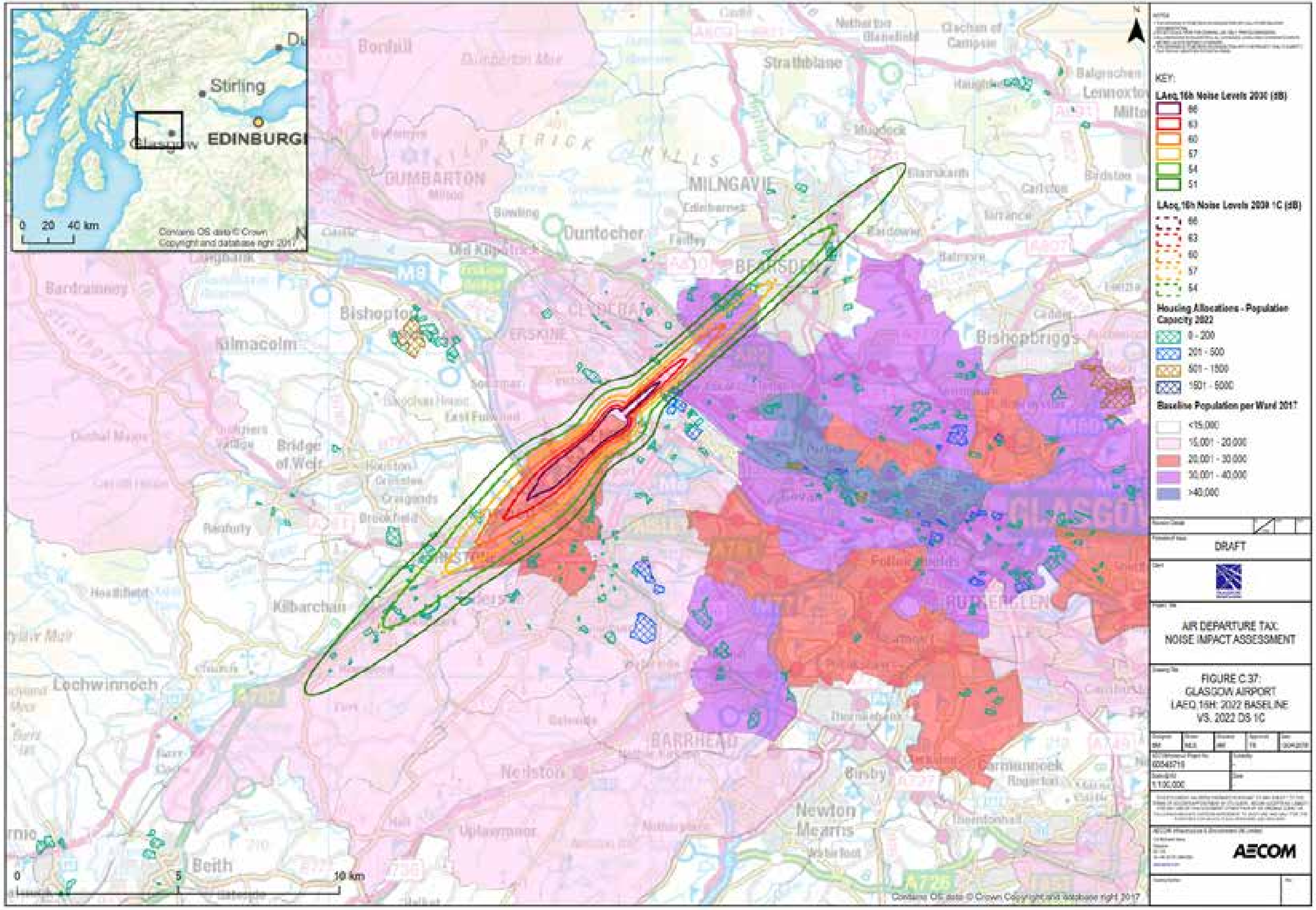


Figure C.38 Glasgow Airport Baseline 2022 v Scenario 1c L_{night} dB Noise Contours

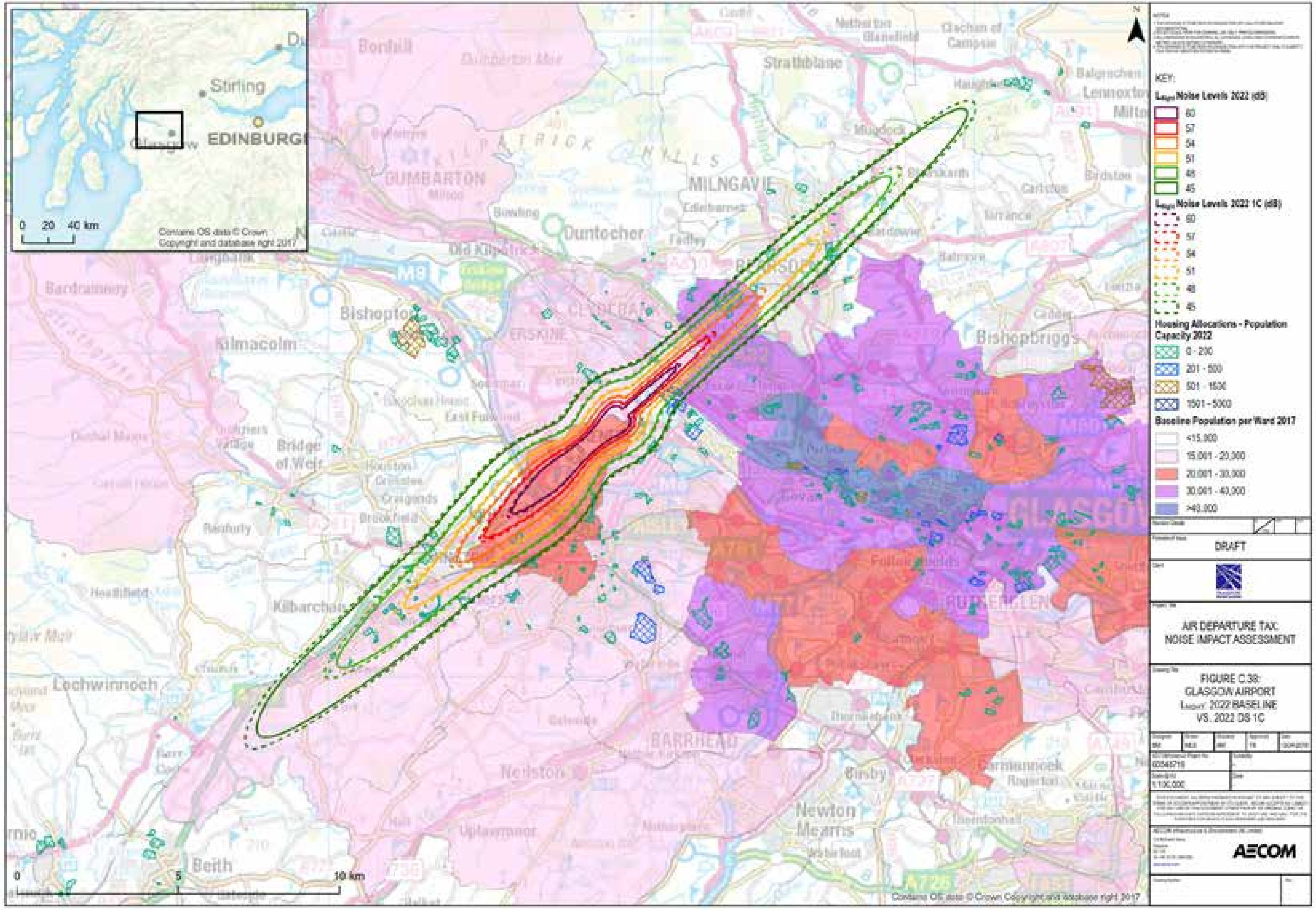


Figure C.39 Glasgow Airport Baseline 2022 v Scenario 2a $L_{Aeq,16h}$ dB Noise Contours

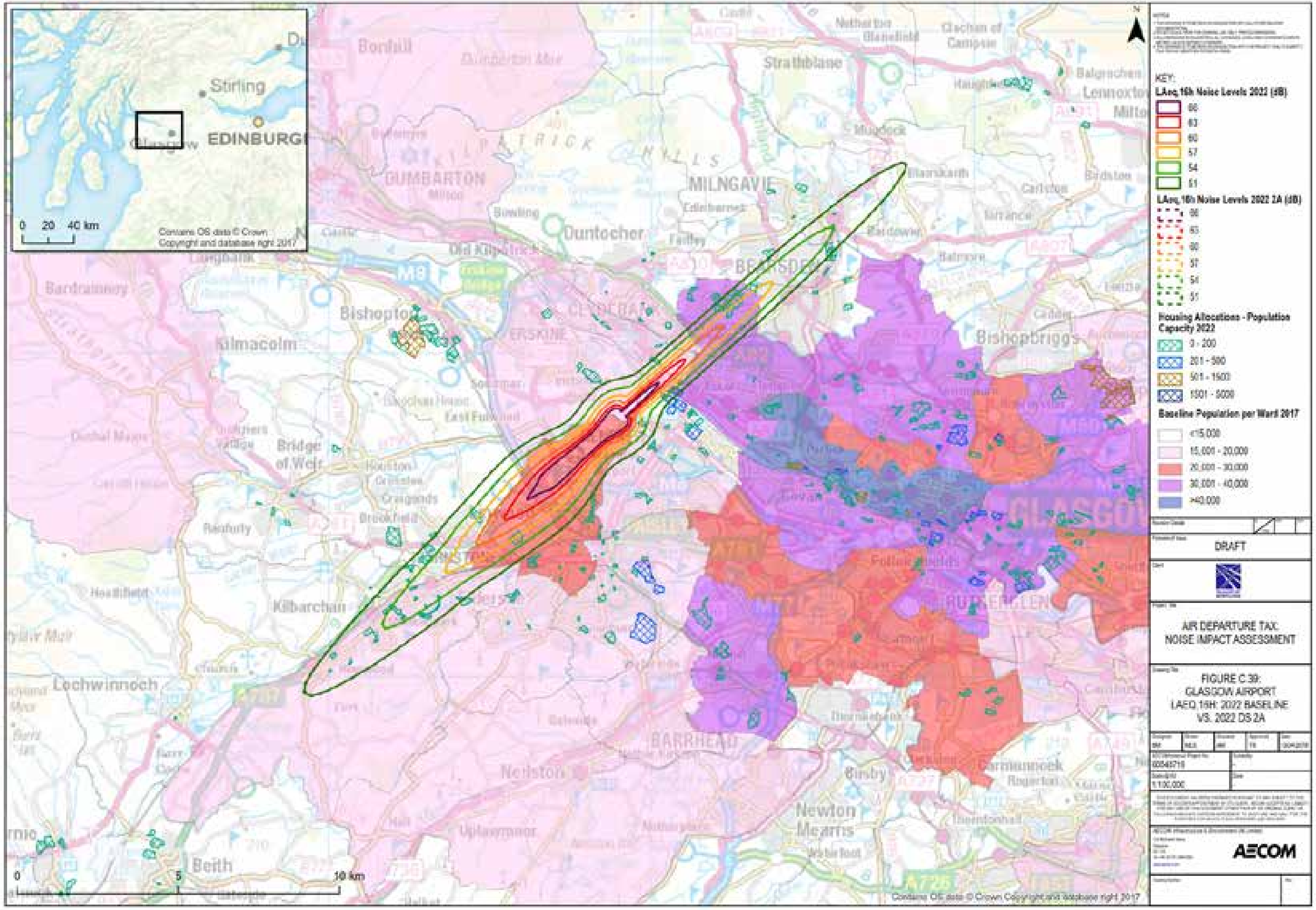


Figure C.40 Glasgow Airport Baseline 2022 v Scenario 2a L_{night} dB Noise Contours

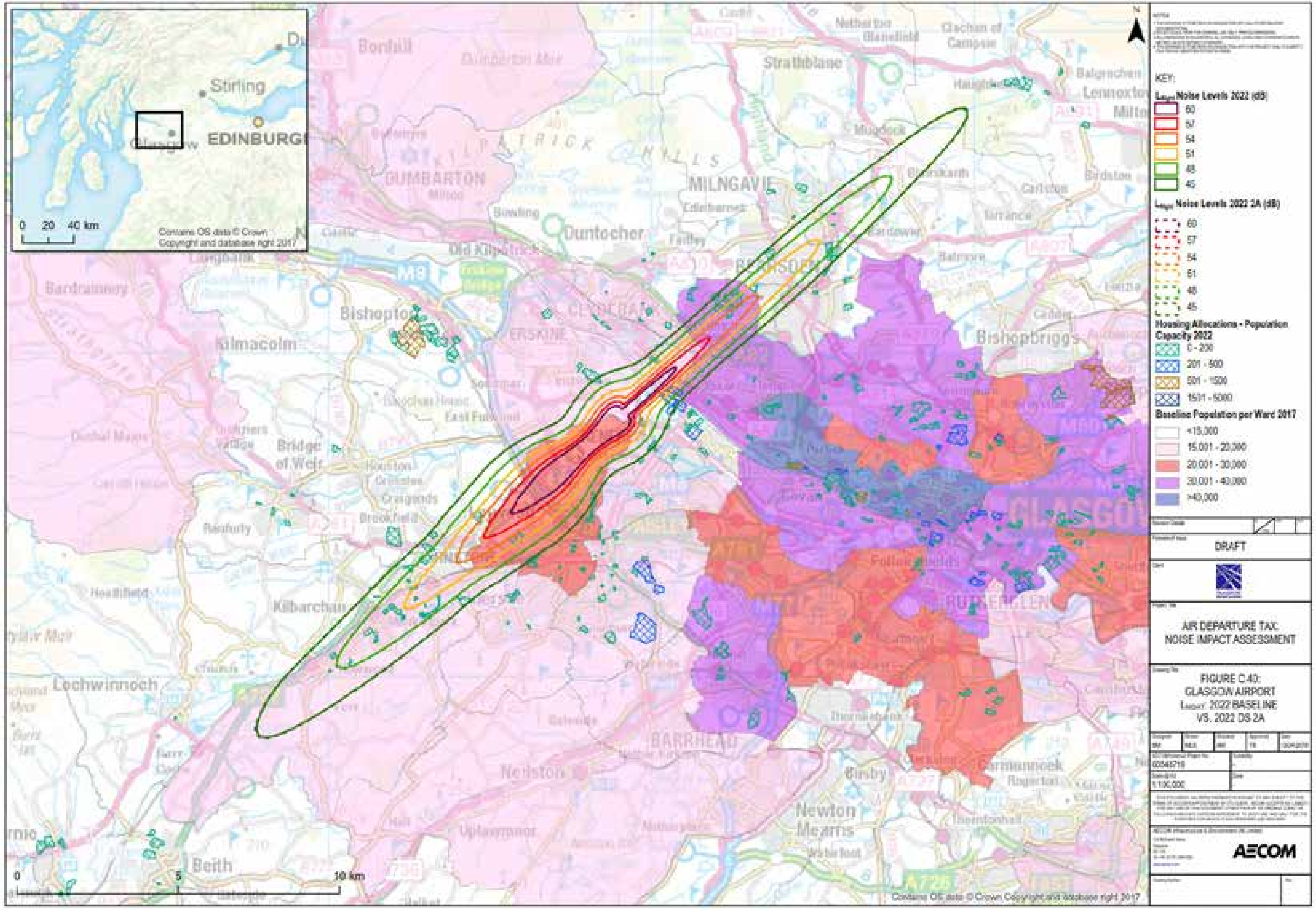


Figure C.41 Glasgow Airport Baseline 2022 v Scenario 2c $L_{Aeq,16h}$ dB Noise Contours

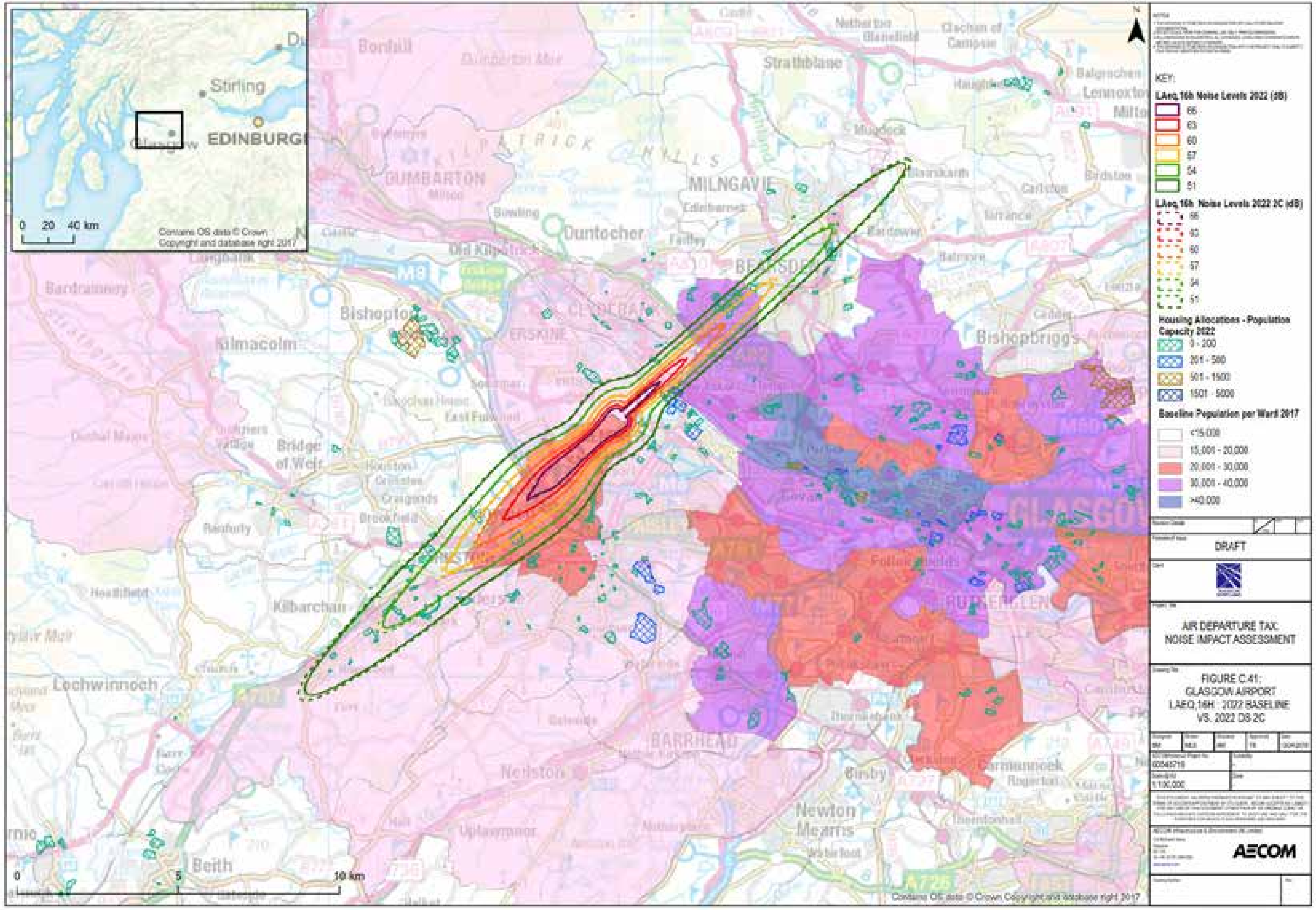


Figure C.42 Glasgow Airport Baseline 2022 v Scenario 2c L_{night} dB Noise Contours

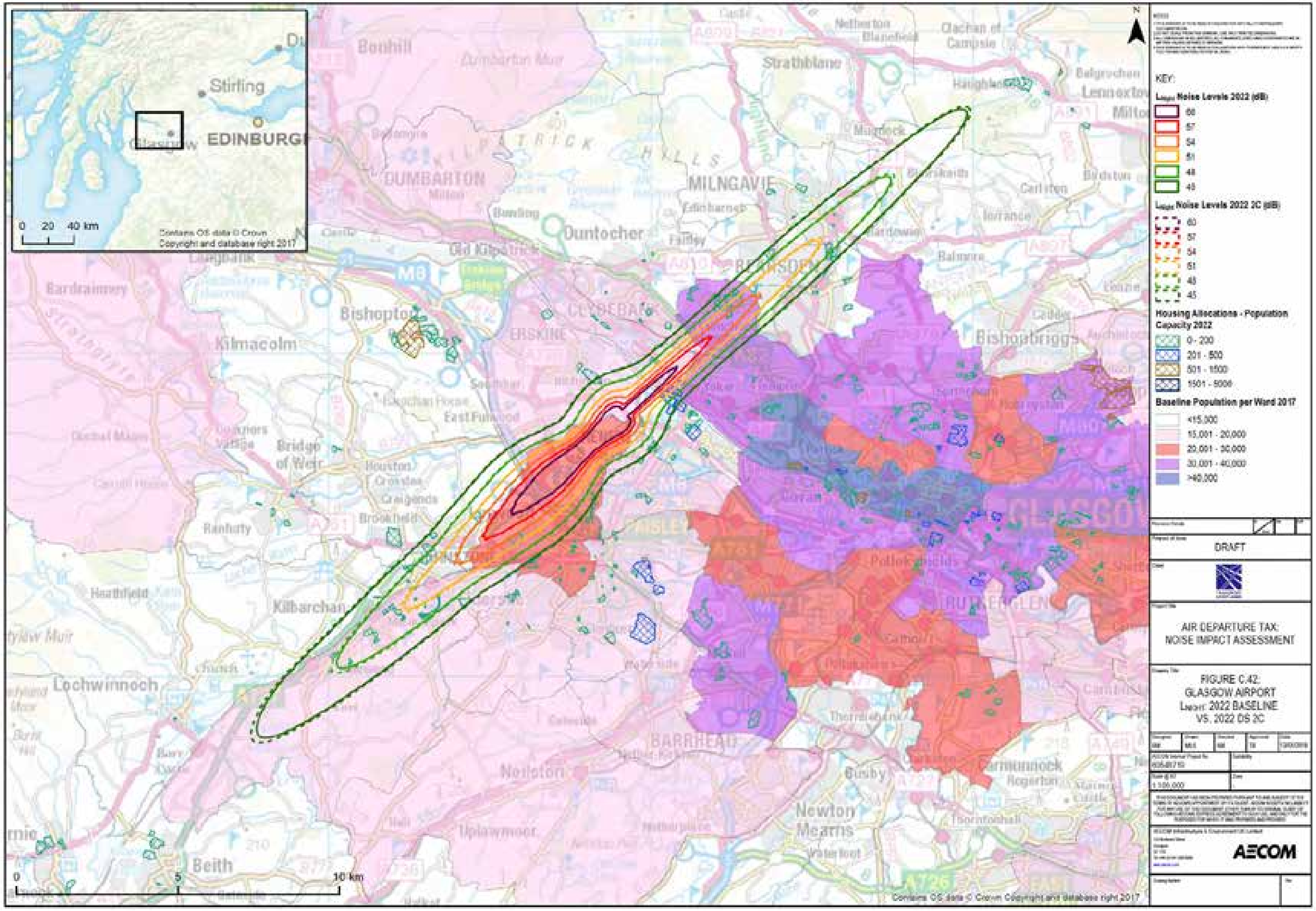


Figure C.43 Glasgow Airport Baseline 2022 v Scenario 3a $L_{Aeq,16h}$ dB Noise Contours

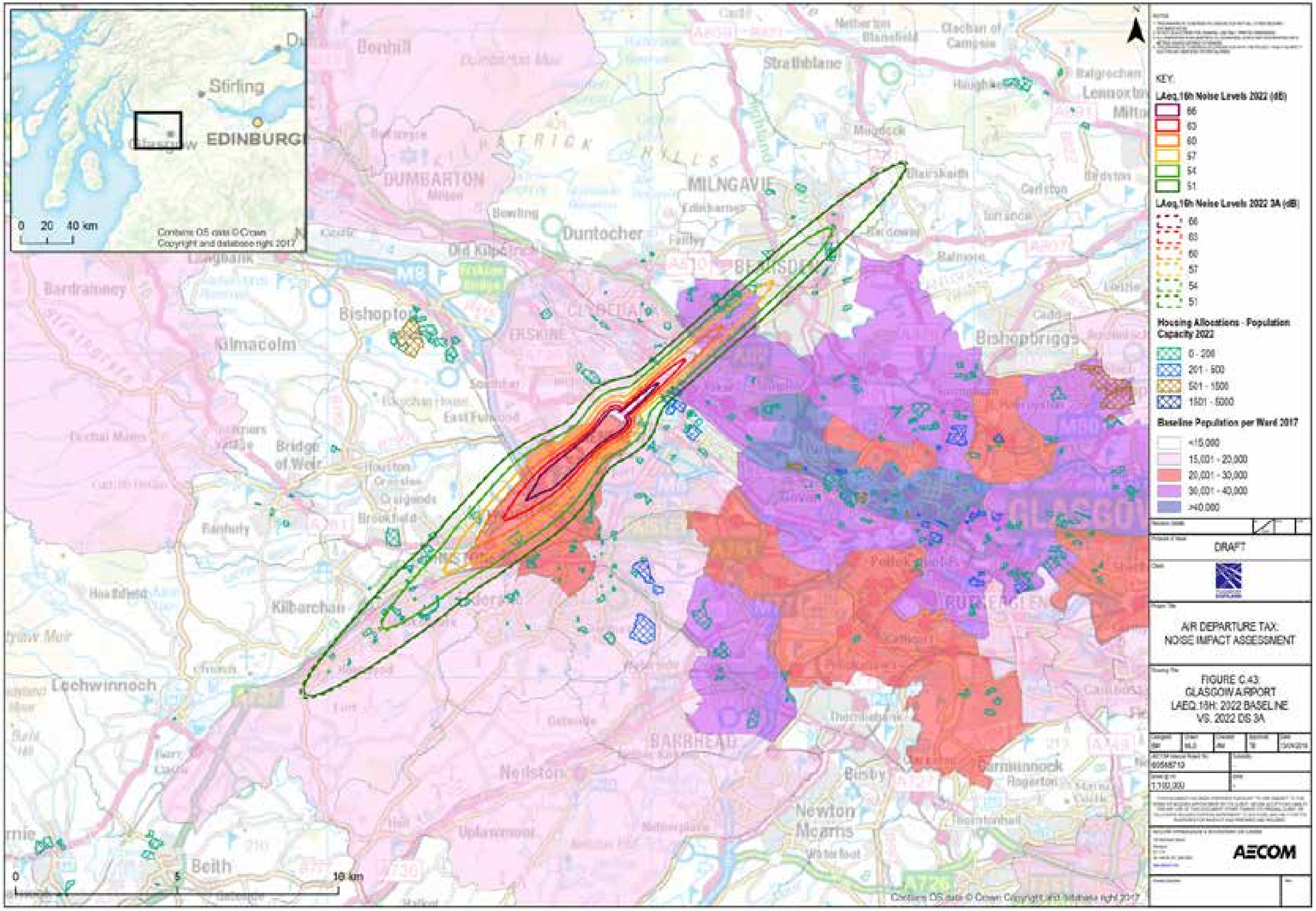


Figure C.44 Glasgow Airport Baseline 2022 v Scenario 3a L_{night} dB Noise Contours

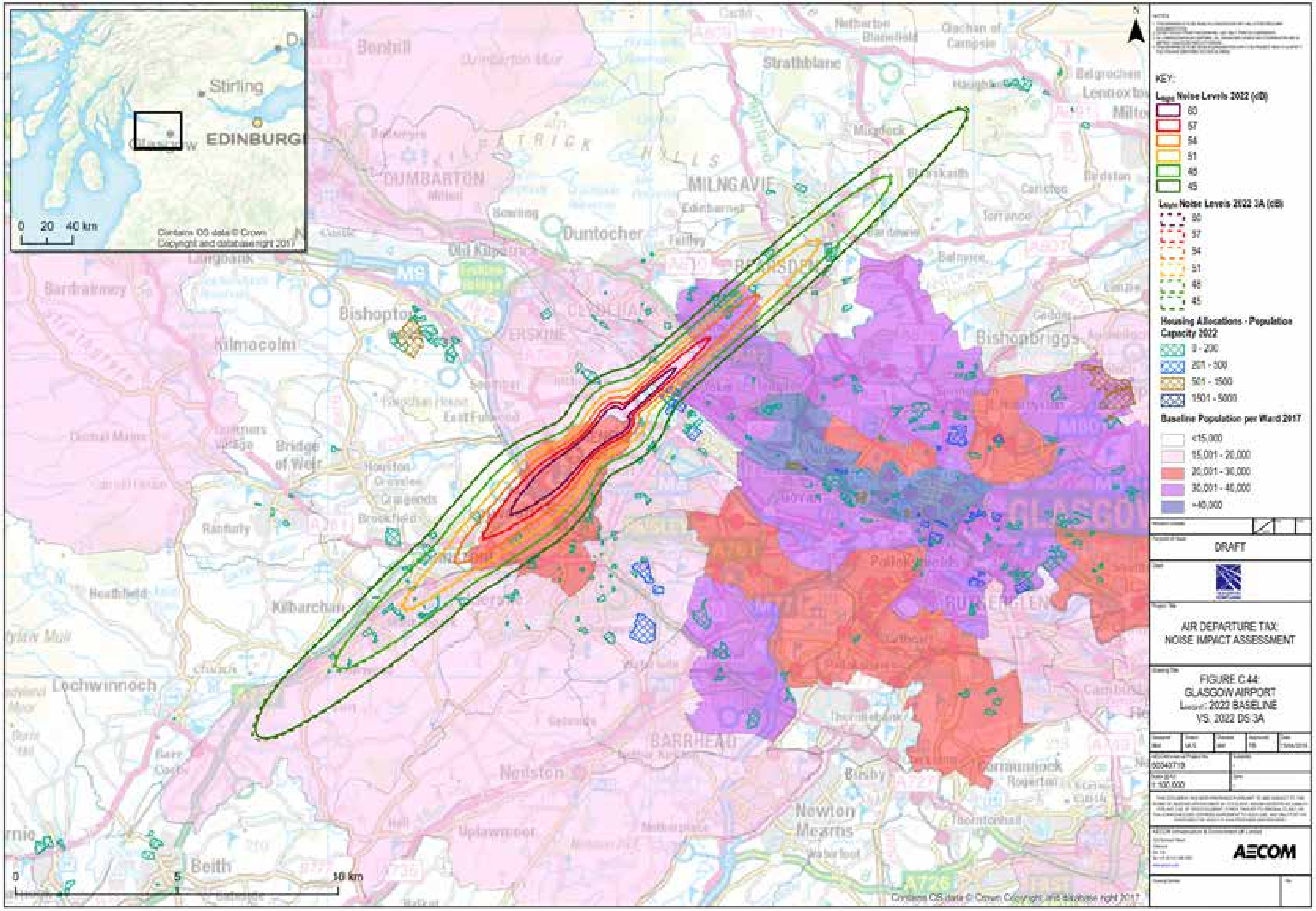


Figure C.45 Glasgow Airport Baseline 2022 v Scenario 3c $L_{Aeq,16h}$ dB Noise Contours

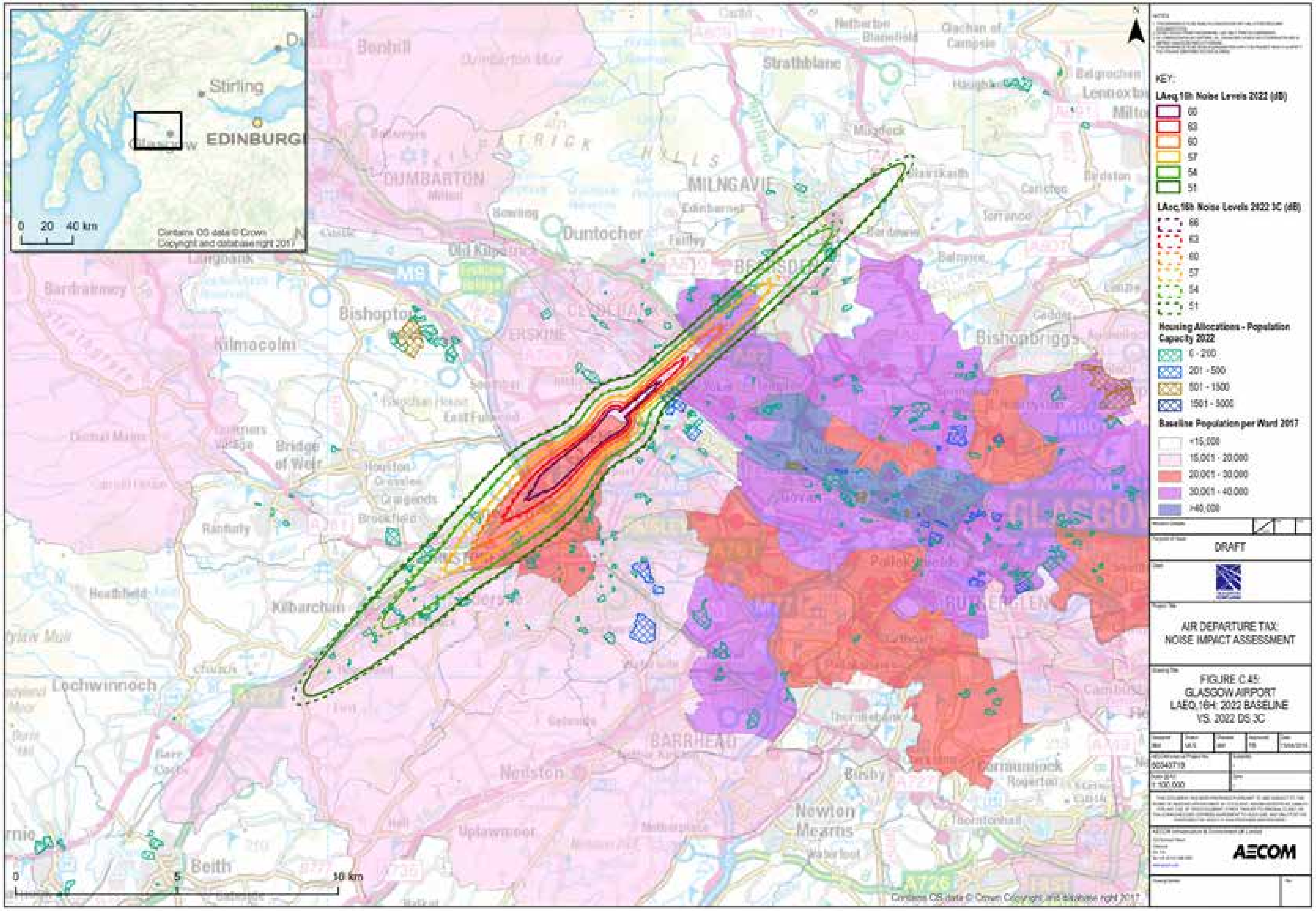


Figure C.46 Glasgow Airport Baseline 2022 v Scenario 3c L_{night} dB Noise Contours

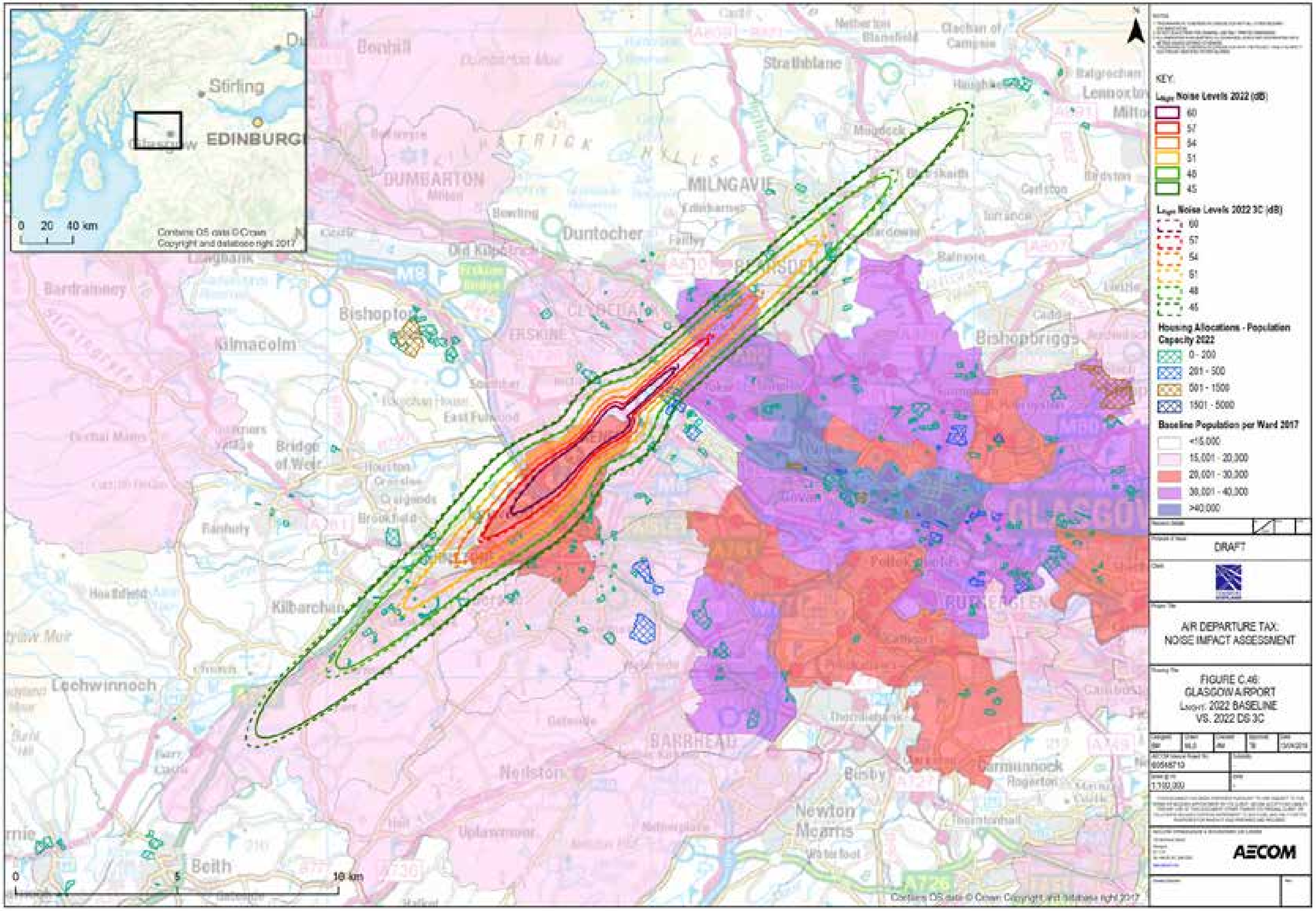


Figure C.47 Prestwick Airport Baseline 2022 v Scenario 1a $L_{Aeq,16h}$ dB Noise Contours

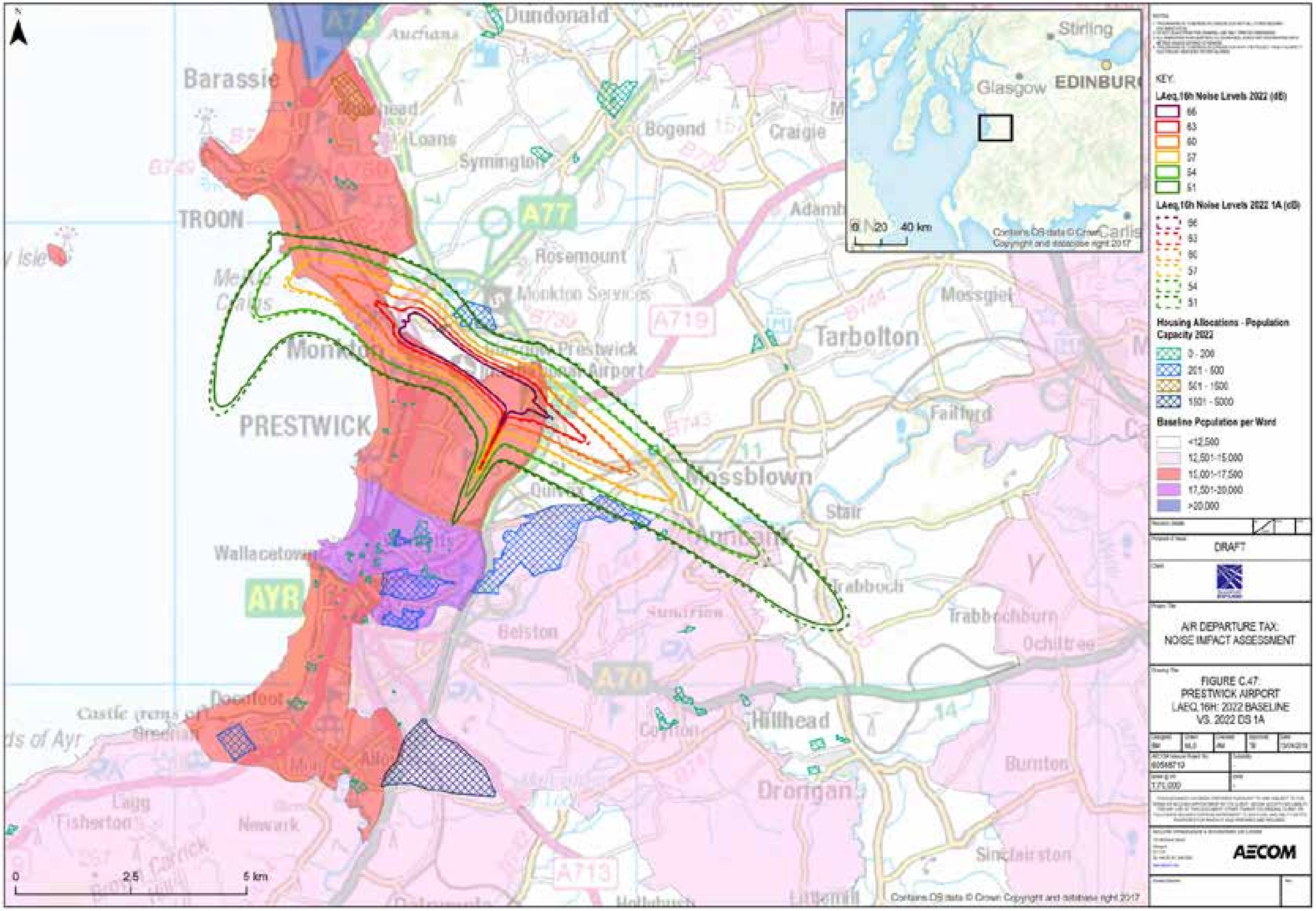


Figure C.48 Prestwick Airport Baseline 2022 v Scenario 1a L_{night} dB Noise Contours

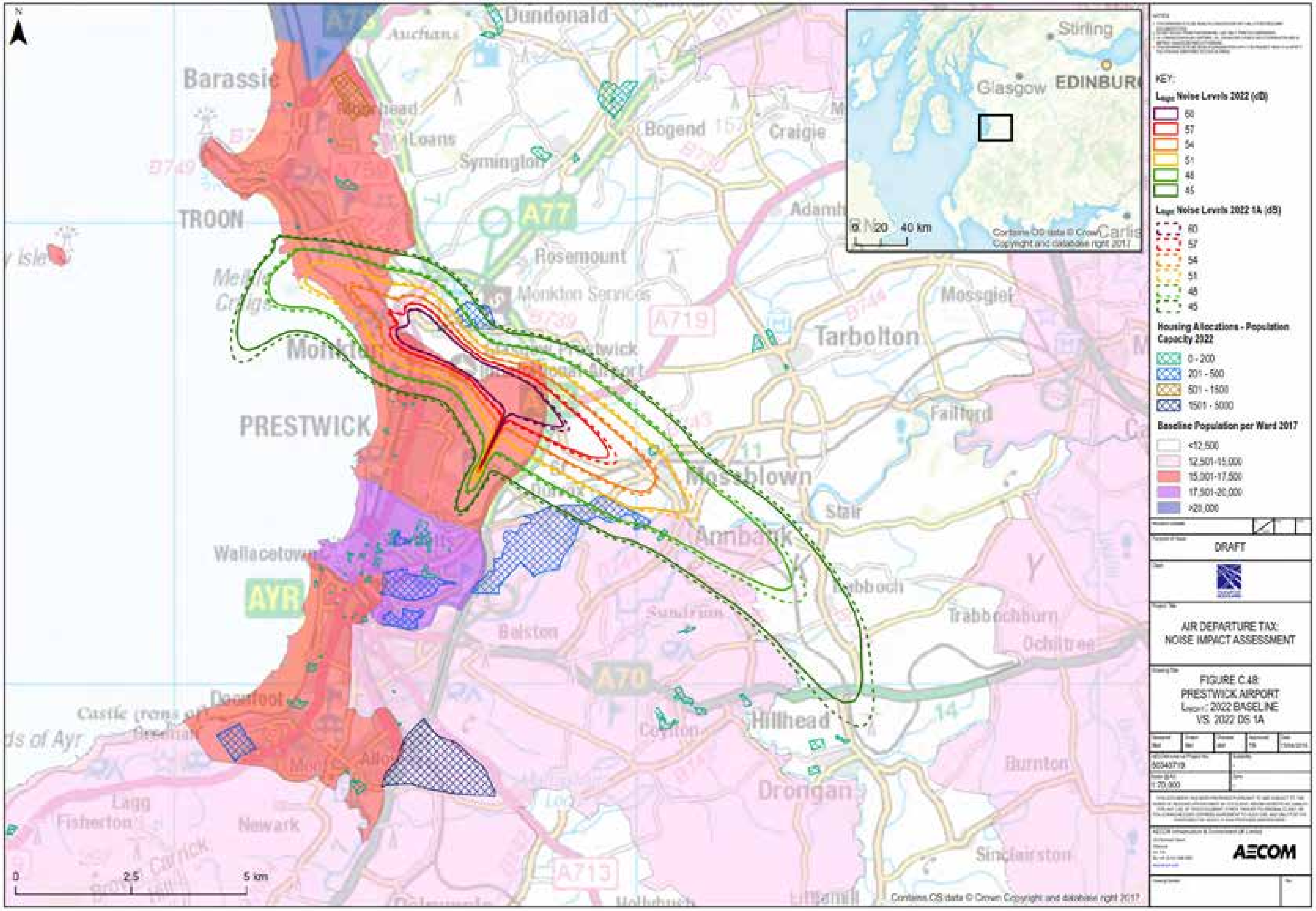


Figure C.49 Prestwick Airport Baseline 2022 v Scenario 1c $L_{Aeq,16h}$ dB Noise Contours

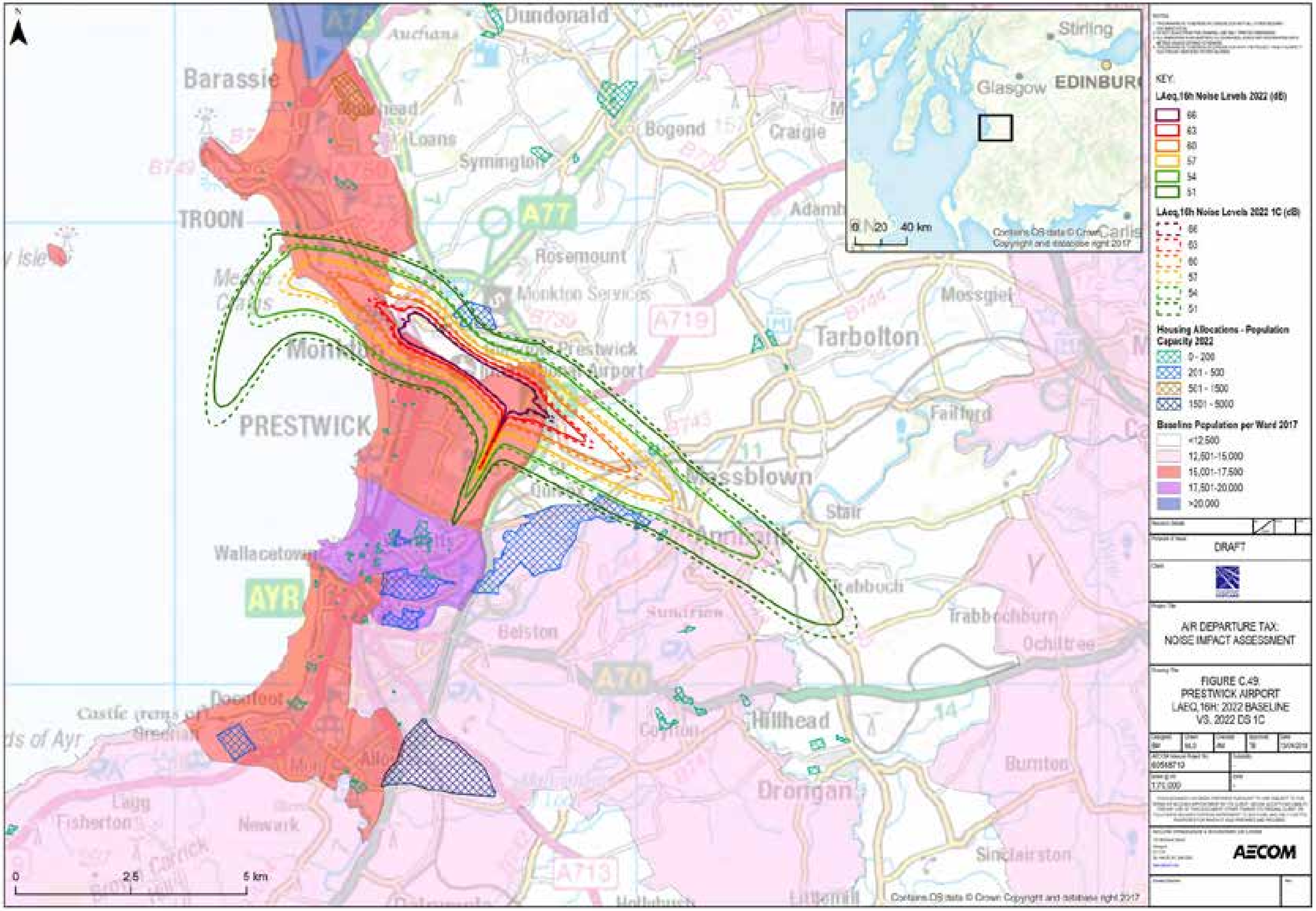


Figure C.50 Prestwick Airport Baseline 2022 v Scenario 1c L_{night} dB Noise Contours

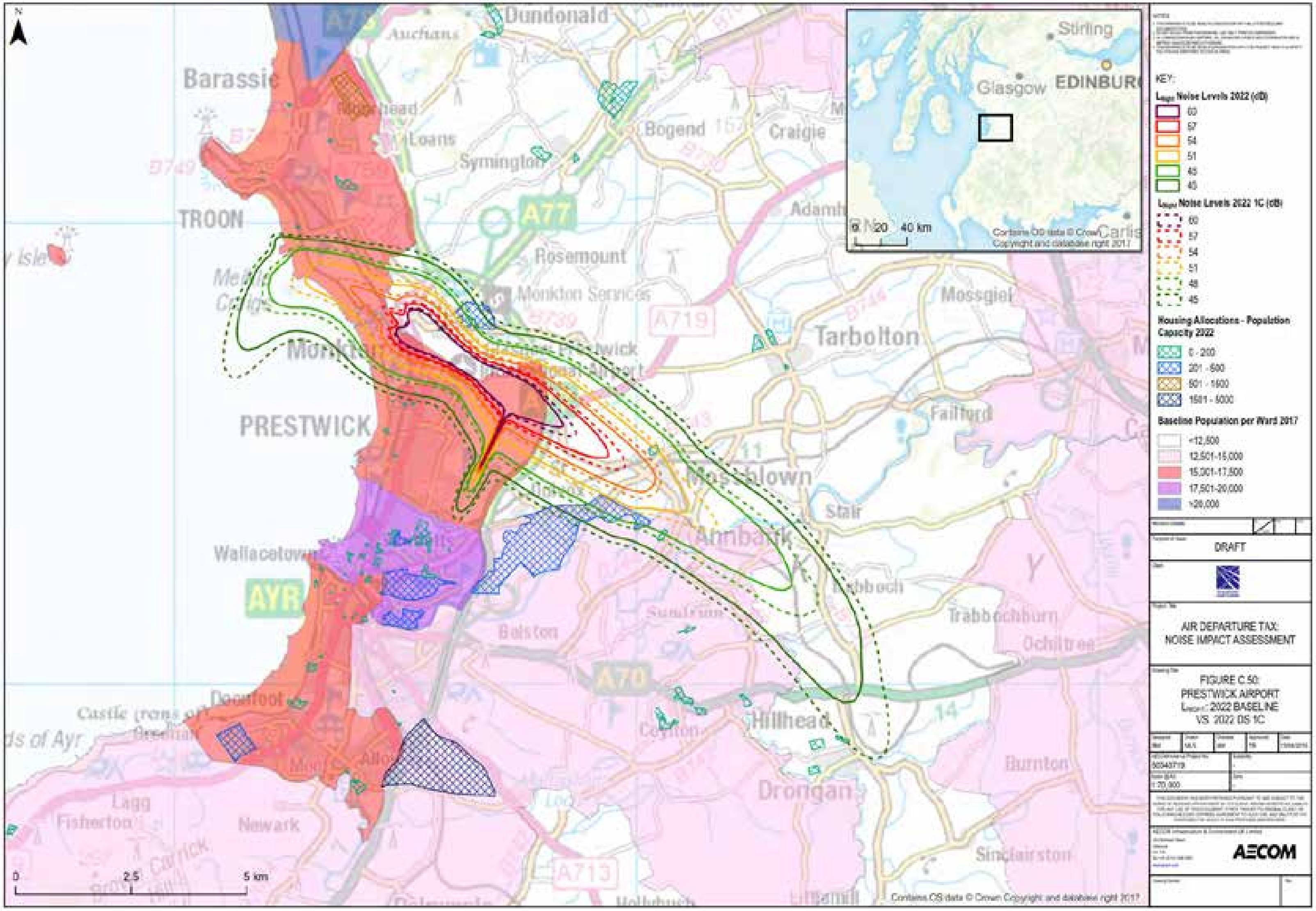


Figure C.51 Prestwick Airport Baseline 2022 v Scenario 2a $L_{Aeq,16h}$ dB Noise Contours

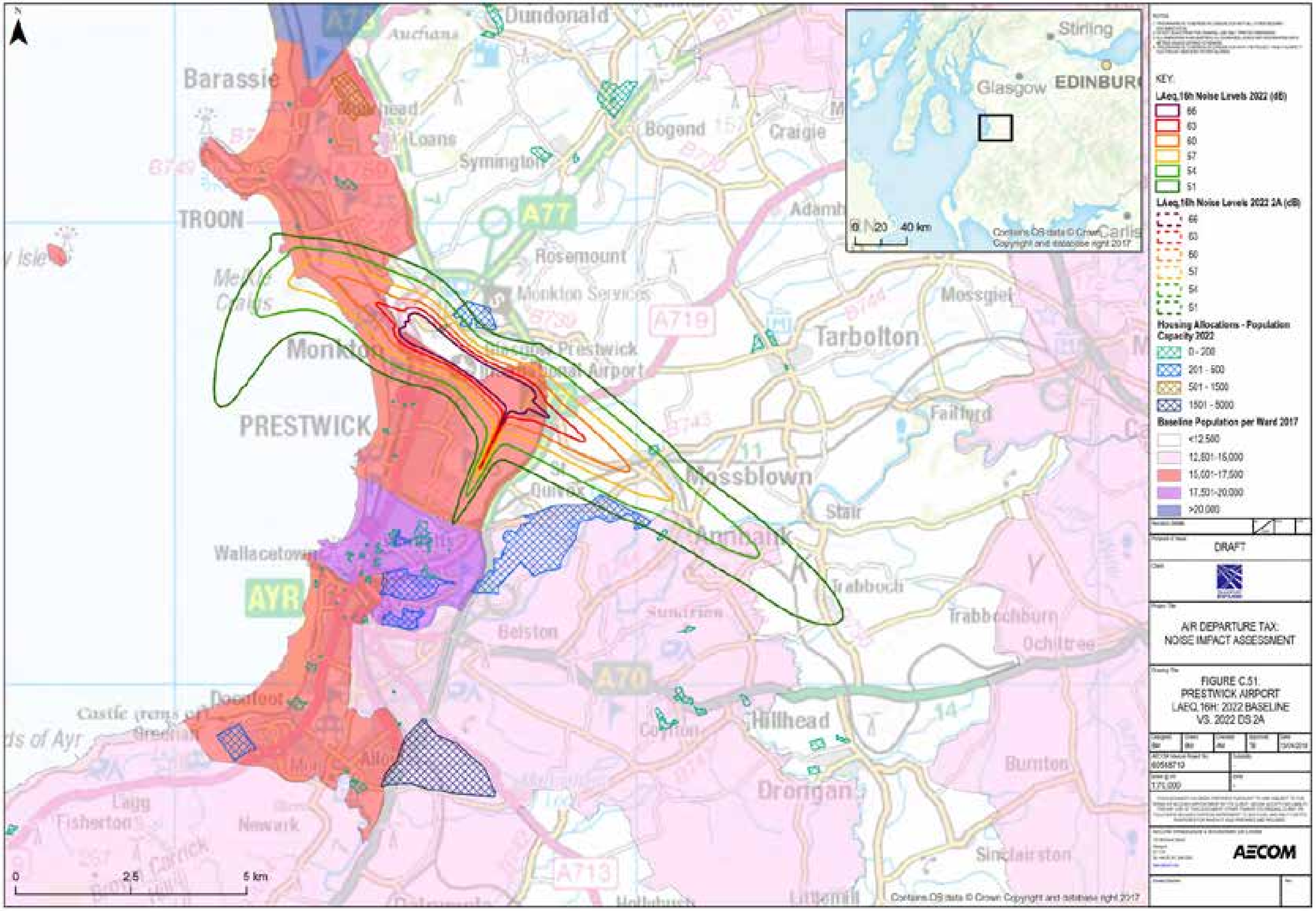


Figure C.52 Prestwick Airport Baseline 2022 v Scenario 2a L_{night} dB Noise Contours

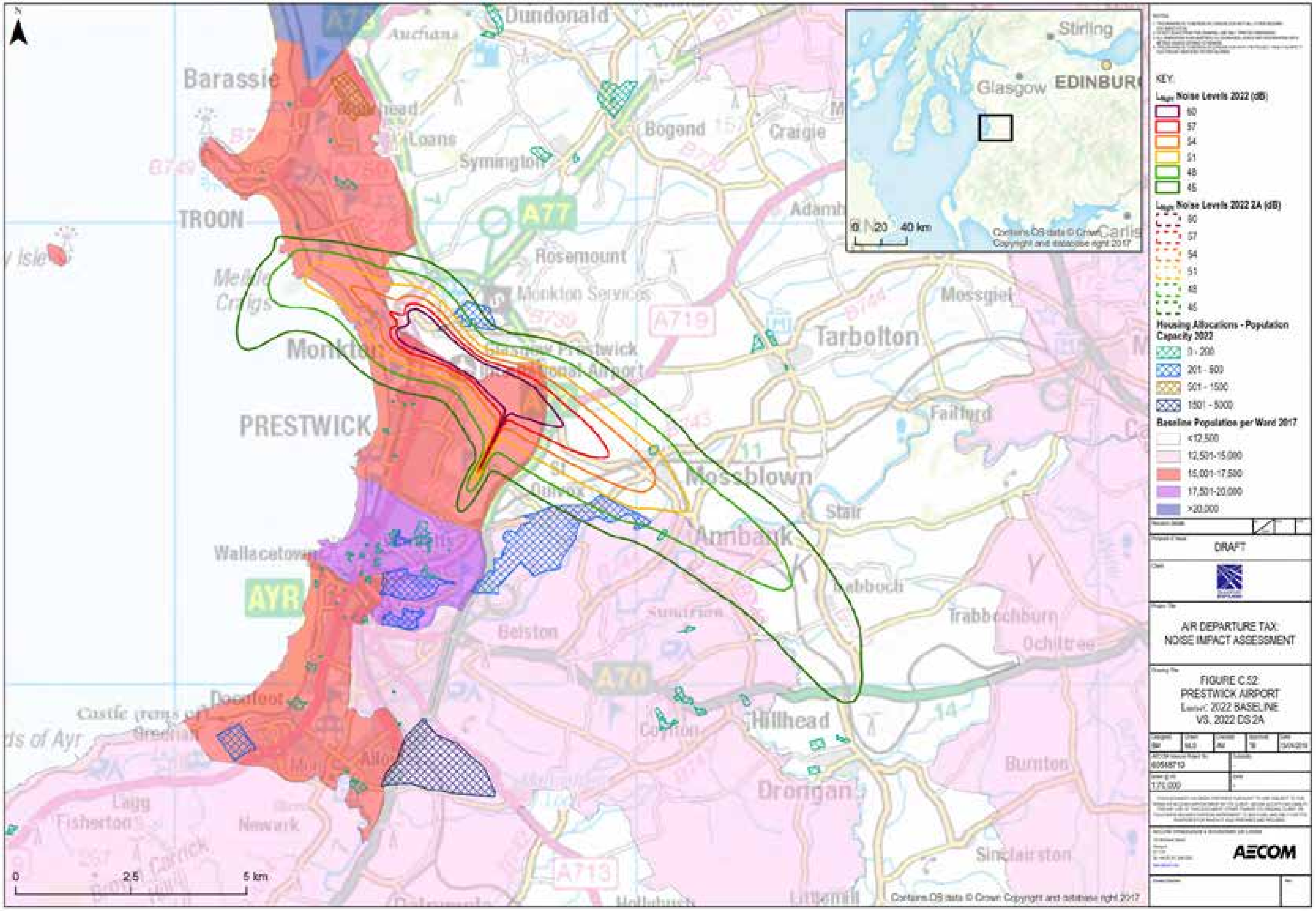


Figure C.53 Prestwick Airport Baseline 2022 v Scenario 2c $L_{Aeq,16h}$ dB Noise Contours

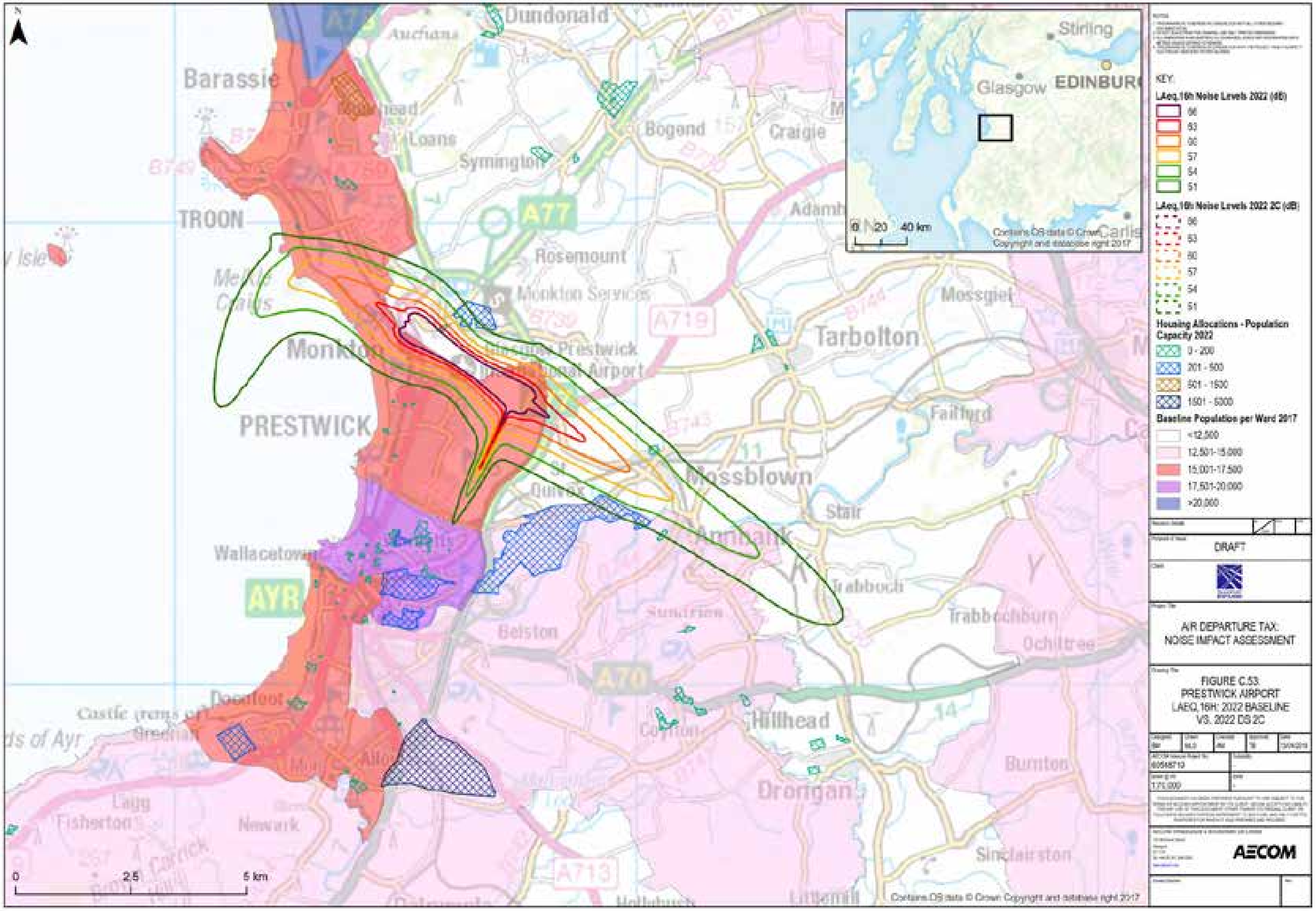


Figure C.54 Prestwick Airport Baseline 2022 v Scenario 2c L_{night} dB Noise Contours

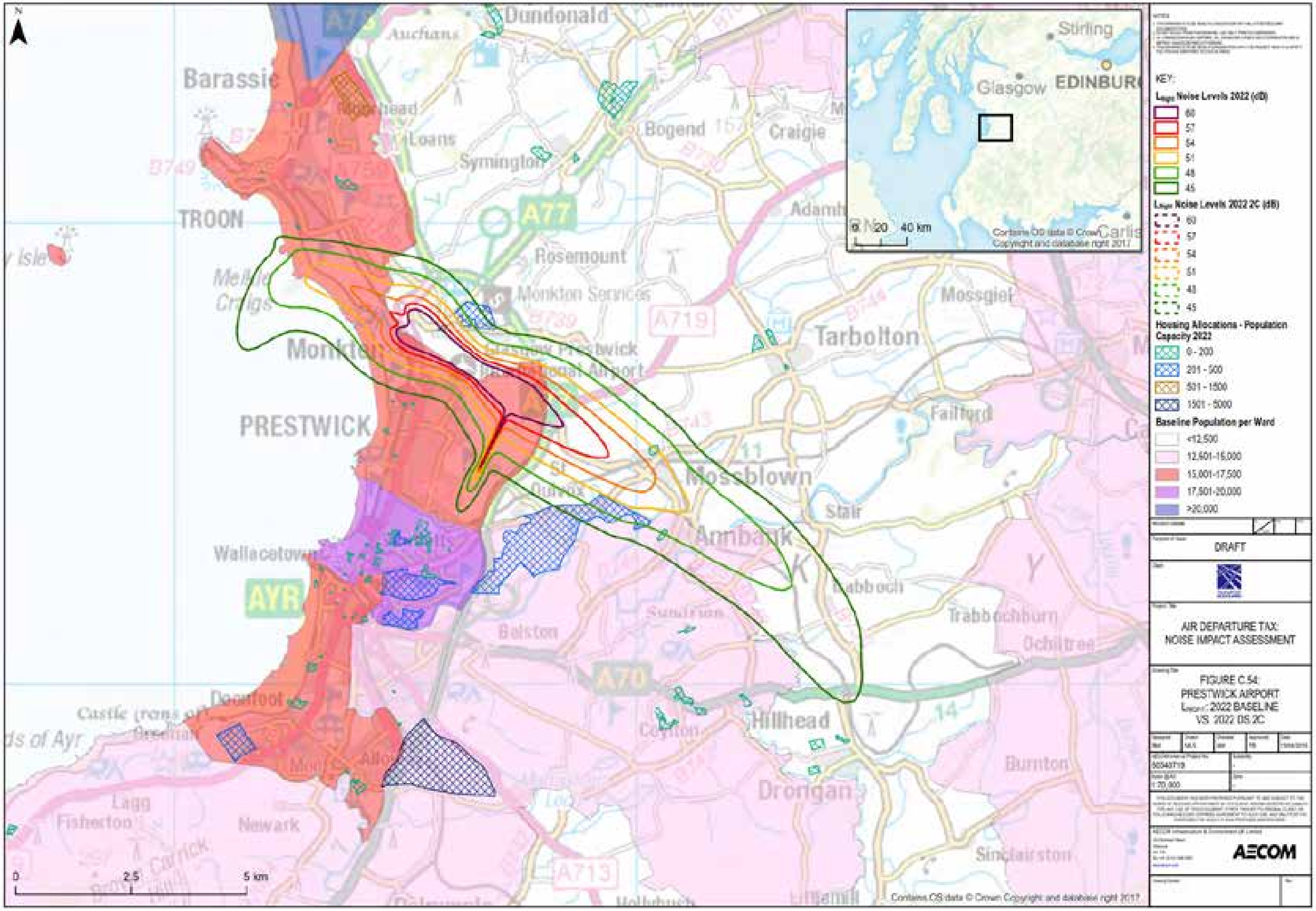


Figure C.55 Prestwick Airport Baseline 2022 v Scenario 3a $L_{Aeq,16h}$ dB Noise Contours

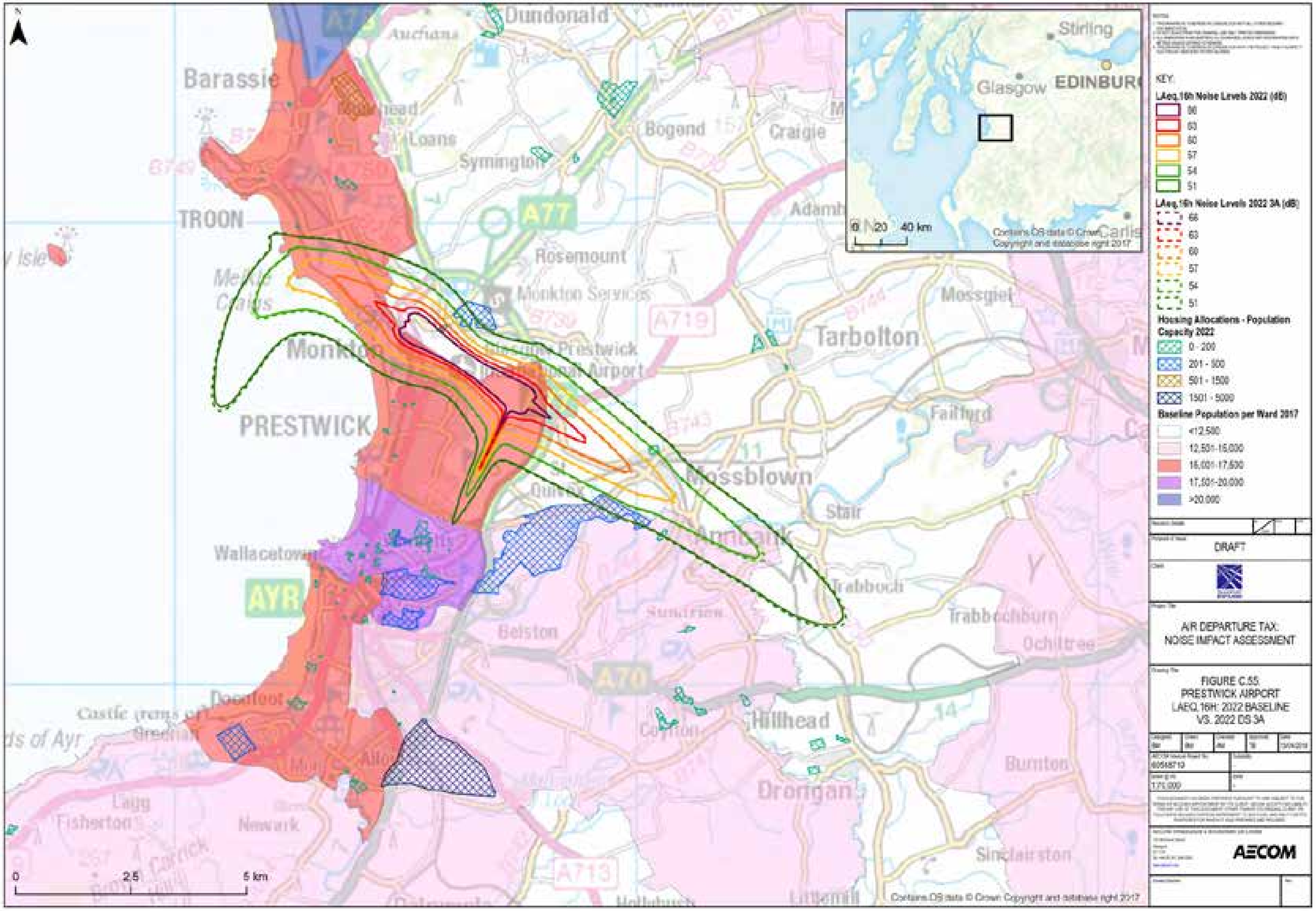


Figure C.56 Prestwick Airport Baseline 2022 v Scenario 3a L_{night} dB Noise Contours

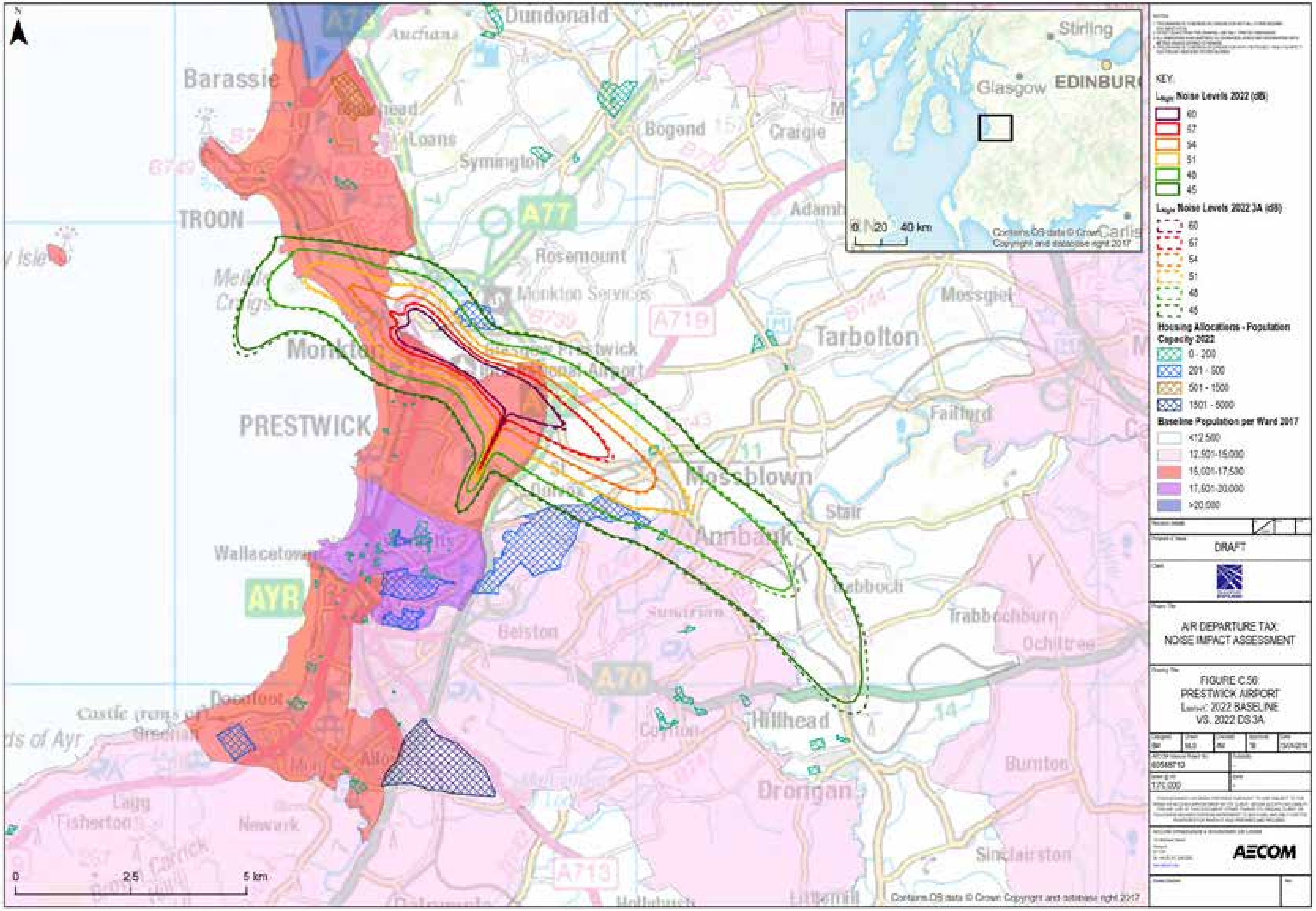


Figure C.57 Prestwick Airport Baseline 2022 v Scenario 3c $L_{Aeq,16h}$ dB Noise Contours

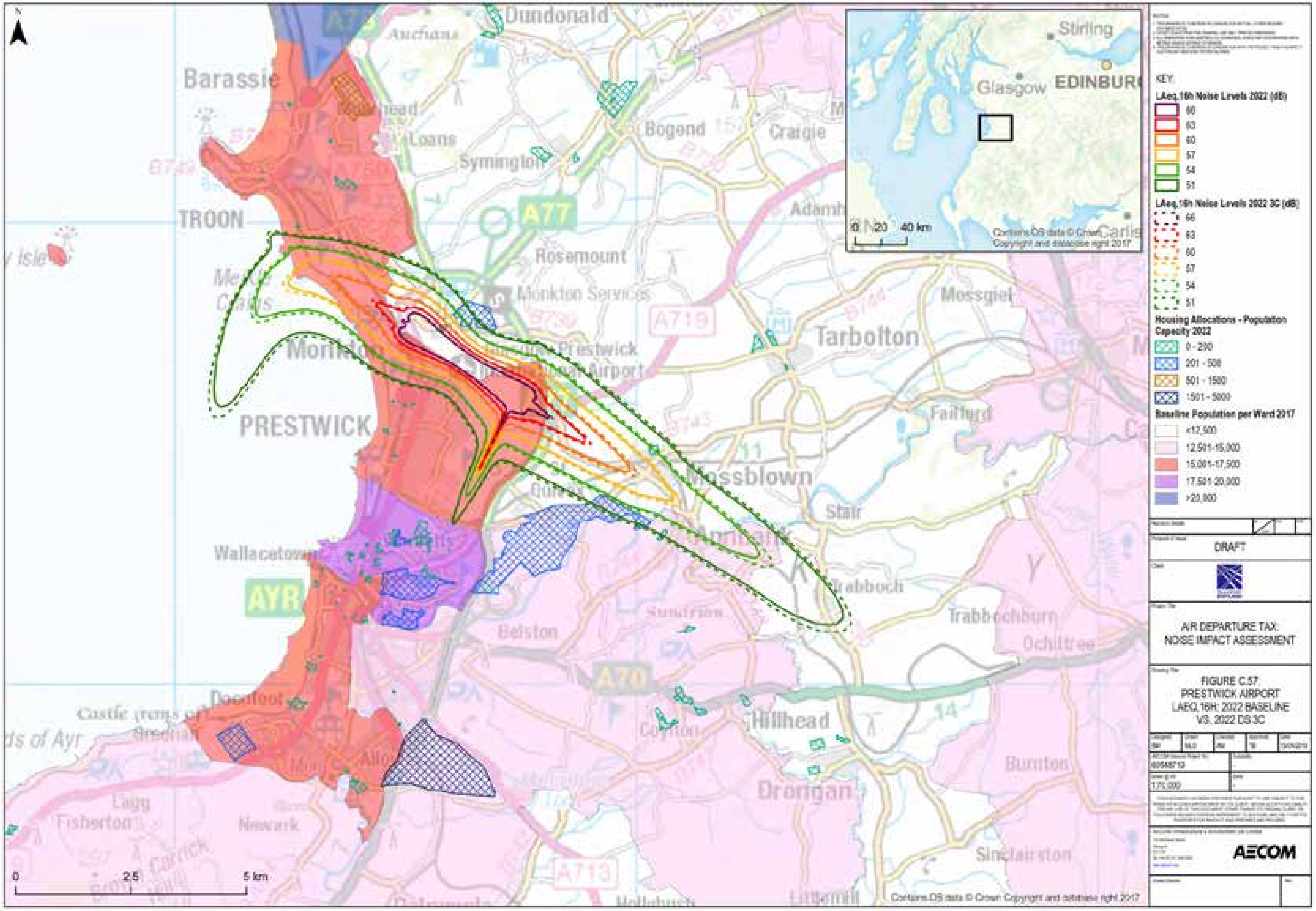
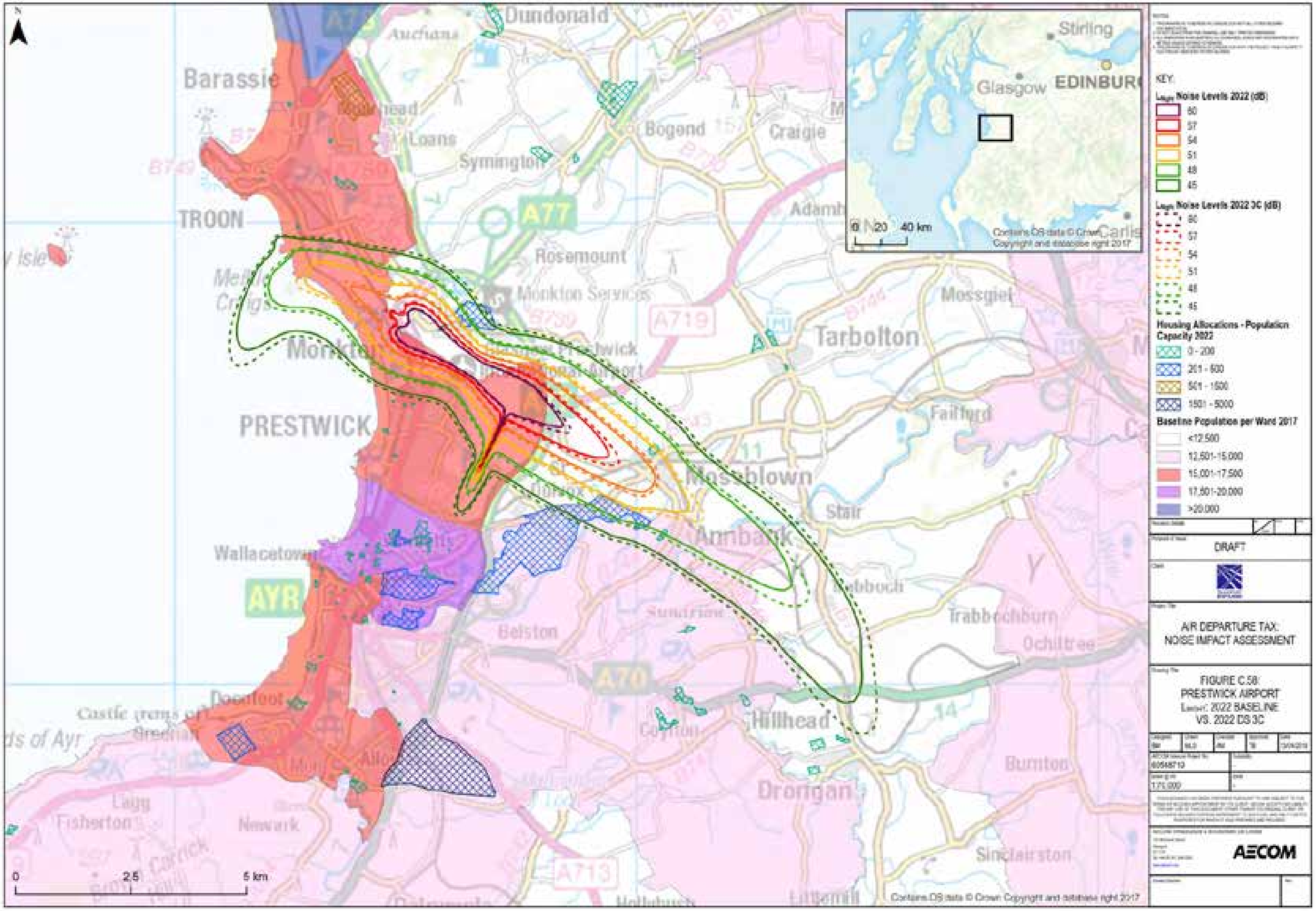


Figure C.58 Prestwick Airport Baseline 2022 v Scenario 3c L_{night} dB Noise Contours



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