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Dublin Airport

Dublin Airport North Runway, Regulation 598/2014 (Aircraft Noise Regulation) Cost Effectiveness Analysis Report

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EXECUTIVE SUMMARY

Regulation 598/2014 of the European Parliament and of the Council of 16 April 2014 (Aircraft Noise Regulation) recommends the use of a cost-effectiveness analysis (CEA) as part of the overall Balanced Approach process outlined in the Aircraft Noise Regulation in assessing new mitigation measures needed to meet a Noise Abatement Objective (NAO). The Aircraft Noise (Dublin Airport) Regulation Act of 2019 (Aircraft Noise Regulation Act of 2019; or the Act) implements the Aircraft Noise Regulation for the purpose of regulating aircraft noise related to aircraft movements at Dublin Airport. Under the Aircraft Noise Regulation Act of 2019, a CEA is required when assessing multiple noise reduction measures. The Balanced Approach process may indicate that operating restrictions are required in addition to other cost-effective measures to achieve an NAO. Annex II of the Aircraft Noise Regulation requires the application of a cost-effectiveness assessment for any proposed operating restrictions.

Effectiveness is based on the degree of noise exposure reduction that a measure can provide compared to a baseline noise exposure level. Cost-effectiveness is determined by dividing the cost to implement the measure by the change in baseline noise exposure levels resulting from the measure. The cost to implement a measure is a critical variable for cost-effectiveness assessment. Annex I of Regulation 598/2014 specifically mentions "the cost of introducing those measures" related to the outcome of the cost-effectiveness analysis for each measure.

The cost-effectiveness evaluation of measures for achieving the NAO for Dublin Airport will be based on calculating the ratio between cost and the reduction in the number of people exposed to a selected unit compared to the future "do nothing" noise exposure levels. The "do nothing" scenario represents a forecast situation resulting from revoking, replacing or amending an operating restriction and maintaining existing noise mitigation measures; it does not include new noise measures. The Aircraft Noise Regulation identifies this condition as the Forecast without New Measures scenario as described in Annex I. The Forecast without New Measures scenario for this North Runway Aircraft Noise Regulation analysis includes existing and planned noise measures and revoking Conditions 3(d) and 5 of the permission granted to Dublin Airport to develop Runway 10L-28R (North Runway).

At present Dublin Airport does not have an established noise problem and related NAO, both are to be set in due course by the Aircraft Noise Competent Authority (ANCA) which was established by Fingal County Council. In order to provide the necessary supporting documentation to allow ANCA to carry out their assessment, daa have developed a candidate NAO (cNAO) to provide a basis for assessment of the proposed aircraft noise reduction measures assessed in this Aircraft Noise Regulation analysis. The summary objective of the cNAO states:

To limit and reduce the adverse effects of long-term exposure to aircraft noise, including health and quality of life, so that long-term noise exposure, particularly at night, does not exceed the situation in 2018. This should be achieved through the application of the Balanced Approach.

The cNAO measures the number of people "highly sleep disturbed" (HSD) and "highly annoyed" (HA) in accordance with the approach recommended by the World Health Organisation's Environmental Noise Guidelines 2018, as endorsed by the European Commission through Directive 2020/367. In addition, metrics are applied to assess priorities at night related to potential high levels of impact and significant adverse effects caused by increasing noise compared to the 2018 situation.

The cost-effectiveness methodology is conducted based on the following process:

- Evaluate noise abatement operational procedures measures

- Evaluate significant adverse effects of candidate noise abatement operational procedure measures
- Evaluate land use planning and management measures
- Determine need for operating restriction measures to meet cNAO and conduct cost-effectiveness on proposed restrictions
- Compare selected group of measures or alternative with the Permitted Operations Situation scenario (refer to Section 7 for more details)

The effectiveness analysis concluded that the Forecast without New Measures meets the cNAO but causes a potential for significant adverse effects due to increases in noise levels, specifically at night, compared to the 2018 noise situation. Additional measures were assessed, and eight preferential runway use scenarios and a residential sound insulation measure was considered. Based on the effectiveness analysis among the eight preferential runway use measure scenarios, Scenario 2 was found to be the most effective because it not only meets the cNAO, but also causes the lowest number of people exposed to increases in noise that could cause a significant adverse effect. Scenario 2 maintains the preferential runway use as described in the North Runway Planning Permission Conditions 3(b) and 3(c) between 07:00 and 22:59, extends this mode of operation into the shoulder hours of the night period between 23:00 and 23:59 and 06:00 and 06:59, and limits use of North Runway between 00:00 and 05:59.

Scenario 2 exposes more dwellings to noise levels of at least 55 dB L_{night} when compared to the 2018 situation; therefore, a Residential Sound Insulation Grant Scheme (RSIGS) is proposed to reduce the effect of the exposure on residents within the dwellings during night-time hours. The RSIGS was found to reduce the number of people with high levels of noise impact.

To ensure the forecast noise exposure levels associated with the fleet mix expected in 2025, a proposed Quota Count (QC) system involving an Annual Night Quota (ANQ) count is added. The Aircraft Noise (Dublin Airport) Regulation Act of 2019 considers a QC measure as an operating restriction, but the ANQ value is not expected to constrain movements up to 2025. Therefore, no costs associated with limiting movements are expected.

To ensure use of the North Runway is controlled, a proposed relevant action would amend Condition 3(d) to maintain the 'no use' requirement with modified exemptions between 00:00 and 05:59. Maintaining the no-use condition between 00:00 and 05:59 is not expected to cause movement and passenger constraints due to the low demand levels during this period.

Based on the cost-effectiveness assessment, the addition of Scenario 2 preferential runway use taken together with the proposed 55 dB L_{night} RSIGS, the proposed ANQ and no use of the North Runway between 00:00 and 05:59, to the existing and planned measures comprises the preferred Forecast including Additional Measures scenario.

Because the Forecast including Additional Measures scenario and the Permitted Operations Situation scenario (with Condition 3(d) and 5 in place in 2025) both meet the cNAO, a cost-effectiveness analysis was conducted to compare the Forecast including Additional Measures scenario to the Permitted Operations Situation scenario to assess which of the two is more cost-effective.

Table ES-1 presents the cost-effectiveness results for the Forecast including Additional Measures and the Permitted Operations Situation scenarios based on the cost to implement divided by the change in population noise exposure levels compared to the 2018 situation.

TABLE ES-1 COST-EFFECTIVENESS OF FORECAST INCLUDING ADDITIONAL MEASURES VERSUS PERMITTED OPERATIONS SITUATION COMPARED TO 2018

	COST-EFFECTIVENESS RATIO TO REDUCE NUMBER OF PEOPLE HIGHLY SLEEP DISTURBED		COST-EFFECTIVENESS RATIO TO REDUCE NUMBER OF PEOPLE HIGHLY ANNOYED	
SCENARIO	2025	CER RANKING	2025	CER RANKING
Forecast including Additional Measures	€113	1	€49	1
Permitted Operations Situation	€42,215	2	€21,162	2

NOTES: CER Ranking based on lowest to highest absolute value ratio.
CER – Cost-Effectiveness Ratio
SOURCE: Ricondo & Associates, Inc., October 2020.

According to Aircraft Noise Regulation, operating restrictions should only be considered if needed to meet an objective and if not more restrictive than necessary to meet an objective. The Permitted Operations Situation scenario by itself would meet the cNAO, but it is more restrictive and not as cost-effective compared to the Forecast including Additional Measures scenario.

1. INTRODUCTION

Regulation 598/2014 of the European Parliament and of the Council of 16 April 2014 (Aircraft Noise Regulation) recommends the use of a cost-effectiveness analysis (CEA) as part of the overall Balanced Approach process outlined in the Aircraft Noise Regulation in assessing new mitigation measures needed to meet a Noise Abatement Objective (NAO). The Aircraft Noise Regulation references the International Civil Aviation Organization's (ICAO's) Balanced Approach guidelines related to not only measures, but also the application of CEA where a noise measure (or combination of noise measures) is proposed to reduce aircraft noise impacts to a level that meets a specific NAO for an airport.

The Aircraft Noise (Dublin Airport) Regulation Act of 2019 (Aircraft Noise Regulation Act of 2019; or the Act) implements the Aircraft Noise Regulation for the purpose of regulating aircraft noise related to aircraft movements at Dublin Airport. Under the Aircraft Noise Regulation Act of 2019, a CEA is required when assessing multiple noise reduction measures. Effectiveness is based on the degree of noise exposure reduction that a measure can provide compared to a baseline noise exposure level. Cost-effectiveness is determined by dividing the cost to implement the measure by the change in baseline noise exposure levels resulting from the measure.

A Balanced Approach process may also indicate that operating restrictions are required in addition to other cost-effective measures to achieve an NAO. Annex II of the Aircraft Noise Regulation requires the application of a cost-effectiveness assessment for any proposed operating restrictions.

The Balanced Approach guidelines and the Aircraft Noise Regulation Act of 2019 do not limit cost effectiveness analysis to operating restrictions alone; they recommend evaluating the cost-effectiveness of proposed feasible

measures.[1,2,3] In addition, the timeframe and ranking of the overall effectiveness of a particular measure among other measures should be considered. Prioritising proposed noise reduction measures based on cost and effectiveness is the objective for this analysis. Because the Aircraft Noise Regulation references the ICAO Balanced Approach, and because it is important to ensure cost-effectiveness in the approach, this CEA evaluates all proposed feasible measures, not just operating restriction measures. The cost-effectiveness approach is a process used to determine which measures are expected to achieve the NAO (effectiveness) at an acceptable level of cost to implement (cost). The assessment may conclude multiple measures are needed and are cost-effective to achieve the NAO.

The following sections summarise the methodology applied to evaluate cost-effectiveness; the baseline noise exposure levels used to assess change in noise exposure; the units of effectiveness selected to assess a measure's influence on reducing noise exposure levels; the estimated costs to implement a measure; and the cost-effective analysis results.

2. METHODOLOGY

CEA is an efficient way to identify the most cost-effective option for achieving a predefined objective. Cost-effectiveness is most useful when the outcome (noise reduction) can be quantified, and an analysis is required to evaluate a series of alternative measures aimed at delivering the outcome to meet the overall objective. Cost-effectiveness analysis is widely used as a best practice to assess alternative measures aimed at meeting the same objective. A cost-effective measure will provide a high level of output at a low level of cost. The output or change will result in meeting an objective as closely as possible.

Cost-effectiveness is assessed by dividing the cost of a measure by the change in noise exposure or effectiveness of the measure, which results in a cost-effectiveness ratio. The cost-effectiveness ratio for different kinds of noise measures can be compared to determine which measure costs less per unit of outcome (e.g., number of people exposed to a selected noise exposure level). In the Balanced Approach guidelines document, ICAO recognises cost-effectiveness analysis as one of the primary commonly used tools available to assess cost and benefits of various measures considered under the Balanced Approach, especially when the objective is known.[4] The Conference of European Directors on Roads (CEDR), while evaluating cost-benefit and cost-effectiveness analysis in managing roadway noise, concluded "the [cost-effectiveness analysis] method is best suited to prioritise interventions in order to reduce noise."[5] In addition to the two recommendations by ICAO and CEDR, the Aircraft Noise Regulation Act of 2019 requires the competent authority to ensure "the likely cost-effectiveness of the identified noise mitigation measures and operating restrictions (if any) is thoroughly evaluated."[6]

The cost-effectiveness evaluation of measures for achieving the NAO for Dublin Airport will be based on calculating the ratio between cost and the reduction in the number of people exposed to a selected unit

[1] International Civil Aviation Organization, Guidance on the Balanced Approach to Aircraft Noise Management, Appendix 2 to Part I, "Analytical Methodologies/Tools to Use in the Evaluation of Likely Costs and Benefits of Study Options," October 10, 2010.

[2] Aircraft Noise (Dublin Airport) Regulation Action 2019. Part 2. 9(2)(c), page 11.

[3] Regulation (EU) No. 598/2014. Article 5 2(c) (L173 12. 6. 2014, page 70.)

[4] International Civil Aviation Organization, *Guidance on the Balanced Approach to Aircraft Noise Management*, Appendix 2 to Part I, "Analytical Methodologies/Tools to Use in the Evaluation of Likely Costs and Benefits of Study Options," October 10, 2010.

[5] Conference of European Directors on Roads, *Technical Report 2017-03 – State of the Art in Managing Road Traffic Noise: Cost-Benefit Analysis and Cost-Effectiveness Analysis*, January 2017, p. 50.

[6] Aircraft Noise (Dublin Airport) Regulation Act 2019, [No. 12] Part 2, Section 9, p. 11.

compared to the future "do nothing" noise exposure levels. The "do nothing" scenario represents a forecast situation resulting from revoking, replacing or amending an operating restriction while maintaining existing noise mitigation measures; it does not include new noise measures. The Aircraft Noise Regulation identifies this condition as the Forecast without New Measures scenario as described in Annex I. The selected effectiveness units or noise metrics and the results of the Forecast without New Measures scenario noise exposure levels are described in the *Dublin Airport North Runway, Noise Information for the Regulation 598/2014 (Aircraft Noise Regulation) Assessment* report developed by Bickerdike Allen Partners LLP.[7] Because a single feasible measure may not be sufficient to address the NAO, a combination of different feasible measures may be needed and combined to make up an alternative that best meets the NAO.

The following sections describe the unit of effectiveness applied for this analysis; the approach to estimating cost to implement measures; the type of cost-effectiveness calculations potentially applicable to this analysis; and the steps used to conduct the cost-effective analysis.

2.1 UNIT OF EFFECTIVENESS

Effectiveness is the level of change or reduction of people exposed to the selected noise metric that a measure causes as compared to a baseline or objective scenario. As previously mentioned, the baseline scenario is called the Forecast without New Measures. Refer to Section 3 for more information on the baseline scenario.

At present Dublin Airport does not have a NAO, it is to be set in due course by the Aircraft Noise Competent Authority (ANCA) which was established by Fingal County Council. At this time ANCA have not determined whether a noise problem exists at Dublin Airport and therefore, at present, an NAO has not been defined. In order to provide the necessary supporting documentation to allow ANCA to carry out their assessment, daa have developed a candidate NAO (cNAO) to provide a basis for assessment of the proposed aircraft noise reduction measures assessed in this Aircraft Noise Regulation analysis.

The NAO is likely to contain a summary objective and details of how the NAO will be measured. The objective scenario may represent an aircraft noise condition set by the competent authority to represent an NAO. For purposes of this Aircraft Noise Regulation assessment, the cNAO objective scenario is based on the 2018 existing noise environment. The summary objective of the cNAO states:

To limit and reduce the adverse effects of long-term exposure to aircraft noise, including health and quality of life, so that long-term noise exposure, particularly at night, does not exceed the situation in 2018. This should be achieved through the application of the Balanced Approach.

In general, the cNAO seeks to limit aircraft noise from Dublin Airport so that the impact on people is no worse than 2018. Being no worse than 2018 should be considered a limit from which daa should reduce its noise impacts downwards from. The Balanced Approach should be used to ensure that all practicable and sustainable measures are implemented to reduce the noise impact form aircraft movements at Dublin Airport. Refer to the *Dublin Airport North Runway, Noise Information for the Regulation 598/2014 (Aircraft Noise Regulation) Assessment* report by Bickerdike Allen Partners LLP for more information on the methodology applied to measure the cNAO.

A measure's effect on reducing aircraft noise is based on a noise metric or unit correlated to the cNAO and the number of people exposed to the noise metric. Effectiveness is the degree to which a feasible measure reduces the number of people exposed to a specified noise metric. The effectiveness evaluation is conducted using aircraft noise modelling and geographic information system (GIS) spatial analysis to quantify population

[7] Bickerdike Allen Partners LLP. Dublin Airport North Runway, Noise Information for the Regulation 598/2014 (Aircraft Noise Regulation) Assessment, November 2020.

exposure levels. Refer to the *Dublin Airport North Runway, Noise Information for the Regulation 598/2014 (Aircraft Noise Regulation) Assessment* report regarding the aircraft noise model input assumptions for each noise abatement measure and the population and dwelling unit count results based on GIS spatial analyses.

A noise metric(s) should be directly related to the cNAO based on resolving a known noise problem, and it can be calculated for all measures that are under consideration. Multiple noise metrics may be applied to assess a measure's ability to meet the overall objective and a measure's ability to address priorities (e.g., people exposed to higher levels that are considered adverse to significant levels). For purposes of this Aircraft Noise Regulation assessment, the appropriate noise metrics are those that can measure progress towards the cNAO and addressing the priorities related to night-time disturbance. The priorities are established based on potential noise problems expected to occur due to the implementation of a proposed future development or action that extends capacity. According to the *Noise Action Plan for Dublin Airport 2019 and 2023 (*the Noise Action Plan*)*, night-time noise levels have increased over the past 10 years as movements increased and non-compatible land use encroachment occurred. The Noise Action Plan indicated that night-time noise may be a problem that may need to be improved.[8] In addition, the Forecast without New Measure scenario described in Section 3 involves replacing North Runway Permitted Condition 3(d) and revoking the North Runway Permitted Condition 5 described in Section 7 which both involve limiting night-time runway use and movements, respectively. Considering both factors, night-time noise is an important noise condition to assess related to the cNAO.

As stated in the *Dublin Airport North Runway, Noise Information for the Regulation 598/2014 (Aircraft Noise Regulation) Assessment* report by Bickerdike Allen Partners LLP, the cNAO will be measured primarily on the number of people "highly sleep disturbed" (HSD) and "highly annoyed" (HA) in accordance with the approach recommended by the World Health Organisation's Environmental Noise Guidelines 2018, as endorsed by the European Commission through Directive 2020/367, which considers noise exposure from the 45 decibels (dB) day-evening-night noise level (L_{den})[9] for HA and the 40 dB night-time noise level (L_{night})[10] for HSD. **Table 2-1** provides the HSD and HA population counts based on the 2018 situation and existing noise mitigation measures, including the current sound insulation schemes.

In addition, Table 2-1 includes the following metrics calculated to assess potential adverse to significant impacts related to night-time noise for the 2018 situation:

- 50 dB L_{night} – a level of night-time noise exposure representing a medium level of impact
- 55 dB L_{night} – a level of night-time noise exposure representing a high level of impact

These levels of impact are consistent with those described in Section 3.3 of the *Dublin Airport North Runway, Noise Information for the Regulation 598/2014 (Aircraft Noise Regulation) Assessment* report by Bickerdike Allen Partners LLP.

[8] Fingal County Council. *Noise Action Plan for Dublin Airport 2019 and 2023*. December 2018.

[9] L_{den} is a noise level based on average energy level over a whole day with a penalty of 10 dB for night-time noise events (23:00 to 07:00) and an additional penalty of 5 dB for evening noise events (19:00 to 23:00).

[10] L_{night} is the average sound energy level between 23:00 and 07:00.

TABLE 2-1 2018 AIRCRAFT NOISE POPULATION EXPOSURE LEVELS

NOISE IMPACT	METRIC	THRESHOLD	NUMBER OF PEOPLE EXPOSED 2018
Number of People Highly Sleep Disturbed	L_{night}	40 dB	42,234
Number of People Highly Annoyed	L_{den}	45 dB	110,196
Medium Impact	L_{night}	50 dB	12,237
High Impact	L_{night}	55 dB	548

NOTES:
dB – decibels
L_{night} – average sound pressure level for an 8-hour period (recommended period of sleep for adults) between 23:00 and 07:00
L_{den} – average sound pressure for 24 hours with noise events weighted at 10 dB for night-time (23:00 to 07:00) and 5 dB for evening (19:00 to 23:00)
SOURCE: Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (noise effect threshold, number of people exposed).

The unit of effectiveness for potential measures to address the overall cNAO will also consider the potential significant adverse effected population caused by increases in L_{den} and L_{night} levels due to the implementation of a proposed noise reduction measure. Implementing noise reduction measures such as noise abatement operational procedures can provide means to meet the cNAO but could cause changes in noise exposure levels for noise-sensitive areas due to the change in operation patterns. The effectiveness assessment includes a metric to assess the potential to cause a significant adverse effect on people caused by the change in L_{den} and L_{night} noise levels associated with implementing a proposed noise measure. Number of people exposed to a potential significant adverse effect caused by a noise increase associated with a proposed noise measure is calculated based on the following thresholds of change compared to the 2018 situation:

- Change in L_{den} levels:
  - Exposed to noise levels between 45 dB and 50 dB L_{den} and an increase at or higher than 9 dB increase
  - Exposed to noise levels between 50 dB and 55 dB L_{den} and an increase at or higher than 6 dB increase
  - Exposed to noise levels between 55 dB and 65 dB L_{den} and an increase at or higher than 3 dB increase
  - Exposed to noise levels between 65 dB and 70 dB L_{den} and an increase at or higher than 2 dB increase
  - Exposed to noise levels 70 dB L_{den} or higher and an increase at or higher than 1 dB increase
- Change in L_{night} levels:
  - Exposed to noise levels between 40 dB and 45 dB L_{night} and an increase at or higher than 9 dB increase
  - Exposed to noise levels between 45 dB and 50 dB L_{night} and an increase at or higher than 6 dB increase
  - Exposed to noise levels between 50 dB and 55 dB L_{night} and an increase at or higher than 3 dB increase
  - Exposed to noise levels between 55 dB and 60 dB L_{night} and an increase at or higher than 2 dB increase
  - Exposed to noise levels at or higher than 60 dB L_{night} and an increase at or higher than 1 dB increase

Refer to Section 3.3 of the *Dublin Airport North Runway, Noise Information for the Regulation 598/2014 (Aircraft Noise Regulation) Assessment* report by Bickerdike Allen Partners LLP for more information on the potential significant adverse effect thresholds. Mitigation measures that meet the cNAO, as measured by HSD and HA populations, are then evaluated to determine those that limit the number of people exposed to changes in noise that can cause potential significant adverse effects caused by a measure compared to the 2018 situation. Measures that have a potential to cause a significant adverse effect on residents were primarily related to noise

abatement operational procedures. Those measures selected that meet the general cNAO and result in the least number of people exposed to potential significant adverse effects caused by change in noise compared to the 2018 situation would be assessed for high impact levels at or higher than 55 dB L_{night}. If there are people exposed to levels at or higher than 55 dB L_{night}, land use mitigation measures would be considered.

2.2 COST TO IMPLEMENT ESTIMATION

The cost to implement a measure is a critical variable for a cost-effectiveness assessment. Annex I of Regulation 598/2014 specifically mentions "the cost of introducing those measures" related to the outcome of the cost-effectiveness analysis for each measure.[11] This analysis evaluates the direct and indirect costs of introducing a feasible measure related to the principal elements of the Balanced Approach. Direct costs may include start-up cost, programme costs, personnel costs, and capital costs. Indirect costs may include costs associated with aircraft delays. Operating restrictions can reduce economic growth; therefore, foregone economic impact is considered as a cost in assessing operating restriction measures that would constrain operation levels. This assessment took a proportionate approach and only considered costs that have a substantial effect on implementing a new measure. The costs are in addition to baseline costs associated with the baseline scenario. All costs related to the Forecast without New Measures scenario and existing measures were considered part of the baseline and are not included in the cost-effectiveness evaluation. Sections 4 and 5 summarise the cost estimates associated with implementing each feasible new measure. The cost values were provided by the subject matter experts related to each proposed measure. Variances in the cost estimates were not made available; therefore, a sensitivity analysis was not possible.

The time horizon for the cost and effectiveness assessment is between 2022 and 2025. The forecast year 2022 represents the year when the North Runway becomes operational, and the forecast year 2025 represents the year when passenger levels would reach 32 million passengers per annum (mppa), which is the planning condition restriction associated with Condition 3 of the Terminal 2 Permission (An Bord Pleanála Ref: PL 06F.217429; FCC Reg. Ref. F06A/1248) and Condition 2 of the Terminal 1 Extension Planning Permission (Fingal County Council Reg. Ref. No. F06A/1843; ABP Ref. No. PL06F.223469). The conditions indicate the combined passenger capacity of Terminal 2 as permitted together with Terminal 1 shall not exceed 32 mppa, unless otherwise authorised by a further grant of planning permission.[12,13] This was related to the policies and objectives of the Dublin Airport Local Area Plan and capacity constraints (transportation) at the eastern campus. The cost-effectiveness assessment is limited to conditions prior to and at the situation when 32 mppa is reached. The forecast conducted by Mott MacDonald indicates 32 mppa will be reached in 2025.[14]

Cost estimates are expressed in constant prices for the purpose of comparing costs in real terms, without considering the effects of inflation, over a fixed time horizon.

The cost-effectiveness analysis was limited to costs incurred within the Republic of Ireland and by the agencies responsible for introducing a proposed noise measure. Although the economic impact assessment conducted by InterVISTAS assessed costs limited to the Republic of Ireland, the evaluation did account for cost impacts linked to European and international passenger travel to Dublin Airport and the related economic impact to Republic of Ireland residents.'[15]

[11] Regulation No 598/2014 of the European Parliament and of the Council of 16 April 2014, Paragraph (6), L 173, 12.6.2014, p. 77.

[12] An Bord Pleanála Ref. PL 06F.220670/Fingal County Council Reg. Ref. F06A/1248.

[13] An Bord Pleanála Ref. PL 06F.223469/Fingal County Council Reg. Ref. F06A/1843

[14] Mott MacDonald, *Dublin Airport Operating Restrictions - Quantification of Impacts on Future Growth September 2020 Update 2022 2025 Period*, version 5.3, September 2020.

[15] InterVISTAS, *Draft Dublin Airport Economic Impact on Operating Restrictions*, October 5, 2020.

As stated in the Aircraft Noise Regulation, the focus is on cost associated with introducing an additional noise measure(s). The basis of the cost to introduce a feasible measure for this cost-effectiveness analysis depends upon who conducts the action to implement the measure or the overall cost to the economy if a measure limits capacity. For example, costs to implement a sound insulation grant programme would be a cost to daa. Costs related to managing runway movements would be incurred directly by the air navigation services provider, the Irish Aviation Authority (IAA). If an operating restriction is proposed, then costs associated with impacts on airlines or on hindering economic growth would need to be considered.

2.3 COST-EFFECTIVENESS ANALYSIS

There are two methods utilised in evaluating cost-effectiveness: overall cost-effectiveness ratio (OCER) rankings and incremental cost-effectiveness ratio (ICER) rankings. The OCER method sorts each feasible measure by its overall cost-effectiveness ratio (e.g., cost of measure per change in population) starting from lowest to highest ratios. The ranking provides a decision-maker the ability to evaluate each measure's effectiveness, but it does not account for the incremental cost or effectiveness if multiple measures are selected.

When multiple measures and different groupings of measures found to be effective need to be considered, an ICER ranking method can be applied to compare the cost-effectiveness of each measure as it is added to another measure. The incremental change analysis begins with the measure (Measure A) with the lowest cost-effectiveness ratio and is subtracted from the baseline, which would have zero cost and zero effectiveness ([Cost of Measure A – Cost of Baseline]/[Effectiveness of Measure A – Effectiveness of Baseline]). The next ICER would be the incremental ratio between the first measure (Measure A) and the second most cost-effective measure (Measure B). This would continue for all measures identified in the group. A comparison of the ICER for each measure can be assessed to evaluate the cumulative cost-effectiveness of all the feasible measures.

If there is more than one measure that is found to be effective, the cost-effectiveness ratios for each feasible measure are compared, and a dominance principle may be applied to determine if measures should be eliminated. The noise abatement operational procedure measures are evaluated first. Any measures that are not effective in meeting the cNAO and priorities are eliminated from further assessment. Second, the OCER for each remaining noise abatement operational procedure measure is calculated and compared to other mutually exclusive feasible measures and ranked from lowest to highest cost-effectiveness ratio. The most cost-effective measure is selected based on the ranking. No further analysis is necessary if the cNAO is met based on the overall cost-effectiveness analysis, but additional mitigation measures may be evaluated to address priorities.

If the cNAO is not met, additional mitigation measures should be evaluated. If only one noise abatement operational procedure measure (within the meaning of the Balanced Approach) is found to be effective and meets the cNAO, a cost-effectiveness analysis is not needed, and the assessment will proceed forward to determine if land use planning and management mitigation measures (within the meaning of the Balanced Approach) are needed to address priorities. If there are multiple land use planning and mitigation measures to consider, a ICER type of cost-effectiveness analysis can be conducted to determine the most cost-effective measure.

The ICER method includes the noise abatement operational procedure measure as the baseline and compares it to the scenario with the noise abatement operational procedure measure and the additional measure (e.g., land use mitigation) to quantify additional effectiveness. The additional reduction in population exposed due to an additional mitigation measure is compared against the implementation cost of the additional measure. The ICERs are compared against other proposed measures added to the selected noise abatement operational procedure measure to select the most cost-effective measure that would be in addition to the cost-effective noise abatement operational procedure measure.

2.4 COST-EFFECTIVENESS ASSESSMENT PROCESS

The methodology considers different types of noise-reduction measures associated with the Balanced Approach principal elements: noise abatement operational procedures; land use planning and management measures; and operating restrictions. Because reduction of noise at the source is limited to the adoption and implementation of certification standards, this element is not within the control of daa. Use of newer and quieter aircraft is considered as part of the forecast movements analysis. If a measure is considered to restrict specific aircraft types, then the measure would fall under the operating restriction element of the Balanced Approach. Refer to the *Dublin Airport Operating Restrictions - Quantification of Impacts on Future Growth* summary report developed by Mott MacDonald for more information on forecast assumptions related to reducing noise at the source based on expected modernisation of airline fleets operating at DUB.[16]

The cost-effectiveness methodology is conducted based on the following process:

- Evaluate noise abatement operational procedures measures
- Evaluate significant adverse effects of candidate noise abatement operational procedure measures
- Evaluate land use planning and management measures
- Determine need for operating restriction measures to meet cNAO and conduct cost-effectiveness on proposed restrictions
- Compare selected group of measures or alternative with the Permitted Operations Situation scenario (refer to Section 7 for more details)

The order in which the feasible measures are assessed is based first on the effect each may have on the shape of the aircraft noise exposure contours. Of the three Balanced Approach principal elements, the noise abatement operational procedure and operating restriction elements (e.g., runway use, flight track location, flight track use) can have the largest potential effect on the shape of an aircraft noise exposure contour. As required by the Aircraft Noise Regulation, operating restriction measures are considered only after all other non-operating restriction feasible measures (mitigation measures) are evaluated; therefore, the first set of feasible mitigation measures assessed for cost-effectiveness are related to noise abatement operational procedures.

Based on the additional alternative measures screening assessment described in the *Dublin Airport North Runway, Regulation 598/2014 (Aircraft Noise Regulation) Forecast Without New Measures and Additional Measures Assessment* report by Ricondo & Associates, Inc., there are eight preferential runway use measures that were determined to be feasible in reducing noise levels. There were no other noise abatement operational procedures such as flight paths or climb/descent profile because they were either already implemented, planned, or not considered feasible. Refer to the *Dublin Airport North Runway, Regulation 598/2014 (Aircraft Noise Regulation) Forecast Without New Measures and Additional Measures Assessment* report for more information on the additional alternative measures screening assessment.

As described in Section 2.1, the primary metrics used to determine if the cNAO is achieved are the Highly Annoyed (HA) and Highly Sleep Disturbed (HSD) population counts. Those noise abatement operational procedure measures that exceed the HA and/or HSD population for the Forecast without New Measures and the 2018 situation would be eliminated from further consideration as these additional abatement procedures if implemented would not meet the cNAO.

The second step would evaluate the number of people that would be have changes in L_{den} and L_{night} levels that can potentially cause significant adverse effects as defined in Section 2.1 under each noise abatement operation

[16] Mott MacDonald, *Dublin Airport Operating Restrictions - Quantification of Impacts on Future Growth September 2020 Update 2022 2025 Period*, version 5.3, September 2020.

procedure measure compared to the 2018 situation. This is a supplemental metric to minimise the potential for significant adverse effects related to changes in L_{den} and L_{night} levels caused by implementing a proposed measure. Due to the significant adverse change in noise levels, the noise abatement operational procedure measure that results in lower HA and HSD populations compared to 2018 with the lowest level of potential significant adverse effects would be selected as the most effective measure. If more than one is identified, a cost-effectiveness ratio would be calculated for each to identify the most cost-effective option.

The third step is to evaluate land use planning and management measures that mitigate residual noise exposure impacts after a preferred cost-effective noise abatement operational procedure measure(s) is selected in order to meet the cNAO and/or address potential significant adverse effects related to night-time noise. This category of mitigation measures would fall within the Balanced Approach land use planning and management element. Sound insulation is recognised in the Balanced Approach as measure under the land use planning and management element and the Environmental Protection Agency (EPA) as a measure for reducing the effects of aircraft noise.[17] To determine the effectiveness of a proposed residential sound insulation measure for purposes of this assessment, all people exposed to "high" external noise levels (consistent with the thresholds discussed in Section 2, high noise level is defined as 55dB L_{night} or higher) have had a 5dB reduction in noise level applied to determine a residual noise assessment rating. If a medium residual noise assessment rating (L_{night} levels between 50 and 55 dB) is determined following this calculation the sound insulation is considered to have reduced the effect on a person inside the dwelling at night from a high level to a medium level of impact. This is consistent with the cNAO priorities related to assessing night-time levels that can present a potential for high levels of impact.

If the cNAO has not been achieved, then the next step is to assess the cost-effectiveness of operating restriction measures, assuming a preferred set of noise abatement operational procedure and land use planning and management measures are selected.

The last step is to compare the selected group of measures chosen to meet the cNAO and compare the cost-effectiveness of the preferred option of measures (call the Forecast including Additional Measures scenario) to the cost-effectiveness of the Permitted Operations Situation scenario that includes the operating restriction for the North Runway (Conditions 3(d) and 5) to determine which of the two provides the most cost-effective means to meet the cNAO. Sections 4, 5, 6 and 7 summarise the results of the CEA process.

3. FORECAST WITHOUT NEW MEASURES NOISE EXPOSURE

A potential noise problem related to not meeting the cNAO for an airport may be identified using a forecast scenario that includes the revocation, replacement or amendment of an operating restriction or capacity enhancement development that is proposed without implementing new noise measures. Annex I of Regulation 598/2014 calls this scenario the Forecast without New Measures. As stated in Annex I, a study of the noise impact on the surrounding area caused by *expanding the capacity, runways, and terminals and by modifying flight paths and approach and take-off routes*[18] without implementing further new measures is required. The Forecast without New Measures scenario for this North Runway Aircraft Noise Regulation analysis includes revoking Conditions 3(d) and 5 of the permission granted to Dublin Airport to develop Runway 10L-28R (North Runway). Refer to Section 7 for more information on the Permitted Operations Situation scenario for the development of Runway

[17] Environmental Protection Agency, *Guidelines on the information to be Contained in Environmental Impact Assessment Reports - DRAFT*, August 2017

[18] Regulation (EU) No. 598/2014. Article 5 2(c) (L173 12. 6. 2014, page 77.)

10L-28R.[19] The Forecast without New Measures scenario includes existing and planned measures to manage aircraft noise. An evaluation of individual feasible noise mitigation measures compared to the Forecast without New Measures scenario is conducted to determine a measure's ability to meet the cNAO.

Forecast flight movements include assumptions related to airline plans to replace older aircraft with newer aircraft that meet Chapter 4 or Chapter 14 noise certification standards. Refer to the *Dublin Airport Operating Restrictions - Quantification of Impacts on Future Growth* by Mott MacDonald for more information on assumed improvements on aircraft technology and expected pace of fleet replacement.[20] One forecast year (2025) was evaluated to account for conditions when passenger demand reaches the 32 mppa passenger capacity level (Terminal 2 Condition 3/Terminal 1 Condition 2 passenger capacity condition) with North Runway in operation.[21] Forecast movement demand and use of quieter aircraft in 2025 was evaluated based on post-COVID expectations and included in the noise modelling assessments. Refer to the *Dublin Airport North Runway, Noise Information for the Regulation 598/2014 (Aircraft Noise Regulation) Assessment* report by Bickerdike Allen Partners LLP for more information (e.g., number of flight movements in the night period) on modelled operation levels. The annual traffic movements (ATM) forecast used to evaluate the Forecast without New Measures scenario is unconstrained by operating conditions (e.g., assuming Condition 5 of the North Runway Planning Permission is revoked) until forecast passenger demand reaches the combined Terminal 1 and 2 annual passenger capacity limit of 32 mppa. The forecast indicates that 32 mppa will be reached by 2025. Aircraft movements may begin to be constrained due to the 32 mppa cap after 2025.

Forecast runway use for the Forecast without New Measures scenario does not include a night-time preference for noise and is as follows:

- Daytime (07:00 to 22:59)
  - Westerly Direction: Runway 28L is the preferred runway for arriving aircraft. Either Runway 28L or 28R is used for departing aircraft as determined by air traffic control.
  - Easterly Direction: Either Runway 10L or 10R, as determined by air traffic control, is preferred for arriving aircraft. Runway 10R is the preferred runway for departing aircraft.
  - Exceptions to the preferred use previously described are cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems, or declared emergencies at other airports.
- Night-Time (23:00 to 06:59): Both Runway 10L-28R and Runway 10R-28L can be used for arrivals and departures as needed during the entire period. This would be determined by IAA air traffic controllers.
- The crosswind runway (Runway 16-34) is limited to occasional essential use for all hours of the day (per Condition 4 in planning permission issued by An Bord Pleanála for development of Runway 10L-28R).

Refer to the *Dublin Airport North Runway, Noise Information for the Regulation 598/2014 (Aircraft Noise Regulation) Assessment* report for more details related to the runway use noise modelling assumptions for the Forecast without New Measures scenario.

[19] Fingal County Council Ref: F04A/1755/E1, An Bord Pleanala Reference Number PL06F.217429

[20] Mott MacDonald, *Dublin Airport Operating Restrictions - Quantification of Impacts on Future Growth September 2020 Update 2022 2025 Period*, version 5.3, September 2020.

[21] Mott MacDonald, *Dublin Airport Operating Restrictions - Quantification of Impacts on Future Growth September 2020 Update 2022 2025 Period*, version 5.3, September 2020.

The Noise Action Plan and conditions associated with the North Runway planning permission issued by An Bord Pleanála in 2007[22] together comprise an extensive aircraft noise management programme that includes existing and planned measures. **Table 3-1** lists the existing and planned measures, organised by the principal elements of the Balanced Approach, indicating whether the measure is existing or planned and whether an existing measure would be retained in the future.

The NPRs selected following the consultation process and subsequent safety assessment for departing aircraft routes include a straight-out path from the South Runway. For the North Runway, departures to the west diverge to the north by either 30-degrees or 75-degrees depending on the final destination of the aircraft. North Runway departures to the east diverge to the north by 15-degrees.[23] The preferred NPRs are considered an existing measure, identified as NA-10 in Table 3-1, and are common to all assessment scenarios. As noted in the description of the Forecast without New Measures scenario above, the existing and planned measures include the operating restriction on Runway 16-34 required under Condition 4 described in the North Runway planning permission.[24] In addition, the residential sound insulation schemes based on the 2016 and 2022 63 dB $L_{Aeq,16hr}$ noise contours are expected to be in place and completed by the time the North Runway is operational.

For purposes of this Aircraft Noise Regulation assessment, residential sound insulation is considered feasible as a land use planning and management measure to reduce exposure to the effects of exterior noise levels within a dwelling unit although it does not reduce external noise exposure. Based on the Environmental Protection Agency (EPA) draft guidelines, sound insulation is considered mitigation by reduction intended to deal with effects that cannot be avoided by focusing on reduction of exposure on the receptor.[25] For the purposes of this analysis, sound insulation does not remove the dwelling unit from the noise exposure area, but reduces the level of impact on people inside a dwelling by 5 dB during night-time hours. Any dwellings eligible for the existing scheme or exposed to at least 63 dB $L_{Aeq,16hr}$ in a future scenario have been considered here as having a reduction of 5 dB for both their L_{den} and the L_{night} exposure based on noise measurements undertaken for the existing insulation schemes. Dwellings not eligible for the existing and planned schemes, but eligible for the new scheme proposed as an additional measure, have been considered here as having a reduction of 5 dB L_{night} exposure, and a reduction of 5 dB for the night component of their L_{den} exposure. While this type of analysis is useful in assessing how the internal conditions within dwellings might benefit from insulation and reduce impact levels inside the dwelling, it does not account for external amenity areas of dwellings. Use of external amenity areas however relate primarily to daytime and evening noise levels, which are largely unaffected by the Forecast without New Measures scenario. Allowing for the benefit of the residential sound insulation schemes in general reduces the number of people assessed with high levels of impact. This reduction is accounted for in calculating number of people highly annoyed, highly sleep disturbed and exposed to night-time levels at or higher than 50 dB L_{night} and at or higher than 55 dB L_{night}.

[22] Fingal County Council Ref: F04A/1755/E1, An Bord Pleanala Reference Number PL06F.217429.

[23] Prior to IAA safety case analysis, the preferred headings for North Runway departures to the west was to diverge to the north by either 15-degrees or 75-degrees depending on the final destination of the aircraft. IAA Safety Risk Department conducted the safety case assessment after public consultation and concluded the headings need to diverge to the north by either 30-degrees or 75-degrees.

[24] Fingal County Council Ref: F04A/1755/E1, An Bord Pleanala Reference Number PL06F.217429

[25] Environmental Protection Agency, *Guidelines on the information to be Contained in Environmental Impact Assessment Reports - DRAFT*, August 2017.

TABLE 3-1 (1 OF 3) EXISTING AND PLANNED NOISE MANAGEMENT MEASURES

MEASURE ID	SOURCE	MEASURE DESCRIPTION	2018	2025
Reduction of Noise at Source (NS)				
NS-1	FCC NAP	Promote quieter aircraft through incentives such as FlyQuiet programmes. This programme expected to be in place by 2022.	✗	✓
NS-2	FCC NAP	Work with airline partners to introduce quieter aircraft, particularly at night, including consideration of incentives. Approaches to incentives under development and expected to be in place by 2022.	✗	✓
Noise Abatement (NA) Operating Procedures				
NA-1	FCC NAP; daa NMP; Dublin Airport Aeronautical Information Publication	*2-Runway Preferential Runway Programme* – Intent of measure is to utilise whenever possible the runways that enable aircraft to avoid noise-sensitive areas during the initial departure and final approach phases of flight. Runway 10 or Runway 28 is the required runway between 0600 and 2300HR local time when the crosswind component is 20KT or less. Runway 28 will be the preferential runway when the tailwind component is 10KT or less and braking action is assessed as good. Aircraft will be required to use these runways except when operational reasons dictate otherwise. If the crosswind component on Runway 10 or Runway 28 is greater than 20KT, Runway 16 or Runway 34 may become the active runway. If the forecast crosswind component on Runway 10 or 28 is greater than 20KT, Runway 16 or 34 may become the active runway. The use of Runway 16-34 will be kept to an absolute minimum subject to operational conditions. Runways will be prioritised for noise abatement purposes between 2300 and 0600HR local time, subject to the same wind calculation method and values as used between 0600 and 2300HR local time. When weather conditions and flight movements permit, runway usage will be prioritised as follows: Arrivals: #1 (Runway 10), #2 (Runway 16), #3 (Runway 28), #4 (Runway 34); Departures: #1 (Runway 28), #2 (Runway 34), #3 (Runway 10), #4 (Runway 16).	✓	✗
NA-2	FCC NAP; daa NMP; Dublin Airport Aeronautical Information Publication	*2-Runway Noise Preferential Routes (NPRs) and Track Keeping* – Intent is to minimise disruption by routing aircraft away from built-up areas, where possible. Unless directed otherwise by IAA-ATC, all aircraft taking off from Dublin Airport are required to follow specific NPRs. To minimise impact, NPRs are designed to avoid overflight of built-up areas, where possible. An NPR is a path or corridor (1.8 kilometres at its widest point) that aircraft follow from take-off until being directed by IAA-ATC onto their main air traffic routes, typically at 3,000 feet altitude above mean sea level. Aircraft flying inside the NPR corridor are considered to be flying on-track. departures from all runways (except easterly departures on the existing Runway 10-28) must maintain course straight out for 5 nautical miles (1 nautical mile = 1,852 metres) after take-off before commencing a turn, unless otherwise cleared by IAA-ATC. Easterly departures on the existing southern runway must maintain course straight out for 5 nautical miles before commencing a turn to the north, or to 6 nautical miles before commencing turn to the south. Once an aircraft reaches the end of the NPR, or at an altitude of 3,000 feet, IAA-ATC will turn it onto a more direct heading to its destination. IAA-ATC can turn aircraft off NPRs below 3,000 feet for safety reasons, for example to avoid storms.	✓	✗
NA-3	FCC NAP; daa NMP; Dublin Airport Aeronautical Information Publication	*Noise Abatement Departure Procedures (NADP) Climb Profile* – Based on noise-abatement departure climb guidance contained in the ICAO's Procedures for Air Navigation Services Aircraft Operations Document 8168 Volume 1, Flight Procedures Appendix to Chapter 3 – NADP2, with thrust cutback at 1,500 feet.	✓	✓
NA-4	Dublin Airport Aeronautical Information Publication	*Visual Approach* – Jet aircraft (Cat C/D) on visual approach to Runways 28, 10, 16, and 34 must join final approach no closer than 6 nautical miles from touchdown. Aircraft must follow a descent path that will not result in being at any time lower than the approach path, which would otherwise be followed using the ILS glide path.	✓	✓
NA-5	FCC NAP	*Continuous Decent Approach (CDA)* – Operates a CDA that reduces the noise experienced on the ground by reducing the overall thrust required during the initial descent and keeping aircraft at higher altitudes for a longer period of time.	✓	✓

TABLE 3-1 (2 OF 3) EXISTING AND PLANNED NOISE MANAGEMENT MEASURES

MEASURE ID	SOURCE	MEASURE DESCRIPTION	2018	2025
NA-6	IAA ATC	*Continuous Climb Operations* - continuous climb operation along a standard departure procedure is intended to limit interruption of the climb profile to cruise altitude and reduces the noise experienced on the ground caused by thrust levels required to keep aircraft level and increases distance from noise-sensitive areas between an aircraft and receptor as soon as possible.	✓	✓
NA-7	FCC NAP; daa NMP; Dublin Airport Aeronautical Information Publication	*Reverse Thrust* – Reverse thrust is used to aid the deceleration of aircraft on landing using the aircraft's engines. This should not be used at night, unless required for safety reasons.	✓	✓
NA-8	FCC NAP; daa NMP	*Engine Ground Running* – Engine test runs are not permitted between 2000HRs and 0700HRs. All aircraft types may undertake testing between 0900 and 2000HRs, and only aircraft up to Code C may undertake engine testing between 0700 and 0900HRs.	✓	✓
NA-9	FCC NAP; daa NMP	*Monitor and Report* – Sustain noise operating procedures through monitoring.	**Partial**	✓
NA-10	Accepted NPR for North Runway	*3-Runway Noise Preferential Routes (NPRs) or Environmental Corridors (ECs) and Track Keeping* – Intent is to minimise disruption by routing aircraft away from built-up areas, where possible. Unless directed otherwise by IAA-ATC, all aircraft taking off from Dublin Airport are required to follow specific NPRs. To minimise impact, NPRs are designed to avoid overflight of built-up areas, where possible. An NPR is a path or corridor (1.8 kilometres at its widest point) that aircraft follow from take-off until being directed by IAA-ATC onto their main air traffic routes, typically at 3,000 feet altitude above mean sea level. Aircraft flying inside the NPR corridor are considered to be flying on-track. The preferred departure flight path NPR is straight out on the South Runway and divergence paths of 30-degrees and 75-degrees for the North Runway for westerly flow and straight out on the South Runway and a divergent path of 15-degreesd for easterly flow.	✗	✓
Land Use (LU) Planning and Management				
LU-1	FCC NAP; daa NMP; FCC County Development Plan; Dublin Airport LAP	*Land Use Compatibility Management Framework* – The land use and planning frameworks include the Fingal County Council's (FCC's) County Development Plan 2017–2023 (Variation No. 1) and the Dublin Airport 2020 Local Area Plan (LAP), which defines four airport noise zones and the associated objective of each zone along with an indication of the potential noise exposure from movements at Dublin Airport. The zones are based on potential noise exposure levels ($L_{Aeq,16hr}$ and L_{night} levels) due to the Airport using either the new northern or existing southern runway for arrivals or departures. The noise zoning system has been developed with the overarching objective to balance the potential impact of aircraft noise from the Airport on both external and internal noise amenity. This allows larger development which may be brought forward in the vicinity of the Airport's flight paths to be identified and considered as part of the planning process. The focus of the noise zones is to ensure compatibility of residential development and ensuring compatibility with pertinent standards and guidance in relation to planning and noise	✓	✓
LU-2	FCC NAP	*Land Use Compatibility Management Review* – Keep under review land-use policies in relation to aircraft noise through the review of existing land-use planning frameworks in so far as they relate to Dublin Airport.	✓	✓
LU-3	FCC NAP	*Encroachment Management* – Monitor noise encroachment associated with Dublin Airport to ensure airport noise policy is appropriately informed through land-use planning frameworks in so far as they relate to Dublin Airport.	✓	✓
LU-4	FCC NAP; daa NMP	*Sound Insulation (HSIP)* – Voluntary to households that qualify by being located within the 2016 63 dB $L_{Aeq,16hr}$ noise contour.	✓	✗
LU-5	North Runway Planning Permission Condition 7	*Sound Insulation (RNIS)* – Voluntary to households that qualify by being located within the 2022 63 dB $L_{Aeq,16hr}$ noise contour. All properties to be completed by the time North Runway is operational.	✗	✓

TABLE 3-1 (3 OF 3) EXISTING AND PLANNED NOISE MANAGEMENT MEASURES

MEASURE ID	SOURCE	MEASURE DESCRIPTION	2018	2025
LU-6	North Runway Planning Permission Condition 9	*Voluntary Dwelling Purchase Scheme* – Approved in 2016, this measure provides voluntary acquisition of eligible dwellings. Eligibility for the scheme is based on the predicted 69 dB $L_{Aeq,16hr}$ contour. This is the noise threshold for participation in the voluntary scheme. The scheme is completely voluntary and places no obligation on any resident to participate. Offers to purchase will include a 30 percent premium on the current market value of the residence. Property valuations will be based on current movements at Dublin Airport and accordingly valuations will not be affected by the new runway. The scheme will remain available for three years after North Runway is operational (2025).	✓	✓
LU-7	North Runway Planning Permission Condition 6	*Voluntary School Sound Insulation* - voluntary noise insulation of schools for all schools and registered pre-schools predicted to fall within the contour of 60 dB $L_{Aeq,16\ hr.}$ The scheme is designed to ensure that maximum noise limits within the classrooms and school buildings generally shall not exceed 45 dB $L_{Aeq,8hr}$ (a typical school day).	✗	✓
Operating Restrictions (OR)				
OR-1	North Runway Planning Permission Condition 4	Crosswind runway (16-34) shall be restricted to essential occasional use on completion of the new runway in accordance with Objective DA03 of the Fingal County Development Plan, 2005-2011. 'Essential' use shall be interpreted as use when required by international regulations for safety reasons.	✗	✓
Monitoring and Community Engagement (CE)				
CE-1	FCC NAP; daa NMP	*Stakeholder Engagement* – Participate in regular meetings with the Dublin Airport Environment Working Group (DAEWG) and Community Liaison Group (CLG).	✓	✓
CE-2	FCC NAP; daa NMP	*Community Engagement Programme* – Includes newsletters and various programmes that support the local community in the form of initiatives and funds.	✓	✓
CE-3	FCC NAP; daa NMP	*Noise and Flight Track Monitoring System* – Enables the analysis of aircraft movements to assess whether they are operating within defined corridors. The primary objective of the Noise and Flight Track Monitoring System is to gather information on aircraft approach and departure routes and resultant noise levels at several key locations. This information is used by daa to respond to any complaints relating to aircraft noise. Continue to promote enhancements of the system to include near live-flight reporting and appropriate additional fixed and/or mobile noise monitoring terminals.	✓	✓
CE-4	FCC NAP; daa NMP	*Noise Complaint Management Systems* – Process and respond to all aviation-related noise complaints in a timely manner.	✓	✓

NOTES:
daa NMP – daa Noise Management Plan
dB – Decibels
FCC NAP – Fingal County Council Noise Action Plan
HR – Hour
IAA ATC – Irish Aviation Authority air traffic control
ICAO – International Civil Aviation Organization
ILS – Instrument Landing System
KT –knots
L_{Aeq} –equivalent average sound level
LAP - - Local Area Plan
SOURCES: Fingal County Council, *Noise Action Plan for Dublin Airport – 2019 to 2023*, December 2018; daa, *Noise Management Plan*, May 2018; Irish Aviation Authority, *Dublin Airport Aeronautical Information Publication*, Section 2.21, November 5, 2020; Fingal County Council, *Dublin Airport 2020 Local Area Plan*, January 2020; Fingal Development Plan 2017-2023 Variation No. 1, December 9, 2019; An Bord Pleanála Reference Number PL06F.217429, 2007.

Table 3-2 summarises the noise exposure levels according to the metrics described in Section 2.1 associated with the unit of effectiveness. The Forecast without New Measures scenario does assume homes located within the 63 dB 16-hour average sound level between 07:00 and 23:00 (63 dB $L_{Aeq,16\,hr}$) will be eligible under the current 2016 and 2022 63 dB $_{LAeq,16\,hr}$ sound insulation schemes (LU-4 and LU-5 described in Table 3-1). As previously stated, the modelled noise levels for the dwelling units located within the Forecast without New Measures scenario 63 dB $L_{Aeq,16\,hr}$ contour were reduced by 5 dB to account for the sound insulation reduction effect which is the targeted noise reduction for the scheme. The number of people exposed to 50 dB L_{night} reported in Table 3-2 account for those residing in homes eligible for insulation under the 63 dB $L_{Aeq,16\,hr}$ scheme.

TABLE 3-2 FORECAST WITHOUT NEW MEASURES NOISE EXPOSURE – NUMBER OF PEOPLE EXPOSED IN 2025

NOISE EFFECT	METRIC	THRESHOLD	NUMBER OF PEOPLE EXPOSED
Number of People Highly Sleep Disturbed	L_{night}	40 dB	33,806
Number of People Highly Annoyed	L_{den}	45 dB	82,271
Medium Impact	L_{night}	50 dB	9,356
High Impact	L_{night}	55 dB	67

NOTES:

Population analysis includes a 5 dB reduction factor for eligible dwelling units under the existing and planned residential sound insulation schemes. The 5 dB reduction does not represent a reduction in exterior levels and does not change the location of the dwelling unit within exterior noise exposure levels.

dB – decibels

L_{night} – average sound pressure level for an 8-hour period (recommended period of sleep for adults) between 23:00 and 07:00

L_{den} – average sound pressure for 24 hours with noise events weighted at 10 dB for night-time (23:00 to 07:00) and 5 dB for evening (19:00 to 23:00)

SOURCE Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (noise effect threshold, number of people exposed)

Table 3-3 compares the 2018 population exposure levels to those modelled for the Forecast without New Measures scenario to determine if the forecast actions without Condition 3(d) and Condition 5 operating restrictions in place conflict with the cNAO for Dublin Airport and, if so, to what degree. A negative value in Table 3-3 represents a decrease from the 2018 situation.

TABLE 3-3 FORECAST WITHOUT NEW MEASURES NOISE EXPOSURE – NUMBER OF PEOPLE EXPOSED IN 2025 COMPARED TO 2018 SITUATION

NOISE EFFECT	METRIC	THRESHOLD	NUMBER OF PEOPLE EXPOSED 2025 COMPARED TO 2018
Number of People Highly Sleep Disturbed	L_{night}	40 dB	-8,428
Number of People Highly Annoyed	L_{den}	45 dB	-27,925
Medium Impact	L_{night}	50 dB	-2,881
High Impact	L_{night}	55 dB	-481

NOTES:

Decrease Increase

Population analysis includes a 5 dB reduction factor for eligible dwelling units under the existing and planned residential sound insulation schemes. The 5 dB reduction does not represent a reduction in exterior levels and does not change the location of the dwelling unit within exterior noise exposure levels.

Negative value represents a decrease compared to 2018.

dB – decibels

L_{night} – average sound pressure level for an 8-hour period (recommended period of sleep for adults) between 23:00 and 07:00

L_{den} – average sound pressure for 24 hours with noise events weighted at 10 dB for night-time (23:00 to 07:00) and 5 dB for evening (19:00 to 23:00)

SOURCE: Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (noise effect threshold, number of people exposed).

Table 3-4 compares the 2018 situation population exposure levels to those modelled for the Forecast without New Measures scenario to determine the degree of change in noise levels without Condition 3(d) and Condition 5 operating restrictions in place. The level of change quantified is the number of people who will be exposed to an increase in noise at a significant adverse effect level as defined in Section 2.1.

TABLE 3-4 FORECAST WITHOUT NEW MEASURES NOISE EXPOSURE – NUMBER OF PEOPLE EXPOSED TO SIGNIFICANT ADVERSE EFFECT CHANGES IN NOISE COMPARED TO 2018

			NUMBER OF PEOPLE EXPOSED
NOISE EFFECT	METRIC	THRESHOLD	2025 COMPARED TO 2018
24-Hour Noise Levels	L_{den}	45 dB and Higher	30,186
Night-Time Noise	L_{night}	40 dB and Higher	17,981

NOTES:

Decrease Increase

Population analysis includes a 5 dB reduction factor for eligible dwelling units under the existing and planned residential sound insulation schemes. The 5 dB reduction does not represent a reduction in exterior levels and does not change the location of the dwelling unit within exterior noise exposure levels.

Negative value represents a decrease compared to 2018.

dB – decibels

L_{night} – average sound pressure level for an 8-hour period (recommended period of sleep for adults) between 23:00 and 07:00

L_{den} – average sound pressure for 24 hours with noise events weighted at 10 dB for night-time (23:00 to 07:00) and 5 dB for evening (19:00 to 23:00)

SOURCE: Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (noise effect threshold, number of people exposed).

The HSD and HA population counts decrease in 2025 if the Forecast without New Measures scenario is implemented compared to 2018 situation levels. The number of people exposed to medium impact night-time noise levels (50 dB L_{night} or higher) and hight impact night-time noise levels (55 dB L_{night} or higher) decreases compared to the 2018 situation. Based on the comparison between the 2018 situation and the Forecast without New Measures scenario, the Forecast without New Measures scenario meets the cNAO, but will cause a potential significant adverse effect on people due to the increase in L_{night} and L_{den} noise levels for some areas. Because the scenario is expected to cause an increase in noise levels that are considered significantly adverse, especially related to the night-time period, additional noise mitigation measures are evaluated to reduce the number of people exposed to the potential significant adverse changes in noise.

The following sections summarise the feasible measures that could be considered for implementation in addition to the existing 21 measures carried over from the existing noise management programme.

4. NOISE ABATEMENT OPERATIONAL PROCEDURE MEASURES

The following subsections summarise the cost-effectiveness results associated with feasible noise abatement operational procedure measures. Refer to the *Dublin Airport North Runway, Regulation 598/2014 (Aircraft Noise Regulation) Forecast Without New Measures and Additional Measures Assessment* report by Ricondo & Associates, Inc. for more information on the identification of and feasibility determination of mitigation measures considered. The cost-effectiveness analysis results are presented in order of the process described in Section 2.4.

4.1 PREFERENTIAL RUNWAY USE MEASURES

The *Dublin Airport North Runway, Regulation 598/2014 (Aircraft Noise Regulation) Forecast Without New Measures and Additional Measures Assessment* report identified eight feasible preferential runway use measures. As the Forecast without New Measures scenario does not propose to alter the operation of the runway system during the daytime, all the measures share a common runway use configuration between 07:00 and 22:59:

- When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control.
- When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft.
- The parallel runways (10R-28L and 10L-28R) shall be used in preference to the cross runway, 16-34.

This use pattern is referred to as Option 7b (detailed in the Environmental Impact Statement Addendum, Section 16 as received by the planning authority on the 9th day of August 2005) in Condition 3 of the North Runway Planning Permission document.

Because the measures are designed to address night-time noise levels per the cNAO, the difference among the eight measures is the preferential runway use configuration at night. Three preferential runway use scenarios (Scenarios 2, 9 and 10) provide access to both runways between 23:00 and 23:59, and between 06:00 and 06:59 (called the shoulder hours) and prefer use of one runway between 00:00 and 05:59. Scenario 10 suggests switching between North Runway and South Runway to provide respite between 00:00 and 05:59. Two preferential runway use scenarios operate in semi-mixed mode (mixed mode for arrivals or departures only) between 23:00 and 06:59 (Scenarios 7 and 8). One scenario maintains Option 7b for 24-hours (Scenario 3), and another proposes Reverse Option 7b during night-time hours (Scenario 4). Scenario 5 suggests alternating between Option 7b and Reverse Option 7b during night-time hours to provide respite.

The following subsections summarise each preferential runway use measure and the effectiveness of each compared to the number of people exposed to night-time noise under the 2018 situation and the Forecast without New Measures scenario.

4.1.1 SUMMARY OF FEASIBLE MEASURES

Table 4-1 summarises each feasible preferential runway use measure. More information on the preferential runway use measures is provided in *Dublin Airport North Runway, Regulation 598/2014 (Aircraft Noise Regulation) Forecast Without New Measures and Additional Measures Assessment* report by Ricondo & Associates, Inc.

TABLE 4-1 (1 OF 2) FEASIBLE PREFERENTIAL RUNWAY USE MEASURES

SCENARIO	TITLE	DESCRIPTION
Scenario 2	**Option 7b and South Runway Only between 00:00 and 05:59**	**06:00 to 23:59**: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft. **00:00 to 05:59**: Movements preferred on the South Runway only (single runway).
Scenario 3	**Option 7b for 24-Hours**	**24 hours**: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft.

TABLE 4-1 (2 OF 2) FEASIBLE PREFERENTIAL RUNWAY USE MEASURES

SCENARIO	TITLE	DESCRIPTION
Scenario 4	**Option 7b and Reverse Option 7b between 23:00 and 06:59**	**07:00 to 22:59**: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft. **23:00 to 06:59**: When winds are westerly, Runway 28R shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10L shall be preferred for departing aircraft.
Scenario 5	**Option 7b and Alternate Option 7b and Reverse Option 7b between 23:00 and 06:59**	**07:00 to 22:59**: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft. **23:00 to 06:59**: Preferred arrival runway will alternate between North and South Runways while either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control in westerly and preferred departure runway will alternate between North and South Runways while either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft in easterly wind conditions each day.
Scenario 7	**Option 7b and Semi-Mixed Mode – Mixed Mode for Departures and Option 7b for Arrivals between 23:00 and 06:59**	**07:00 to 22:59**: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft. **23:00 to 06:59**: Both North and South Runways available for departures (runway used depends on whether turn to the north or south is required based on destination); prefer arrivals landing on the South Runway in westerly conditions and the North Runway in easterly conditions unless this exceeds the single-runway capacity for a given hour. If single-runway capacity is exceeded, then arrivals are moved to the other runway.
Scenario 8	**Option 7b and Semi-Mixed Mode – Mixed Mode for Arrivals and Option 7b for Departures between 23:00 and 06:59**	**07:00 to 22:59**: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft **23:00 to 06:59**: Both North and South Runways available for arrivals (assumed 50/50 split); prefer departures take off on the North Runway in westerly conditions and the South Runway in easterly conditions.
Scenario 9	**Option 7b and North Runway Only between 00:00 and 05:59**	**06:00 to 23:59**: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft. **00:00 to 05:59**: Movements preferred on the North Runway only (single runway).
Scenario 10	**Option 7b and Alternate Use of North and South Runway between 00:00 and 05:59**	**06:00 to 23:59**: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft. **00:00 to 05:59**: Alternate each night between movements on the North Runway only and the South Runway only.

NOTES:
Scenario 1 represents the Permitted Operations Situation scenario; Scenario 6 represents the Forecast without New Measures scenario
Mixed-Mode – both North Runway and South Runway can be used for arrivals and departures
Single Runway – limit arrivals and departures to one runway
SOURCE: Bickerdike Allen Partners LLP, November 2020 (situation scenario descriptions).

4.1.2 EFFECTIVENESS

This section summarises the effectiveness of each feasible preferential runway use scenario described in Table 4.1 in meeting the cNAO and addressing priorities related to potential significant adverse effects caused by changes in L_{den} and L_{night} levels.

First, comparisons to the HSD and HA population counts for each proposed measure compared to the 2018 situation were conducted. Those preferential runway use scenarios that indicate a higher total HSD and HA population compared to the 2018 situation were eliminated from further consideration. **Table 4-2** reports the HSD or HA populations for each scenario and indicates those scenarios eliminated from further consideration based on 2018 situation comparisons. A decrease in people exposed to noise levels compared to the 2018 situation is depicted with a negative value. Based on the comparative results, the Forecast without New Measures scenario and all preferential runway use measure scenarios did meet the overall cNAO; therefore, none were eliminated from further consideration based on comparing to the 2018 situation.

TABLE 4-2 EFFECTIVENESS OF FEASIBLE MEASURES TO ACHIEVE NOISE ABATEMENT OBJECTIVE – COMPARISON TO THE 2018 SITUATION

SCENARIO	POPULATION RESULTS		COMPARISON TO 2018 SITUATION		STATUS
	NO. OF PEOPLE HIGHLY ANNOYED	NO. OF PEOPLE HIGHLY SLEEP DISTURBED	NO. OF PEOPLE HIGHLY ANNOYED	NO. OF PEOPLE HIGHLY SLEEP DISTURBED	
Forecast without New Measures	82,271	33,806	-27,925	-8,428	Proceed
Scenario 2	69,255	24,429	-40,941	-17,805	Proceed
Scenario 3	66,469	21,918	-43,727	-20,315	Proceed
Scenario 4	78,946	31,967	-31,249	-10,266	Proceed
Scenario 5	79,360	30,219	-30,836	-12,014	Proceed
Scenario 7	82,913	33,858	-27,282	-8,376	Proceed
Scenario 8	68,978	23,820	-41,218	-18,414	Proceed
Scenario 9	67,783	22,586	-42,412	-19,648	Proceed
Scenario 10	69,153	24,585	-41,043	-17,648	Proceed

NOTES:

Decrease Increase

Population analysis includes a 5 dB reduction factor for eligible dwelling units under the existing and planned residential sound insulation schemes. The 5 dB reduction does not represent a reduction in exterior levels and does not change the location of the dwelling unit within exterior noise exposure levels.

Negative value indicates a decrease in population exposure compared to the 2018 situation.

SOURCE: Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (population values).

Second, a comparison to the HSD and HA populations between each preferential runway use scenario and the Forecast without New Measures scenario was conducted. Those preferential runway use scenarios that indicate a higher total HSD and/or HA population were eliminated from further consideration. **Table 4-3** reports the HSD or HA population for each scenario and indicates those scenarios eliminated from further consideration based on the comparisons. A decrease in people exposed to noise levels compared to the Forecast without New Measures scenario is depicted with a negative value. Based on the comparative results, Scenario 7 does not provide a decrease in HA and HSD populations at levels that are lower than the Forecast without New Measures; therefore, Scenario 7 was eliminated from further consideration.

TABLE 4-3 EFFECTIVENESS OF FEASIBLE MEASURES TO ACHIEVE NOISE ABATEMENT OBJECTIVE – COMPARISON TO FORECAST WITHOUT NEW MEASURES

SCENARIO	POPULATION RESULTS		COMPARISON TO FORECAST WITHOUT NEW MEASURES SCENARIO		STATUS
	NO. OF PEOPLE HIGHLY ANNOYED	NO. OF PEOPLE HIGHLY SLEEP DISTURBED	NO. OF PEOPLE HIGHLY ANNOYED	NO. OF PEOPLE HIGHLY SLEEP DISTURBED	
Scenario 2	69,255	24,429	-13,016	-9,376	Proceed
Scenario 3	66,469	21,918	-15,802	-11,887	Proceed
Scenario 4	78,946	31,967	-3,324	-1,838	Proceed
Scenario 5	79,360	30,219	-2,911	-3,586	Proceed
Scenario 7	82,913	33,858	643	52	Eliminate
Scenario 8	68,978	23,820	-13,293	-9,986	Proceed
Scenario 9	67,783	22,586	-14,487	-11,220	Proceed
Scenario 10	69,153	24,585	-13,118	-9,220	Proceed

NOTES:

Decrease Increase

Population analysis includes a 5 dB reduction factor for eligible dwelling units under the existing and planned residential sound insulation schemes. The 5 dB reduction does not represent a reduction in exterior levels and does not change the location of the dwelling unit within exterior noise exposure levels.
Negative value indicates a decrease in population exposure compared to the 2018situation.
SOURCE: Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (population values).

Third, a comparison to the number of people exposed to a change in noise levels compared to the 2018 situation that are considered to cause a potential significant adverse effect under each remaining preferential runway use scenario was conducted. The preferential runway use scenario(s) that indicated the lowest total number of people exposed to significant adverse effect changes in L_{night} and L_{den} noise levels compared to the 2018 situation was selected to proceed forward. **Table 4-4** lists the number of people exposed to noise level changes equivalent to significant adverse effects for each remaining preferential runway use scenario and indicates those eliminated from further consideration. The preferential runway use scenario with the lowest number of people exposed to changes that potentially cause significant adverse effects resulting from the change in noise levels for both L_{night} and L_{den} levels is Scenario 2. Scenario 3 is the closest, but the number of people exposed to significant adverse changes in L_{night} levels is approximately two times more than Scenario 2. In conclusion, Scenario 2 was the only measure selected to proceed forward in the analysis.

4.1.3 COST TO IMPLEMENT

Costs to implement a proposed measure do not include costs that would have been incurred under the Forecast without New Measures scenario, including the implementation of the preferred NPR procedures. After coordination with the IAA, costs related to preferential runway use is associated primarily with air traffic controller staffing and delay, which were identified as primary cost differentiators compared to the Forecast without New Measures scenario.

TABLE 4-4 EFFECTIVENESS OF FEASIBLE MEASURES TO MINIMISE SIGNIFICANT ADVERSE EFFECTS CAUSED BY CHANGES IN L_{DEN} AND L_{NIGHT} LEVELS – COMPARISON TO 2018 SITUATION

SCENARIO	NUMBER OF PEOPLE SIGNIFICANTLY ADVERSELY EFFECTED – L_{NIGHT}	NUMBER OF PEOPLE SIGNIFICANTLY ADVERSE EFFECTED – L_{DEN}	STATUS
Scenario 2	1,529	7,949	Proceed
Scenario 3	3,206	9,023	Eliminate
Scenario 4	28,995	38,596	Eliminate
Scenario 5	19,505	28,596	Eliminate
Scenario 8	11,071	15,994	Eliminate
Scenario 9	14,647	15,143	Eliminate
Scenario 10	8,702	11,402	Eliminate

NOTES:

Decrease Increase

Population analysis includes a 5 dB reduction factor for eligible dwelling units under the existing and planned residential sound insulation schemes. The 5 dB reduction does not represent a reduction in exterior levels and does not change the location of the dwelling unit within exterior noise exposure levels.

Negative value indicates a decrease in population exposure compared to 2018 conditions.

L_{night} – average sound pressure level for an 8-hour period (recommended period of sleep for adults) between 23:00 and 07:00

L_{den} – average sound pressure for 24 hours with noise events weighted at 10 dB for night-time (23:00 to 07:00) and 5 dB for evening (19:00 to 23:00)

SOURCE: Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (population values).

4.1.3.1 AIR TRAFFIC CONTROLLER STAFFING

Direct costs for a measure may include start-up cost, programme costs, personnel costs, and capital costs. Direct costs associated with implementing Scenario 2 preferential runway use measure is primarily the responsibility of the IAA. Based on daa discussions with the IAA, the primary direct cost difference for proposed runway use measures is staffing. The IAA did not indicate any other direct or indirect costs. Preferential runway use measures that keep both the North Runway and South Runway operational between 00:00 and 05:59 would require up to three air traffic controllers. This cost is included in the Forecast without New Measures scenario; therefore, no additional staffing costs are expected. Scenarios 2 limits movements to one runway between 00:00 and 05:59; therefore, the number of air traffic controllers is reduced, and cost savings are expected as a result from the implementation of this measure compared to the Forecast without New Measures scenario. Based on discussion between daa and IAA, the expected savings resulting from the reduced staffing level is €1,108,825 per year. **Table 4-5** lists the expected reduction in air traffic controller staffing costs for Scenario 2.

TABLE 4-5 AIR TRAFFIC CONTROLLER STAFFING CUMULATIVE COSTS

SCENARIO	DESCRIPTION	2025
Scenario 2	Single Runway 00:00 – 05:59 – reduction in ATC staff	-€3,326,475

NOTE: All cost estimates are expressed in constant prices

SOURCE: Ricondo & Associates, Inc., October 2019 (based on IAA staff cost estimates provided by daa).

4.1.3.2 DELAY COST

An indirect cost associated with a proposed preferential runway use measure is additional delay that may occur due to managing movement with limited capacity. The Forecast without New Measures situation scenario and Scenario 2 do not limit use to a single runway for either arrivals or departures between 06:00 and 23:59, which is when most peak movements can occur on a typical day. It provides flexibility during high-demand hours (e.g., 06:00 to 07:00 for departures and 23:00 to 23:59 for arrivals). Although Scenario 2 is expected to include a limit on the North Runway between 00:00 and 05:59 as defined in Section 6, delays and associated costs were not expected to be substantially different compared to the Forecast without New Measures scenario for 2025.

4.1.3.3 TOTAL COST PER SITUATION SCENARIO

The total cost for Scenario 2 is a cost savings due to the reduction in air traffic controller staffing between 00:00 and 05:59.

4.1.4 COST-EFFECTIVENESS

Although the effectiveness assessment concludes that Scenario 2 is the most effective preferential runway use measure, a cost-effective assessment is conducted to facilitate the comparison with the Permitted Operations Situation scenario detailed in Section 7. **Table 4-6** presents the cost-effectiveness results based on the costs divided by the change in the HA and HSD population compared to the Forecast without New Measures scenario. When calculating cost-effectiveness ratios, decreases in number of people exposed were treated as positive values and increases were negative values. If a decrease is expected with some additional cost, the cost-effectiveness ratio would be positive. If a decrease is expected with a cost savings, a negative cost-effectiveness ratio would occur. A negative ratio would also occur if an increase in number of people is expected with an additional cost. It is critical the values used to calculate the ratio are considered when determining which proposal are more cost-effective. The results indicate that Scenario 2 is cost-effective because it:

- reduces the HSD and HA populations below the Forecast without New Measures scenario and 2018 situation levels;
- causes the lowest number of people exposed to changes in L_{night} and L_{den} at potential significant adverse effect levels compared to the 2018 situation; and
- provides a cost savings compared to the Forecast without New Measures scenario.

The results will be used to compare cost-effectiveness with the Permitted Operations Situation scenario described in Section 7.

TABLE 4-6 COST-EFFECTIVENESS RATIO OF PREFERENTIAL RUNWAY USE SCENARIO 2 COMPARED TO FORECAST WITHOUT NEW MEASURES

SCENARIO	HIGHLY ANNOYED POPULATION EFFECTIVENESS	HIGHLY SLEEP DISTURBED POPULATION EFFECTIVENSS	COST	HIGHLY ANNOYED POPULATION RATIO (€/PERSON)	HIGHLY SLEEP DISTURBED POPULATION RATIO (€/PERSON)
Scenario 2	13,016	9,376	-€3,326,475	-€256	-€355

SOURCE: Ricondo & Associates, Inc., November 2020.

4.2 NOISE ABATEMENT FLIGHT PROCEDURES

This section evaluates proposed measures intended to modify aircraft flight paths or altitude profiles to reduce noise levels over communities. As discussed in Section 3, Forecast without New Measures, and detailed in Table 3-1, the baseline situation includes 17 existing or planned noise abatement flight procedures measures.

Based on the assessment documented in the *Dublin Airport North Runway, Regulation 598/2014 (Aircraft Noise Regulation) Forecast Without New Measures and Additional Measures Assessment* report, there were no additional proposed noise abatement flight procedures related to approach altitude profiles, departure altitude profiles, or flight paths deemed feasible for this cost-effectiveness analysis.

5. LAND USE PLANNING AND MANAGEMENT MEASURES

Scenario 2 meets the cNAO and addresses the priority to limit potential significant adverse effects caused by increases in L_{night} and L_{den} noise levels without the addition of other measures. However, Scenario 2 in forecast year 2025 conditions causes an increase in the number of people exposed to 55 dB L_{night} levels by 826 and 346 people compared to the Forecast without New Measures and the 2018 situation, respectively, indicating that the scenario does not adequately address those people highly impacted by night-time noise. This section summarises the cost-effectiveness assessment of the proposed land use mitigation measures intended to mitigate people exposed to levels that are considered to potentially cause a high impact based on the most cost-effective noise operational procedure runway use scenario, Scenario 2.

5.1 SUMMARY OF FEASIBLE MEASURES

Table 3-1 shows the existing land use planning and management measures expected to continue in the future. daa plans to continue the existing residential sound insulation programme (LU-5 or RNIS) based on the daytime 16-hour average sound level of 63 dB (Leq 63 dB $L_{Aeq,16hr}$) and complete it by the time the North Runway is operational. The aircraft noise modelling analysis accounted for homes eligible under the current scheme, and Scenario 2 noise modelling results indicated dwellings will be exposed to levels higher than 55 dB L_{night} in 2025. To address the high level impact, the following land use planning and management measure was proposed:

- Residential Sound Insulation Grant Scheme (RSIGS) – Dwelling units exposed to 55 dB L_{night} or higher under forecast 2025 levels are eligible for a sound insulation grant scheme. The insulation grant scheme is expected to provide a reduction in interior noise levels for treated rooms to reduce the exposure of the effect at a high impact level. (note: this measure does not remove the dwelling from the modelled exterior noise exposure level; therefore, effectiveness is not assumed for daytime and evening hours)

5.2 EFFECTIVENESS

For purposes of this Aircraft Noise Regulation assessment, residential sound insulation is considered feasible as a land use planning and management measure to reduce exposure to the effects of exterior noise levels within a dwelling unit. Based on the Environmental Protection Agency (EPA) draft guidelines, sound insulation is considered mitigation by reduction intended to deal with effects that cannot be avoided by focusing on reduction of exposure on the receptor.[26] For purposes of this assessment, sound insulation does not remove the dwelling unit from the noise exposure area but reduces the effect on people by 5 dB during night-time hours. Any dwellings eligible for the new scheme proposed as an additional measure, have been considered here as having a reduction of 5 dB L_{night} exposure, and a reduction of 5 dB for the night component of their L_{den} exposure. While this type of analysis is useful in assessing how the internal conditions within dwellings might benefit from insulation to reduce high levels of impact from outside, it does not account for external amenity areas of dwellings. Allowing for the benefit of the residential sound insulation schemes in general reduces the number of people assessed with high level of impact caused by night-time noise levels. The 5 dB reduction is accounted for in calculating number of people highly annoyed, highly sleep disturbed and exposed to night-time levels at or higher than 55 dB L_{night}, and provides levels to compare against the Forecast without New Measures scenario and Scenario 2 to assess effectiveness.

[26] Environmental Protection Agency, *Guidelines on the information to be Contained in Environmental Impact Assessment Reports - DRAFT*, August 2017.

This section summarises the effectiveness of each feasible measure in reducing the number of people exposed to 55 dB L_{night} or higher compared to Scenario 2. **Table 5-1** presents the number of people exposed under 2025 operation conditions if the proposed 55 dB L_{night} sound insulation grant scheme was implemented separately under Scenario 2 conditions. The result indicated the measure will reduce the total number of people exposed to 55 dB or higher L_{night} levels (high impact levels) compared to Scenario 2 without proposed new land use measures by 831 people. (note: the reduction does not equate to the dwelling moving out of the 55 dB L_{night} or higher exposure area)

5.3 COST TO IMPLEMENT

The proposed method to implement the programme is issuance of grants to homeowners who voluntarily participate. The costs are based on a grant scheme of €20,000 per dwelling, the costs to set up the grant scheme programme (€300,000) and annual administration cost of the programme (€100,000). According to the *Dublin Airport North Runway, Noise Information for the Regulation 598/2014 (Aircraft Noise Regulation) Assessment* report, approximately 242 dwelling units would be exposed to 55 dB and higher L_{night} in 2025 after accounting for eligible homes under the existing sound insulation measures. For cumulative cost estimation purposes, this analysis assumes all dwelling units would accept the grant scheme and complete the sound insulation of the relevant rooms starting in 2022 and complete them by 2025, which is a span of three years. **Table 5-2** indicates the cumulative cost estimate for sound insulation for the three years.

TABLE 5-1 EFFECTIVENESS OF PROPOSED SOUND INSULATION MEASURE - 2025

SCENARIO	NUMBER OF PEOPLE EXPOSED TO 55 DB OR HIGHER L_{NIGHT}	CHANGE IN PEOPLE EXPOSED COMPARED TO SCENARIO 2	STATUS
Scenario 2	893	N/A	N/A
Scenario 2 with the addition of 55 dB L_{night} Residential Sound Insulation Grant Scheme	62	-831	Proceed

NOTES:

Decrease Increase

Population analysis includes a 5 dB reduction factor for eligible dwelling units under the proposed 55 dB L_{night} grant scheme. The 5 dB reduction does not represent a reduction in exterior levels and does not change the location of the dwelling unit within exterior noise exposure levels.

Negative value indicates a decrease in population exposure compared to Situation Scenario 2 conditions.

dB – decibels N/A – comparison of Scenario 2 on itself is not applicable

L_{night} – average sound pressure level for an 8-hour period (recommended period of sleep for adults) between 23:00 and 07:00

SOURCE: Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (population values).

TABLE 5-2 CUMULATIVE COST ESTIMATE TO IMPLEMENT PROPOSED SOUND INSULATION MEASURE

SITUATION SCENARIO	2025
Scenario 2 with the addition of 55 dB L_{night} RSIGS	€5,340,000

NOTES: Cost estimate based on constant prices and is sum of costs for all three years.

dB – decibels

L_{night} – average sound pressure level for an 8-hour period (recommended period of sleep for adults) between 23:00 and 07:00

SOURCES: Ricondo & Associates, Inc., November 2020 (cumulative cost for forecast year); Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (dwelling unit counts); daa, October 2019 (estimated residential sound insulation costs).

5.4 COST-EFFECTIVENESS

Table 5-3 presents the cost-effectiveness results based on the cost to implement the proposed 55 dB or higher L_{night} residential sound insulation grant measure divided by the change in people exposed to 55 dB or higher L_{night} noise levels compared to Scenario 2 without new land use measures indicated in Table 5-1.

TABLE 5-3 COST-EFFECTIVENESS RATIO OF PROPOSED SOUND INSULATION MEASURE

SITUATION SCENARIO	2025 RATIO (€ PER PERSON)
Scenario 2 with the addition of 55 dB L_{night} RSIGS	€6,427

NOTES:
dB – decibels
L_{night} – average sound pressure level for an 8-hour period (recommended period of sleep for adults) between 23:00 and 07:00
SOURCE: Ricondo & Associates, Inc., November 2020.

6. OPERATING RESTRICTION MEASURE

After noise mitigation measures associated with noise abatement operational procedures and land use planning and management are assessed, operating restrictions may be considered if the noise abatement objective is not yet met. In accordance with the Regulation 598/2014, an operating restriction measure should not be more restrictive than necessary to meet the NAO. If the NAO is met prior to this step, then operating restriction measures are not necessary.

Scenario 2 with the addition of the proposed 55 dB L_{night} RSIGS for people exposed to high level of impact caused by night-time noise levels above 55 dB L_{night} meets the cNAO and priority associated with reducing high level night-time disturbance. Therefore, operating restriction measures are not necessary. Although the alternative meets the cNAO, daa proposes to include a limit on use of Runway 10L-28R between 00:00 and 05:59 and a proposed Quota Count (QC) measure to ensure that noise levels forecast to occur in 2025 meet the cNAO. These proposed operating restriction measures are considered operating restrictions by the Balanced Approach, but are not expected to restrict capacity up to 32 mppa or prevent specific aircraft using Dublin Airport in 2025. These measures were considered as a means to ensure that the actual noise situation in 2025 will be similar to the preferred scenario with additional noise mitigation measures using the forecasted fleet mix and proposed night-time runway mode of operation.

To ensure the benefits of noise reduction caused by the Scenario 2 preferential runway use measure limiting use of Runway 10L-28R between 00:00 and 05:59, daa proposes that Runway 10L-28R will not be used for take-off or landing movements between 00:00 and 05:59, except in cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems, declared emergencies at other airports or where the Runway 10L-28R length is required for a specific aircraft type. Limiting use of the runway as proposed is considered a runway use operating restriction. Forecast demand up to 2025 and to the 32 mppa passenger activity level between 00:00 and 05:59 is not expected to exceed capacity levels of a single runway. Therefore, the proposed limitation on Runway 10L-28R between 00:00 and 05:59 is not expected to constrain aircraft movements or access to the Airport, and is not expected to cause additional costs to airlines, passengers, the European air traffic system or the economy. The proposed limitation on Runway 10L-28R between 00:00 and 05:59 is carried forward as part of Scenario 2 preferential runway use with the addition of the proposed 55 dB L_{night} RSIGS measure.

To ensure the forecast noise exposure levels associated with the fleet mix expected in 2025, a Quota Count (QC) system involving an Annual Night Quota (ANQ) count is proposed. The proposed QC measure would assign a QC value to each individual aircraft movement based on the certified noise level of that aircraft. Lower QC values

are applied for aircraft with lower noise levels, higher values for noisier aircraft. The QC accumulates for each ATM against the Noise Quota (NQ) across the applicable time period. As such, the system allows a greater number of quieter aircraft movements within a given quota, encouraging the use of quieter aircraft. A proposed Annual Night Quota (ANQ) has been developed for the period 23:30 to 06:00 (known as the Night Quota Period [NQP]) consistent with airports operating similar QC based systems. daa proposes an ANQ of 7,990 for each year from the opening of the North Runway to 2025.

The Aircraft Noise Regulation considers a QC or Noise Quota (NQ) measure as an operating restriction, but the proposed ANQ will allow growth in overall air traffic movements at night for forecast movements up to 2025 whilst ensuring that the overall effects of aircraft noise are no worse than that upon which North Runway planning permission was originally granted and not worse than in 2018. The 32 mppa passenger capacity limit on the terminals is expected to constrain movements prior to any potential constraints caused by the ANQ measure.

The overall effects of use of quieter aircraft are already included in the forecast ATMs for 2025; therefore, there is no modelled reduction in noise levels if the ANQ is included. Costs to implement the proposed ANQ are not yet known until the measure is further defined but are expected to be minimal and limited to administrative costs. Because the ANQ is not expected to cause operational constraints up to 2025 or prior to reaching the 32 mppa passenger capacity limit, there are no significant costs expected to airlines, passengers, the European air traffic system and the economy. The proposed ANQ measure is carried forward as part of Scenario 2 preferential runway use with the addition of the proposed 55 dB L_{night} RSIGS measure.

7. COMPARISON OF FORECAST INCLUDING ADDITIONAL MEASURES AND PERMITTED OPERATIONS SITUATION SCENARIOS

Permission granted to Dublin Airport for the development of Runway 10L-28R and Terminal 2 included the following conditions, which restrict the movements of the runway system and place a cap on the number of passengers that can use the terminals at the Airport:

- North Runway
  - Condition 3(d) – Runway 10L-28R shall not be used for take-off or landing between 23:00 and 07:00.
  - Condition 5 – The average number of night-time aircraft movements at the Airport shall not exceed 65 per night (between 23:00 and 07:00) when measured over the 92-day modelling period.
- Terminal 2 – limits the annual number of passengers using the Airport's terminals to 32 mppa

Previous permission by An Bord Pleanála (Reference Number PL06F.217429, 2007) to build the North Runway included operational conditions that restrict aircraft access to Dublin Airport to address potential night-time noise impacts. In addition, previous permission to construct Terminal 2 included a planning condition on the number of annual passengers at 32 mppa. This condition was intended to address transportation access capacity at the eastern campus of Dublin Airport, and it was not intended as an aircraft noise reduction measure. Maintaining the existing consents is considered a situation based on the Aircraft Noise (Dublin Airport) Regulation Act 2019, and for purposes of this assessment is called the Permitted Operations Situation scenario.

This Aircraft Noise Regulation cost-effectiveness analysis compares the cost-effectiveness results of the Permitted Operations Situation scenario to the Forecast including Additional Measures scenario, which includes not only the existing and planned measures, but also the preferred additional measures determined based on

the cost-effectiveness analysis. This section compares the two scenarios to evaluate which of the two is more cost-effective to address the same cNAO and related priorities.

7.1 SUMMARY OF FEASIBLE MEASURES

The Permitted Operations Situation scenario includes existing and planned measures, North Runway Planning Permission Condition 3(a), North Runway Planning Permission Condition 3(b), North Runway Planning Permission Condition 3(c) and the following operating restrictions and terminal capacity limits:

- North Runway Planning Permission – Condition 3(d) – Runway 10L-28R shall not be used for take-off or landing between 23:00 and 07:00.[27]
- North Runway Planning Permission – Condition 4 – The crosswind runway (16-34) shall be restricted to essential occasional use on completion of the new runway in accordance with Objective DA03 of the Fingal County Development Plan, 2005-2011.[28] This is considered a planned measure listed in Table 3-1 as OR-1.
- North Runway Planning Permission – Condition 5 – The average number of night-time aircraft movements at the Airport shall not exceed 65 per night (between 23:00 and 07:00) when measured over the 92-day modelling period.[29]
- Terminal 2 Planning Permission – Condition 3 – The combined capacity of Terminal 2 as permitted together with Terminal 1 shall not exceed 32 mppa, unless otherwise authorised by a further grant of planning permission. This was related to the policies and objectives of the Dublin Airport Local Area Plan and capacity constraints (transportation) at the eastern campus.[30]

The Permitted Operations Situation scenario would constrain the total number of movements Dublin Airport may serve, even though the runway and airfield can accommodate more movements.

The Forecast including Additional Measures scenario includes existing and planned measures and the following:

- North Runway Planning Permission, Condition 4 – The crosswind runway (16-34) shall be restricted to essential occasional use on completion of the new runway in accordance with Objective DA03 of the Fingal County Development Plan, 2005-2011.[31]
- Terminal 2 Planning Permission, Condition 3 – The combined capacity of Terminal 2 as permitted together with Terminal 1 shall not exceed 32 mppa, unless otherwise authorised by a further grant of planning permission.
- Scenario 2 Preferential Runway Use
  - 07:00 to 22:59: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft (note: consistent with North Runway Planning Permission Conditions 3(b) and 3(c))

[27] Fingal County Council Ref: F04A/1755/E1, An Bord Pleanala Reference Number PL06F.217429.

[28] Fingal County Council Ref: F04A/1755/E1, An Bord Pleanala Reference Number PL06F.217429.

[29] Fingal County Council Ref: F04A/1755/E1, An Bord Pleanala Reference Number PL06F.217429.

[30] An Bord Pleanála Ref. PL 06F.220670/Fingal County Council Reg. Ref. F06A/1248.

[31] Fingal County Council Ref: F04A/1755/E1, An Bord Pleanala Reference Number PL06F.217429.

- 23:00 to 23:59: Same as preferential runway use between 07:00 to 22:59. (note: consistent with North Runway Planning Permission Conditions 3(b) and 3(c))
- 00:00 to 05:59 – Limit take-off or landings to South Runway (Runway 10L-28R) except in cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems or declared emergencies at other airports or where Runway 10R-28L length is required for a specific aircraft type. Refer to the operating restriction measure detailed below, which adds a use limit condition to North Runway between 00:00 and 05:59.
- 06:00 to 06:59 - Same as preferential runway use between 07:00 to 22:59. (note: consistent with North Runway Planning Permission Conditions 3(b) and 3(c))
- Proposed limitation on Runway 10L-28R between 00:00 and 05:59 - Runway 10L-28R shall not be used[32] for take-off or landing between 00:00 and 05:59 (except in cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems, declared emergencies at other airports or where Runway 10R-28L length is required for a specific aircraft type) (note: Relevant Action is to amend North Runway Planning Permission Condition 3(d))

- Proposed Residential Sound Insulation Grant Scheme to address night-time noise levels of at least 55 dB L_{night} in 2025
- Proposed QC system based on ANQ for the period 23:30 to 06:00 to be applied for each year from the opening of the North Runway to 2025[33] (note: Relevant Action is to replace North Runway Planning Permission Condition 5 with this measure)

This scenario may begin to be constrained after annual passenger levels reach 32 mppa but will not be constrained due to movement or use restrictions related to preferential runway and time of day operation limits.

7.2 EFFECTIVENESS

Table 7-1 presents the HSD and HA populations for the Forecast without New Measures scenario, Forecast including Additional Measures scenario, and the Permitted Operations Situation scenario. **Table 7-2** compares the metrics of the three scenarios to the 2018 situation; and compares the Forecast including Additional Measures and the Permitted Operations Situation scenarios to the Forecast without New Measures scenario. Both the Forecast including Additional Measures and Permitted Operations Situation scenarios reduce the HSD and HA populations. Both scenarios meet the cNAO and associated night-time disturbance priorities.

TABLE 7-1 SCENARIO POPULATION EXPOSURE LEVEL RESULTS

SCENARIO	HIGHLY SLEEP DISTURBED POPULATION	HIGHLY ANNOYED POPULATION
Forecast without New Measures Scenario	33,806	82,271
Forecast including Additional Measures	24,381	69,221
Permitted Operations Situation	19,434	64,714

SOURCE: Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (population values).

[32] Between 00:00 and 05:59, the airfield is limited to the South Runway only and there will be no use of the North Runway except for certain situations. This limit is considered a runway use operating restriction but is not expected to restrict operations or access due to forecast low demand between 00:00 and 05:59 and the available capacity of the South Runway.

[33] The Annual Night Quota between 23:30 and 06:00 is not expected to limit operations at passenger levels below 32 mppa.

7.3 COST TO IMPLEMENT

Table 7-3 presents the cumulative costs for the Forecast including Additional Measures scenario and the Permitted Operations Situation scenario. Costs for the Forecast including Additional Measures scenario are the combined sum of the preferential runway use measure costs listed in Table 4-5 and the RSIGS costs summarised in Table 5-2.

Costs associated with the Permitted Operations Situation scenario are related to the constrained number of movements forecast for 2022 to 2025 due to the North Runway operating restrictions compared to unconstrained levels up to 2025, which is the year when the 32 mppa is expected to be reached. An economic impact study conducted by InterVISTAS based on forecast movement conditions post-COVID conducted by Mott MacDonald[34], determined the constrained number of movements would lead to loss in value of goods and services produced (gross value added [GVA]) compared to the unconstrained scenario. All costs are expressed in 2020 prices.[35]

TABLE 7-2 EFFECTIVENESS OF SCENARIOS COMPARED TO 2018 SITUATION AND FORECAST WITHOUT NEW MEASURES SCENARIO

SCENARIO	CHANGE IN PEOPLE EXPOSED COMPARED TO 2018 SITUATION		CHANGE IN PEOPLE EXPOSED COMPARED TO FORECAST WITHOUT NEW MEASURES SCENARIO	
	HIGHLY SLEEP DISTURBED POPULATION	HIGHLY ANNOYED POPULATION	HIGHLY SLEEP DISTURBED POPULATION	HIGHLY ANNOYED POPULATION
Forecast without New Measures	-8,428	-27,925	N/A	N/A
Forecast including Additional Measures	-17,853	-40,975	-9,425	-13,050
Permitted Operations Situation	-22,800	-45,481	-14,372	-17,556

NOTES:

Decrease Increase

Negative value indicates a decrease in population exposure.

N/A – Not Applicable to compare Forecast without New Measures to itself

L_{night} – average sound pressure level for an 8-hour period (recommended period of sleep for adults) between 23:00 and 07:00

SOURCE: Bickerdike Allen Partners LLP, *A11267_12_CA049_14.0 Summary of Results Including Mitigation* Excel Sheet, October 29, 2020 (population values).

[34] Mott MacDonald, *Dublin Airport Operating Restrictions - Quantification of Impacts on Future Growth September 2020 Update 2022 2025 Period*, version 5.3, September 2020.

[35] InterVISTAS, *Update Report Draft Dublin Airport Economic Impact of Operating Restrictions*, October 2020.

TABLE 7-3 ESTIMATED TOTAL COST COMPARISON TO IMPLEMENT – FORECAST INCLUDING ADDITIONAL MEASURES VERUS PERMITTED OPERATIONS SITUATION SCENARIOS

SCENARIO	CUMULATIVE COST 2025
Forecast including Additional Measures[1]	€2,013,525
Permitted Operations Situation [2]	€962,500,000

NOTES:
1 Forecast including Additional Measures scenario cost estimate is expressed in constant prices.
2 Permitted Operations Situation scenario costs are in 2020 euros.
SOURCES: Ricondo & Associates, Inc., July 2020 (sum of costs for Forecast including Additional Measures scenario); InterVISTAS, *InterVISTAS_EconImpact_PostCOVID_5Oct2020*, Economic Impact Output Excel worksheet, October 5, 2020 (total gross value added cost estimates).

The implications of the operating restrictions would extend across the entire economy of the Republic of Ireland, due to the lower connectivity that Dublin Airport would be able to offer. The night-time operation cap would restrict early morning departures to Europe, which would hamper business connectivity; reduce long-haul connectivity, impacting business and tourism; hamper Dublin Airport's ability to develop as a hub airport; reduce the range of destinations connected to Ireland; and reduce air cargo services, impacting Ireland's trade and supply chain competitiveness. The operating restrictions imposed by the planning permission for North Runway contradict the aims and commitments of the National Aviation Policy. The negative effects of the operating restrictions on both long haul and short haul flights reduce the connectivity and competitiveness of Dublin Airport. Consequently, the decreased traffic and air services result in a reduced economic contribution to the national economy.

The assessed impact is a loss of air traffic movements and associated 1.1 million passengers per year (a 3.5 percent decrease compared to unconstrained forecast levels) and a cumulative loss over the four-year period 2022 to 2025 of 4.3 million passengers. The operating restrictions particularly impact on the recovery and growth of the Dublin Airport-based Irish carriers Aer Lingus and Ryanair, who are constrained at levels 4.4 percent below the unconstrained case by 2025. The Dublin Airport-based carriers require early morning departures and late evening arrivals for their short haul movements, and Aer Lingus requires early morning arrivals for its transatlantic movements. Non-Irish carriers are less affected by the restrictions as they have proportionately fewer movements in the restricted 23:00 to 07:00 period. The operating restrictions constrain growth in short haul movements throughout the day, as the lack of night slots limits the number of Dublin Airport-based aircraft that can be accommodated, with each aircraft performing multiple flights during the operating day. In summary, in the constrained scenario (with the current North Runway Planning Permission conditions in place), there is a forecasted 3.2 percent decrease in flights across a 24-hour period in 2025. Refer to InterVISTAS' *Update Draft Dublin Airport Economic Impact of Operating Restrictions* report for more information on the economic impact study methodology and results.[36]

Economic impact of the operating restrictions is related to the forgone economic impact resulting from the operating restrictions, which InterVISTAS projected to reach up to €963 million in GVA by 2025. The Irish economy could forgo an additional 3,430 jobs by 2025 if the North Runway operating restrictions are maintained. The majority of this forgone economic impact is expected to occur outside of the aviation sector—62 percent of the total impact is catalytic impacts (tourism, trade, investment, etc.) and another 21 percent is from indirect and induced impacts (supplier and spending in the wider economy).[37]

[36] InterVISTAS, *Update Report Draft Dublin Airport Economic Impact of Operating Restrictions*, October 2020.

[37] InterVISTAS, *Update Report Draft Dublin Airport Economic Impact of Operating Restrictions*, October 2020.

7.4 COST-EFFECTIVENESS

Table 7-4 presents the cost-effectiveness results for Forecast including Additional Measures scenario and the Permitted Operations Situation scenario based on the cost to implement divided by the change in population noise exposure levels compared to the 2018 situation. The intent of this comparison is to assess which of the two scenarios is most cost-effective in meeting the cNAO. The HSD and HA populations are the units of measure used to determine effectiveness.

The cost-effectiveness ratio for the Forecast including Additional Measures scenario is significantly lower compared to the Permitted Operations Situation scenario for all metrics because of the lower cost. The cost associated with loss in economic growth is substantially higher compared to implementing a preferential runway use measure and additional sound insulation. Both scenarios meet the cNAO, but the Permitted Operations Situation scenario is far more restrictive compared to the Forecast including Additional Measures scenario. According to Aircraft Noise Regulation, operating restrictions should only be considered if needed to meet an objective and if not more restrictive than necessary to meet an objective.

TABLE 7-4 COST-EFFECTIVENESS OF FORECAST INCLUDING ADDITIONAL MEASURES VERSUS PERMITTED OPERATIONS SITUATION SCENARIO COMPARED TO 2018 SITUATION

SCENARIO	COST-EFFECTIVENESS RATIO TO REDUCE THE HIGHLY SLEEP DISTURBED POPULATION		COST-EFFECTIVENESS RATIO TO REDUCE THE HIGHLY ANNOYED POPULATION	
	2025	CER RANKING	2025	CER RANKING
Forecast including Additional Measures	€112.78	1	€49.14	1
Permitted Operations Situation	€42,215.11	2	€21,162.55	2

NOTES: CER Ranking based on lowest to highest absolute value ratio.
CER – Cost-Effectiveness Ratio
SOURCE: Ricondo & Associates, Inc., November 2020.

8. RECOMMENDATIONS

Based on the cost-effectiveness analysis results, the following measures are recommended in addition to the existing and planned noise reduction measures to comprise the Forecast including Additional Measures scenario recommendation:

- 3-Runway Preferential Runway Use
  - 07:00 to 22:59: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft (note: consistent with North Runway Planning Permission Conditions 3(b) and 3(c))
  - 23:00 to 23:59: Same as preferential runway use between 07:00 to 22:59. (note: consistent with North Runway Planning Permission Conditions 3(b) and 3(c))
  - 00:00 to 05:59 – Limit take-off or landings to South Runway (Runway 10L-28R) except in cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems, declared emergencies at other airports or where Runway 10R-28L length is required for a specific aircraft type. Refer to operating restriction measure to add use limit condition to North Runway between 00:00 and 05:59.
  - 06:00 to 06:59 - Same as preferential runway use between 07:00 to 22:59. (note: consistent with North Runway Planning Permission Conditions 3(b) and 3(c))

  - Limitation on Runway 10L-28R between 00:00 and 05:59 - Runway 10L-28R shall not be used[38] for take-off or landing between 00;00 and 05;59 (except in cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems or declared emergencies at other airports or where Runway 10R-28L length is required for a specific aircraft type) (note: Relevant Action is to amend North Runway Planning Permission Condition 3(d))

- Residential Sound Insulation Grant Programme: Provide sound insulation grant assistance to sound insulate dwelling units with exterior levels at 55 dB L_{night} or higher based on forecast 2025 levels

- Annual Night Quota (ANQ) count of 7,990 between 23:30 to 06:00 (Night Quota Period) to be applied for each year from the opening of the North Runway to 2025. (note: Relevant Action is to replace North Runway Planning Permission Condition 5 with this measure)

Table 8-1 lists all the existing and recommended noise reduction measures included as part of the Forecast including Additional Measures scenario.

For purposes of the North Runway application, the Forecast including Additional Measures proposes the following Relevant Action:

- Amend Condition 3(d) so that it reads: *Runway 10L-28R shall not be used for take-off or landing between 0000 and 0559 except in cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems or declared emergencies at other airports or where Runway 10L-28R length is required for a specific aircraft type.*

- Replace the existing operating restriction imposed by Condition 5 with a noise quota system also known as an Annual Night Quota (ANQ) that would read: *A noise quota system for night-time noise will be introduced at the airport. The airport shall be subject to an annual noise quota of 7,990 between the hours of 2330 and 0600.*

The Forecast including Additional Measures, which includes the Relevant Actions, is referred to as the Proposed Relevant Action in the Environmental Impact Report Assessment (EIAR).

[38] Between 00:00 and 05:59, the airfield is limited to the South Runway only and there will be no use of the North Runway except for certain situations. This limit is considered a runway use operating restriction but is not expected to restrict operations or access due to forecast low demand between 00:00 and 05:59 and the available capacity of the South Runway.

TABLE 8-1 (1 OF 4) EXISTING, PLANNED AND RECOMMENDED NOISE MANAGEMENT MEASURES

MEASURE ID	SOURCE	MEASURE DESCRIPTION	2018	2025
Reduction of Noise at Source (NS)				
NS-1	FCC NAP	Promote quieter aircraft through incentives such as FlyQuiet programmes. This programme is expected to be in place by 2022.	✗	✓
NS-2	FCC NAP	Work with airline partners to introduce quieter aircraft, particularly at night, including consideration of incentives. Approaches to incentives under development and expected to be in place by 2022.	✗	✓
Noise Abatement (NA) Operating Procedures				
NA-1	FCC NAP; daa NMP; Dublin Airport Aeronautical Information Publication	*2-Runway Preferential Runway Programme* – Intent of measure is to utilise whenever possible the runways that enable aircraft to avoid noise-sensitive areas during the initial departure and final approach phases of flight. Runway 10 or Runway 28 is the required runway between 0600 and 2300HR local time when the crosswind component is 20KT or less. Runway 28 will be the preferential runway when the tailwind component is 10KT or less and braking action is assessed as good. Aircraft will be required to use these runways except when operational reasons dictate otherwise. If the crosswind component on Runway 10 or Runway 28 is greater than 20KT, Runway 16 or Runway 34 may become the active runway. If the forecast crosswind component on Runway 10 or 28 is greater than 20KT, Runway 16 or 34 may become the active runway. The use of Runway 16-34 will be kept to an absolute minimum subject to operational conditions. Runways will be prioritised for noise abatement purposes between 2300 and 0600HR local time, subject to the same wind calculation method and values as used between 0600 and 2300HR local time. When weather conditions and flight movements permit, runway usage will be prioritised as follows: Arrivals: #1 (Runway 10), #2 (Runway 16), #3 (Runway 28), #4 (Runway 34); Departures: #1 (Runway 28), #2 (Runway 34), #3 (Runway 10), #4 (Runway 16).	✓	✗
NA-2	FCC NAP; daa NMP; Dublin Airport Aeronautical Information Publication	*2-Runway Noise Preferential Routes (NPRs) or Environmental Noise Corridors and Track Keeping* – Intent is to minimise disruption by routing aircraft away from built-up areas, where possible. Unless directed otherwise by IAA-ATC, all aircraft taking off from Dublin Airport are required to follow specific NPRs. To minimise impact, NPRs are designed to avoid overflight of built-up areas, where possible. An NPR is a path or corridor (1.8 kilometres at its widest point) that aircraft follow from take-off until being directed by IAA-ATC onto their main air traffic routes, typically at 3,000 feet altitude above mean sea level. Aircraft flying inside the NPR corridor are considered to be flying on-track. departures from all runways (except easterly departures on the existing Runway 10-28 must maintain course straight out for 5 nautical miles (1 nautical mile = 1,852 metres) after take-off before commencing a turn, unless otherwise cleared by IAA-ATC. Easterly departures on the existing southern runway must maintain course straight out for 5 nautical miles before commencing a turn to the north, or to 6 nautical miles before commencing turn to the south. Once an aircraft reaches the end of the NPR, or at an altitude of 3,000 feet, IAA-ATC will turn it onto a more direct heading to its destination. IAA-ATC can turn aircraft off NPRs below 3,000 feet for safety reasons, for example to avoid storms.	✓	✗
NA-3	FCC NAP; daa NMP; Dublin Airport Aeronautical Information Publication	*Noise Abatement Departure Procedures (NADP) Climb Profile* – Based on noise-abatement departure climb guidance contained in the ICAO's Procedures for Air Navigation Services Aircraft Operations Document 8168 Volume 1, Flight Procedures Appendix to Chapter 3 – NADP2, with thrust cutback at 1,500 feet.	✓	✓
NA-4	Dublin Airport Aeronautical Information Publication	*Visual Approach* – Jet aircraft (Cat C/D) on visual approach to Runways 28, 10, 16, and 34 must join final approach no closer than 6 nautical miles from touchdown. Aircraft must follow a descent path that will not result in being at any time lower than the approach path, which would otherwise be followed using the ILS glide path.	✓	✓
NA-5	FCC NAP	*Continuous Decent Approach (CDA)* – Operates a CDA that reduces the noise experienced on the ground by reducing the overall thrust required during the initial descent and keeping aircraft at higher altitudes for a longer period of time.	✓	✓

TABLE 8-1 (2 OF 4) EXISTING, PLANNED AND RECOMMENDED NOISE MANAGEMENT MEASURES

MEASURE ID	SOURCE	MEASURE DESCRIPTION	2018	2025
NA-6	IAA ATC	*Continuous Climb Operations* - continuous climb operation along a standard departure procedure is intended to limit interruption of the climb profile to cruise altitude and reduces the noise experienced on the ground caused by thrust levels required to keep aircraft level and increases distance from noise-sensitive areas between an aircraft and receptor as soon as possible.	✓	✓
NA-7	FCC NAP; daa NMP; Dublin Airport Aeronautical Information Publication	*Reverse Thrust* – Reverse thrust is used to aid the deceleration of aircraft on landing using the aircraft's engines. This should not be used at night, unless required for safety reasons.	✓	✓
NA-8	FCC NAP; daa NMP	*Engine Ground Running* – Engine test runs are not permitted between 2000HRs and 0700HRs. All aircraft types may undertake testing between 0900 and 2000HRs, and only aircraft up to Code C may undertake engine testing between 0700 and 0900HRs.	✓	✓
NA-9	FCC NAP; daa NMP	*Monitor and Report* – Sustain noise operating procedures through monitoring.	**Partial**	✓
NA-10	Accepted NPR for North Runway	*3-Runway Noise Preferential Routes (NPRs) or Environmental Corridors (ECs) and Track Keeping* – Intent is to minimise disruption by routing aircraft away from built-up areas, where possible. Unless directed otherwise by IAA-ATC, all aircraft taking off from Dublin Airport are required to follow specific NPRs. To minimise impact, NPRs are designed to avoid overflight of built-up areas, where possible. An NPR is a path or corridor (1.8 kilometres at its widest point) that aircraft follow from take-off until being directed by IAA-ATC onto their main air traffic routes, typically at 3,000 feet altitude above mean sea level. Aircraft flying inside the NPR corridor are considered to be flying on-track. The preferred departure flight path NPR is straight out on the South Runway and divergence paths of 30-degrees and 75-degrees for the North Runway for westerly flow and straight out on the South Runway and a divergent path of 15-degreesd for easterly flow.	✗	✓
NA-11		*3-Runway Preferential Runway Programme* – Intent of measure is to utilise whenever possible the runways that enable aircraft to avoid noise-sensitive areas during the initial departure and final approach phases of flight. From 06:00 to 23:59: When winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control. When winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft. From 00:00 to 5:59: Limit take-off or landings to South Runway (Runway 10L-28R) except in cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems or declared emergencies at other airports or where Runway 10R-28L length is required for a specific aircraft type.	✗	✓
Land Use (LU) Planning and Management				
LU-1	FCC NAP; daa NMP; FCC County Development Plan; Dublin Airport LAP	*Land Use Compatibility Management Framework* – The land use and planning frameworks include the Fingal County Council's (FCC's) County Development Plan 2017–2023 (Variation No. 1) and the Dublin Airport 2020 Local Area Plan (LAP), which defines four airport noise zones and the associated objective of each zone along with an indication of the potential noise exposure from movements at Dublin Airport. The zones are based on potential noise exposure levels ($L_{Aeq,16hr}$ and L_{night} levels) due to the airport using either the new northern or existing southern runway for arrivals or departures. The noise zoning system has been developed with the overarching objective to balance the potential impact of aircraft noise from the Airport on both external and internal noise amenity. This allows larger development which may be brought forward in the vicinity of the Airport's flight paths to be identified and considered as part of the planning process. The focus of the noise zones is to ensure compatibility of residential development and ensuring compatibility with pertinent standards and guidance in relation to planning and noise	✓	✓
LU-2	FCC NAP	*Land Use Compatibility Management Review* – Keep under review land-use policies in relation to aircraft noise through the review of existing land-use planning frameworks in so far as they relate to Dublin Airport.	✓	✓

TABLE 8-1 (3 OF 4) EXISTING, PLANNED AND RECOMMENDED NOISE MANAGEMENT MEASURES

MEASURE ID	SOURCE	MEASURE DESCRIPTION	2018	2025
LU-3	FCC NAP	*Encroachment Management* – Monitor noise encroachment associated with Dublin Airport to ensure airport noise policy is appropriately informed through land-use planning frameworks in so far as they relate to Dublin Airport.	✓	✓
LU-4	FCC NAP; daa NMP	*Sound Insulation (HSIP)* – Voluntary to households that qualify by being located within the 2016 63 dB $L_{Aeq,16hr}$ noise contour.	✓	✗
LU-5	North Runway Planning Permission Condition 7	*Sound Insulation (RNIS)* – Voluntary to households that qualify by being located within the 2022 63 dB $L_{Aeq,16hr}$ noise contour. All properties to be completed by the time North Runway is operational.	✗	✓
LU-6	North Runway Planning Permission Condition 9	*Voluntary Dwelling Purchase Scheme* – Approved in 2016, this measure provides voluntary acquisition of eligible dwellings. Eligibility for the scheme is based on the predicted 69 dB $L_{Aeq,16hr}$ contour. This is the noise threshold for participation in the voluntary scheme. The scheme is completely voluntary and places no obligation on any resident to participate. Offers to purchase will include a 30 percent premium on the current market value of the residence. Property valuations will be based on current movements at Dublin Airport and accordingly valuations will not be affected by the new runway. The scheme will remain available for three years after North Runway is operational (2025).	✓	✓
LU-7	North Runway Planning Permission Condition 6	*Voluntary School Sound Insulation* - voluntary noise insulation of schools for all schools and registered pre-schools predicted to fall within the contour of 60 dB $L_{Aeq,16hr}$. The scheme is designed to ensure that maximum noise limits within the classrooms and school buildings generally shall not exceed 45 dB $L_{Aeq,8hr}$ (a typical school day).	✗	✓
LU-8		*Night-time Sound Insulation Grant Programme* – A grant programme for households that qualify by being located between the 2025 forecast L_{night} 55 dB and higher noise contours.	✗	✓
Operating Restrictions (OR)				
OR-1	North Runway Planning Permission Condition 4	Crosswind runway (16-34) shall be restricted to essential occasional use on completion of the new runway in accordance with Objective DA03 of the Fingal County Development Plan, 2005-2011. 'Essential' use shall be interpreted as use when required by international regulations for safety reasons.	✗	✓
OR-2		Runway 10L-28R "No Use" Limit: This measure is intended to ensure that noise levels forecast to occur in 2025 meet the cNAO Runway 10L-28R shall not be used for take-off or landing between 00:00 hours and 05:59 hours (except in cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems or declared emergencies at other airports or where Runway 10R-28L length is required for a specific aircraft type). Due to historic and forecast low demand, this restriction is not expected to impact Dublin Airport capacity and efficiency, the European aviation system and the economy.		
OR-3		Quota Count: This measure is intended to ensure that noise levels forecast to occur in 2025 meet the cNAO. The proposed quota count is based on an Annual Night Quota (ANQ) count of 7,990 between 23:30 to 06:00 (Night Quota Period) to be applied for each year from the opening of the North Runway to 2025		
Monitoring and Community Engagement (CE)				
CE-1	FCC NAP; daa NMP	*Stakeholder Engagement* – Participate in regular meetings with the Dublin Airport Environment Working Group (DAEWG) and Community Liaison Group (CLG).	✓	✓
CE-2	FCC NAP; daa NMP	*Community Engagement Programme* – Includes newsletters and various programmes that support the local community in the form of initiatives and funds.	✓	✓

TABLE 8-1 (4 OF 4) EXISTING, PLANNED AND RECOMMENDED NOISE MANAGEMENT MEASURES FOR PREFFERRED OPTION

MEASURE ID	SOURCE	MEASURE DESCRIPTION	2018	2025
CE-3	FCC NAP; daa NMP	*Noise and Flight Track Monitoring System* – Enables the analysis of aircraft movements to assess whether they are operating within defined corridors. The primary objective of the Noise and Flight Track Monitoring System is to gather information on aircraft approach and departure routes and resultant noise levels at several key locations. This information is used by daa to respond to any complaints relating to aircraft noise. Continue to promote enhancements of the system to include near live-flight reporting and appropriate additional fixed and/or mobile noise monitoring terminals.	✓	✓
CE-4	FCC NAP; daa NMP	*Noise Complaint Management Systems* – Process and respond to all aviation-related noise complaints in a timely manner.	✓	✓

NOTES:
cNAO – candidate Noise Abatement Objective
daa NMP – daa Noise Management Plan
dB – Decibels
FCC NAP – Fingal County Council Noise Action Plan
HR – Hour
IAA ATC – Irish Aviation Authority air traffic control
ICAO – International Civil Aviation Organization
ILS – Instrument Landing System
KT –knots
L_{Aeq} – average sound level in A-weighted decibels
LAP - Local Area Plan

SOURCES: Fingal County Council, *Noise Action Plan for Dublin Airport – 2019 to 2023*, December 2018; daa, *Noise Management Plan*, May 2018; Irish Aviation Authority, *Dublin Airport Aeronautical Information Publication*, Section 2.21, November 5, 2020; Fingal County Council, *Dublin Airport 2020 Local Area Plan*, January 2020; Fingal Development Plan 2017-2023 Variation No. 1, December 9, 2019; An Bord Pleanála Reference Number PL06F.217429, 2007.