13B. Air noise modelling methodology

13B.1 Introduction

13B.1.1 This replacement appendix of the Environmental Impact Assessment Report Supplement (EIAR Supplement), prepared by Bickerdike Allen Partners LLP, describes the modelling methodology for the air noise predictions of the future scenarios assessed in Chapter 13 of the EIAR Supplement. Chapter 13 also repeats the results for 2018 which were presented in the 2021 EIAR Addendum. The 2021 methodology is not repeated here.

- Section 13B.1.2 details the scenarios that have been assessed and presents summaries of the aircraft movements.
- Section 13B.3 sets out the methodology and the assumptions used in the prediction of airborne aircraft noise levels and the production of noise contours.
- Section 13B.4 sets out the methodology used to assess the number of people and dwellings within the contours, as well as noise sensitive community buildings such as schools and hospitals.

Changes from 2021 EIAR Addendum Methodology

13B.1.2 A summary of the changes from the air noise modelling methodology used in the 2021 EIAR Addendum is as follows:

- Updated to latest software version
- Updated set of forecast aircraft movements
- Departure routes based on recent radar data
- Departure profiles based on recent radar data
- Validation exercise updated to utilise more recent noise measurement data
- Updated assumption regarding when mixed mode operations would be used. Specifically, the 2021 EIAR Addendum assumed that between 06:00 and 07:59, both runways would be used for departures. In this EIAR Supplement it is assumed that only one runway will be used for departures during this period.

13B.2 Assessment Scenarios

Scenarios to be Assessed

13B.2.1 Four scenarios have been included in the air noise assessment described in this Appendix; these are:

- 2025 Permitted
- 2025 Proposed
- 2035 Permitted
- 2035 Proposed

13B.2.2 The future assessments are based on air traffic movement forecasts which have been supplied by Mott Macdonald.

13B.2.3 The annual day, evening and night movements, and the summer day and night movements are given in the tables below by aircraft type for each of the scenarios. Aircraft types with a small number of movements have been grouped under “Other”.

Table 13B-1: 2025 Permitted Scenario Forecast Movements

Aircraft Type	2025 Permitted Scenario Forecast Movements				
	Annual			92-Day Summer	
	Day 07h-19h	Evening 19h-23h	Night 23h-07h	Day 07h-23h	Night 23h-07h
Airbus A306	631	315	315	1,261	268
Airbus A319	1,892	0	0	1,892	535
Airbus A320	36,899	11,038	4,100	52,037	13,564
Airbus A320neo	9,777	2,208	631	12,615	3,391
Airbus A321	1,892	946	315	3,154	803
Airbus A321neo	8,200	0	946	9,146	2,320
Airbus A330	9,461	0	946	10,407	2,677
Airbus A330neo	631	0	0	631	178
Airbus A350	0	0	0	0	0
ATR 42	0	0	0	0	0
ATR 72	10,407	2,208	0	12,615	3,570
BAe 146/Avro RJ	0	0	0	0	0
Boeing 737-400	631	1,261	631	2,523	535
Boeing 737-700	0	0	0	0	0
Boeing 737-800	39,737	10,723	5,046	55,506	14,278
Boeing 737 MAX	20,184	12,300	3,469	35,953	9,192
Boeing 757	1,892	315	315	2,523	625
Boeing 767	631	1,261	631	2,523	535
Boeing 777	631	0	631	1,261	178
Boeing 777X	631	631	0	1,261	357
Boeing 787	5,046	631	631	6,307	1,606
Bombardier CS300	1,577	946	0	2,523	714
Bombardier Dash 8	631	0	0	631	178
Embraer E190/195	5,677	2,523	315	8,515	2,320
Embraer E190-E2	946	0	0	946	268
Other	2,523	1,261	0	3,784	1,071
Total	**160,525**	**48,568**	**18,922**	**228,015**	**59,166**

Table 13B-2: 2025 Proposed Scenario Forecast Movements

Aircraft Type	2025 Proposed Scenario Forecast Movements				
	Annual			92-Day Summer	
	Day 07h-19h	Evening 19h-23h	Night 23h-07h	Day 07h-23h	Night 23h-07h
Airbus A306	315	315	945	1,576	178
Airbus A319	1,891	0	0	1,891	535
Airbus A320	34,346	9,768	9,138	53,252	12,494
Airbus A320neo	8,823	1,891	945	11,659	3,034
Airbus A321	1,891	630	630	3,151	714
Airbus A321neo	6,302	0	1,576	7,878	1,785
Airbus A330	8,823	0	945	9,768	2,499
Airbus A330neo	630	0	0	630	178
Airbus A350	0	0	0	0	0
ATR 42	0	0	0	0	0
ATR 72	11,659	2,521	1,891	16,070	4,016
BAe 146/Avro RJ	0	0	0	0	0
Boeing 737-400	315	1,576	2,521	4,411	535
Boeing 737-700	0	0	0	0	0
Boeing 737-800	42,854	11,659	6,302	60,815	15,439
Boeing 737 MAX	19,852	11,659	4,096	35,607	8,924
Boeing 757	1,891	315	315	2,521	625
Boeing 767	315	1,260	1,891	3,466	446
Boeing 777	315	0	945	1,260	89
Boeing 777X	630	630	0	1,260	357
Boeing 787	5,042	630	1,891	7,562	1,606
Bombardier CS300	1,576	945	0	2,521	714
Bombardier Dash 8	630	0	0	630	178
Embraer E190/195	4,727	2,521	630	7,878	2,053
Embraer E190-E2	945	0	0	945	268
Other	2,521	1,260	1,260	5,042	1,071
Total	**156,291**	**47,581**	**35,922**	**239,794**	**57,738**

Table 13B-3: 2035 Permitted Scenario Forecast Movements

Aircraft Type	2035 Permitted Scenario Forecast Movements				
	Annual			92-Day Summer	
	Day 07h-19h	Evening 19h-23h	Night 23h-07h	Day 07h-23h	Night 23h-07h
Airbus A306	315	0	315	631	89
Airbus A319	631	0	0	631	178
Airbus A320	4,099	1,577	315	5,991	1,606
Airbus A320neo	43,201	11,667	4,415	59,283	15,528
Airbus A321	0	631	0	631	178
Airbus A321neo	10,091	315	1,261	11,667	2,945
Airbus A330	2,523	315	631	3,469	803
Airbus A330neo	6,622	0	315	6,937	1,874
Airbus A350	631	0	0	631	178
ATR 42	0	0	0	0	0
ATR 72	10,406	2,207	0	12,613	3,570
BAe 146/Avro RJ	0	0	0	0	0
Boeing 737-400	631	1,261	631	2,523	535
Boeing 737-700	0	0	0	0	0
Boeing 737-800	0	631	0	631	178
Boeing 737 MAX	59,283	22,389	8,514	90,186	23,113
Boeing 757	0	315	315	631	89
Boeing 767	0	0	0	0	0
Boeing 777	0	0	0	0	0
Boeing 777X	631	631	631	1,892	357
Boeing 787	8,829	1,892	1,261	11,983	3,034
Bombardier CS300	2,207	946	0	3,153	892
Bombardier Dash 8	631	0	0	631	178
Embraer E190/195	0	631	0	631	178
Embraer E190-E2	7,253	1,892	315	9,460	2,588
Other	2,523	1,261	0	3,784	1,071
Total	**160,505**	**48,562**	**18,920**	**227,987**	**59,166**

Table 13B-4: 2035 Proposed Scenario Forecast Movements

Aircraft Type	2035 Proposed Scenario Forecast Movements				
	Annual			92-Day Summer	
	Day 07h-19h	Evening 19h-23h	Night 23h-07h	Day 07h-23h	Night 23h-07h
Airbus A306	315	0	315	630	89
Airbus A319	630	0	0	630	178
Airbus A320	3,466	945	1,576	5,987	1,249
Airbus A320neo	40,018	10,714	8,193	58,924	14,368
Airbus A321	0	315	315	630	89
Airbus A321neo	8,193	315	1,891	10,398	2,409
Airbus A330	2,206	315	1,260	3,781	714
Airbus A330neo	5,987	0	315	6,302	1,696
Airbus A350	315	0	315	630	89
ATR 42	0	0	0	0	0
ATR 72	11,659	2,521	1,891	16,070	4,016
BAe 146/Avro RJ	0	0	0	0	0
Boeing 737-400	315	1,576	2,521	4,411	535
Boeing 737-700	0	0	0	0	0
Boeing 737-800	0	630	0	630	178
Boeing 737 MAX	62,390	22,687	10,714	95,791	24,095
Boeing 757	0	315	315	630	89
Boeing 767	0	0	315	315	0
Boeing 777	0	0	0	0	0
Boeing 777X	630	630	630	1,891	357
Boeing 787	8,508	1,891	3,466	13,865	2,945
Bombardier CS300	2,206	945	0	3,151	892
Bombardier Dash 8	630	0	0	630	178
Embraer E190/195	0	630	0	630	178
Embraer E190-E2	6,302	1,891	630	8,823	2,320
Other	2,521	1,260	1,260	5,042	1,071
Total	**156,291**	**47,581**	**35,922**	**239,794**	**57,738**

13B.3 Noise Modelling Methodology

Software

13B.3.1 The noise modelling utilises the Federal Aviation Authority Aviation Environmental Design Tool (AEDT) version 3e, which is compliant with *ECAC.CEAC Doc 29 4th Edition Report on Standard Method of Computing Noise Contours around Civil Airports* and with *EU Commission Directive 2015/996 Establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council*. This was the latest version of the software when the assessment work began.

13B.3.2 The AEDT software evaluates aircraft noise in the vicinity of airports using flight track information, aircraft fleet mix, aircraft profiles and terrain. The AEDT software is used to produce noise exposure contours as well as predict noise levels at specific user-defined sites. For Dublin Airport the input data has comprised:

- physical details of the airport, both current and future,
- the topography of the surrounding area,
- the aircraft movements themselves,
- the routes flown by the aircraft movements,
- the procedures used by the aircraft movements,
- dwelling, population and community building data.

Study Area

13B.3.3 The study area is based on the largest extent of likely impacts due to air noise, i.e. encompassing an envelope formed by the lowest value noise contours assessed for each metric. The extents of the study area are contained within a rectangle that extends 30 km to the west, 35 km to the east, 20 km to the north and 15 km to the south of the centre of the South Runway at Dublin Airport. Figure 13B-1 shows the study area.

AEDT Study

13B.3.4 The AEDT default weather settings for Dublin Airport and all-soft ground lateral attenuation have been used. The directivity effects of aircraft bank angle have been allowed for in accordance with EU Directive 2015/996.

13B.3.5 Terrain data has been acquired for the study area. This was provided by emapsite in the form of a Digital Terrain Model dataset and has been incorporated within the noise model.

Airport Layout

13B.3.6 The airfield layout including runways and taxiways is shown on the AIP Ireland Aerodrome Chart[1]. This information (taken from the version dated 23 February 2023) has been used to locate the Dublin Airport runways in the model.

Aircraft Movements

13B.3.7 The AEDT software includes noise information for many common aircraft types, but it does not include every aircraft type. Therefore, the actual and forecast aircraft types need to be mapped to aircraft types in the AEDT software. For most aircraft, substitutions are proposed by the AEDT software or the ANP database[2] where a similar alternative aircraft type is used to model the actual type. For larger aircraft this generally does not involve a change but for the smaller aircraft, and in particular the general aviation aircraft, some substitutions occur. Where the AEDT and ANP databases have no guidance, an aircraft type has been assigned based on the aircraft size and engine details.

13B.3.8 This is in accordance with EU Directive 2015/996 which states that "The ANP database provided in Appendix I covers most existing aircraft types. For aircraft types or variants for which data are not currently listed, they can best be represented by data for other, normally similar, aircraft that are listed."

13B.3.9 Helicopters and military aircraft have been excluded from this assessment as they perform less than 1% of the aircraft movements at Dublin Airport and therefore do not materially contribute to the noise contours. They have historically been excluded from aircraft noise contours produced for Dublin Airport.

13B.3.10 This is in accordance with EU Directive 2015/996 which states "Where noise generating activities associated with airport operations do not contribute materially to the overall population exposure to aircraft noise and associated noise contours, they may be excluded. These activities include: helicopters, taxiing, engine testing and use of auxiliary power-units."

[1] The Aeronautical Information Publication (AIP), https://www.airnav.ie/air-traffic-management/aeronautical-information-management/aip-package
[2] Aircraft Noise and Performance Database, https://www.aircraftnoisemodel.org

Runway Usage

13B.3.11 Now that the North Runway is operational the Crosswind Runway (16/34) is used only for essential use (e.g. when there are strong crosswinds) as stated in Condition 4 of the North Runway Permission. The past use of the crosswind runway has been reviewed and is reported in *Crosswind Runway Information, Requested by ANCA RFI Appendix A, Request H and Table 4 Items 79, 80 and 81, Ricondo, May* 2021. Allowing for this, for the purposes of noise modelling the future usage of the Crosswind Runway is assumed to be 1% of aircraft movements, with the remaining 99% of movements on the two main runways.

13B.3.12 The distribution between runway ends is based on the 10-year average (2013-2022), as required by the Aircraft Noise Competent Authority (ANCA) for the annual reporting at Dublin Airport. The resulting modelled future runway usage over a given year is summarised in Table 13B-5 below.

Table 13B-5: Future Runway Usage

Runway	Arrivals	Departures
10L/10R	22.6%	22.6%
28L/28R	76.4%	76.4%
16	0.71%	0.71%
34	0.29%	0.29%

13B.3.13 Now that the North Runway is operational Dublin Airport operates during the daytime (07:00 – 23:00) in accordance with Conditions 3a-3c per the mode of operation Option 7b, as detailed in the Environmental Impact Statement Addendum, Section 16 as received by the planning authority on the 9th day of August, 2005. This provides that:

a. “the parallel runways (10R-28L and 10L-28R) shall be used in preference to the Crosswind Runway, 16-34,

b. 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,

c. 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,

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.”

13B.3.14 In practice it is expected that, unless capacity requires mixed mode or there are exceptional circumstances, the runways will operate in segregated mode during the daytime with arrivals using either Runway 10L or Runway 28L and departures using either Runway 10R or Runway 28R depending on wind direction.

13B.3.15 An exception to this is maintenance activity on the South Runway, requiring the use of the North Runway. This is expected to occur for around 4 nights every 6-8 weeks, and has therefore been assumed to occur on 8% of nights. When maintenance is required for the South Runway, it is expected the North Runway will be used for all flights in the period 23:30 to 04:29. It has been assumed that any maintenance required on the North Runway will occur during the night hours when the South Runway is preferred.

13B.3.16 Any movements by Code F aircraft are expected to always use the North Runway. However, there are no Code F aircraft in the latest forecasts.

13B.3.17 A method of estimating mixed mode runway usage on the main runways (North and South) for modelling purposes has been developed in consultation with daa and AirNav Ireland. The modelled runway usage has been determined on an hourly basis.

13B.3.18 Most of the time the runways will operate in segregated mode, i.e. one runway for all arrivals, the other for all departures. However, there may be occasions during peak hours when runways will need to operate in some degree of mixed mode, i.e. both runways used simultaneously for arrivals and/or departures.

13B.3.19 The method assumes activity switches from segregated mode to mixed mode where activity is such that any of the three following single runway capacity limits are exceeded:

i. More than 35 arrivals in one hour.

ii. More than 44 departures in one hour.

iii. More than 48 movements (combined arrivals and departures) on one runway in one hour.

13B.3.20 In mixed mode, where each individual runway handles both arrivals and departures, departures will operate using the compass departure principle. This means that if a departure is using a route that turns to the north then the North Runway will be used, and conversely if it is using a route that turns to the south, the South Runway will be used.

13B.3.21 For westerly operations when in mixed mode as few arrivals as possible will use 28R, while not exceeding the single runway capacity limit of 48 combined arrivals and departures on runway 28L. For easterly operations when in mixed mode as few arrivals as possible will use 10R, while not exceeding the single runway capacity limit of 48 combined arrivals and departures on runway 10L.

13B.3.22 When using the North Runway most aircraft will not use the full length on departure, and instead join the runway from the 1st intermediate taxiway. The exceptions are Code E and any Code F aircraft, which will typically use the full runway length.

13B.3.23 When using the South Runway, all aircraft are assumed to use the full runway length for westerly departures, and to join the runway from the intersection with taxiway S6, unless the full runway length is required.

13B.3.24 During the night-time period (23:00 – 07:00) for the Permitted Scenarios the South Runway is the preferred runway. For the Proposed Scenarios the South Runway is the preferred runway in the core night period (00:00-06:00). Between 23:00 and 00:00 and between 06:00-07:00 the runway usage follows the same principles as in the daytime, i.e. Option 7b.

13B.3.25 The resulting runway usage by hour on an average annual day for both easterly and westerly operations is shown in Table 13B-6 and Table 13B-7 for the Permitted Scenarios, and in Table 13B-8 and Table 13B-9 for the Proposed Scenarios.

Table 13B-6: Average Annual Day Runway Usage By Hour – Westerly Operations, Permitted Scenarios

Hour	2025 Permitted		2035 Permitted	
	28L (South)	28R (North)	28L (South)	28R (North)
00:00-00:59	2	0	2	0
01:00-01:59	3	0	3	0
02:00-02:59	0	0	0	0
03:00-03:59	2	0	2	0
04:00-04:59	6	0	6	0
05:00-05:59	18	0	18	0
06:00-06:59	16	0	16	0
07:00-07:59	17	29	17	29
08:00-08:59	19	16	19	16
09:00-09:59	15	16	15	16
10:00-10:59	16	16	16	16
11:00-11:59	17	16	17	16
12:00-12:59	21	16	21	16
13:00-13:59	21	21	22	21
14:00-14:59	20	17	20	18
15:00-15:59	16	27	16	27
16:00-16:59	14	17	14	17
17:00-17:59	21	17	21	17
18:00-18:59	18	17	18	17
19:00-19:59	18	22	18	22
20:00-20:59	13	14	13	14
21:00-21:59	16	12	16	12
22:00-22:59	27	10	28	10
23:00-23:59	4	0	4	0

Note: All values rounded to nearest whole number

Table 13B-7: Average Annual Day Runway Usage By Hour – Easterly Operations, Permitted Scenarios

Hour	2025 Permitted		2035 Permitted	
	10L (North)	10R (South)	10L (North)	10R (South)
00:00-00:59	0	2	0	2
01:00-01:59	0	3	0	3
02:00-02:59	0	0	0	0
03:00-03:59	0	2	0	2
04:00-04:59	0	6	0	6
05:00-05:59	0	18	0	18
06:00-06:59	0	16	0	16
07:00-07:59	17	29	17	29
08:00-08:59	19	16	19	16
09:00-09:59	15	16	15	16
10:00-10:59	16	16	16	16
11:00-11:59	17	16	17	16
12:00-12:59	21	16	21	16
13:00-13:59	21	21	22	21
14:00-14:59	20	17	20	18
15:00-15:59	16	27	16	27
16:00-16:59	14	17	14	17
17:00-17:59	21	17	21	17
18:00-18:59	18	17	18	17
19:00-19:59	18	22	18	22
20:00-20:59	13	14	13	14
21:00-21:59	16	12	16	12
22:00-22:59	27	10	28	10
23:00-23:59	0	4	0	4

Note: All values rounded to nearest whole number

Table 13B-8: Average Annual Day Runway Usage By Hour – Westerly Operations, Proposed Scenarios

Hour	2025 Proposed		2035 Proposed	
	28L (South)	28R (North)	28L (South)	28R (North)
00:00-00:59	13	1	13	1
01:00-01:59	6	1	6	1
02:00-02:59	2	0	2	0
03:00-03:59	2	0	2	0
04:00-04:59	12	0	12	0
05:00-05:59	11	0	11	0
06:00-06:59	3	27	3	27
07:00-07:59	10	30	10	30
08:00-08:59	19	16	19	16
09:00-09:59	17	16	17	16
10:00-10:59	15	16	15	16
11:00-11:59	17	16	17	16
12:00-12:59	18	15	18	15
13:00-13:59	22	20	22	20
14:00-14:59	19	16	19	16
15:00-15:59	14	26	14	26
16:00-16:59	12	19	12	19
17:00-17:59	20	19	20	19
18:00-18:59	19	17	19	17
19:00-19:59	17	25	17	25
20:00-20:59	13	15	13	15
21:00-21:59	13	14	13	14
22:00-22:59	25	9	25	9
23:00-23:59	16	3	16	3

Note: All values rounded to nearest whole number

Table 13B-9: Average Annual Day Runway Usage By Hour – Easterly Operations, Proposed Scenarios

Hour	2025 Proposed		2035 Proposed	
	10L (North)	10R (South)	10L (North)	10R (South)
00:00-00:59	1	13	1	13
01:00-01:59	1	6	1	6
02:00-02:59	0	2	0	2
03:00-03:59	0	2	0	2
04:00-04:59	0	12	0	12
05:00-05:59	0	11	0	11
06:00-06:59	3	27	3	27
07:00-07:59	10	30	10	30
08:00-08:59	19	16	19	16
09:00-09:59	17	16	17	16
10:00-10:59	15	16	15	16
11:00-11:59	17	16	17	16
12:00-12:59	18	15	18	15
13:00-13:59	22	20	22	20
14:00-14:59	19	16	19	16
15:00-15:59	14	26	14	26
16:00-16:59	12	19	12	19
17:00-17:59	20	19	20	19
18:00-18:59	19	17	19	17
19:00-19:59	17	25	17	25
20:00-20:59	13	15	13	15
21:00-21:59	13	14	13	14
22:00-22:59	25	9	25	9
23:00-23:59	16	3	16	3

Note: All values rounded to nearest whole number

Flight Routes

13B.3.26 Flight routes refer to the ground tracks followed by aircraft. In practice every aircraft follows a slightly different route, depending on the weather conditions and aircraft characteristics. For modelling purposes, it is typically considered sufficient to model each distinct route using what is known as a backbone track, as well as a number of sub-tracks either side of the backbone tracks to represent the variation in actual routes flown.

13B.3.27 This approach is in accordance with EU Directive 2015/996 which states that "It is common practice to treat the data for a single route as a sample from a single population; i.e. to be represented by one backbone track and one set of dispersed subtracks".

13B.3.28 This approach has the benefit of reducing the complexity of the noise model without significantly affecting its accuracy, as well as enabling current and future operations to be modelled using the same approach.

13B.3.29 Due to the expected limited use of the Crosswind Runway in the future, the areas exposed to the minimum noise levels of interest do not reach the point where aircraft turn off the extended runway centreline. Straight arrival and departure routes have therefore been used for the Crosswind Runway in the interests of reducing the complexity of the model.

13B.3.30 Based on a review of radar data, approaching aircraft are generally lined up with the extended centreline of the runway at least 17 km from the runway threshold. Consequently, the approach routes on the two main runways have been modelled as straight from this point to the runway. Before this point arrivals are modelled using 7 routes which cover the broad swathe of directions that the arriving aircraft approach from. Flights have been equally distributed between the 7 routes. The modelled arrival routes are shown in pink on Figure 13B-2 and 13B-3.

13B.3.31 Commercial fixed-wing aircraft fall into one of four categories based on their approach speed. These are denoted A, B, C and D, with A being the slowest and D being the fastest. Dublin Airport operates two sets of departure routes, one for category A and B aircraft and another for category C and D aircraft. In general, categories A and B contain general aviation and propeller aircraft, with jet aircraft falling into categories C or D. It is therefore relevant to consider these two categories of aircraft separately with respect to departure routes.

13B.3.32 Departure routes have been based on radar data. For the South Runway they are based on radar data for the calendar year of 2022. The current North Runway departure routes were implemented on 23 February 2023. For the North Runway the modelled routes are therefore based on radar data for the period 23 February to 30 June 2023.

13B.3.33 The process followed to convert the radar data into a set of average departure tracks is outlined below:

1. Assign each radar track to a route group, as these are not currently populated automatically by the recording system at the airport. The route group was assigned based on where the track was heading once it was a certain distance from the airport. Some route groups were not used for all runway ends, and some route groups were combined where they are initially identical. In some cases, it was necessary to subdivide route groups to account for the range of locations where aircraft turn. The route groups are given in Table 13B-10 below.

Table 13B-10: Route Groups

Route Group (Track Name)	Description
DEXEN	Initial turn south, heading east
INKUR	Heading west
LIFFY	Initial turn north, heading east
NEPOD	Heading south
OLONO	Heading south-south-west
PELIG	Heading southwest
ROTEV	Heading north
SUROX	Heading northwest

2. For each route group determine a proxy mean flight track from the radar data.
3. For each route group, create a series of “gates” along the proxy mean flight track.
4. For each gate, calculate the point at which each track (in the same route group) goes through the gate.
5. For each route group, create a mean track and a number of sub-tracks. The route for each sub-track has been based on the average of the tracks within the relevant percentiles at each gate. The number of sub-tracks and percentiles used has been based on the values given in ECAC Doc 29 4th Edition Volume 2, Appendix C.

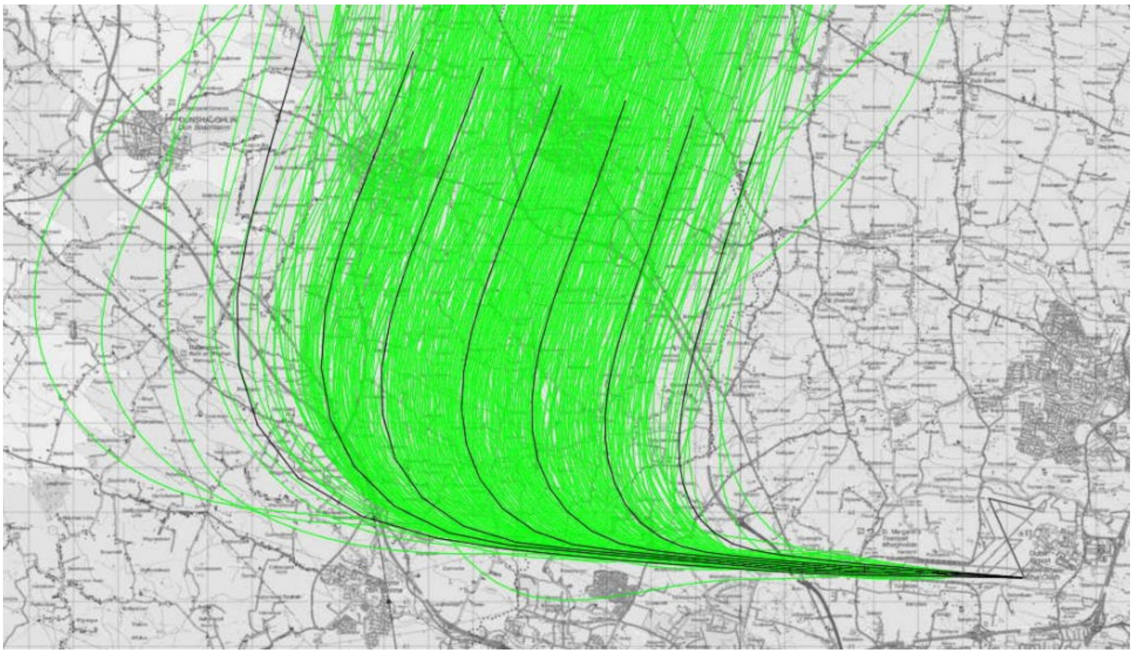
13B.3.34 Aircraft on departure are allocated a route to follow. In practice, this route is not followed precisely by all aircraft allocated to this route. The actual pattern of departing aircraft is dispersed about the route’s centreline.

13B.3.35 The ECAC document recommends that normally 7 discrete sub-tracks (including the mean track) will be adequate. This has been followed except where a limited number of actual tracks are available to base them on, and in these cases a lower number of sub-tracks have been used.

13B.3.36 The percentages in the ECAC document are based on a normal distribution and mean that the area within the outermost sub tracks will contain the large majority of the radar tracks, but not every single one.

13B.3.37 An example of a resulting set of dispersed modelled flight tracks overlaid on the actual radar tracks is given in Chart 13B-1, which shows a sample of 500 tracks which followed the Runway 28 ROTEV route for Category C/D aircraft. The seven dispersed modelled flight tracks are shown in black, with the actual radar tracks shown in green.

Chart 13B-1: Example of Modelled and Actual Flight Tracks



13B.3.38 The modelled departure routes are shown in Figure 13B-2 and 13B-3.

13B.3.39 For the South Runway the resulting set of routes are similar to those used in the 2021 EIAR. However, for the North Runway, the initial turn occurs earlier than previously anticipated. The latest modelled set of routes are based on actual radar data.

Route Usage

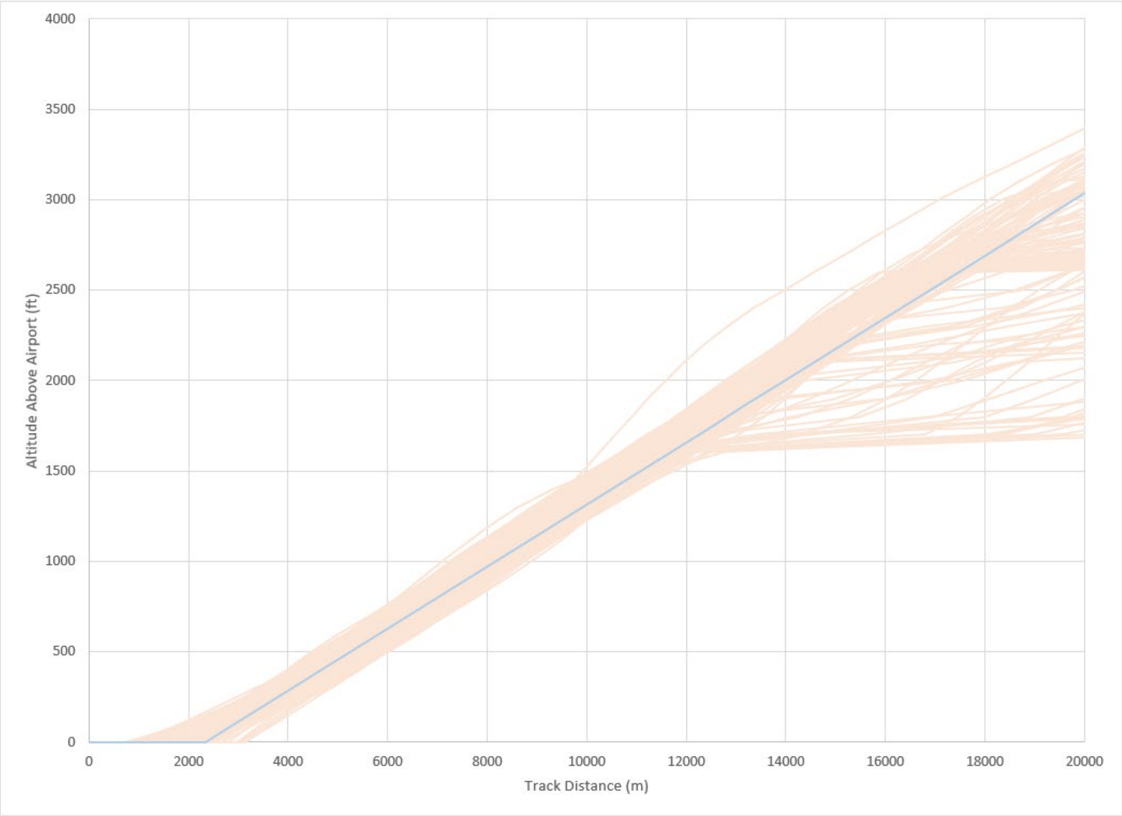
13B.3.40 The forecasts for future years provide destination airports for each departure movement. This has been combined with an assessment that has been carried out of which departure route was used for each destination country based on actual 2022 data.

Flight Profiles

Arrival Profiles

13B.3.41 The standard arrival profiles for many of the aircraft in the AEDT database include level sections. Advice from the IAA is that aircraft routinely carry out continuous descent approach (CDA) procedures at Dublin Airport. Analysis of radar data confirms that this is the case for the large majority of arrivals in the vicinity of the airport. Therefore 3 degree CDA profiles have been created and used for all aircraft types. Chart 13B-1 below compares the modelled “USER” profile for the Airbus A320ceo with the radar tracks for a representative sample of arrivals by this aircraft in 2018. The Airbus A320ceo is one of the most common types operating at the airport. Any level sections also end at least 12 km from the airport, which for arrivals from the east (i.e. the majority), means the aircraft are over the sea at the time.

Chart 13B-2: Comparison of “USER” Arrival Profile and Radar Tracks for Airbus A320ceo



Departure Profiles

13B.3.42 For departure movements the AEDT software offers a number of flight profiles for most aircraft types, and in particular for the larger aircraft types. These relate to different departure weights which are greatly affected by the length of the flight, and consequently the fuel load. In the AEDT software this is referred to as the stage length and is in increments of 500 nm up to 1,500 nm and then in increments of 1,000 nm. As the stage length increases the aircraft has to depart with greater fuel and so its flight profile is slightly lower than when a shorter stage length is flown.

13B.3.43 For some of the aircraft types, in particular the smaller aircraft, only one stage length is available in the AEDT software. For the remainder a stage length was chosen based on the distance to the destination airport.

13B.3.44 This approach complies with EU Directive 2015/996 which states that “Vertical dispersion is usually represented satisfactorily by accounting for the effects of varying aircraft weights on the vertical profiles.”

13B.3.45 For each of the main noise-dominant aircraft types, the radar data for the calendar year of 2022 was reviewed and a custom profile created to match the actual flown profile as closely as possible. In particular it involved changes to the default initial departure thrust and the initial climb altitude for many aircraft types.

13B.3.46 This was done separately for each runway end and for each stage length option available. Where limited data was available, assumptions were made based on other data for that aircraft type and runway end.

13B.3.47 For the most common aircraft, the Airbus A320 and the Boeing 737-800, airlines were consulted to check that the resulting assumptions used were in line with what occurs in practice. As specific departure procedures are commercially sensitive information, this is not repeated here, but they were broadly in line with the assumptions.

13B.3.48 For aircraft types other than the main noise-dominant types, the “STANDARD” or “MODIFIED_AW” profiles available in AEDT were used, depending on the stage length.

13B.3.49 The aircraft profiles for all the aircraft types reviewed at Dublin Airport can be broadly described by the following phases:

1. Takeoff

13B.3.50 This starts with the aircraft stationary on the ground, it will then use takeoff thrust (which can be maximum thrust or a percentage of it) to accelerate on the runway and get off the ground. This phase ends when the aircraft reaches the desired speed for the initial climb phase, which should be shortly after leaving the ground.

2. Initial climb

13B.3.51 Still using takeoff thrust, the aircraft continues to climb, with a constant speed.

3. Flap retraction

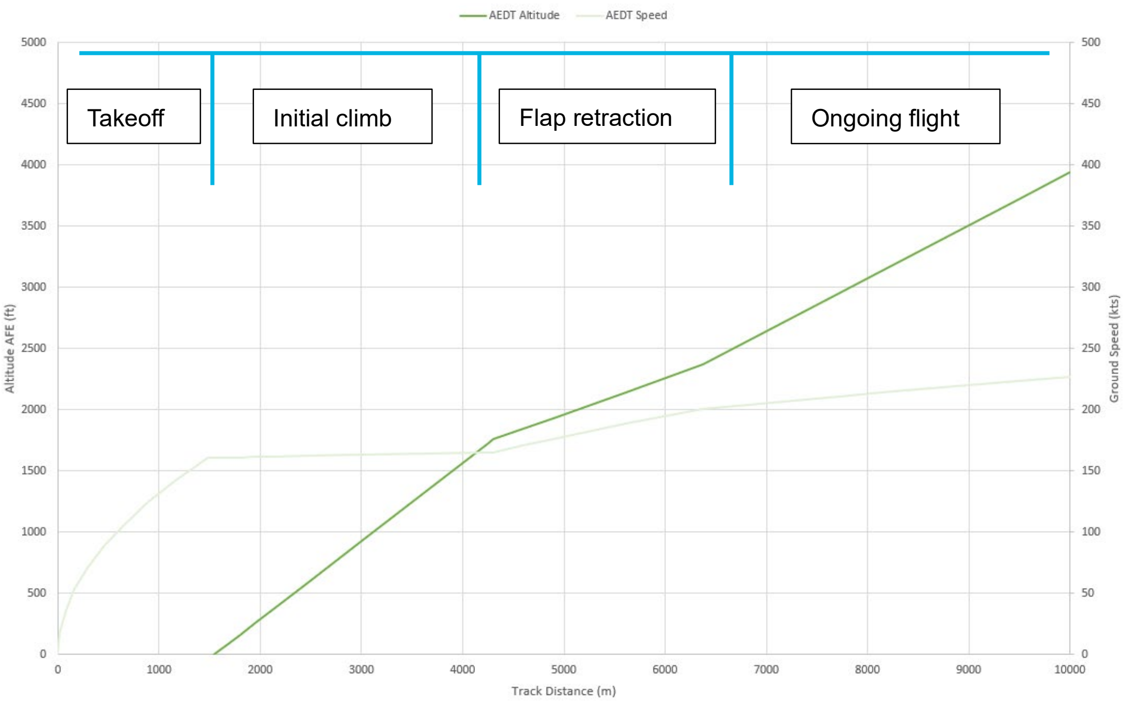
13B.3.52 The aircraft will now switch to climb thrust and will gain both altitude and speed. Within the model this is represented by a certain percentage of the available thrust being used for acceleration, with the remainder being used for climbing. Flaps are retracted at certain speeds, often in stages.

4. Ongoing flight

13B.3.53 With flaps fully retracted, the aircraft continues to gain both altitude and speed using climb thrust. The percentage of thrust being used for acceleration is typically reduced from the previous phase. This phase continues until the aircraft is outside the modelled area.

13B.3.54 An example profile showing these phases is presented in Chart 13B-2, which shows the modelled profile of a Boeing 737-800 Stage 1 departure using Runway 28L.

Chart 13B-3: Phases of Flight Profile



13B.3.55 The general steps followed to produce the modelled profiles are outlined below. In some cases, other adjustments were required. A profile was created separately for each combination of runway end, aircraft type, and stage length, where sufficient data was available.

- Identify the base AEDT type for each actual aircraft type.
- Compare the average radar profile (altitude and ground speed) with the model output from AEDT.
- If necessary, reduce takeoff thrust from maximum to better match the climb gradient in the initial climb phase. The takeoff thrust was never reduced lower than 75% of the AEDT default value, based

on the guidance in ECAC Doc 29 that this is often stipulated as a lower limit by airworthiness authorities. For many aircraft types, in particular larger aircraft such as the Boeing 767, a higher value of minimum thrust was used.

- If necessary, adjust the initial climb altitude to better match the radar data.
- Leaving the flap retraction speeds as per the default profiles, set the percentage of thrust used for accelerating in the flap retraction phase to match the altitude and speed from the radar data as closely as possible. If necessary, adjust the default climb thrust.
- Set the percentage of thrust used for accelerating in the continued flight phase to match the altitude and speed from the radar data as closely as possible.

13B.3.56 The AEDT departure profiles for many of the aircraft in the AEDT database finish at 10,000 ft. To allow predictions over the whole of the study area the departure profiles for all aircraft have been extended to 30,000 ft or for certain aircraft the maximum altitude AEDT calculates to be achievable for the particular aircraft type.

13B.3.57 For stage lengths with insufficient data, the same approach was adopted, with the takeoff thrust extrapolated based on the relative modelled departure weights from the modelled profiles of stage lengths which had sufficient data for the same runway end and aircraft type.

13B.3.58 In cases where there was insufficient data for a runway end, the North and South Runway profiles were assumed to be the same as for Runway 28L, and the Cross Runway profiles were assumed the be the same as Runway 28L, but with no reduction in thrust. This is because the Cross Runway is significantly shorter, and the available data suggests that most aircraft use close to the maximum thrust available.

13B.3.59 The base AEDT types for each actual aircraft type considered are given in Table 13B-10 below.

Table 13B-11: Operational Aircraft Types and Base AEDT Types

Aircraft Type Description	Base AEDT Type
Airbus A300-600	A300-622R
Airbus A319	A319-131
Airbus A320	A320-211
Airbus A320neo	A320-271N
Airbus A321	A321-232
Airbus A321neo	A320-271N
Airbus A330-300	A330-301
Airbus A350	A350-941
ATR 72	ATR72-212A
Boeing 737-400	737400
Boeing 737-800	737800
Boeing 757-200	757RR
Boeing 767-300	767300
Boeing 767-400	767400
Boeing 777-200	777200
Boeing 777-300	777300
Boeing 787	7878R
Boeing 737 MAX 8	7378MAX
Embraer E190	EMB190

13B.3.60 An example of a resulting modelled aircraft profile compared with actual radar profiles is given in Chart 13B-3 for altitude and Chart 13B-4 for ground speed, which show the modelled profile by an Airbus A320 Runway 28L Stage 1 departure, alongside the average and percentiles containing 95% of the flights.

Chart 13B-4: Example of Modelled and Actual Flight Profiles – Altitude

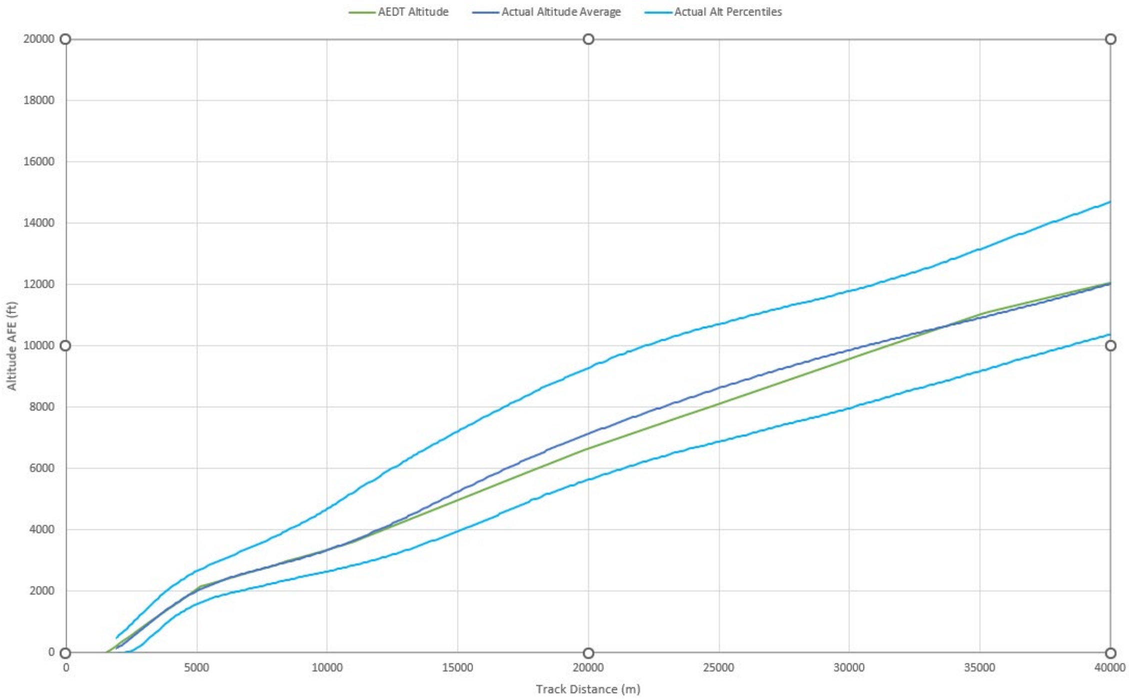
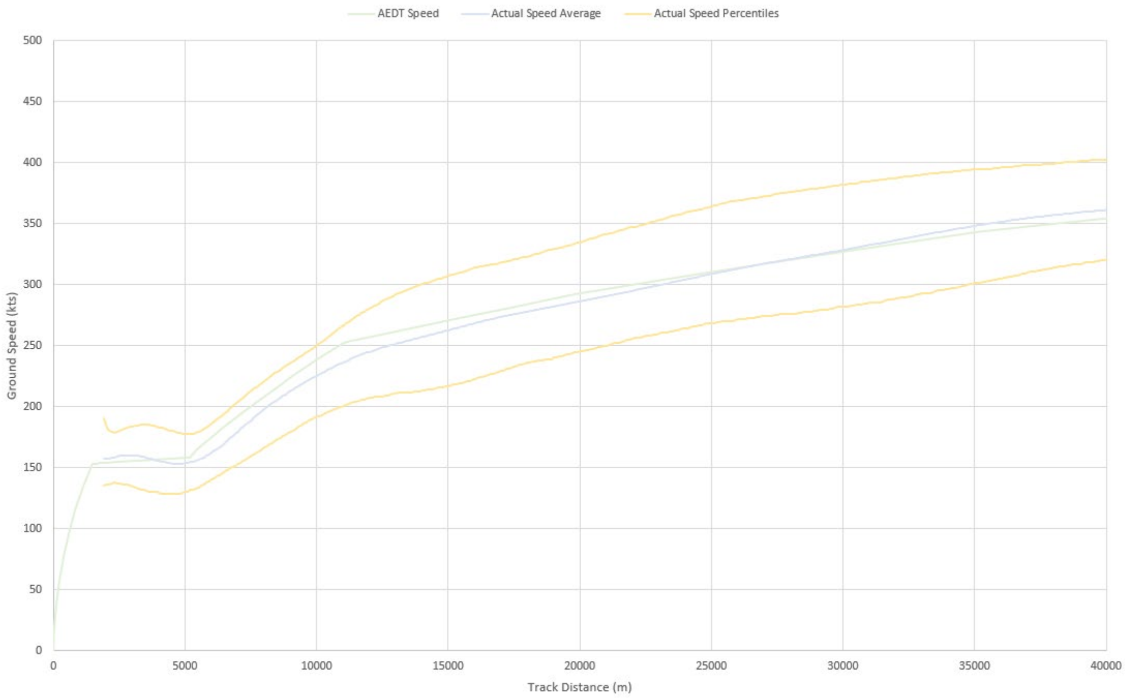


Chart 13B-5: Example of Modelled and Actual Flight Profiles – Ground Speed



13B.3.61 This approach is in line with EU Directive 2015/996 which advises that "Caution must be exercised before adopting default procedural steps provided in the ANP database (customarily assumed when actual procedures are not known). These are standardised procedures that are widely followed but which may or may not be used by operators in particular cases".

AEDT Validation

13B.3.62 Measured noise levels taken by the Dublin Airport Noise and Track Keeping (NTK) system have been used to carry out a noise validation exercise. Specifically, the results from Noise Monitoring Terminals (NMTs) 1, 2 and 20 between January and December 2022 have been used, and the results from a mobile NMT measuring North Runway departures from 23 February to 30 June 2023.

13B.3.63 Due to the limited period, the mobile NMT results were only included for aircraft types with at least 50 measured results.

13B.3.64 Some aircraft which overly NMT2 routinely turn before reaching NMT20, or are not recorded for some other reason such as the noise level not being far enough above the background level. For aircraft types where the number of measured results at NMT20 was fewer than 80% of the number of results at NMT2, the NMT20 results were not used as they may only be the louder portion of the measurements.

13B.3.65 The noise levels from the monitors are automatically correlated with aircraft movements using the radar track keeping system and the average determined by aircraft type and operation. A number of parameters are measured by the system, and for this validation the Sound Exposure Level (SEL) of the individual aircraft movements has been used.

13B.3.66 To take into account the measured levels the AEDT software has been used to predict the level at the NMT locations using the recommended AEDT aircraft type. This has been compared to the measured averages for the aircraft types when separately arriving and departing. Adjustments were then made to the modelled aircraft noise levels to minimise differences between the measured and predicted results. This was done by adjusting the AEDT NPD data for the modelled aircraft types so that the movement-weighted average modelled noise levels at the NMTs matched that measured.

13B.3.67 Nineteen aircraft have had modifications made to their arrival and departure noise assumptions. The modifications are detailed in Table 13B-12 below.

Table 13B-12: Modifications to AEDT Default Assumptions

Aircraft Type	Arrivals		Departures	
	AEDT Type	Adjustment (dB)	AEDT Type	Adjustment (dB)
Airbus A300-600	A300-622R	-3.0	A300-622R	-1.4
Airbus A319	A319-131	-0.8	A319-131	+1.8
Airbus A320	A320-211	-0.6	A320-211	+0.2
Airbus A320neo	A320-271N	0.0	A320-271N	+0.9
Airbus A321	A321-232	-0.5	A321-232	+0.9
Airbus A321neo	A320-271N	+0.3	A320-271N	+1.9
Airbus A330-300	A330-301	-0.7	A330-301	-0.2
Airbus A350	A350-941	-0.4	A350-941	+0.9
ATR 72	ATR72-212A	+3.5	ATR72-212A	+3.1
Boeing 737-400	737400	+0.6	737400	-1.0
Boeing 737-800	737800	-0.8	737800	0.0
Boeing 757-200	757RR	+0.1	757RR	+1.1
Boeing 767-300	767300	-1.8	767300	-2.9
Boeing 767-400	767400	+1.2	767400	+3.2
Boeing 777-200	777200	+0.5	777200	+4.0
Boeing 777-300	777300	-0.4	777300	-2.1
Boeing 787	7878R	+0.2	7878R	+2.7
Boeing 737 MAX 8	7378MAX	-0.1	7378MAX	+1.3
Embraer E190	EMB190	-0.8	EMB190	+1.1

13B.3.68 These modifications achieve a better correlation between predicted and measured noise at the airport, resulting in differences between predicted and measured levels of less than 1 dB at each of the three NMTs. The exception is the RJ85 which has a difference between modelled noise levels and measured noise levels at NMT20 of more than 2 dB. For this aircraft NMT20 correlates fewer departures than NMT2. It is possible that NMT20 is only recording the loudest departures by this aircraft, resulting in an average measured level that is not representative.

13B.3.69 This is in line with EU Directive 2015/996, which requires that “All input values affecting the emission level of a source, including the position of the source, shall be determined with at least the accuracy corresponding to an uncertainty of ± 2dB(A) in the emission level of the source”.

Performance of Modernised Aircraft Types

13B.3.70 For the recently introduced and future aircraft types in the forecasts which are not contained within the AEDT model, assumptions have been made for their expected noise levels. This is based on a comparison with either the current generation aircraft that is being directly replaced, or the most similar aircraft type available in AEDT.

13B.3.71 The expected changes in noise levels are primarily based on a comparison of average certification noise levels between the current and modernised aircraft types from the *EASA Approved Noise Levels database*[3]. A summary of these is given in Table 13B-13. For aircraft whose certification noise levels were not available the assumptions are based on those used by the ERCD for the Airports Commission (2014)[4].

Table 13B-13: Summary of Entries in EASA Database for Relevant Aircraft Types

Aircraft Type	# Entries in EASA Database	Average of EASA Noise Certification Levels (EPNdB)		
		Lateral	Flyover	Approach
Airbus A220-300	36	86.9	81.5	92.3
Airbus A330-300	811	98.3	91.1	98.4
Airbus A330neo	74	92.2	87.8	98.0
Embraer E190	192	92.3	83.8	92.4
Embraer E195-E2	30	86.4	78.3	91.7

13B.3.72 For arrivals the approach level was utilised. For departures the average of the lateral and flyover levels was utilised. For each modernised aircraft type where an assumption was needed, the arrival and departure noise levels were separately compared with the relevant current aircraft type. The resulting adjustments are given in Table 13B-14. These differences were applied after the adjustments to the existing types set out in Table 13B-12.

Table 13B-14: Expected Change in Noise Levels between Current and Modernised Aircraft Types

Current Aircraft Type	Modernised Aircraft Type	Expected Change in Noise Levels between Current and Modernised Aircraft Types (dB)	
		Arrival	Departure
Embraer E190	Airbus A220-300	-0.1	-3.8
Airbus A330-300	Airbus A330neo	-0.3	-4.7
Embraer E190	Embraer E195-E2	-0.7	-5.7

13B.3.73 For the Boeing 777X, no certification information was available. As assumption was made based on historic trends, that arrival noise levels would improve by 0.05 dB per year, and departure noise levels would improve by 0.2 dB per year, compared to the previous type. This resulted in this aircraft type being modelled as quieter than a Boeing 777-200 by 1.6 dB on arrival, and 6.4 dB on departure.

[3] Latest version available at https://www.easa.europa.eu/easa-and-you/environment/easa-certification-noise-levels. Assessment used version dated 5th June 2023
[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389579/noise_methodology_addendum.pdf

13B.4 Population and Demographics Assessment Methodology

Dwelling and Population Data

13B.4.1 Dwelling data has been acquired from GeoDirectory for 2019 Q2, which was the dataset utilised in the original EIAR. The same dataset has been used for all assessment scenarios in this EIAR Supplement for consistency.

13B.4.2 An assessment of not yet built dwellings, which have already been granted planning permission, has been carried out. This has utilised information on permitted developments provided by Tom Phillips and Associates (TPA) covering the period 2019 to 2023, which has been compared to the 2019 Q2 data from GeoDirectory, to ensure that developments are not counted twice if they have already commenced. This resulted in a separate consented dwellings database.

13B.4.3 Population data has been estimated using the average dwelling occupancy by small area. This has been obtained for 2016 based on Census data from the Central Statistics Office[5], by dividing the number of people by the number of dwellings for each small area. It has then been determined into which of the small areas each of the dwellings falls, based upon which they have been assigned the average dwelling occupancy for the relevant area.

13B.4.4 An assessment of zoned land has also been undertaken. This identified a number of areas which are designated for residential use. Some of these already contain existing or permitted dwellings and so are included in those datasets. The remaining areas have been assumed to have future developments with an average density of 35 dwellings per hectare and 3 people per dwelling. The dwelling density is based on a recent planning history search for the various sites and relevant local area plans. 3 people per dwelling is a conservative estimate based on the 2016 Census data, which found an average occupancy of a little under 3 people per dwelling for the study area.

Community Buildings

13B.4.5 Noise sensitive community buildings have been identified through a review of the GeoDirectory data. For the purposes of this assessment noise sensitive education buildings include nurseries, schools, colleges and universities, but not day-care or creches. Noise sensitive healthcare buildings include healthcare facilities where people may have an overnight stay such as hospitals or nursing homes, but not GP surgeries or dentists.

Noise prediction

13B.4.6 Each dwelling and community building has been included in the AEDT model as a receptor. A representative set of receptors has been created for each permitted development and zoned land area based on site plans and other publicly available information. Noise levels have been predicted at each of these receptor locations.

[5] http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=EP008