INWARD NOISE IMPACT ASSESSMENT FOR A PROPOSED RESIDENTIAL DEVELOPMENT AT MAYESTON POPPINTREE, FINGLAS CO. DUBLIN

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Fingal County Council

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EXECUTIVE SUMMARY

AWN Consulting has been commissioned to carry out a study in relation to the potential inward noise impact on a proposed residential development at Mayeston, Poppintree, Finglas, Dublin 11.

A noise survey and review of published noise maps has been undertaken to determine the baseline noise environment at the proposed development site. In accordance with the guidance set out in ProPG and the Noise Action Plan for Fingal County 2019 – 2023 (NAP). The site has been classified as having a range of noise levels associated with a '*Medium to High Risk'* of noise impacts due to the proximity of the site to the M50 road.

Due to the relative high incident noise levels mitigation measures for have been specified where necessary for building elements on some façades. The noise mitigation measures and principles that have been outlined in this report will ensure that good internal noise levels will be achieved across the Proposed Development and proposed mitigation measures in the form of acoustic screens and consideration of building layouts will ensure that most of the outdoor amenity space in the Proposed Development will have acceptable noise levels.

The Acoustic Design Statement presented in this report has assessed the impact of traffic noise levels on the Proposed Development and has been prepared in accordance with ProPG as required by the Fingal County Council NAP. The Proposed Development can function in compliance with the requirements of ProPG once appropriate consideration is given at the detailed design stage to the sound insulation mitigation measures and principles outlined in this report.

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1.0 INTRODUCTION

AWN Consulting Limited (AWN) has been commissioned to carry out a study in relation to the potential noise impacts incident on the proposed residential development at Mayeston Poppintree, Finglas, Dublin 11. This report presents the details of the acoustic design of the Proposed Development, identifies potential noise impacts, and outlines detailed measures and specifications required to mitigate the potential impacts.

Figure 1 presents the approximate outline of the proposed development site (approximate red line boundary) in the context of the surrounding environment. The M50 road is located directly to the north of the site boundary.

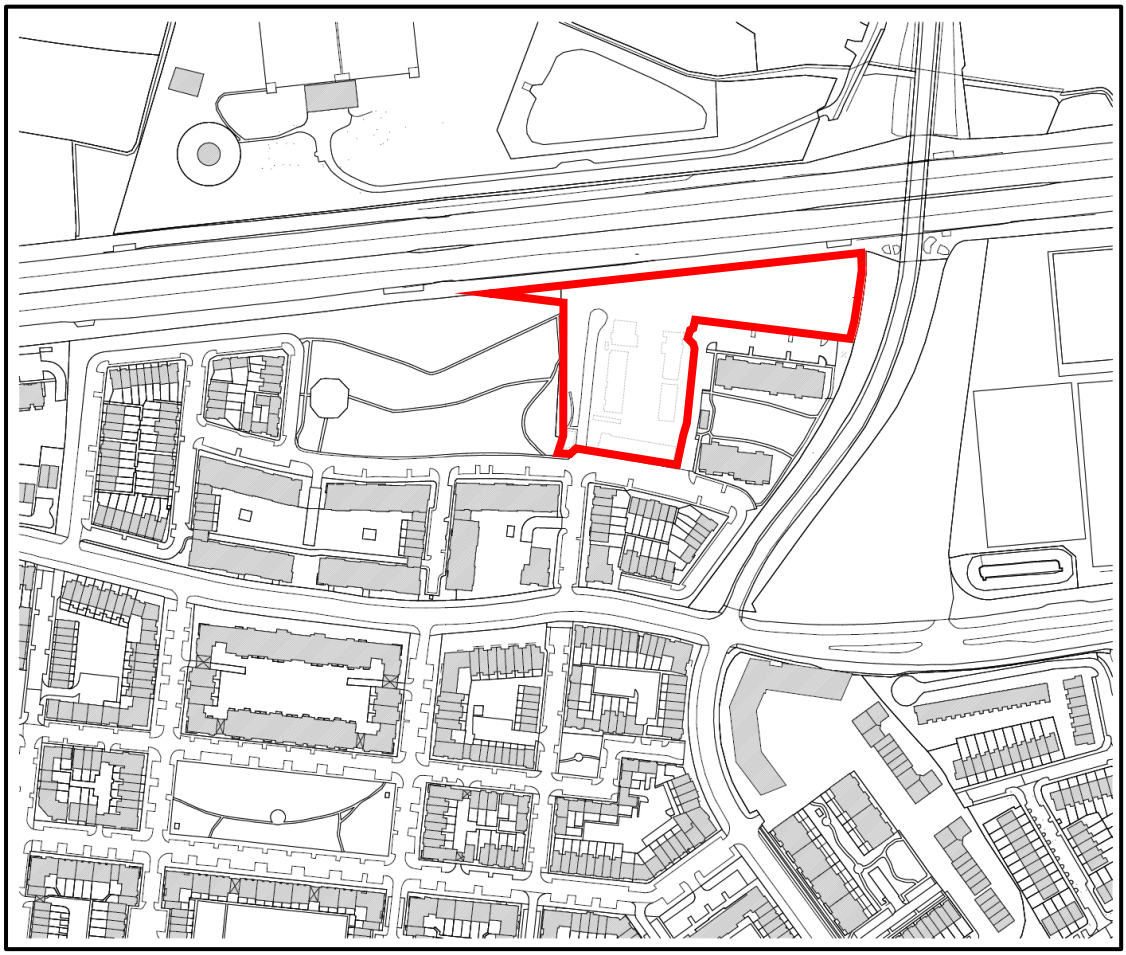

Figure 1 Location of proposed development indicated by approximate red line boundary

Appendix A presents a glossary of acoustic terminology that is used throughout this report.

2.0 DESIGN GUIDANCE

2.1 Noise Action Plan for Fingal County 2019 – 2023

Noise Action Plan for Fingal County 2019 – 2023 (NAP) states the following with respect to assessing the noise impact on new residential development:

> *"The design and construction of buildings is regulated under the Building Control Acts 1990 to 2014 to ensure the safety of people within the built environment. The current Irish Building Regulations call for certain constructions to offer "reasonable resistance" to both airborne and impact sound. In the absence of any form of objective criteria, reference is often made to the guidance values put forward in the "Similar Construction" method described in Technical Guidance Document E."*
>
> *In the scenario where new residential development or other noise sensitive development is proposed in an area with an existing climate of environmental noise, there is currently no clear national guidance on appropriate noise exposure levels. The EPA has suggested in the interim, that Action Planning Authorities should examine planning policy guidance notes, such as ProPG (2017). Such guidance notes have been produced with a view to providing practitioners with guidance on a recommended approach to the management of noise within the planning system.*

In addition to the above, the following is also stated in the NAP:

> *In advance of any national guidance relating to noise in the planning process, the following actions relating to planning and development will be considered for implementation:*
>
> *a) To integrate Noise Action Plans into the County Development Plans.*
> *b) To develop guidelines relating to Noise and Planning for FCC. These guidelines should outline the considerations to be taken into account when determining planning applications for both noise-sensitive developments and for those activities which will generate noise. They should introduce the concept of a risk based approach to assessment of noise exposure, and for Good Acoustic Design to be encouraged as part of all new residential developments in FCC.*
> *c) To require developers to produce a noise impact assessment and mitigation plans, where necessary, for any new development where the Planning Authority considers that any new development will impact negatively on pre-existing environmental noise levels within their Council area*
> *d) To ensure that future developments are designed and constructed in such a way as to minimise noise disturbances in accordance with Department of the Environment, Community and Local Government planning guidelines such as the Urban Design Manual. e.g. the position, direction and height of new buildings, along with their function, their distance from roads, and the position of noise barriers and buffer zones with low sensitivity to noise,*
> *e) To ensure that new housing areas and in particular brown field developments will be planned from the outset in a way that ensures*

that at least the central area is quiet. This could mean designating the centre of new areas as pedestrian

f) *To require sound proofing for all windows, in all new residential developments, where noise maps have indicate undesirable high noise levels. This may also lead to a requirement to install ducted*

In accordance with this NAP, the following Acoustic Design Statement (ADS) has been prepared to comply with the requirements of this policy.

2.2 ProPG: Planning & Noise

The *Professional Guidance on Planning & Noise* (ProPG) document was published in May 2017. The document was prepared by a working group comprising members of the Association of Noise Consultants (ANC), the Institute of Acoustics (IOA) and the Chartered Institute of Environmental Health (CIEH). Although not a government document, since its adoption it has been generally considered as a best practice guidance and has been widely adopted in the absence of equivalent Irish guidance.

The ProPG outlines a systematic risk-based 2-stage approach for evaluating noise exposure on prospective sites for residential development. The two primary stages of the approach can be summarised as follows:

- Stage 1 – Comprises a high-level initial noise risk assessment of the proposed site considering either measured and or predicted noise levels, and;
- Stage 2 – Involves a full detailed appraisal of the proposed development covering four “key elements” that include:
    - Element 1 - Good Acoustic Design Process;
    - Element 2 - Noise Level Guidelines;
    - Element 3 - External Amenity Area Noise Assessment, and;
    - Element 4 - Other Relevant Issues.

A key component of the evaluation process is the preparation and delivery of an Acoustic Design Statement (ADS) which is intended for submission to the planning authority. This document is intended to clearly outline the methodology and findings of the Stage 1 and Stage 2 assessments, so that the planning authority can make an informed decision on the application. ProPG outlines the following possible recommendations in relation to the findings of the ADS:

A. Planning consent may be granted without any need for noise conditions;
B. Planning consent may be granted subject to the inclusion of suitable noise conditions;
C. Planning consent should be refused on noise grounds in order to avoid significant adverse effects (“avoid”); or,
D. Planning consent should be refused on noise grounds in order to prevent unacceptable adverse effects (“prevent”).

Section 3.0 of the ProPG provides a more detailed guide on decision making to aid local authority planners on how to interpret the findings of an accompanying Acoustic Design Statement (ADS). A summary of the ProPG approach is illustrated in Figure 2.

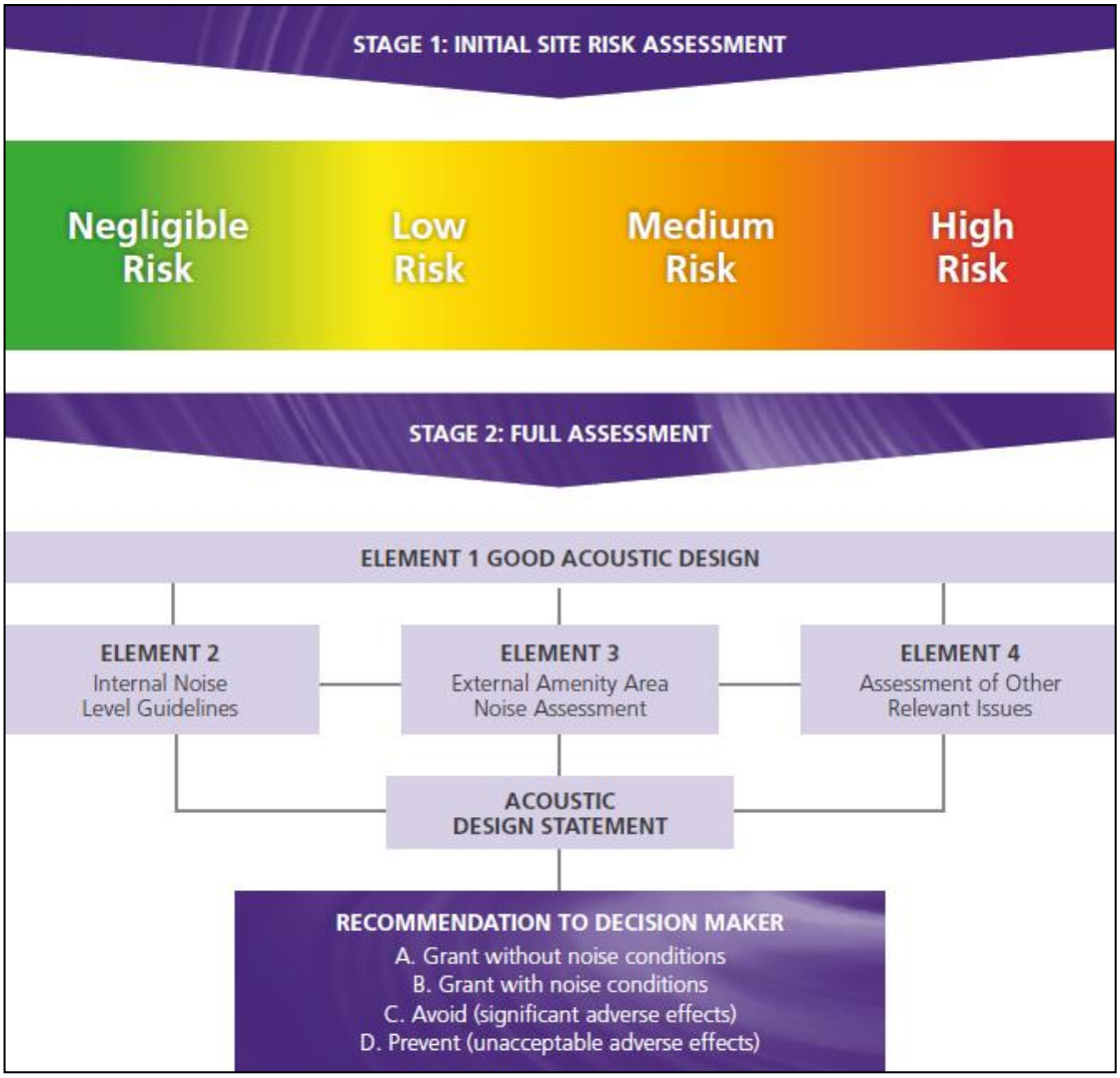

Figure 2 ProPG Approach (Source: ProPG)

2.3 Fingal Development Plan Policy on Aircraft Noise

The Fingal County Council Development Plan 2023-2029 outlines Noise Zones and policy objectives in relation to aircraft noise from Dublin Airport.

Four noise zones (Zone A to D) are now indicated representing potential site exposure to aircraft exposure. The council will actively resist residential development within Zone A, and resist in Zone B and C pending independent acoustic advice and mitigation measures. Certain specific residential developments located in Zone D may be required to demonstrate that aircraft noise intrusion has been considered in the design.

Table 1 below outlines the objectives to be adhered to by applicants for developments in each zone.

Zone	Indication of Potential Noise Exposure during Airport Operations	Objective
D	≥ 50 dB and < 54 dB $L_{Aeq, 16hr}$ and ≥ 40 dB and < 48 dB L_{night}	**To identify noise sensitive developments which could potentially be affected by aircraft noise and to identify any larger residential developments in the vicinity of the flight paths serving the Airport in order to promote appropriate land use and to identify encroachment.**

Zone	Indication of Potential Noise Exposure during Airport Operations	Objective
		All noise sensitive development within this zone is likely to be acceptable from a noise perspective. An associated application would not normally be refused on noise grounds, however where the development is residential-led and comprises non residential noise sensitive uses, or comprises 50 residential units or more, it may be necessary for the applicant to demonstrate that a good acoustic design has been followed. *Applicants are **advised** to seek expert advice.*
C	≥ 54 dB and < 63 dB $L_{Aeq, 16hr}$ and ≥ 48 dB and < 55 dB L_{night}	**To manage noise sensitive development in areas where aircraft noise may give rise to annoyance and sleep disturbance, and to ensure, where appropriate, noise insulation is incorporated within the development** *Noise sensitive development in this zone is less suitable from a noise perspective than in Zone D. A noise assessment **must** be undertaken in order to demonstrate good acoustic design has been followed.* *The noise assessment must demonstrate that relevant internal noise guidelines will be met. This **may** require noise insulation measures.* *An external amenity area noise assessment **must** be undertaken where external amenity space is intrinsic to the development's design. This assessment should make specific consideration of the acoustic environment within those spaces as required so that they can be enjoyed as intended. Ideally, noise levels in external amenity spaces should be designed to achieve the lowest practicable noise levels.* *Applicants are **strongly advised** to seek expert advice.*
B	≥ 54 dB and < 63 dB $L_{Aeq, 16hr}$ And ≥ 55 dB L_{night}	**To manage noise sensitive development in areas where aircraft noise may give rise to annoyance and sleep disturbance, and to ensure noise insulation is incorporated within the development.** *Noise sensitive development in this zone is less suitable from a noise perspective than in Zone C. A noise assessment **must** be undertaken in order to demonstrate good acoustic design has been followed.* *Appropriate well-designed noise insulation measures **must** be incorporated into the development in order to meet relevant internal noise guidelines.* *An external amenity area noise assessment **must** be undertaken where external amenity space is intrinsic to the development's design. This assessment should make specific consideration of the acoustic environment within those spaces as required so that they can be enjoyed as intended. Ideally, noise levels in external amenity spaces should be designed to achieve the lowest practicable noise levels.* *Applicants **must** seek expert advice.*
A	≥ 63 dB $L_{Aeq, 16hr}$ and/or ≥ 55 dB L_{night}	**To resist new provision for residential development and other noise sensitive uses.** *All noise sensitive developments within this zone may potentially be exposed to high levels of aircraft noise, which may be harmful to health or otherwise unacceptable. The provision of new noise sensitive developments will be resisted.*

Notes:

- 'Good Acoustic Design' means following the principles of assessment and design as described in ProPG: *Planning & Noise – New Residential Development*, May 2017;

Zone	Indication of Potential Noise Exposure during Airport Operations	Objective
• Internal and External Amenity and the design of noise insulation measures should follow the guidance provided in British Standard BS8233:2014 *'Guidance on sound insulation and noise reduction for buildings'*		

Table 1 Aircraft Noise Zones

2.3.1 Noise Action Plan for Dublin Airport 2019 – 2023

The Noise Action Plan for Dublin Airport (2019 – 2023) was published by Fingal County Council in 2019. The plan outlines the following objective in relation to aircraft noise:

> *"to avoid, prevent and reduce, where necessary, on a prioritised basis the effects due to long term exposure to aircraft noise, including health and quality of life through implementation of the International Civil Aviation Organisation's 'Balanced Approach' to the management of aircraft noise as set out under EU Regulation 598/2014"*

Whilst the plan outlines a range of measures to achieve this objective, the document is focussed primarily on the outward impact of the airport and aircraft noise and consider planning only in the context of outward impact such as the encroachment of airport activities on existing uses.

Discussion on the consideration of the inward noise impacts on residential amenity is considered in more detail in the NAP.

3.0 STAGE 1 – NOISE RISK ASSESSMENT

3.1 Methodology

The initial noise risk assessment is intended to provide an early indication of any acoustic issues that may be encountered. It calls for the categorisation of the site as a negligible, low, medium, or high risk based on the pre-existing noise environment. Figure 3 presents the basis of the initial noise risk assessment; it provides appropriate risk categories for a range of continuous noise levels either measured and/or predicted on site.

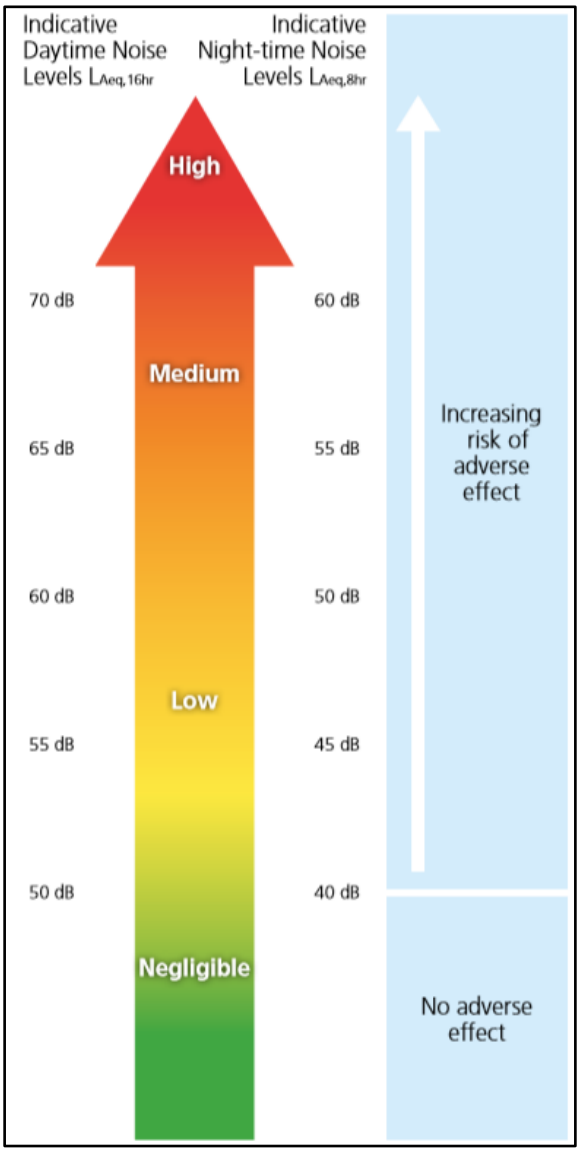

Figure 3 ProPG Stage 1 - Initial Noise Risk Assessment

It should be noted that a site should not be considered a negligible risk if more than 10 L_{AFmax} events exceed 60 dB during the night period and the site should be considered a high risk if the L_{AFmax} events exceed 80 dB more than 20 times a night.

Paragraph 2.9 of ProPG states that,

> *"The noise risk assessment may be based on measurements or prediction (or a combination of both) as appropriate and should aim to describe noise levels over a "typical worst case" 24 hour day either now or in the foreseeable future."*

In this instance it is proposed to develop a 3D computer noise model of the development site and predict the noise levels across the entire site to investigate the initial noise risk. The noise model will use the measured noise levels during the survey, discussed in Section 3.2, to validate the model. Furthermore, the model allows the site to be assessed considering the changes in topography that are required to allow development. This is to comply with the requirements of paragraph 2.8 of ProPG which states,

> *"The risk assessment should not include the impact of any new or additional mitigation measures that may subsequently be included in development proposals for the site and proposed as part of a subsequent planning application. In other words, the risk assessment should include the acoustic effect of any existing site features that will remain (e.g., retained buildings, changes in ground level) and exclude the acoustic effect of any site features that will not remain (e.g., buildings to be demolished, fences and barriers to be removed) if development proceeds."*

3.2 Baseline Noise Environment

Environmental noise surveys have been conducted to quantify noise emissions across the existing site. The survey was conducted in general accordance with ISO1996-2:2017 *Acoustics - Description, Measurement and Assessment of Environmental Noise - Determination of Sound Pressure Levels*. The following sections presents the result of the survey and discussion of the existing noise environment.

3.2.1 Measurement Locations

Four measurement locations were selected; each is described in turn below and shown in Figure 4.

Locations 1 & 2: Two attended noise monitoring locations were selected in the green area north of Mayeston Green residences and directly south of the M50. Located in the general area of proposed developments' Block E.

Locations 3 & 4: Two attended noise monitoring locations were chosen to the west side of the site adjacent to Mayeston Green residential block and south of the M50. Located in the general area of proposed developments' Block A and D.

3.2.2 Survey Periods

Attended noise measurements were conducted over the following periods:

- 10:30hrs to 13:30hrs on 5 May 2021

The measurements cover a period that was selected in order to provide a typical snapshot of the existing noise climate, with the primary purpose being to ensure that the proposed noise criteria associated with the development are commensurate with the prevailing environment.

The weather conditions during the survey periods were generally dry and calm.

3.2.3 Personnel & Instrumentation

AWN conducted the measurements during all survey periods. The attended noise measurements were conducted using a Brüel & Kjaer 2250 SLM, S/N: 3008402. Sound Level Meter was check-calibrated before and after the survey using a Brüel & Kjær Type 4231 Sound Level Calibrator.

3.2.4 Procedure

Measurements were conducted at each location on a cyclical basis during the daytime period. Sampling duration for the noise measurements was 15 minutes. The results were noted onto a Survey Record Sheet immediately following each sample and also saved to the instrument memory for later analysis where appropriate. Survey personnel noted all primary noise sources contributing to noise build-up.

3.2.5 Measurement Parameters

The noise survey results are presented in terms of the following three parameters:

L_{Aeq} is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period.

L_{A10} is the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise.

L_{A90} is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

L_{Amax} is the Maximum sound level that is measured during the sample period.

The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing. All sound levels in this report are expressed in terms of decibels (dB) relative to $2x10^{-5}$ Pa.

3.2.6 Results & Discussion

Location 1

The survey results for Location 1 are summarised in Table 2.

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)			
		$L_{Aeq,T}$	L_{Amax}	$L_{A10,T}$	$L_{A90,T}$
Daytime	10:31 – 10:46	71	81	72	69
	11:02 – 11:17	71	75	72	69
	11:33 – 11:48	70	75	72	69

Table 2 Summary of Measured Noise Levels at Location 1

During daytime monitoring periods, the main source of noise noted in the area was road traffic along the M50. Also observed was residential traffic, people in the locality and birdsong. Daytime noise levels were measured at 71 dB $L_{Aeq,15min}$ and 69 dB $L_{A90,15min}$. Noise levels during daytime periods were typically steady.

No significant source of vibration was noted during the survey periods.

Location 2

The survey results for Location 2 are summarised in Table 3.

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)			
		$L_{Aeq,T}$	L_{Amax}	$L_{A10,T}$	$L_{A90,T}$
Daytime	10:47 – 11:02	71	76	73	69
	11:18 – 11:33	71	77	73	69
	11:49 – 12:04	70	76	72	68

Table 3 Summary of Measured Noise Levels at Location 2

During daytime monitoring periods, the main source of noise noted in the area was road traffic along the M50. Also observed were people in the locality and birdsong. Daytime noise levels were measured at 71 dB $L_{Aeq,15min}$ and 69 dB $L_{A90,15min}$. Noise levels during daytime periods were typically steady.

No significant source of vibration was noted during the survey periods.

Location 3

The survey results for Location 3 are summarised in Table 4.

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)			
		$L_{Aeq,T}$	L_{Amax}	$L_{A10,T}$	$L_{A90,T}$
Daytime	12:10 – 12:25	68	72	69	66
	12:41 – 12:56	67	72	68	64
	13:13 – 13:28	67	73	68	64

Table 4 Summary of Measured Noise Levels at Location 3

During daytime monitoring periods, the main source of noise noted in the area was road traffic along the M50, landscaping works, people in the locality and birdsong. Daytime noise levels were measured between 67 and 68 dB $L_{Aeq,15min}$ and between 64 and 66 dB $L_{A90,15min}$. Noise levels during the daytime periods were typically steady.

Location 4

The survey results for Location 4 are summarised in Table 5.

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)			
		$L_{Aeq,T}$	L_{Amax}	$L_{A10,T}$	$L_{A90,T}$
Daytime	12:26 – 12:41	67	75	68	64
	12:57 – 13:12	66	71	68	65
	13:28 – 13:43	66	72	68	63

Table 5 Summary of Measured Noise Levels at Location 4

During daytime monitoring periods, the main source of noise noted in the area was road traffic along the M50, landscaping works, people in the locality and birdsong. Daytime noise levels were measured between 66 and 67 dB $L_{Aeq,15min}$ and between 63 and 65 dB $L_{A90,15min}$. Noise levels during daytime periods were typically steady.

Figure 4 indicates the noise monitoring locations the site.

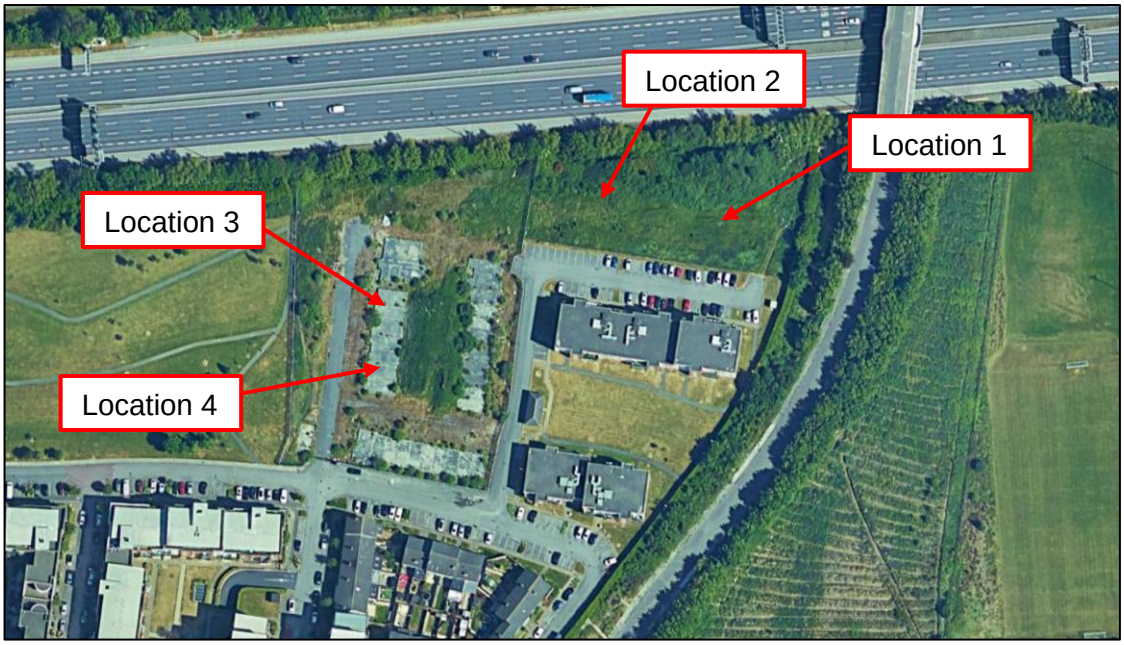

Figure 4 Noise Monitoring Locations

The noise environment at the site was dominated by passing traffic along the M50 and to a lesser extent from Mayeston Hall, also noise from rustling foliage was noticed during periods of elevated wind gusts.

3.3 EPA Noise Maps

In addition to the baseline noise level measured on site, reference has been made to the *Round 4 Noise Maps for Roads – Dublin Agglomeration*. noise maps prepared by Transport Infrastructure Ireland (TII) and published by the EPA[1] (https://gis.epa.ie/EPAMaps/) for road traffic within the Dublin Agglomeration. The noise maps are provided for the overall day evening night period in terms of L_{den} and for the night-time period in terms of $L_{night.}$

Reference is made to the L_{night} mapping information to compare against the relevant parameters of the ProPG assessment. The predicted noise levels across the development site for road traffic using the L_{den} parameter.

The road traffic noise maps indicate noise levels of greater than 75 dB L_{den} across the most exposed area of the development site, reducing to around 70 dB L_{den} at the southern boundary. The measured noise levels at Locations 1 - 4 at ground level were within the 66 to 71 dB $L_{Aeq.}$ Note that the dB L_{den} parameter and the dB L_{day} parameter are not directly comparable, this is discussed in further detail later in this section.

The road traffic noise maps indicate day-time road traffic noise levels of greater than 70 dB L_{night} across the most exposed area of the development site, reducing to around 60 dB L_{night} at the southern boundary.

Table 6 summarises the TII predicted road traffic noise levels across the site.

1 Available to download on the Environmental Protection Agency (EPA) Mapping website https://gis.epa.ie/EPAMaps/

Noise Source	L_{den}, dB	L_{night}, dB	L_{day}, dB Note A
Road Traffic	70 – 77	60 – 70	67 - 72

Table 6 Estimated Noise Levels at Development Site

Note A L_{day} has been estimated by assuming day and evening noise levels are equal

The measured data from the baseline noise survey indicates that levels may be slightly higher during certain periods of the day, which is expected, overall, the measured levels indicate good alignment with the EPA noise road traffic noise maps.

Comment on Impact of Covid on Measured Baseline Levels

Based on the review of TII traffic counter data[2] from a counter at M50 Between Jn05 N02/M50 and Jn04 Ballymun, Finglas, Co. Dublin, it is evident that there was a reduction in traffic volumes on the M50 arising from restrictions linked to the Covid-19 Pandemic. A comparison of the monthly Average Traffic (ADT) for the most recent year with "normal" traffic flows (May 2019) and comparison of the traffic flows for the month of the survey in May 2021 confirms a reduction in traffic numbers of around 15%. A 25% reduction in traffic numbers corresponding to a reduction in noise of 1 dB. Therefore, it is reasonable to assume that noise levels at locations close to the M50 would typically see a reduction in noise levels of less than 1 dB lower when compared to 'normal' most recent normal conditions i.e., May 2019, when Covid-19 travel restrictions were not in place. These levels of variation are not significant and within the bounds of the overall measurement uncertainty.

3.4 Future Noise Environment

There are no planned changes to the surrounding noise environment expected within future years which will significantly alter the noise environment measured. Traffic volumes have the potential to increase along the M50, however a doubling in traffic flows would be required to result in a 3 dB change in the noise environment. An increase of 25% in traffic is required to increase traffic noise levels by 1 dB which is insignificant in the overall context of the noise environment across the site. Given the limited capacity for significant traffic volume increases along the M50, the future noise environment assumed for this project is expected to be within at least 1 dB of the baseline scenario.

3.4.1 Dublin Airport Noise Zone

Dublin Airport is located approximately 1.5 km to the north of the development site and a portion of the Proposed Development site is on the line of Airport Zone C. However, the significantly dominant source of noise across the development site is from road traffic from the M50. It is confirmed that once the potential impact from road traffic noise is addressed there will be no residual issue in internal residential units from aircraft noise.

3.5 Noise Prediction Modelling

3.5.1 Methodology

Proprietary noise calculation software was used for the purposes of establishing the prevailing noise levels at the proposed site. The selected software, Brüel & Kjær Type 7810 *Predictor*, calculates noise levels in accordance with the *Calculation of Road Traffic Noise (CRTN - ISBN 0 11 550847 3)* issued by the UK Department of Transport

[2] Traffic Data gathered from www.trafficdata.tii.ie

in 1988. This is the standard recognised for the prediction of road traffic noise by Transport Infrastructure Ireland (TII) and the Environmental Noise Regulations 2006 SI/140 2006.

The following information was included in the model:

- Site layout drawings of proposed development.
- OS mapping of surrounding environment.
- Topography data supplied by the design team.
- Annual Average Daily Traffic (AADT) flows used for the assessment have been obtained from data from TTI data base.
    - M50: AADT flow of 142,600 with 8.3% HGV which is based on the most recent figure for 2022 which is the highest figure of the previous 4 years.

3.5.2 Model Validation

Noise levels recorded during the attended survey were used to calibrate the noise model to within 2 dB of the calculated values. This is regarded as a strong correlation in respect of predicted noise levels and considering the attended measurements represent a snapshot of time over a specific period of the day and the predicted levels are based on a 16-hour L_{day} average. Noise levels are calculated over daytime periods, i.e., 07:00 to 23:00 hrs and night-time periods, 23:00 to 07:00 hrs.

Position	Period	Average Measured Noise Level, dB	Predicted Noise Level, dB
Loc-1	Daytime, $L_{Aeq,16hr}$	70 – 71	68
	Night-time, $L_{Aeq,8hr}$	--	62
Loc-2	Daytime, $L_{Aeq,16hr}$	70 – 71	71
	Night-time, $L_{Aeq,8hr}$	--	64
Loc-3	Daytime, $L_{Aeq,16hr}$	67 – 68	65
	Night-time, $L_{Aeq,8hr}$	--	59
Loc-4	Daytime, $L_{Aeq,16hr}$	66 – 67	64
	Night-time, $L_{Aeq,8hr}$	--	58

Table 7 Calculated and measured Noise Levels at Development Site

Figures 5 and 6 overleaf display the calculated noise contours at 4 m height across the existing site for day and night-time periods.

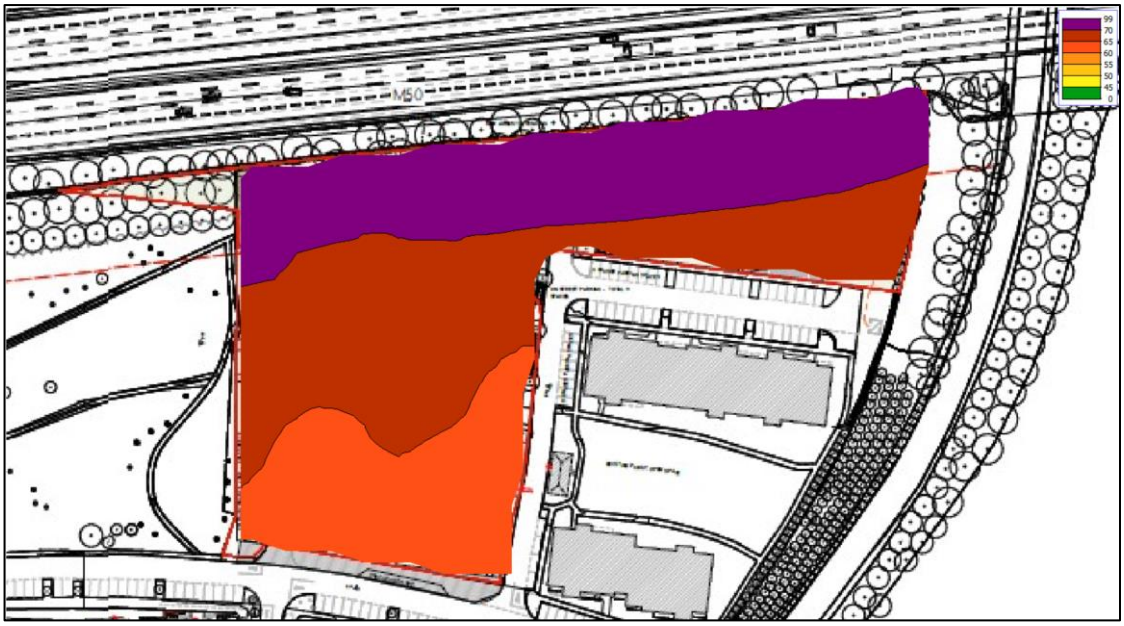

Figure 5 Predicted L_{day} noise levels at 4m across existing site daytime

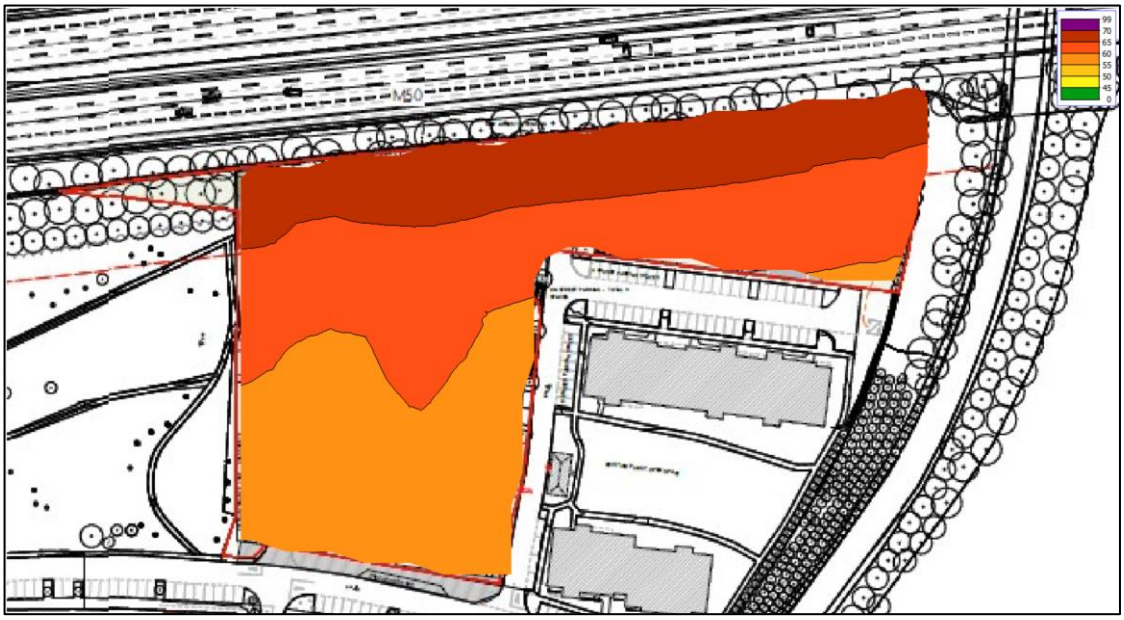

Figure 6 Predicted L_{night} noise levels at 4m across existing site night-time

3.6 Noise Risk Assessment Conclusion

Considering the noise levels presented in the previous sections, the initial site noise risk assessment has concluded that the level of risk across the site varies from medium to high noise risk at the boundary of the M50.

ProPG states the following with respect to negligible, low, medium, and high risks:

Negligible Risk — *These noise levels indicate that the development site is likely to be acceptable from a noise perspective, and the application need not normally be delayed on noise grounds.*

Low Risk — *At low noise levels, the site is likely to be acceptable from a noise perspective provided that a good acoustic design process is followed and is demonstrated in an ADS which confirms how*

the adverse impacts of noise will be mitigated and minimised in the finished development.

Medium Risk — *As noise levels increase, the site is likely to be less suitable from a noise perspective and any subsequent application may be refused unless a good acoustic design process is followed and is demonstrated in an ADS which confirms how the adverse impacts of noise will be mitigated and minimised, and which clearly demonstrate that a significant adverse noise impact will be avoided in the finished development.*

High Risk — *High noise levels indicate that there is an increased risk that development may be refused on noise grounds. This risk may be reduced by following a good acoustic design process that is demonstrated in a detailed ADS. Applicants are strongly advised to seek expert advice.*

Given the above it can be concluded that the development site may be categorised as *Medium to High Risk* depending on the proximity to the surrounding road network i.e., the M50. As such an Acoustic Design Strategy will be required to demonstrate that suitable care and attention has been applied in mitigating and minimising noise impact to such an extent that an adverse noise impact will be avoided in the final development.

ProPG states the following regarding how the initial site noise risk should be used:

> *"2.12 It is important that **the assessment of noise risk at a proposed residential development site is not the basis for the eventual recommendation to the decision maker**. The recommended approach is intended to give the developer, the noise practitioner, and the decision maker an early indication of the likely initial suitability of the site for new residential development from a noise perspective and the extent of the acoustic issues that would be faced. Thus, a site considered to be high risk will be recognised as presenting more acoustic challenges than a site considered as low risk. A site considered as negligible risk is likely to be acceptable from a noise perspective and need not normally be delayed on noise grounds. A potentially problematical site will be flagged at the earliest possible stage, with an increasing risk indicating the increasing importance of good acoustic design."*

Therefore, following the guidance contained in ProPG does not preclude residential development on sites that are identified as having medium or high-risk noise levels. It merely identifies the fact that a more considered approach will be required to ensure the developments on the higher risk sites are suitable designed to mitigate the noise levels. The primary goal of the approach outlined in ProPG is to ensure that the best possible acoustic outcome is achieved for a particular site.

4.0 STAGE 2 – FULL ACOUSTIC ASSESSMENT

4.1 Element 1 – Good Acoustic Design Process

4.1.1 ProPG Guidance

In practice, good acoustic design should deliver the optimum acoustic design for a site without adversely affecting residential amenity or the quality of life or occupants or compromising other sustainable design objectives. It is important to note that ProPG specifically states that good acoustic design is not equivalent to overdesign or "*gold plating"* of all new development but that it seeks to deliver the optimum acoustic environment for a given site.

Section 2.23 of the ProPG outlines the following checklist for Good Acoustic Design (GAD):

- Check the feasibility of relocating or reducing noise levels from relevant sources.
- Consider options for planning the site or building layout.
- Consider the orientation of proposed building(s).
- Select construction types and methods for meeting building performance requirements.
- Examine the effects of noise control measures on ventilation, fire regulation, health and safety, cost, CDM (construction, design, and management) etc.
- Assess the viability of alternative solutions; and,
- Assess external amenity area noise.

In the context of the proposed development, each of the considerations listed above have been addressed in the following subsections.

4.1.2 Application of GAD Process to Proposed Application

The proposed development applies a series of GAD measures, ranging from the strategic massing of the building volumes and apartment layouts to additional acoustic screening and sound insulation at the façade.

Relocation or Reduction of Noise from Source

Noise sources incident upon the development site (i.e., road traffic, aircraft noise etc.) are located outside the redline boundary of the site and therefore it is beyond the scope of this development to introduce any noise mitigation at source.

Planning, Layout and Orientation

The four building blocks of the core development cluster around a central courtyard with the individual blocks stepping in height from three to six storeys. This creates a physical noise barrier around the courtyard, increasing in height towards the M50 and the more exposed western and eastern boundaries of the site. Block A, with six storeys the highest block, sits at the northern edge, parallel to the M50, directly shielding most of the residential amenities to the south.

Building Massing

Most of the proposed apartments face the protected courtyard on the quieter facades. The apartments along the most exposed north facade of Block A, B and E have their living spaces oriented to the quieter west and east facades. Additional acoustic screening with winter gardens and glazed second layer screens to windows are integrated along the north elevations and the north western and north eastern corners.

Acoustic Screens

Two full height glazed acoustic screens between Block A, Block B as well as Block D will provide noise screening to the inner courtyard while safeguarding its solar exposure. The screens will not only attenuate noise traffic noise in the courtyard but will also reduce the incident noise on the west elevations of Block B and north facing elevations of Block C and D.

Acoustic Fence

A timber noise barrier along the northern site boundary, similar in specification to the fencing at adjoining residential developments at Creston Avenue and Mayeston Lawn, (e.g., solid barrier with a surface density of > 20 kg/m^2) will provide some additional noise attenuation to the car parking area and the ground floor of the north elevations.

Select Construction Types for meeting Building Regulations

A mix of construction types could be considered for the building envelope. Masonry construction types offers high levels of sound insulation performance. However, as is typically the case the glazed elements and any required ventilation paths to achieve compliance with Part F of the Building Regulations will be the weakest elements in the façade in terms of sound insulation performance.

Consideration will therefore be given to the provision of upgraded glazing and appropriate ventilation (acoustic ventilation and/or mechanical). Note that it may not be possible to achieve the desirable internal acoustic environments with windows open. Instead, the proposal here will be to provide dwelling units with glazed elements and ventilators that have good acoustic insulation properties so that when the windows are closed the noise levels internally are good.

It is understood that open windows will not be required for background ventilation requirements, occupants will be able to open the windows should they chose, however, doing so will increase the internal noise levels. The provision of an attenuated natural ventilation widow system on the more exposed elevations, notably the north and west elevations of Block A and the west elevation of Block D will improve the sound insulation afforded by a standard typical open window. A glazed balustrade with a second low level opening window section is proposed on some facades, as noted, essentially the design places a glazed screen (balustrade) directly in front of the open element to acoustically screen the direct noise path thus improving the sound attenuation of an open window, natural ventilation scenario. Research has shown that an outside to inside attenuation of 20 - 25 dB can be achieved with these types of attenuated natural ventilation designs. An assessment of the impact of open windows is presented in section 4.2.3.

Assess External Amenity Area Noise

ProPG provides the following advice with regards to external noise levels for amenity areas in the development:

> *"The acoustic environment of external amenity areas that are an intrinsic part of the overall design should always be assessed and noise levels should ideally not be above the range 50 – 55 dB $L_{Aeq,16hr}$, which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces but should not be prohibited."*

Summary

Considering the constraints of the site, in so far as possible and without limiting the extent of the development area, the principles of GAD will be applied to the development.

In terms of viable alternatives to acoustic treatment of façade elements, currently it is not considered likely that there will be further options for mitigation.

4.2 Element 2 – Internal Noise Guidelines

4.2.1 Internal Noise Criteria

Element 2 of the ProPG document sets out recommended internal noise targets derived from BS 8233 (2014). The recommended indoor ambient noise levels are set out in Table 8 and are based on annual average data, they omit occasional events where higher intermittent noisy events may occur, such as New Year's Eve.

Activity	Location	(07:00 to 23:00hrs)	(23:00 to 07:00hrs)
Resting	Living room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$ 45 dB $L_{Amax,T}$*

Table 8 ProPG Internal Noise Levels

*Note The document comments that the internal $L_{AFmax,T}$ noise level may be exceeded up to 10 times per night without a significant impact occurring.

In addition to these absolute internal noise levels ProPG provides guidance on flexibility of these internal noise level targets. For instance, in cases where the development is considered necessary or desirable, and noise levels exceed the external guidelines, then a relaxation of the internal L_{Aeq} values by up to 5 dB can still provide reasonable internal conditions.

4.2.2 Predicted Façade Noise Levels

Incident noise levels have been predicted across the development site at the location of each façade in accordance with the methodology outlined in Section 3.5.

A noise barrier of 2.4 m in height that is in place along the northern boundary of the site has been included in the noise prediction model.

At the detailed design progresses, a specification for the proposed acoustic screen on the north and west of the development will be confirmed.

Figures 7 and 8 present visually the noise levels predicted across the site for day and night time period with a summary of the levels.

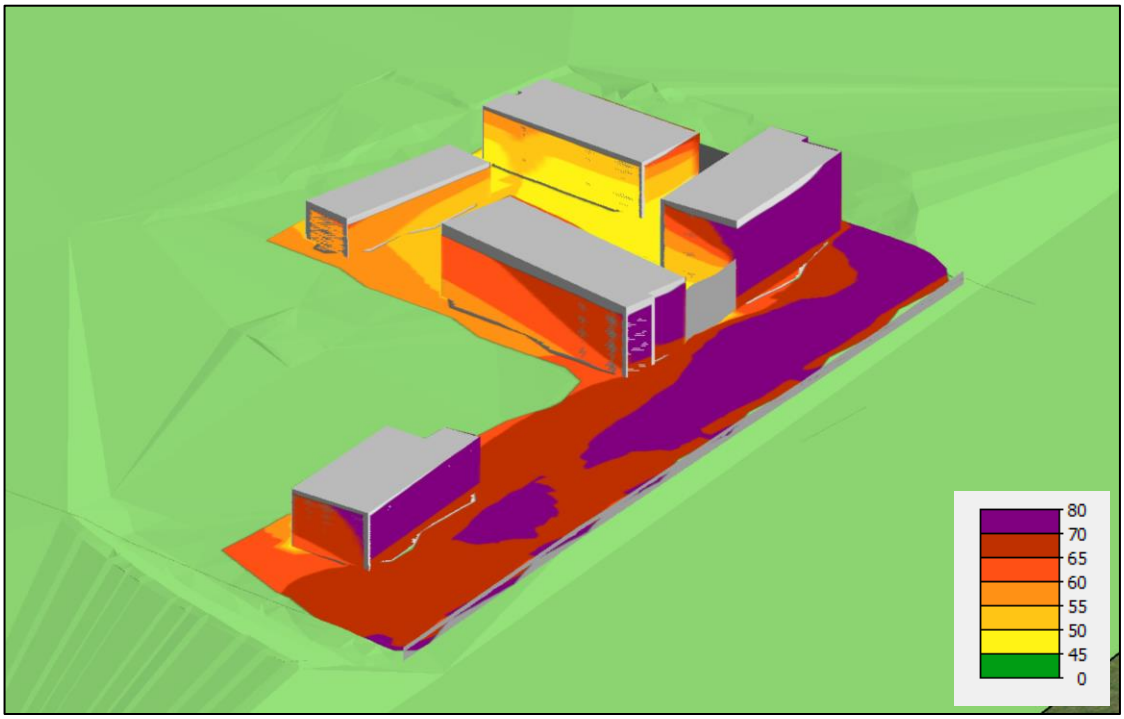

Figure 7 Calculated Daytime Noise Levels

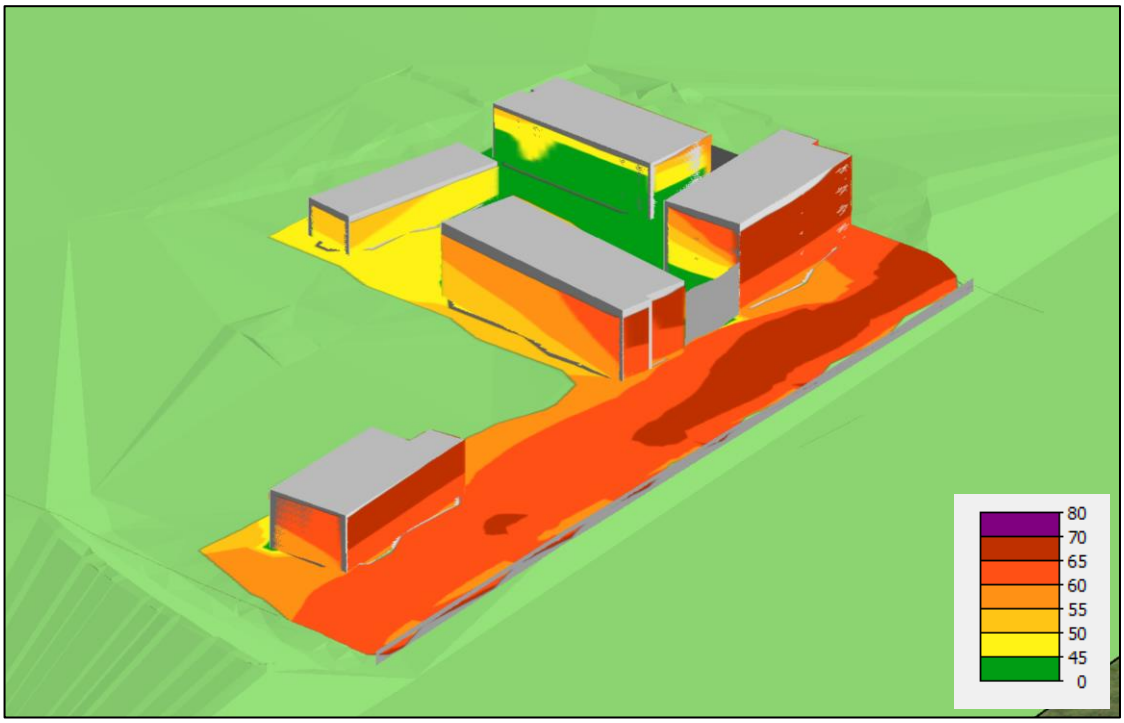

Figure 8 Calculated Night-time Noise Levels

Following a detailed review of the predicted noise levels at sensitive facades across the proposed development, the facades of the buildings have been grouped into the following categories:

- Facades indicated by the red line in Figure 9,
- Facades indicated by the blue line in Figure 9,
- Facades indicated by the orange line in Figure 9, and
- Facades indicated by the green line in Figure 9.

The following discussion is focused on the area described above as identified in Figure 9. The assessment presented in this acoustic design statement is based on the highest incident noise levels at the various elevations of the Proposed Development. At the detailed design stage, it will be possible to refine the specifications across all floor levels and facades.

Figure 9 Mark-up of facades that require a minimum sound insulation specification on building elements.

4.2.3 Discussion on Open/Closed Windows

The typical level of sound reduction offered by a partially open window is typically applied as 15 dB[3].

Considering the design goals outlined in Table 8 and sound reduction across an open window of 15 dB, the external free-field noise levels that would be required to ensure that internal noise levels do not exceed 'good' or 'reasonable' internal noise levels have been summarised in Table 9.

As stated in Section 4.1.2, attenuated natural ventilation widow system on the more exposed elevations, notably the north and west elevations of Block A and the west elevation of Block D will improve the sound insulation afforded by a standard typical open window. for this review we have assumed an outside to inside attenuation of 20 dB.

[3] Section 2.33 of ProPG, additional information can be found in the DEFRA NANR116: *'Open/Closed Window Research' Sound Insulation Through Ventilated Domestic Windows'*

Level Desired	Day 07:00 to 23:00hrs	Night 23:00 to 07:00hrs
Good (i.e. at or below the internal noise levels)	50 – 55 dB $L_{Aeq,16hour}$	45 dB $L_{Aeq,8hour}$
Reasonable (i.e. 5 dB above the internal noise levels)	55 – 60 dB $L_{Aeq,16hour}$	50 dB $L_{Aeq,8hour}$
Reasonable - with attenuated natural ventilation (see section 4.1.2). Natural ventilation is not required to meet background ventilation requirements.	65 dB $L_{Aeq,16hour}$	55 dB $L_{Aeq,8hour}$

Table 9 External Noise Levels Required to Achieve Internal Noise Levels

Facades Marked in Red in Figure 9

- Predicted external L_{day} levels at the facades are in the range of 68 – 76 dB $L_{Aeq,16hour}$
- Predicted external L_{night} Levels at the facades are in the range of 62 – 69 dB $L_{Aeq,8hour}$
- There should be no passive ventilation paths in living spaces on these facades any ventilation paths should be ducted above the ceiling line and incorporate suitable in-line attenuators as required.
- It is expected that all minimum ventilation requirements will be provided by the mechanical ventilation system, and that occupants will not be required to open windows along these facades.
- Should occupants wish to open windows, the internal noise levels in most instances will be above the recommended internal noise thresholds for night time periods and daytime periods outlined in Table 9.

Facades Marked in Blue in Figure 9

It is expected that an additional 3 - 5 dB of attenuation between outdoor to indoor with an open window can be achieved due to the angle of incidence between the road and these windows[4]. Therefore, these windows in an open position are expected to provide a level difference for road traffic noise of 18 dB from outside to inside.

This may allow external noise levels of up to 63 dB $L_{Aeq,16hour}$ during the day night a 53 dB $L_{Aeq,8hour}$ at night while still achieving reasonable internal noise levels with an open window.

- Predicted external L_{day} levels at the facades are in the range of 59 – 68 dB $L_{Aeq,16hour}$
- Predicted external L_{night} Levels at the facades are in the range of 53 – 62 dB $L_{Aeq,8hour}$
- There should be no passive ventilation paths in living spaces on these facades any ventilation paths should be ducted above the ceiling line and incorporate suitable in-line attenuators as required.
- On some lower levels adequate background ventilation may be provided by a mechanical ventilation system that may incorporate wall mounted ventilators and/or trickle vents - to be determined at the detailed design stage.
- It is expected that all minimum ventilation requirements will be provided by the mechanical ventilation system, and that occupants will not be required to open windows along these facades.

[4] See Table 4-3 of DEFRA NANR116: *'Open/Closed Window Research' Sound Insulation Through Ventilated Domestic Windows'*

- Should occupants wish to open windows, the internal noise levels in most instances will be above the recommended internal noise thresholds for night time periods and daytime periods outlined in Table 9.

Facades Marked in Orange in Figure 9

- Predicted external L_{day} levels at the facades are in the range of 55 – 60 dB $L_{Aeq,16hour}$
- Predicted external L_{night} Levels at the facades are in the range of 48 – 53 dB $L_{Aeq,8hour}$
- Adequate background ventilation will be provided by a mechanical ventilation system that may incorporate wall mounted ventilators and/or trickle vents - to be determined at the detailed design stage.
- It is expected that all minimum ventilation requirements will be provided by the mechanical ventilation system, and that occupants will not be required to open windows along these facades.
- Should occupants wish to open windows, good to reasonable internal noise levels will still be achieved internally rooms outlined in Table 9.

Facades Marked in Green in Figure 9

- Predicted external L_{day} levels at the facades are up to 55 dB $L_{Aeq,16hour}$
- Predicted external L_{night} Levels at the facades are 48 dB $L_{Aeq,8hour}$
- Adequate background ventilation will be provided by a mechanical ventilation system that may incorporate wall mounted ventilators and/or trickle vents - to be determined at the detailed design stage.
- Should occupants wish to open windows, good to reasonable internal noise levels will still be achieved internally rooms outlined in Table 9.

4.2.4 Proposed Façade Treatment

The British Standard BS EN 12354-3: 2000: *Building acoustics – Estimation of acoustic performance of buildings from the performance of elements – Part 3: Airborne sound insulation against outdoor sound* provides a calculation methodology for determining the sound insulation performance of the external envelope of a building. The method is based on an elemental analysis of the building envelope and can take account of both the direct and flanking transmission paths.

The Standard allows the acoustic performance of the building to be assessed taking account of the following:

- Construction type of each element (i.e. windows, walls, etc.);
- Area of each element;
- Shape of the façade, and;
- Characteristics of the receiving room.

The principles outlined in BS EN 12354-3 are also referred to in BS8233 and Annex G of BS8233 provides a calculation method to determine the internal noise level within a building using the composite sound insulation performance calculated using the methods outlined in BS EN 12354-3. The methodology outlined in Annex G of BS8233 has been adopted here to determine the required performance of the building facades. This approach corrects the noise levels to account for the frequency content of road traffic noise which has been determined from the baseline survey.

The ventilation strategy for the development will be in accordance with Part F of the Building Regulations and will be finalised at the detail design stage. The ventilation system will be designed to incorporate suitable noise attenuation to ensure that any addition noise from mechanical services or noise break-in via ducted systems will not be significant. The appropriate systems and specifications will be selected at the detailed design stage to ensure that the internal noise criteria are achieved in sensitive spaces.

For this assessment we have assumed that ventilation systems will be designed to incorporate suitable noise attenuation to ensure that the any addition noise from mechanical services noise or noise break-in via ducted systems will not be significant. The appropriate systems and specifications will be selected at the detailed design stage to ensure that the internal noise criteria are achieved in sensitive spaces[5].

Glazing

As is the case in most buildings, the glazed elements of the building envelope are typically the weakest element from a sound insulation perspective. In this instance the facades will require a glazing system that, when closed, achieve the minimum sound insulation performance as set out in Table 10.

Glazing Type	Figure 9 Legend	SRI (dB) - Octave Band Centre Frequency (Hz)						Overall Weighted Value, dB
		125	250	500	1k	2k	4k	
Type 1		26	34	44	56	53	52	45 R_w
Type 2		24	25	31	42	44	49	36 R_w
Type 3		22	20	26	36	39	31	31 R_w

Table 10 Sound Insulation Performance Requirements for Glazing, SRI (dB)

There are three glazing specifications for the proposed development. The acoustic performance specifications apply to the overall glazing system. In the context of the acoustic performance specification the 'glazing system' includes all component parts that form the glazing element of the façade, i.e., glass, frames, seals, openable elements etc. The specifications provided in Table 10 are indicative and based on the worst case predicted noise levels at each façade. The specifications of the glazing system may change, and the details can be developed further during the detailed design stage notwithstanding, the construction elements must be designed to achieve the internal noise criteria outlined in section 4.2.1.

For glazing Type 1, this level of performance would be expected to be readily achieved from a suitable secondary glazing system.

Where closed winter gardens are incorporated the glazing specification can be reduced significantly as the winter garden system will attenuate incident noise levels. The minimum specification for glazing can be confirmed when the details of the wintergarden are available and appropriate specifications will be developed during the detailed design stage.

Wall Construction

In general, all wall constructions (i.e., block work or concrete) offer a high degree of sound insulation, much greater than that offered by the glazing systems. Therefore, noise intrusion via the wall construction is expected to be minimal but will be confirmed

5 Sensitive spaces include the proposed Creche.

at the detailed design stage. The calculated internal noise levels across the building façade have assumed a minimum sound reduction index of 52 dB R_w for this construction.

Roof Construction

The sound insulation of the roof will be sufficient, provided the roof and internal linings provide an overall sound insulation performance of at least 10 dB higher than the glazing specification for the relevant windows (see Tables 10 & 11). The sound insulation of the roof construction performance shall be confirmed during the detailed design stage. The calculated internal noise levels across the building façade have assumed a minimum sound reduction index of 60 dB R_w for this construction.

4.3 Element 3 – External Amenity Area Noise Assessment

The ProPG document includes a requirement to address external noise levels across amenity spaces as part of the acoustic design statement. ProPG refers directly to the guidance contained within BS 8233 (2014) for this element of the assessment which states:

> *"The acoustic environment of external amenity areas that are an intrinsic part of the overall design should always be assessed and noise levels should ideally not be above the range 50 – 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces but should not be prohibited."*

Figure 12 shows the predicted daytime $L_{Aeq,16hour}$ noise levels from road traffic across the site at a height of 1.5 m, this height is used to assess noise impact in amenity areas e.g., persons using the areas for recreation.

Figure 12 Amenity Noise levels Across the Development Site dB $L_{Aeq,16-hour}$ at 1.5m height.

The NAP defines areas with noise levels of >70 dB(A) L_{day} as being undesirably high sound levels and desirably low levels at <55 dB(A) $L_{day.}$ It will not be possible to achieve desirably low levels in the area at the north of the site in proximity to the M50 Road and the noise levels in this area are, by definition, undesirably high.

Open balconies located on the red and blue facades will likely have noise levels above the 55 dB L_{Aeq} (depending on facade and the floor level) which is above those recommended in BS 8233. The standard notes, however, that achievement of noise levels on balconies is not always possible and other alternative spaces should be available as part of the development with lower noise levels. The development layout incorporates landscaped green spaces at ground level between buildings, the largest and most screened area proposed is situated in the centre of Blocks A, B, C and D. These areas are designed as amenity spaces for residents. These areas are further set back from the M50 Road and benefit from shielding from surrounding buildings and noise barriers resulting in cumulative noise levels (road traffic and aircraft) that are predicted to be below 55 dB $L_{Aeq,T}$ and, by definition, are desirably low.

Where noise levels are predicted to be above recommended values, consideration may be given to the above guidance at detailed design to protect the amenity of proposed balconies, terraces and landscaped areas located along the southwestern façades and boundary to achieve the lowest practicable noise levels. Options for protecting the amenity of balcony spaces include the use glazed screen and/or winter gardens. Where closed winter gardens are incorporated noise level in the wintergardens are expected to be within the recommended level of 55 dB L_{Aeq}.

In conclusion it is considered that the design of the proposed development site has been developed to achieve the lowest practical noise levels in external amenity spaces.

4.4 Element 4 – Assessment of Other Relevant Issues

Element 4 considers other factors that *may* prove pertinent to the assessment, these are defined in the document as:

- 4(i) compliance with relevant national and local policy
- 4(ii) magnitude and extent of compliance with ProPG
- 4(iii) likely occupants of the development
- 4(iv) acoustic design v unintended adverse consequences
- 4(v) acoustic design v wider planning objectives

Each is discussed in turn below.

4.4.1 Compliance with Relevant National and Local Policy

There are no National policy documents relating to the acoustic design of residential dwellings. Locally the Noise Action Plan for Fingal County 2019 – 2023 (NAP) recommends that the guidance contained within ProPG should be used in assessing the noise impact on new residential developments being introduced to existing noise sources.

4.4.2 Magnitude and Extent of Compliance with ProPG

As discussed within this report the following conclusions have been drawn with regards to the extent of compliance with ProPG:

- All dwellings as part of the development can designed to achieve good internal noise levels and provide adequate ventilation in accordance with Part F of the Building Regulations;
- External amenity areas have been assessed and are determined to be within the target level for most of the site. In the amenity space at the north of the site between the duplex units and the site boundary, the external noise levels under are above the target levels set out in ProPG but are considered acceptable for the development in line with the FCC NAP.

Based on the preceding it is concluded that the proposed development can be designed to function in compliance with the requirements of ProPG once appropriate consideration is given at the detailed design stage to the sound insulation mitigation measures and principles outlined in this report.

4.4.3 Likely Occupants of the Development

The development consists of residential accommodation. The criteria adopted as part of this assessment are based on those recommended for permanent dwellings and are therefore considered robust and appropriate for the occupants.

4.4.4 Acoustic Design v Unintended Adverse Consequences

Unintended adverse consequences did not occur on this project.

4.4.5 Acoustic Design v Wider Planning Objectives

Acoustic design must be considered in the context of wider planning objectives, particularly the National Planning Framework 2040. The National Planning Framework (NPF) is an important document which must be taken into consideration in the making

of local planning policy to be contained in new statutory plans. Please refer to planning documentation prepared by Brady Shipman Martin.

5.0 CONCLUSION

An inward noise impact assessment has been undertaken at the proposed development site following the guidance set out in ProPG as required by the Noise Action Plan for Fingal County 2019 – 2023.

> The site has been identified as having a range of noise levels associated with a *Medium to High Risk'* of noise impacts based on the proximity to the M50 road.

The acoustic screen in the design plans will be required to screen road traffic noise levels from the M50 from amenity space located between Blocks A, B, C & D. In addition to this mitigation measure, a minimum sound insulation specification on building elements have been provided for key facades to ensure that the internal noise levels will be within the recommended criteria with windows closed.

In this assessment it has been assumed that ventilation systems will be designed to incorporate suitable noise attenuation to ensure that the any addition noise from mechanical services noise or noise break-in via ducted systems will not be significant. The appropriate systems and specifications for all façade elements i.e., glazing, ventilation, and façade systems, will be reviewed and selected at the detailed design stage to ensure that the internal noise criteria are achieved in sensitive spaces.

For most of the site the noise levels in external amenity areas will be within the threshold for desirably low noise levels as set out in the NAP. It is considered that the design of the proposed development site has been developed to achieve the lowest practical noise levels in external amenity spaces.

The Acoustic Design Statement presented in this report has assessed the impact of traffic noise levels on the proposed development and has been prepared in accordance with the requirements of ProPG as required by the FCC NAP. The proposed development can be designed to function in compliance with the requirements of ProPG once appropriate consideration is given at the detailed design stage to the sound insulation mitigation measures and principles outlined in this report.

APPENDIX A
GLOSSARY OF ACOUSTIC TERMINOLOGY

Ambient noise — The totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, near and far.

Background noise — The steady existing noise level present without contribution from any intermittent sources. The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 per cent of a given time interval, T ($L_{AF90,T}$).

dB — Decibel - The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the RMS pressure of the sound field and the reference pressure of 20 micro-pascals (20 μPa).

dB(A) — An 'A-weighted decibel' - a measure of the overall noise level of sound across the audible frequency range (20 Hz – 20 kHz) with A-frequency weighting (i.e. 'A'–weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.

Hertz (Hz) — The unit of sound frequency in cycles per second.

$L_{Aeq,T}$ — This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T).The closer the L_{Aeq} value is to either the L_{AF10} or L_{AF90} value indicates the relative impact of the intermittent sources and their contribution. The relative spread between the values determines the impact of intermittent sources such as traffic on the background.

L_{AFmax} — is the instantaneous fast time weighted maximum sound level measured during the sample period.

L_{den} — Is the 24 hour noise rating level determined by the averaging of the L_{day} with the $L_{evening}$ plus a 5 dB penalty and the L_{night} plus a 10 dB penalty. L_{den} is calculated using the following formula:

$$L_{\text{den}} = 10log\left(\frac{1}{24}\right)\left(12 * \left(10^{\frac{Lday}{10}}\right) + 4 * \left(10^{\frac{Levening+5}{10}}\right) + 8 * \left(10^{\frac{Lnight+10}{10}}\right)\right)$$

L_{day} — is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the day periods of a year

L_{night} — is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the night periods of a year.

Octave band — A frequency interval, the upper limit of which is twice that of the lower limit. For example, the 1,000Hz octave band contains acoustical energy between 707Hz and 1,414Hz. The centre frequencies used for the designation of octave bands are defined in ISO and ANSI standards.