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# ATTACHMENT-7-1-3-2 NOISE IMPACT ASSESSMENT FOR EPA LICENCE APPLICATION

Technical Report Prepared For

**Amazon Data Services Ireland Limited**

Prepared By

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Our Reference

217501/1060NR01

Date of Issue

19 April 2022



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## Document History

| Document Reference | | Original Issue Date | |
|---|---|---|---|
| 217501/1060NR01 | | 19 April 2022 | |
| Revision Level | Revision Date | Description | Sections Affected |
| | | | |
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## Record of Approval

| Details | Written by | Approved by |
|---|---|---|
| Signature | | |
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| Date | 19 April 2022 | 19 April 2022 |

# EXECUTIVE SUMMARY

Amazon Data Services Ireland Limited (‘**ADSIL’**) operate three data storage facilities on a site located at Cruiserath Road, Dublin 15. AWN Consulting has been commissioned to prepare a noise impact assessment for the operation of the facility to be compiled and submitted as part of the Industrial Emissions (IE) licence application process.

This technical report has been prepared to provide details in relation to the noise impact assessment for the licence application. The assessment is based on the most up-to-date design details available for development and has been prepared with due consideration of the guidance contained within the Environmental Protection Agency (EPA) document *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) 2016*.

Section 6 of the EPA’s NG4 Guidance outlines the following assessment stages for the noise impact assessment for licence applications.

- Stage 1 – Baseline Noise Survey / Monitoring Locations;
- Stage 2 – Derivation of Noise Criteria;
- Stage 3 – Assessment of Noise Impact; and,
- Stage 4 – Reporting / Licence Application Form.

This report has been prepared with consideration of the four assessment stages outlined above.

An environmental noise survey was conducted to quantify the existing noise environment in the vicinity of nearest Noise Sensitive Receivers (NSL’s) to the site. The survey was conducted in general accordance with the EPA’s NG4 Guidance.

Appropriate operational noise criteria have been derived for the site following review of noise survey data and receiving environment, in accordance with the relevant NG4 Guidance. The applicable noise criteria identified are in line with the typical limit values for noise from licensed sites.

To assess the impact of noise from new mechanical plant at nearby NSL’s, a detailed computer-based noise model has been prepared using a proprietary noise modelling software package. Noise prediction calculations have carried out in accordance with ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*. The predicted cumulative noise levels at all NSL’s for new mechanical plant and the levels of existing plant noise from the facility are within the day, evening and night-time noise criteria for site operations.

# CONTENTS

# 1.0 INTRODUCTION

Amazon Data Services Ireland Limited (‘**ADSIL’**) operate three data storage facilities on a site located at Cruiserath Road, Dublin 15. AWN Consulting has been commissioned to prepare a noise impact assessment for the operation of the facility to be compiled and submitted as part of the Industrial Emissions (IE) licence application process.

This assessment is based on the predicted noise emissions from the installation and the most up-to-date design details available for the development and has been prepared with due consideration to the guidance contained within the Environmental Protection Agency (EPA) document *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) 2016.* This report has been prepared in accordance with the four noise impact assessment stages outlined in Section 6 of NG4, which are as follows:

- Stage 1 – Baseline Noise Survey / Monitoring Locations;
- Stage 2 – Derivation of Noise Criteria;
- Stage 3 – Assessment of Noise Impact; and,
- Stage 4 – Reporting / Licence Application Form.

Figure 1 illustrates the site location in the context of the surrounding environment.




***Figure 1*** Site Location & Context

The nearest residential locations are located to the west of development lands on the opposite side of a section of the R121. This includes, amongst others the Curragh Hall and Ballentree estates. A hotel is located to the north of the site and the eastern boundary of the site is shared with existing industrial lands and operations. The southern boundary of the site is formed by another section of the R121 with industrial, agricultural lands and a cemetery beyond.

Appendix A to this report presents a glossary of the acoustic terminology referred to in this document.

## 2.0 FUNDAMENTALS OF ACOUSTICS

In order to provide a broader understanding of some of the technical discussion in this report, this section provides a brief overview of the fundamentals of acoustics and the basis for the preparation of this noise assessment.

A sound wave travelling through the air is a regular disturbance of the atmospheric pressure. These pressure fluctuations are detected by the human ear, producing the sensation of hearing. In order to take account of the vast range of pressure levels that can be detected by the ear, it is convenient to measure sound in terms of a logarithmic ratio of sound pressures. These values are expressed as Sound Pressure Levels (SPL) in decibels (dB).

The audible range of sounds expressed in terms of Sound Pressure Levels is 0dB (for the threshold of hearing) to 120dB (for the threshold of pain). In general, a subjective impression of doubling of loudness corresponds to a tenfold increase in sound energy which conveniently equates to a 10dB increase in SPL. It should be noted that a doubling in sound energy (such as may be caused by a doubling of traffic flows) increases the SPL by 3dB.

The frequency of sound is the rate at which a sound wave oscillates and is expressed in Hertz (Hz). The sensitivity of the human ear to different frequencies in the audible range is not uniform. For example, hearing sensitivity decreases markedly as frequency falls below 250Hz. In order to rank the SPL of various noise sources, the measured level has to be adjusted to give comparatively more weight to the frequencies that are readily detected by the human ear. Several weighting mechanisms have been proposed but the 'A-weighting' system has been found to provide one of the best correlations with perceived loudness. SPL's measured using 'A-weighting' are expressed in terms of dB(A). An indication of the level of some common sounds on the dB(A) scale is presented in Figure 2.



The established prediction and measurement techniques for the dB(A) parameter are well developed and widely applied. For a more detailed introduction to the basic principles of acoustics, reference should be made to an appropriate standard text[1].

1 For example, *Woods Practical Guide to Noise Control* by Ian Sharland.

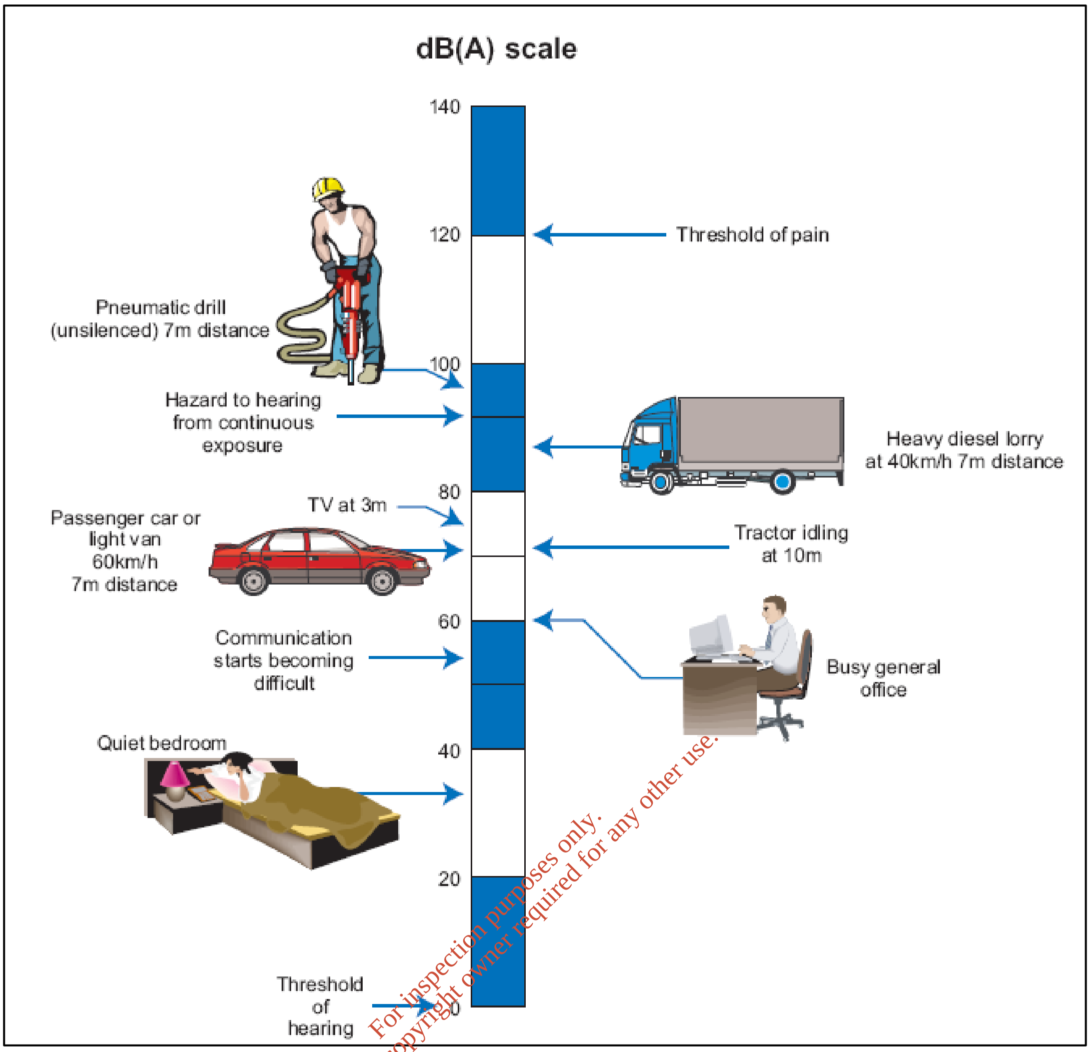


***Figure 2*** *Level of Typical Sounds on the dB(A) Scale – (TII – Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes)*

## 3.0 RECEIVING ENVIRONMENT

This section deals with ‘Stage 1’ of the noise impact assessment as outlined in the EPA’s NG4 Guidance. Note this section has been based on baseline noise surveys completed for the planning applications for the original buildings on the site (i.e. prior to the construction of any of the projects considered here) and is considered representative of the environment at this stage in time.

An environmental noise survey has been conducted in order to quantify the existing noise environment. The survey was conducted in general accordance with ISO 1996: 2017: *Acoustics – Description, measurement and assessment of environmental noise*. Specific details are set out below.

### 3.1 Choice of Measurement Locations

Noise measurements were conducted at four positions in the vicinity of the site. The locations of these measurements are shown on Figure 3.

***Table 1*** Measurement Locations & Descriptions

| Location | Description | Photo |
|---|---|---|
| A | Location A (private estate) is located off Curragh Hall Gate at the kerbside as indicated on to the right and on Figure 3 |  |
| B | Location B (private estate) is located in the vicinity of a private house in the Ballentree estate facing the site as indicated right and on Figure 3 |  |
| C | Location C (private estate) is located in the vicinity of a private house within the Willow estate facing the site as indicated to the right and on Figure 3. |  |
| D | Representative of a hotel located to the north of the site at a distance of some 160m from the nearest proposed structure on the site. |  |

Figure 3 details the approximate location of the measurement positions identified above.

### 3.2 Survey Periods

Noise measurements were conducted during a daytime period and a typical night-time period selected to measure of existing background noise levels during periods where people are attempting to go to sleep or are sleeping. Due to the fact that the units in question here operate on a 24-hour basis, their potential impact during night-time periods is the critical issue. The surveys were conducted during the following periods:

- Daytime – 07:50hrs to 11:45hrs on 15 November 2016, and;
- Night-time – 23:50hrs on 10 November to 02:40hrs on 11 November 2016.

### 3.3 Personnel & Instrumentation

The noise measurements were performed using a Brüel & Kjær Type 2260 Sound Level Analyzer. Before and after the survey the measurement apparatus was check calibrated using a Brüel & Kjær Type 4231 Sound Level Calibrator. The unattended noise monitoring was completed used a RION NL-52 sound level meter.

### 3.4 Procedure

Measurements were conducted at the boundary location noted above. Sample periods for the noise measurements were typically 15 minutes. The results were noted onto a Survey Record Sheet immediately following each sample and were also saved to the instrument memory for later analysis if required. Survey personnel noted the primary noise sources contributing to noise build-up.



The night-time weather conditions were dry and calm, with a temperature of 2°C, low southerly winds of 2 m/s and approximately 10% cloud cover. The daytime weather conditions were dry and calm, with a temperature of 13°C, southerly westerly winds of 5 m/s and approximately 90% cloud cover.



***Figure 3*** Noise Monitoring Locations

## 3.5 Measurement Parameters

The survey results are presented in terms of the following 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.

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.

Another parameter that will be commented upon in this report is the $L_{ArT}$.

$L_{Ar\,T}$ The $L_{Aeq}$ during a specified time interval, plus specified adjustments for tonal character and impulsiveness of the sound.

It should be noted for this assessment it has been assumed that detailed design will be carried out in order that there will be not tonal or impulsive noise emissions for the development. Therefore, in this instance $L_{Aeq}$ is equal to $L_{Ar\,T}$.



## 3.6 Survey Results

### 3.6.1 Location A

The survey results for Location A are given in Table 2 below.

***Table 2*** Summary of Results for Location A

| Start Time | | Measured Noise Levels (dB re. $2x10^{-5}$ Pa) | | |
|---|---|---|---|---|
| | | $L_{Aeq}$ | $L_{AF10}$ | $L_{AF90}$ |
| Daytime | 07:52 | 56 | 59 | 49 |
| | 09:14 | 58 | 59 | 48 |
| | 10:30 | 56 | 60 | 44 |
| Night-time | 23:51 | 43 | 47 | 35 |
| | 01:23 | 40 | 43 | 33 |

Ambient daytime noise levels at this location were dominated by the R121. Other noise sources noted including local estate traffic movements and occasional aircraft movements overhead. Distant road traffic noise typically dictated background noise levels. Ambient (i.e. $L_{Aeq,15min}$) levels were in the range of 56 to 58 dB with background noise levels in the range of 44 to 49 dB.

Night-time noise levels were influenced by the R121 and distant road traffic movements along with occasional local vehicle movements. Ambient noise levels were in the range of 40 to 43 dB with background noise levels were in the range 33 to 35 dB.

### 3.6.2 Location B

The survey results for Location B are given in Table 3 below.

***Table 3*** Summary of Results for Location B

| Start Time | | Measured Noise Levels (dB re. $2x10^{-5}$ Pa) | | |
|---|---|---|---|---|
| | | $L_{Aeq}$ | $L_{AF10}$ | $L_{AF90}$ |
| Daytime | 08:10 | 57 | 59 | 52 |
| | 09:32 | 58 | 59 | 47 |
| | 10:50 | 58 | 59 | 45 |
| Night-time | 00:15 | 47 | 51 | 39 |
| | 01:44 | 42 | 45 | 34 |

Ambient daytime noise levels at this location were dominated by the R121 and occasional traffic movements in the nearby residential estate. Other noise sources noted including dogs barking, occasional aircraft movements overhead and pedestrian activity. Distant road traffic noise typically dictated background noise levels. Ambient (i.e. $L_{Aeq,15min}$) levels were in the range of 57 to 58 dB with background noise levels in the range of 45 to 52 dB.

Night-time noise levels were influenced by the R121 and distant road traffic movements. Ambient noise levels were in the range of 42 to 47 dB with background noise levels were in the range 34 to 39 dB.

### 3.6.3 Location C

The survey results for Location C are given in Table 4.

***Table 4*** Summary of Results for Location C

| Start Time | | Measured Noise Levels (dB re. $2x10^{-5}$ Pa) | | |
|---|---|---|---|---|
| | | $L_{Aeq}$ | $L_{AF10}$ | $L_{AF90}$ |
| Daytime | 08:31 | 59 | 60 | 53 |
| | 09:51 | 59 | 62 | 48 |
| | 11:08 | 60 | 63 | 46 |
| Night-time | 00:38 | 44 | 47 | 35 |
| | 02:06 | 41 | 43 | 35 |

Ambient daytime noise levels at this location were dominated by the R121 and occasional traffic movements in the nearby residential estate. Other noise sources noted including dogs barking, occasional aircraft movements overhead and birdsong. Distant road traffic noise typically dictated background noise levels. Ambient (i.e. $L_{Aeq,15min}$) levels were in the range of 59 to 60 dB with background noise levels in the range of 46 to 53 dB.

Night-time noise levels were influenced by the R171 and distant road traffic movements along with occasional aircraft overhead and a degree of existing mechanical services noise. Ambient noise levels were in the range of 41 to 44 dB with background noise levels the order of 35 dB.

### 3.6.4 Location D

The survey results for Location D are given in Table 5.

***Table 5*** Summary of Results for Location D

| Start Time | | Measured Noise Levels (dB re. $2x10^{-5}$ Pa) | | |
|---|---|---|---|---|
| | | $L_{Aeq}$ | $L_{AF10}$ | $L_{AF90}$ |
| Daytime | 08:50 | 54 | 56 | 49 |
| | 10:10 | 57 | 57 | 46 |
| | 11:27 | 59 | 59 | 45 |
| Night-time | 01:01 | 43 | 46 | 38 |
| | 02:25 | 43 | 47 | 38 |

Ambient daytime noise levels at this location were dominated by the R121 and occasional traffic movements in the nearby residential estate. Other noise sources noted included occasional aircraft movements overhead. Distant road traffic noise typically dictated background noise levels. Ambient (i.e. $L_{Aeq,15min}$) levels were in the range of 54 to 59 dB with background noise levels in the range of 45 to 49 dB.

Night-time noise levels were influenced by the R121 and distant road traffic movements along distant existing mechanical plant. Ambient noise levels were the order of 43 dB with background noise levels the order of 38 dB.



### 3.7 Ecologically sensitive areas or areas of special interest

An Appropriate Assessment (AA) Screening Report prepared by Moore Group previously submitted to FCC as part of the planning application for Building B and C (FCC Reg. Ref.: FW19A/0087) and has been submitted with this licence application (Attachment-6-3-4-AA Screening-Planning-Aug-2019). Based on the AA Screening, the subject site is not within, or proximal to a European conservation site. The closest European site is the Rye Water Valley/Carton SAC (site code 001398) which is located 8.8 km from the site.

Based on the separation distance from the facility to the nearest ecologically sensitive area and European site it is highly unlikely that noise arising from the facility under any scenario would have any impact on these sites. Therefore, the noise impact on ecologically sensitive area has been scoped out of any further assessment.

## 4.0 REVIEW OF RELEVANT GUIDANCE

This section deals with 'Stage 2' of the noise impact assessment as outlined in the EPA's NG4 Guidance.

The discussion of appropriate IE Licence noise emission criteria for the overall facility will be conducted in accordance with the NG4 document. This approach is summarised below in accordance with guidance detailed in Section 4 of the NG4 document.

### 4.1 Quiet Area Screening

The proposed development is not considered a quiet area in this instance as it fails to meet any of the criteria outlined in EPA's Guidance. The most stringent of these criteria are noted in bullet points and commented on below.

- At least 3km from urban area with a population >1,000 people;

The site is located within the agglomeration of Dublin City and is therefore located less than 3km from a population significantly greater than 1,000.

- At least 3km away from any local industry;

Other industrial sites operate within 3km of the site.

- At least 5km away from any National Primary Route;

A section of the M3 national road is located some 1.6 km to the south west of the site.

### 4.2 Low Background Noise Area Screening

In order to establish whether the noise sensitive locations in the vicinity of the site would be considered 'low background noise' areas, the noise levels measured during the environmental noise survey need to satisfy all three of the following criteria:

- Arithmetic Average of $L_{A90}$ During Daytime Period ≤40dB $L_{A90}$, and;
- Arithmetic Average of $L_{A90}$ During Evening Period ≤35dB $L_{A90}$, and;
- Arithmetic Average of $L_{A90}$ During Night-time Period ≤30dB $L_{A90}$.

***Table 6*** Comparison of Measurement Results with NG4 Low Background Noise Area Criteria

| Location | Period | $L_{A90,T}$ (dB) | NG4 Screening (dB $L_{A90,T}$) | Satisfies All Criteria for Low Background Noise Area? |
|---|---|---|---|---|
| A | Daytime | 47 | ≤40 | No |
| | Evening | 42 | ≤35 | |
| | Night-time | 34 | ≤30 | |
| B | Daytime | 48 | ≤40 | No |
| | Evening | 43 | ≤35 | |
| | Night-time | 37 | ≤30 | |
| C | Daytime | 49 | ≤40 | No |
| | Evening | 44 | ≤35 | |
| | Night-time | 35 | ≤30 | |
| D | Daytime | 47 | ≤40 | No |
| | Evening | 42 | ≤35 | |
| | Night-time | 38 | ≤30 | |

The arithmetic average $L_{A90}$ results at each location are compared against the criteria in Table 6. As outlined in Table 6, none of the locations would be considered 'Areas of Low Background Noise' as the measured noise levels do not satisfy the criteria. Note evening background noise levels are assumed to be some 5 dB lower than those measured during night time periods for the purposes of this assessment.

## 4.3 Determining Appropriate Noise Criteria

Based on the EPA NG4 guidance, the following noise criteria are appropriate at the nearest NSL's to the facility:

- Daytime (07:00 to 19:00hrs) 55dB $L_{Ar,15min}$
- Evening (19:00 to 23:00hrs) 50dB $L_{Ar,15min}$
- Night time (23:00 to 07:00hrs) 45dB $L_{Aeq,15min}$

During the night period, no tonal or impulsive noise from the facility should be clearly audible or measurable at any NSL. The applicable noise criteria identified are in line with the typical limit values for noise from licensed sites.

There are some plant items proposed for the development site that are designed to be used in emergency situations, for example, when grid power supplies fail. It is common practice to allow a relaxation of noise limits associated with emergency plant operations. Section 4.4.1 of EPA NG4 contains the following comments in relation to emergency plant items:

> *"In some instances, licensed sites will have certain items of emergency equipment (e.g. standby generators) that will only operate in urgent situations (e.g. grid power failure). Depending upon the context, it may be deemed permissible for such items of equipment to give rise to exceedances in the noise criteria/limits during limited testing and emergency operation only. If such equipment is in regular use for any purposes other than intermittent testing, it is subject to the standard limit values for the site".*



It is therefore considered that the proposed noise criterion of 55dB $L_{Aeq,(15mins)}$ is appropriate in emergency scenarios for daytime, evening and night-time periods. In relation to commercial properties an emergency operation criterion of 65dB $L_{Aeq,15min}$ is proposed.

## 4.4 Compliance Noise Monitoring

See Attachment 7.5 of the Licence application for further details on the noise sensitive locations.

Given there may be potential access constraints at some noise sensitive locations and the presence of extraneous noise sources in the vicinity, it may be necessary to undertake compliance noise monitoring (if required) at the site boundary or at a suitable proxy location and assess to the nearest NSL's. Any such assessment should be undertaken in accordance with the guidance outlined in the EPA NG4 document and supported by a sufficiently detailed noise report outlining the calculation methods used to determine the noise emission levels at the NSL's.

## 5.0 ASSESSMENT

This section deals with 'Stage 3' of the noise impact assessment as outlined in the EPA's NG4 Guidance.

The noise levels expected at nearest NSL's, due to the operation of the facility, must be considered and presented as part of the licence application.

The following sections present details of the assessment and the findings. Further information in relation to the noise prediction model, inputs, calculation settings and assessment assumptions are provided in Appendix B to this report.

It should be noted that noise impact assessment has been completed using information obtained from the design team for significant items of plant which were procured from vendors.

### 5.1 Noise Sensitive Locations

Noise prediction calculations have been carried out at the representative nearest noise sensitive locations (NSL's) surrounding the site. Details of the NSL's used for the prediction calculations are presented in Table 7. Free field noise emission levels have been predicted at 4m height in all cases.



***Table 7*** Coordinates of Noise Sensitive Receivers

| Noise Sensitive Location | National Grid Reference | |
|---|---|---|
| | North | East |
| R01 | 707,240 | 741,693 |
| R02 | 707,257 | 741,732 |
| R03 | 707,274 | 741,765 |
| R04 | 707,292 | 741,798 |
| R05 | 707,337 | 741,866 |
| R06 | 707,378 | 741,941 |
| R07 | 707,453 | 741,982 |
| R08 | 707,472 | 742,025 |
| R09 | 707,487 | 742,064 |
| R10 | 707,507 | 742,104 |
| R11 | 707,514 | 742,171 |
| R12 | 707,507 | 742,250 |
| R13 | 707,671 | 742,224 |
| R14 | 707,807 | 741,630 |
| R15 | 707,820 | 741,462 |


***Figure 4*** Noise Assessment Locations

## 5.2 Noise Source Data

The noise modelling completed indicates the following limits in relation to the sound power levels of various items of plant associated with the overall site development. Plant items will be selected in order to achieve the stated noise levels and or appropriate attenuation will be incorporated into the design of the plant/building in order that the plant noise emission levels are achieved on site (including any system regenerated noise).

***Table 8*** $L_{WA}$ levels Utilised in Noise Model – Building A

| Source | $L_{WA}$ - Octave Band Centre Frequency | | | | | | | | dB (A) |
|---|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| Roof Fan Note A | 56 | 65 | 67 | 68 | 68 | 68 | 60 | 55 | 75 |
| DH CR ER Supply (Roof) Note B | 65 | 75 | 76 | 71 | 63 | 60 | 53 | 48 | 72 |
| Electrical Room CRAH Note C | 55 | 68 | 66 | 69 | 60 | 66 | 66 | 57 | 75 |
| AHU Louvre (per unit) Note D | 55 | 58 | 69 | 68 | 62 | 63 | 65 | 61 | 74 |
| Generator Exhaust Note E | 54 | 63 | 74 | 73 | 66 | 67 | 71 | 66 | 79 |
| Generator Intake Note E | 88 | 90 | 82 | 83 | 83 | 80 | 78 | 76 | 94 |
| Generator Rear Note E | 88 | 90 | 82 | 83 | 83 | 80 | 78 | 76 | 94 |
| Generator Stack Note F | 84 | 77 | 77 | 73 | 69 | 74 | 71 | 71 | 86 |
| Generator Sides & Roof Note E | 82 | 93 | 92 | 94 | 94 | 93 | 88 | 75 | 101 |
| Pumps Note G | 38 | 48 | 55 | 65 | 64 | 65 | 61 | 52 | 70 |
| 110kvA Transformer (x 4) | 54 | 66 | 69 | 74 | 72 | 68 | 63 | 53 | 78 |

*Note A* It is assumed the relevant $L_W$ associated with the roof fan(s) is 85dB(A) as detailed in supplied data sheets (i.e. Dannan Data "Data Hall EX Fan" PROJECT G Site Noise Sources spreadsheet). Provision of atmosphere side attenuation to reduce the exhaust $L_{WA}$ level of 75dB as detailed in Table 1 is required and has been assumed.

*Note B* It is assumed the relevant $L_W$ associated with the roof fan(s) is 72dB(A) as detailed in supplied data sheets (i.e. Dannan Data for *Fresh Air Inlet Connection* "Electrical Room CRAH" PROJECT G Site Noise Sources spreadsheet).

*Note C* It is assumed the relevant $L_W$ associated with electrical room extract fan(s) is 91dB(A) as detailed in supplied data sheets (i.e. Data for "Electrical Room EX Fan" PROJECT G Site Noise Sources spreadsheet). Provision of in line attenuation offering the following minimum sound reduction has been assumed:

| Element | Sound Insertion Loss dB – Octave Band Centre Frequency (Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Splitter | 6 | 8 | 13 | 15 | 18 | 12 | 9 | 8 |
| Filter | 0 | 2 | 2 | 2 | 4 | 7 | 7 | 12 |

*Note D* It is assumed the relevant $L_W$ associated with the roof fan(s) is 84dB(A) as detailed in supplied data sheets (i.e. Dannan Data "Data Hall AHU" PROJECT G Site Noise Sources spreadsheet). Provision of atmosphere side attenuation to reduce the exhaust $L_{WA}$ level of 74dB as detailed in the table below is assumed.

| Element | Sound Insertion Loss dB – Octave Band Centre Frequency (Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Attenuator | 6 | 12 | 15 | 20 | 20 | 20 | 20 | 20 |
| Filter | 0 | 2 | 2 | 2 | 4 | 7 | 7 | 12 |

*Note E* Assuming generator housing dimensions of 17m (L) x 4m (W) x 4m (H). Data based on CAT data supplied in relation to previous sites.

*Note F* Additional attenuation due to 20m stack and additional bends assumed.

*Note G* Acoustic enclosures will be provided for external pumps in order that the stated noise levels in Table 8 are achieved.

***Table 9*** $L_{wA}$ levels Utilised in Noise Model – Building B & C

| Source | $L_{wA}$ - Octave Band Centre Frequency | | | | | | | | dB (A) |
|---|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| Roof Fan | 69 | 70 | 63 | 62 | 61 | 62 | 64 | 60 | 74 |
| Compressors | -- | 78 | 74 | 71 | 71 | 68 | 60 | 53 | 81 |
| AHU Louvres | 43 | 59 | 60 | 62 | 60 | 59 | 56 | 45 | 68 |
| Electrical Room Extract Fan Note H | 43 | 63 | 62 | 62 | 50 | 46 | 29 | 17 | 67 |
| Catcher Room Extract Fan Note H | 43 | 63 | 62 | 62 | 50 | 46 | 29 | 17 | 67 |
| Generator Intake Note I | 81 | 80 | 76 | 73 | 63 | 61 | 55 | 69 | 85 |
| Generator Rear Note I | 84 | 78 | 68 | 67 | 69 | 67 | 70 | 62 | 86 |
| Generator Stack Note J | 84 | 78 | 68 | 67 | 69 | 67 | 70 | 62 | 86 |
| Generator Sides & Roof Note I | 78 | 87 | 86 | 82 | 76 | 65 | 53 | 55 | 91 |
| 220KvA Transformer Note K | 58 | 70 | 73 | 78 | 76 | 72 | 67 | 57 | 82 |

*Note H* 6054-DUB064-CRAH UNITS - SOUND CALCS - 250Pa ESP - REV A - 23-03-2018

*Note I* Assuming generator housing dimensions of 15m (L) x 3.6m (W) x 3. 7m (H). Data based on Cummings data.

*Note J* Additional attenuation due to 20m stack and additional bends assumed.

*Note K* The following extract from the "*EirGrid Evidence Based Environmental Studies Study 8: Noise – Literature review and evidence based field study on the noise effects of high voltage transmission development (May 2016)*" states the following in relation to noise impacts associated with 220KvA transformer installations:

*"The survey on the 220kv substation at Gorman indicated that measured noise levels (LAeq) were approximately 43dB(A) at 5m from the most affected boundary of the substation. This is marginally above the WHO night-time threshold limit for preventing disturbance to sleep (i.e. 42dB). Spectral analysis of the noise from the Gorman substation demonstrated that there are a number of distinct tonal elements to noise in the low to mid frequency range. To avoid any noise impacts from 220kV substations at sensitive receptors, it is recommended that a distance of 20m is maintained between the nearest site boundary and the nearest sensitive receptor."*

Considering the distance between the 220kvA substation and the nearest off site locations of some 240m noise from this installation is not predicted to be an issue off site.

## 5.3 Calculation Methodology

A 3D computer-based prediction model has been prepared in order to quantify the noise level associated with the proposed building. This section discusses the methodology behind the noise modelling process.

### 5.3.1 DGMR iNoise

Proprietary noise calculation software has been used for the purposes of this modelling exercise. The selected software, DGMR iNoise, calculates noise levels in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996*.

DGMR iNoise is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. Predictor calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of A weighted sound power levels ($L_{WA}$);
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m).



### 5.3.2 Brief Description of ISO9613-2:1996

ISO9613-2:1996 calculates the noise level based on each of the factors discussed previously. However, the effect of meteorological conditions is significantly simplified by calculating the average downwind sound pressure level, $L_{AT}$(DW), for the following conditions:

- wind direction at an angle of ±45° to the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and;
- wind speed between approximately 1ms$^{-1}$ and 5ms$^{-1}$, measured at a height of 3m to 11m above the ground.

The equations and calculations also hold for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear calm nights. The basic formula for calculating $L_{AT}$(DW) from any point source at any receiver location is given by:

$$L_{fT}(DW) = LW + Dc - A \qquad \textbf{Eqn. A}$$

Where:

$L_{fT}$(DW) is an octave band centre frequency component of $L_{AT}$(DW) in dB relative to $2\times10^{-5}$Pa;
$L_W$ is the octave band sound power of the point source;
$D_c$ is the directivity correction for the point source;
A is the octave band attenuation that occurs during propagation, namely attenuation due to geometric divergence, atmospheric absorption, ground effect, barriers and miscellaneous other effects.

The estimated accuracy associated with this methodology is shown in Table 8 below:

***Table 10*** Estimated Accuracy for Broadband Noise of $L_{AT}$(DW)

| Height, h* | Distance, d† | |
|---|---|---|
| | 0 < d < 100m | 100m < d < 1,000m |
| 0<h<5m | ±3dB | ±3dB |
| 5m<h<30m | ±1dB | ±3dB |

* *h is the mean height of the source and receiver. † d is the mean distance between the source and receiver. N.B. These estimates have been made from situations where there are no effects due to reflections or attenuation due to screening.*

### 5.3.3 Input Data and Assumptions

The noise model has been constructed using data from various source as follows:

*Site Layout* The general site layout has been obtained from the drawings forwarded by MCA Architects.

*Local Area* The location of noise sensitive locations has been obtained from a combination of site drawings provided by MCA Architects and others obtained from Ordinance Survey Ireland (OSI).

*Heights* The heights of buildings on site have been obtained from site drawings forwarded by MCA Architects. Off-site buildings have been assumed to be 8m high for houses and 16m for apartments with the exception of industrial buildings where a default height of 15m has been assumed.

*Contours* Site ground contours/heights have been obtained from site drawings forwarded by MCA where available.

## 5.4 Predicted Noise Levels

This section presents the predicted noise levels at the nearest noise sensitive locations. The cumulative impact of all modelled noise sources on the site has been assessed for two distinct operational scenarios.

*Scenario A* would be considered to be the most representative of the day to day operation.

*Scenario B* is representative of emergency situation; a loss, reduction or instability of grid power supply, critical maintenance to power systems, a request from the utility supplier (or third party acting on its behalf) to reduce grid electricity load. It should be noted that such an event is an extremely rare occurrence.

Figures 5 and 6 presents the predicted noise contour plot for mechanical services and process plant associated with the development for Scenarios A and B receptively.

The predicted cumulative noise levels from mechanical plant at Buildings A, B and C are tabulated in Table 11 for each NSL.

***Table 11*** Predicted Cumulative Operational Noise Levels at NSL's for Mechanical Plant Items at Building A, B and C

| Location | Plant Predicted Level (dB) | |
|---|---|---|
| | Scenario A | Scenario B |
| R01 | 38 | 55 |
| R02 | 39 | 53 |
| R03 | 40 | 52 |
| R04 | 39 | 52 |
| R05 | 38 | 52 |
| R06 | 37 | 52 |
| R07 | 37 | 53 |
| R08 | 37 | 53 |
| R09 | 37 | 53 |
| R10 | 36 | 53 |
| R11 | 35 | 52 |
| R12 | 33 | 50 |
| R13 | 35 | 51 |
| R14 | 42 | 48 |
| R15 | 38 | 55 |

Table 12 presents the predicted plant noise emission levels at the nearest NSL's and compares the results against the relevant criteria that have been derived for the site for Scenario A.



***Table 12*** Predicted Operational Noise Levels vs Criteria – Scenario A

| Receptor | Predicted $L_{Aeq,T}$ | Day (07:00 – 19:00hrs) | | Evening (19:00 – 23:00hrs) | | Night (23:00 – 07:00hrs) | |
|---|---|---|---|---|---|---|---|
| | | Criterion dB $L_{Ar,T}$ | Complies? | Criterion dB $L_{Ar,T}$ | Complies? | Criterion dB $L_{Aeq,T}$ | Complies? |
| R01 | 38 | | Yes | | Yes | | Yes |
| R02 | 39 | | Yes | | Yes | | Yes |
| R03 | 40 | | Yes | | Yes | | Yes |
| R04 | 39 | | Yes | | Yes | | Yes |
| R05 | 38 | | Yes | | Yes | | Yes |
| R06 | 37 | | Yes | | Yes | | Yes |
| R07 | 37 | | Yes | | Yes | | Yes |
| R08 | 37 | 55 | Yes | 50 | Yes | 45 | Yes |
| R09 | 37 | | Yes | | Yes | | Yes |
| R10 | 36 | | Yes | | Yes | | Yes |
| R11 | 35 | | Yes | | Yes | | Yes |
| R12 | 33 | | Yes | | Yes | | Yes |
| R13 | 35 | | Yes | | Yes | | Yes |
| R14 | 42 | | Yes | | Yes | | Yes |
| R15 | 38 | | Yes | | Yes | | Yes |

Table 13 presents the predicted plant noise emission levels at the nearest NSL's and compares the results against the relevant criteria that have been derived for the site for Scenario B.

***Table 13*** Predicted Operational Noise Levels vs Criteria – Scenario B

| Receptor | Predicted $L_{Aeq,T}$ | Day (07:00 – 19:00hrs) | | Evening (19:00 – 23:00hrs) | | Night (23:00 – 07:00hrs) | |
|---|---|---|---|---|---|---|---|
| | | Criterion dB $L_{Ar,T}$ | Complies? | Criterion dB $L_{Ar,T}$ | Complies? | Criterion dB $L_{Aeq,T}$ | Complies? |
| R01 | 55 | 55 | Yes | 55 | Yes | 55 | Yes |
| R02 | 53 | | Yes | | Yes | | Yes |
| R03 | 52 | | Yes | | Yes | | Yes |
| R04 | 52 | | Yes | | Yes | | Yes |
| R05 | 52 | | Yes | | Yes | | Yes |
| R06 | 52 | | Yes | | Yes | | Yes |
| R07 | 53 | | Yes | | Yes | | Yes |
| R08 | 53 | | Yes | | Yes | | Yes |
| R09 | 53 | | Yes | | Yes | | Yes |
| R10 | 53 | | Yes | | Yes | | Yes |
| R11 | 52 | | Yes | | Yes | | Yes |
| R12 | 50 | | Yes | | Yes | | Yes |
| R13 | 51 | | Yes | | Yes | | Yes |
| R14 | 48 | | Yes | | Yes | | Yes |
| R15 | 55 | | Yes | | Yes | | Yes |


***Figure 5*** Operational Noise Prediction Contours – Scenario A

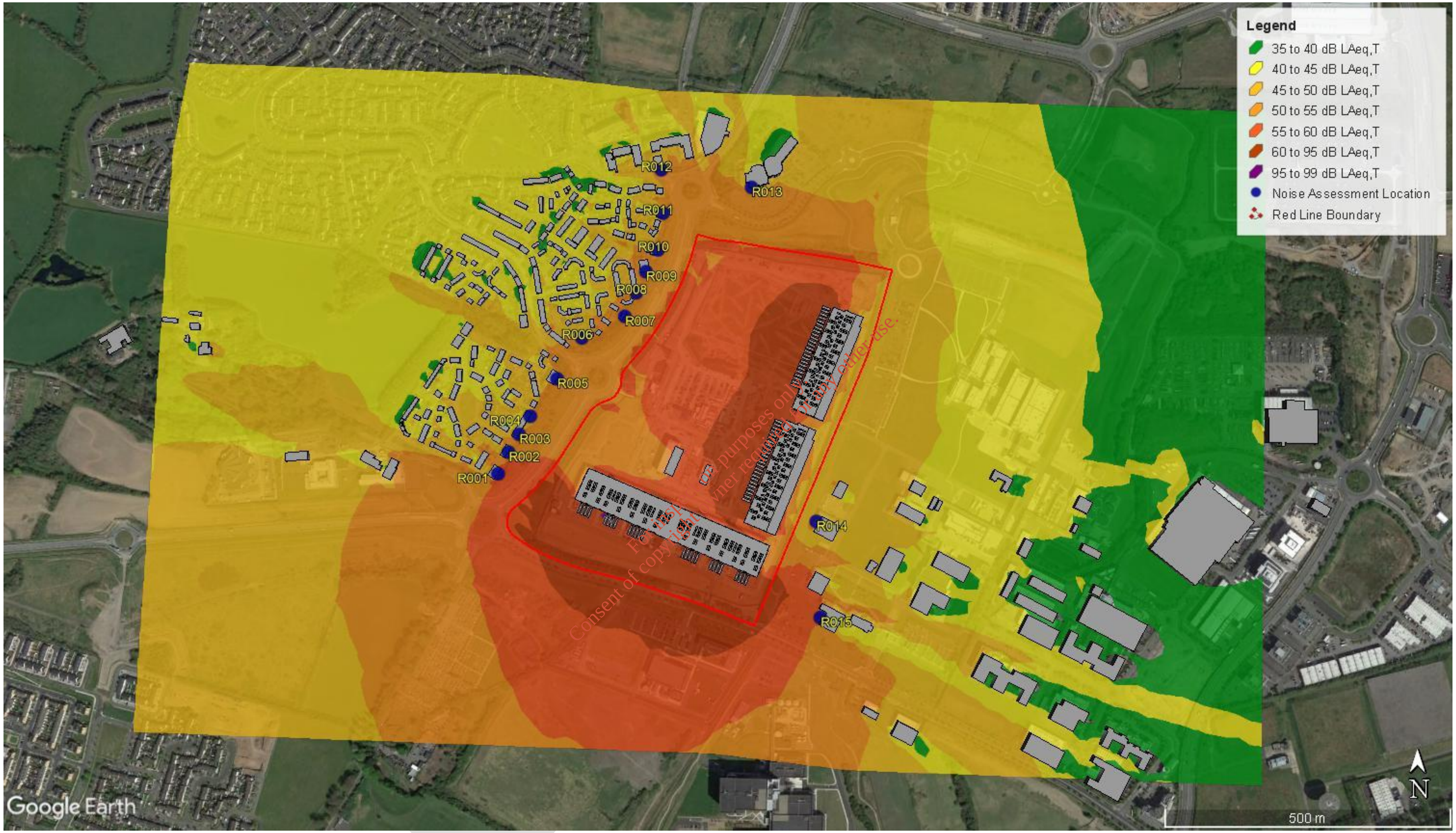


***Figure 6*** Operational Noise Prediction Contours – Scenario B

## 6.0 CONCLUSION

A detailed noise survey has been completed at three noise sensitive locations surrounding the site to establish the existing noise environment. This work has demonstrated that the existing noise environment is dictated by road traffic noise and noise associated with aircraft movements and some existing industry plant noise.

In accordance with the relevant NG4 Guidance, appropriate operational noise criteria have been derived for the site which are based on consideration of the existing licence noise conditions and the existing noise environment at the nearest NSL's.

A noise impact assessment has been completed using information obtained from the design team for significant items of new mechanical plant. A detailed computer-based noise model has been prepared using proprietary noise modelling software in accordance with the calculation method outlined in ISO 9613-2:1996.

The predicted noise levels at all NSL's are below the day, evening and night-time noise criteria that are applicable to the site operations.

## 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 ($L_{AF90,T}$).

**broadband** — Sounds that contain energy distributed across a wide range of frequencies.

**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 $L_{pA}$** — 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.

**impulsive noise** — A noise that is of short duration (typically less than one second), the sound pressure level of which is significantly higher than the background.

**$L_{Aeq,T}$** — 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.

**$L_{AFN}$** — The A-weighted noise level exceeded for N% of the sampling interval. Measured using the "Fast" time weighting.

**$L_{AFmax}$** — is the instantaneous slow time weighted maximum sound level measured during the sample period (usually referred to in relation to construction noise levels).

**$L_{Ar,T}$** — The Rated Noise Level, equal to the $L_{Aeq}$ during a specified time interval (T), plus specified adjustments for tonal character and impulsiveness of the sound.

**$L_{AF90}$** — Refers to those A-weighted noise levels in the lower 90 percentile of the sampling interval; it is the level which is exceeded for 90% of the measurement period. It will therefore exclude the intermittent features of traffic and is used to estimate a background level. Measured using the "Fast" time weighting.

## APPENDIX A
## GLOSSARY OF ACOUSTIC TERMINOLOGY (Continued)

**$L_{AT}$(DW)** equivalent continuous downwind sound pressure level.

**$L_{fT}$(DW)** equivalent continuous downwind octave-band sound pressure level.

**low frequency noise** LFN - noise which is dominated by frequency components towards the lower end of the frequency spectrum.

**noise** Any sound, that has the potential to cause disturbance, discomfort or psychological stress to a person exposed to it, or any sound that could cause actual physiological harm to a person exposed to it, or physical damage to any structure exposed to it, is known as noise.

**noise sensitive location** NSL – Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels.

**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.

**rating level** See $L_{Ar,T}$.

**sound power level** The logarithmic measure of sound power in comparison to a referenced sound intensity level of one picowatt (1pW) where:

$$Lw = 10 Log \frac{P}{P_0} \text{ dB}$$

Where: p is the rms value of sound power in pascals; and

$P_0$ is 1 pW.

**sound pressure level** The sound pressure level at a point is defined as:

$$Lp = 20 Log \frac{P}{P_0} \text{ dB}$$

**specific noise level** A component of the ambient noise which can be specifically identified by acoustical means and may be associated with a specific source. In BS 4142, there is a more precise definition as follows: 'the equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval ($L_{Aeq, T}$)'.

## APPENDIX A
## GLOSSARY OF ACOUSTIC TERMINOLOGY (Continued)

| | |
|---|---|
| **tonal** | Sounds which cover a range of only a few Hz which contains a clearly audible tone i.e. distinguishable, discrete or continuous noise (whine, hiss, screech, or hum etc.) are referred to as being ‘tonal’. |
| **$^1/_3$ octave analysis** | Frequency analysis of sound such that the frequency spectrum is subdivided into bands of one–third of an octave each. |

# APPENDIX B
# NOISE MODELLING DETAILS

## Noise Model

A 3D computer-based prediction model has been prepared in order to quantify the noise level associated with the proposed building. This section discusses the methodology behind the noise modelling process.

## DGMR iNoise

Proprietary noise calculation software has been used for the purposes of this modelling exercise. The selected software, DGMR iNoise, calculates noise levels in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996*.

DGMR iNoise is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. Predictor calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of A weighted sound power levels ($L_{WA}$);
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m).

## Brief Description of ISO9613-2: 1996



ISO9613-2:1996 calculates the noise level based on each of the factors discussed previously. However, the effect of meteorological conditions is significantly simplified by calculating the average downwind sound pressure level, $L_{AT}$(DW), for the following conditions:

- wind direction at an angle of ±45° to the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and;
- wind speed between approximately 1ms$^{-1}$ and 5ms$^{-1}$, measured at a height of 3m to 11m above the ground.

The equations and calculations also hold for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear calm nights.

The basic formula for calculating $L_{AT}(DW)$ from any point source at any receiver location is given by:

$$L_{fT}(DW) = LW + Dc - A \qquad \textbf{Eqn. A}$$

Where:

$L_{fT}(DW)$ is an octave band centre frequency component of $L_{AT}(DW)$ in dB relative to $2x10^{-5}$Pa;
$L_W$ is the octave band sound power of the point source;
$D_c$ is the directivity correction for the point source;
A is the octave band attenuation that occurs during propagation, namely attenuation due to geometric divergence, atmospheric absorption, ground effect, barriers and miscellaneous other effects.

The estimated accuracy associated with this methodology is shown in Table B.1 below:

***Table B.1*** Estimated Accuracy for Broadband Noise of $L_{AT}(DW)$

| Height, h* | Distance, d† | |
|---|---|---|
| | 0 < d < 100m | 100m < d < 1,000m |
| 0<h<5m | ±3dB | ±3dB |
| 5m<h<30m | ±1dB | ±3dB |

* h is the mean height of the source and receiver. † d is the mean distance between the source and receiver.

N.B. These estimates have been made from situations where there are no effects due to reflections or attenuation due to screening.



### Input Data and Assumptions

The noise model has been constructed using data from various source as follows:

*Site Layout* The general site layout has been obtained from the drawings forwarded by MCA Architects.

*Local Area* The location of noise sensitive locations has been obtained from a combination of site drawings provided by MCA Architects and others obtained from Ordinance Survey Ireland (OSI).

*Heights* The heights of buildings on site have been obtained from site drawings forwarded by MCA Architects. Off-site buildings have been assumed to be 8m high for houses and 16m for apartments with the exception of industrial buildings where a default height of 15m has been assumed.

*Contours* Site ground contours/heights have been obtained from site drawings forwarded by MCA Architects where available.

Figure B1 presents a 3D render of the developed site noise model for the current proposals.

## Modelling Calculation Parameters[2]

Prediction calculations for plant noise have been conducted in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996*.

Ground attenuation factors of 0.5 have been assumed. No metrological corrections were assumed for the calculations. The atmospheric attenuation outlined in Table B.3 has been assumed for all calculations.

***Table B.3*** Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

| Temp (ºC) | % Humidity | Octave Band Centre Frequencies (Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| 10 | 70 | 0.12 | 0.41 | 1.04 | 1.92 | 3.66 | 9.70 | 33.06 | 118.4 |

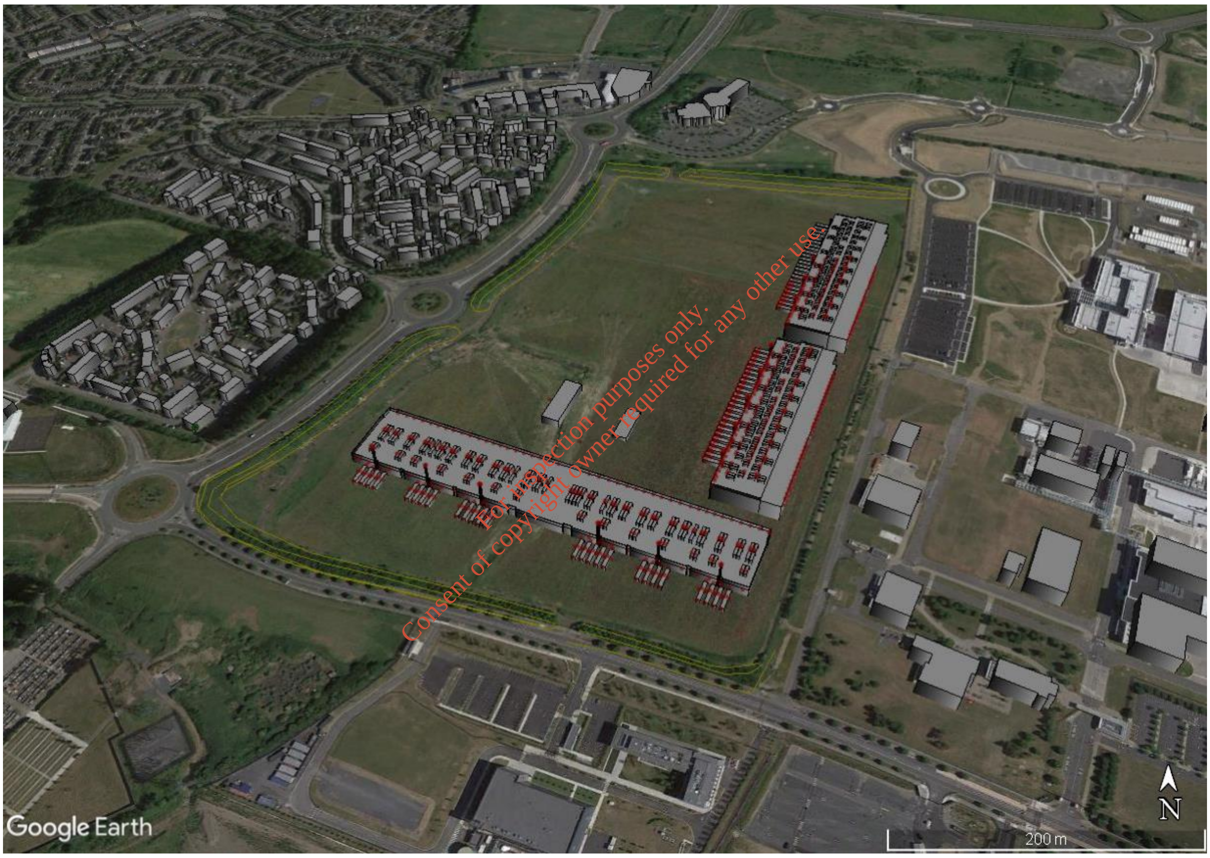



***Figure B1*** Images of Developed Noise Model – View of Site

2 See Appendix C for further discussion of calculation parameters.

# APPENDIX C
# NOISE MODELLING PARAMETERS

Prediction calculations for noise emissions have been conducted in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996*. The following are the main aspects that have been considered in terms of the noise predictions presented in this instance.

*Directivity Factor*: The directivity factor (D) allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measures in a down wind direction, corresponding to the worst-case propagation conditions and needs no further adjustment.

*Ground Effect:* Ground effect is the result of sound reflected by the ground interfering with the sound propagating directly from source to receiver. The prediction of ground effects is inherently complex and depend on source height receiver height propagation height between the source and receiver and the ground conditions. The ground conditions are described according to a variable defined as G, which varies between 0.0 for hard ground (including paving, ice concrete) and 1.0 for soft ground (includes ground covered by grass trees or other vegetation) Our predictions have been carried out using various source height specific to each plant item, a receiver heights of 1.6m for single storey properties and 4m for double. An assumed ground factor of G = 0.5 has been applied off site. Noise contours presented in the assessment have been predicted to a height of 4m in all instances. For construction noise predictions have been made at a level of 1.6m as these activities will not occur at night.



*Geometrical Divergence* This term relates to the spherical spreading in the free-field from a point sound source resulting in attenuation depending on distance according to the following equation:

$$A_{geo} = 20 \text{ x } \log \text{ (distance from source in meters)} + 11$$

*Atmospheric Absorption* Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation is dependent on the temperature and relative humidity of the air through which the sound is travelling and is frequency dependent with increasing attenuation towards higher frequencies. In these predictions a temperature of 10$^{o}$C and a relative humidity of 70% have been used, which give relativity low levels of atmosphere attenuation and corresponding worst case noise predictions.

***Table C1*** Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

| Temp ($^{o}$C) | % Humidity | Octave Band Centre Frequencies (Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| 10 | 70 | 0.12 | 0.41 | 1.04 | 1.92 | 3.66 | 9.70 | 33.06 | 118.4 |

*Barrier Attenuation* The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise.