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VOLUME I MAIN TEXT – CHAPTER 9 NOISE AND VIBRATION

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June 2024

9 NOISE AND VIBRATION

9.1 Introduction

This chapter outlines the noise and vibration impact assessment for the Project and assesses the potential impacts and likely significant effects of noise and vibration associated with the construction and operational phases of the Project.

During the construction phase, there is potential for noise and vibration impacts at the nearest noise-sensitive properties from the use of construction plant and equipment. The operational phase of the Project has the potential to impact nearby noise-sensitive receptors, due to noise sources such as plant and equipment, traffic movements and car parking.

The effects of construction and operational noise and vibration have been assessed within this noise and vibration chapter.

The construction noise targets are set out along with the assessment methodology and results of the construction noise predictions. Construction noise mitigation measures are detailed such that noise targets are met throughout the construction phases.

Operational noise has been assessed, and noise mitigation recommendations made where appropriate.

The specific objectives of the noise and vibration assessment are to:

- Describe the existing noise baseline;
- Define the assessment methodology and significance criteria used in completing the noise and vibration impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address the likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

This Chapter is supported by the following Volume III Technical Appendices:

- Appendix 9.1: Baseline Noise Monitoring Survey;
- Appendix 9.2: Construction and Operational Noise Sensitive Receptors;
- Appendix 9.3: Construction Noise Assessment and;
- Appendix 9.4: Noise Propagation Modelling Inputs and Results

Operational vibration affecting noise receptors has been scoped out as there are no known significant vibration sources associated with the Project. There are therefore no significant operational vibration impacts anticipated.

9.2 Methodology

9.2.1 Relevant Guidance

The noise and vibration impact assessment has followed the methodology set out in chapter 3: EIA Methodology. Specific to the noise and vibration impact assessment, the following guidance documents have also been considered:

- Institute of Environmental Management and Assessment (IEMA) Guidelines for Environmental Noise Impact Assessment (2014);
- World Health Organisation (WHO) – Guidelines for Community Noise (1999);
- British Standard BS4142:2014+A1:2019 Methods for Rating and Assessing Industrial and Commercial Sound;
- Design Manual for Roads and Bridges Volume 11, Section 3, Part 7, LA 111 Noise and Vibration;
- Guidelines for the Treatment of Noise and Vibration in National Road Schemes – National Roads Authority (now Transport Infrastructure Ireland);
- Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes;
- Calculation of Road Traffic Noise (CRTN) - Department of Transport Welsh Office 1988;
- British Standard BS 8233:2014 Sound Insulation and Noise Reduction for Buildings – Code of Practice;
- British Standard BS5228: 2009+A1:2014, Code of Practice of Noise and Vibration Control on Construction and Open Sites. Part 1: Noise;
- British Standard BS5228: 2009+A1:2014, Code of Practice of Noise and Vibration Control on Construction and Open Sites. Part 2: Vibration;
- Environmental Protection Agency (EPA) Guidelines on the Information to be contained in Environmental Impact Assessment Reports;
- British Standards BS 7445-1:2003 Description and Measurement of Environmental Noise – Part 1: Guide to Quantities and Procedures (BS, 7445-1)and
- ISO9613: Attenuation of Sound during Propagation Outdoors Part 2 General Method of Calculation.

9.2.1.1 Institute of Environmental Management and Assessment (IEMA) Guidelines for Environmental Noise Impact Assessment (2014)

IEMA noise impact assessment guidelines address the key principles of noise impact assessment and are applicable to all development proposals where noise effects are likely to occur.

The guidelines provide specific support on how noise impact assessment fits within the Environmental Impact Assessment (EIA) process. They cover:

- How to scope a noise assessment;
- Issues to be considered when defining the baseline noise environment;
- Prediction of changes in noise levels as a result of implementing development proposals; and
- Definition and evaluation of the significance of the effect of changes in noise levels (for use only where the assessment is undertaken within an EIA).

The guidelines define core methods and techniques, used within the noise impact assessment process, and endeavour to highlight their limitations, where relevant. They can be applicable to all stages of a project, from construction through operation to restoration and decommissioning.

9.2.1.2 World Health Organisation (WHO) Guidelines for Community Noise

In the World Health Organisation (WHO) Guidelines for Community Noise (1999), a L_{Aeq} threshold daytime noise limit of 55 dB is suggested for outdoor living areas in order to protect the majority of people from being seriously annoyed. A second daytime limit of 50 dB is also given as a threshold limit for moderate annoyance.

The guidelines suggest that an internal L_{Aeq} not greater than 30 dB for continuous noise is needed to prevent negative effects on sleep. This is equivalent to a façade level of 45 dB L_{Aeq}, assuming open windows or a free-field level of about 42 dB L_{Aeq}. If the noise is not continuous, then the internal level required to prevent negative effects on sleep is a $L_{Amax,fast}$ of 45 dB. Therefore, for sleep disturbance, the continuous level as well as the number of noisy events should be considered.

The WHO Night Noise Guidelines for Europe was published in 2009 on the back of extensive research completed by a WHO working group. Considering the scientific evidence on the threshold of night noise exposure indicated by $L_{night,outside}$ as defined in the Environmental Noise Directive [2002/49/EC], a $L_{night,outside}$ of 40dB should be the target of the night noise guideline (NNG) to protect public, including the most vulnerable groups such as children, the chronically ill and the elderly. An interim target of 55dB is recommended where the NNG cannot be achieved. These guidelines are applicable to Member States of the European Region and may be considered as an extension to the previous WHO Guidelines for Community Noise (1999).

In 2011, the WHO published the *Methodological Guidance for Estimating the Burden of Disease from Environmental Noise*. This document outlines the principles of quantitative assessment of the burden of disease from environmental noise, describes the status in terms of the implementation of the European Noise Directive and reviews evidence on exposure-response relationships between noise and cardiovascular diseases.

In 2018, the WHO Regional Office for Europe has developed guidelines, based on the growing understanding of health impacts of exposure to environmental noise. The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. Leisure noise in this context refers to all noise sources that people are exposed to due to leisure activities, such as attending nightclubs, pubs, fitness classes, live sporting events, concerts or live music venues and listening to loud music through personal listening devices.

The 2018 guidelines are published by the WHO Regional Office for Europe. In terms of their health implications, the recommended exposure levels can be considered applicable in other regions and suitable for a global audience.

9.2.1.3 British Standard BS4142:2014 Methods for Rating Sound and Assessing Industrial and Commercial Sound

BS4142:2014 describes methods for rating and assessing sound of an industrial and/or commercial nature at residential noise-sensitive receptors, which includes:

- Sound from industrial and manufacturing processes;
- Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- Sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

BS 4142 also provides procedures in determining if the noise in question is likely to give rise to complaints from residents in the vicinity.

BS 4142 states that one should '*obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level and consider the following:*

a. *Typically, the greater this difference, the greater the magnitude of the impact.*

b. *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*

c. *A difference of around + 5 dB is likely to be an indication of an adverse impact, depending on the context.*

d. *The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.*

The aforementioned rating level is based upon the specific noise level of the noise source in question. A correction should be applied to the specific noise level to obtain an increased rating level if ‘a tone, impulse or other characteristic occurs, or is expected to be present, for new or modified sound sources.

To summarise, BS4142 section 9.2 advises the following in regards to corrections for acoustic characteristics:

- Tonality – for sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0 dB and +6 dB for tonality. Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible and 6 dB where it is highly perceptible.
- Impulsivity – A correction of up to +9 dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level., Subjectively, this can be converted to a penalty of 3 dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible.
- Other sound characteristics – Where the specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.
- Intermittency – When the specific sound has identifiable on/off conditions, if the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.

9.2.1.4 Design Manual for Roads and Bridges Volume 11, Section 3, Part 7, LA 111 Noise and Vibration

This assessment is based on the guidance given in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 7, LA 111. This document sets out the requirements for noise and vibration assessments from road projects, applying a proportionate and consistent approach using best practice and ensuring compliance with relevant legislation.

9.2.1.5 Guidelines for the Treatment of Noise and Vibration in National Road Schemes – National Roads Authority (now Transport Infrastructure Ireland)

This document provides guidance on the treatment of noise and vibration during the planning and design of national road schemes and includes design goals, noise prediction methodology and other assessment guidance. The guidelines also reference other relevant guidance, such as CRTN.

9.2.1.6 Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes - National Roads Authority (now Transport Infrastructure Ireland)

The NRA’s Guidelines for the Treatment of Noise and Vibration in National Road Schemes, as revised by the National Roads Authority in October 2004, are based on the Authority’s phased approach to road scheme planning and development. They cover the Constraints, Route Corridor Selection and Environmental Impact Assessment stages.

The Guidelines also set out a “design goal” for noise to ensure that the current roads programme proceeds on a path of sustainable development. This Good Practice Guidance is intended to expand and supplement the advice already provided in the Guidelines on these matters.

The guidance outlines the recommended phases of acoustic design for national road schemes, as well as technical detail of noise monitoring, noise predictions and mitigation. In additional to operational road traffic noise and vibration, the document also provides guidance regarding construction noise and vibration.

9.2.1.7 UK Department of Transport (Welsh Office) – Calculation of Road Traffic Noise (CRTN)

This Calculation of Road Traffic Noise (CRTN) guidance document outlines the procedures to be applied for calculating noise from road traffic. The document consists of three different sections, covering a general method for predicting noise levels at a distance from a highway, additional procedures for more specific situations and a measurement method for situations where the prediction method is not suitable. The prediction method constitutes the preferred calculation technique but in a small number of cases, traffic conditions may fall outside the scope of the prediction method, and it will then be necessary to resort to measurement. The prediction method has been used in this instance to determine the likely noise impact from traffic flow increases as a result of the Project.

This guidance document has been referenced as it provides the prediction methods for determining road traffic noise.

9.2.1.8 British Standard 8233:2014 Sound Insulation and Noise Reduction for Buildings – Code of Practice

BS8233:2014 provides guidance values for a range of ambient noise levels within residential and commercial/industrial properties as shown in Table 9.1.

Table 9.1: Internal Ambient Noise Levels for Living Spaces

Activity	Location	07:00 – 23:00	23:00 – 07:00
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 $L_{Aeq, 8hr}$

The standard allows for a further relaxation in standards of up to 5dB where "development is considered necessary or desirable". In relation to external amenity areas such as gardens and patios, the standard states that it is desirable that external noise does not exceed 50 dB $L_{Aeq,T}$ with an upper guideline value of 55 dB $L_{Aeq,T}$.

This guidance document has been used as reference for the internal standard ambient noise levels to be achieved inside residential properties.

9.2.1.9 British Standard BS5228:2009+A1:2014 Noise and Vibration Control on Construction and Open Sites

This British standard consists of two parts and covers the need for protection against noise and vibration of persons living and working in the vicinity of construction and open sites. The standard recommends procedures for noise and vibration control during construction operations and aims to assist architects, contractors and site operatives, designers, developers, engineers, local authority environmental health officers and planners.

9.2.1.10 British Standard BS5228: 2009+A1:2014, Code of Practice of Noise and Vibration Control on Construction and Open Sites Part 1: Noise

Part 1 of the standard provides a method of calculating noise from construction plant, including:

- Tables of source noise levels;
- Methods for summing up contributions from intermittently operating plant;
- A procedure for calculating noise propagation;
- A method for calculating noise screening effects; and
- A way of predicting noise from mobile plant, such as haul roads.

The standard also provides guidance on legislative background, community relations, training, nuisance, project supervision and control of noise and vibration.

The ABC method outlined in Section E3.2 has been used for the purposes of determining whether the predicted noise levels from the construction activities will result in any significant noise impact at the nearest noise sensitive properties.

Table 9.2 outlines the applicable noise threshold limits that apply at the nearest noise sensitive receptors. The determination of what category to apply is dependent on the existing baseline ambient (LAeq) noise level (rounded to the nearest 5dB) at the nearest noise sensitive property. For weekday daytime, if the ambient noise level is less than the Category A threshold limit, the Category A threshold limit (i.e. 65dB) applies. If the ambient noise level is the same as the Category A threshold limit, the Category B threshold limit (i.e., 70dB) applies. If the ambient noise level is more than the Category A threshold limit, the Category C threshold limit (i.e., 75dB) applies.

Table 9.2: Noise Threshold Limits at Nearest Sensitive Receptors

	Threshold Limits [dB(A)]		
	Category A	Category B	Category C
Night-time (23:00 - 07:00)	45	50	55
Evening and Weekends (19:00 - 23:00 Weekdays, 13:00-23:00 Saturdays, 07:00-23:00 Sundays)	55	60	65
Weekday daytime (07:00-19:00) and Saturdays (07:00-13:00)	65	70	75

9.2.1.11 British Standard BS5228: 2009+A1:2014, Code of Practice of Noise and Vibration Control on Construction and Open Sites Part 2: Vibration

Part 2 of the standard gives recommendations for basic methods of vibration control relating to construction and open sites where work activities/operations generate significant vibration levels, including industry-specific guidance.

Human beings are known to be very sensitive to vibration, the threshold of perception being typically in the Peak Particle Velocity (PPV) range of 0.14 $mm \cdot s^{-1}$ to 0.3 $mm \cdot s^{-1}$. Vibrations above these values can disturb, startle, cause annoyance or interfere with work activities. At higher levels they can be described as unpleasant or even painful. In residential accommodation, vibrations can promote anxiety lest some structural mishap might occur. Guidance of effects of vibration levels are illustrated in Table 9.3 below.

Table 9.3: Guidance on Effects of Vibration Levels

Vibration Level	Effect
0.14 $mm \cdot s^{-1}$	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 $mm \cdot s^{-1}$	Vibration might be just perceptible in residential environments.
1.0 $mm \cdot s^{-1}$	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10 $mm \cdot s^{-1}$	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Limits of transient vibration, above which cosmetic damage could occur, are given numerically in Table 9.4 (Ref: BS5228-2:2009+A1:2014). Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 9.4, and major damage to a building structure can occur at values greater than four times the tabulated values.

Table 9.4: Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak Particle Velocity (PPV) (mm/s) in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings.	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above
Unreinforced or light framed structures. Residential or light commercial buildings.	15 mm/s at 4 Hz increasing to 20 mm/S at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.

This guidance document has been used for the assessment of construction noise from the Project.

9.2.1.12 Environmental Protection Agency (EPA) Guidelines on the Information to be contained in Environmental Impact Assessment Reports

The EPA Guideline on the Information to be contained in Environmental Impact Assessment Reports outlines the context and general approach for Environmental Impact Assessment, with detailed guidance for each aspect of the EIA and associated reporting.

9.2.1.13 British Standards BS 7445-1:2003 Description and Measurement of Environmental Noise – Part 1: Guide to Quantities and Procedures (BS, 7445-1)

British Standard BS7445 provides the framework within which environmental noise should be quantified. BS 7445: Part 1 provides guidance to quantities and procedures in relation to environmental noise monitoring. BS7445-1 states that sound level meters that are used should conform to specifications of Class or Type 1 (or Class or Type 2 as a minimum) as given in BESN 61672.

The Class of a noise level meter describes its accuracy as defined by the relevant international standards. Sound level meters are defined by International Standards such as IEC 61672-1:2013 (or BS EN61672-1:2003). These standards define a wide range of complex accuracy, performance and calibration criteria that instruments must meet to be fit for purpose. Within the Standard, there are two allowable levels of tolerance and these are known as Class 1 and Class 2. Class 1 is more accurate than Class 2.

These Class 1 and Class 2 tolerances are necessary as a way of dealing with variations in the instruments. The variations are caused by the different electronic components used inside the sound level meters and because of the way different meters have been designed and verified. Even the test equipment used to check the sound level meters during manufacture will introduce some variation.

All equipment shall be calibrated and the configuration for calibration shall be in accordance with the manufacturer's instructions. A comprehensive recalibration at certain time intervals (for example annually) may be prescribed by authorities responsible for the use of the measurement results. A field check shall be made by the user at least before and after each series of measurements, preferably including an acoustic check of the microphone

Meteorological conditions are not prescribed but it is recommended that wind speed should not exceed 5 m /s at height of 3-11m above ground, any temperature inversions near ground, or heavy precipitation.

9.2.1.14 ISO 9613 Attenuation of Sound during Propagation Outdoors Part 2 General Method of Calculation

ISO9613 (Part 2) specifies a methodology for calculating the attenuation of sound during propagation outdoors under meteorological conditions favourable to sound propagation. The standard applies to light downwind conditions and takes into account attenuation due to the following:

- Geometrical divergence;
- Atmospheric absorption;
- Ground effects:
- Reflection from surfaces;
- Screening by obstacles.

The ISO9613 methodology is used to predict equivalent continuous A-weighted sound pressure level (L_{Aeq}), including algorithms for octave-band source data from 63 Hz to 8 kHz. For this Project, ISO9613 has been implemented in CadnaA noise propagation modelling software. Further details are presented in Appendix 9.4.

9.2.2 Assessment Criteria and Assignment of Significance

9.2.2.1 Likelihood of Impacts

In keeping with the typical scope of an Environmental Impact Assessment (EIA), the emphasis of this noise and vibration chapter is on the assessment of the potential effects of the Project upon the surrounding environment (nearest noise-sensitive receptors) during the construction and operational phases.

As detailed in IEMA Guidelines for Environmental Noise Impact Assessment the following terminology and definitions are detailed as:

1. Noise Impact -The difference in the acoustic environment before and after the implementation of the proposals (also known as the magnitude of change). This includes any change in noise level and in other characteristics/features, and the relationship of the resulting noise level to any standard benchmarks.
2. Noise Effect -The consequence of the noise impact. This may be in the form of a change in the annoyance caused, a change in the degree of intrusion or disturbance caused by the acoustic environment, or the potential for the change to alter the character of an area such that there is a perceived change in quality of life. This will be dependent on the receptor and its sensitivity.
3. Significance of Effect -The evaluation of the noise effect and, particularly if the noise impact assessment is part of a formal EIA, deciding whether or not that impact is significant.

9.2.2.2 Receptor Sensitivity / Value

Sensitive receptors, in the context of noise and vibration, are typically residential premises but can also include schools, places of worship and noise-sensitive commercial premises. This is taken from the Scottish Government's Technical Advice Note (TAN) on Assessment of Noise, Table 2.1 Level of sensitivity associated with various examples of noise-sensitive receptors. Section 2.21 of TAN States

> "*There are three levels of sensitivity "high" "medium" and "low". The ranking is primarily based on the relationship between the amenity associated with a NSR and its susceptibility to noise.*"

TAN Chapter 2, Table 2.1 Level of Sensitivity Associated with Various Examples of Noise-sensitive Receptors provides sensitivity, description and examples of noise-sensitive receptors. Therefore, sensitivity of receptors, as defined in TAN has been used as reference criteria for sensitivity of receptors within this chapter.

Table 9.5 contains the general significance criteria that have been used for determining the level of impact associated with a particular aspect of the Project. Different aspects of noise from the Project (e.g. construction, plant/equipment, traffic etc.) are assessed using the different methodologies as described in the relevant guidance document. Where feasible, the significance criteria have been used in the various assessments included in this chapter having regard to the sensitivity of receptors.

Table 9.5: Receptor Sensitivity (Ref: TAN Assessment of Noise)

Sensitivity	Description	Examples of NSR
High	Receptors where people or operations are particularly susceptible to noise	Residential, including private gardens where appropriate. Quiet outdoor areas used for recreation Conference facilities Theatres/Auditoria/Studios Schools during the daytime Hospitals/residential care homes Places of worship
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance	Offices Bars/Cafes/Restaurants where external noise may be intrusive. Sports grounds when spectator noise is not a normal part of the event and where quiet conditions are necessary (e.g. tennis, golf, bowls)
Low	Receptors where distraction or disturbance from noise is minimal	Buildings not occupied during working hours Factories and working environments with existing high noise levels Sports grounds when spectator noise is a normal part of the event Night Clubs

Receptors expected to be affected by noise and vibration impacts from the Project are residential receptors who are deemed to be highly sensitive. The significance of the effect is determined as a function of the sensitivity of the receptor and the magnitude of impact/effect they are exposed to, as summarised below in Table 9.6.

9.2.2.3 Magnitude of Impact Criteria

The magnitude of impact will be determined for of each element of the noise and vibration assessment. Descriptions of each magnitude of impact are shown in Table 9.6.

Table 9.6: Definitions of Magnitude

Sensitivity	Descriptor
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse). Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial).
Medium	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements (Adverse). Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial).
Low	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements (Adverse). Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial).
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse). Very minor benefit to or positive addition of one or more characteristics, features or elements (Beneficial).

Details of how each noise assessment methodology relates for the magnitude of impact are shown in the sections below.

9.2.2.3.1 Construction Noise Magnitude of Impact

Construction noise comprises both plant noise and site traffic noise. The construction noise 'of effect' for this assessment refers to the '5dB change' method in BS5228-1:2009 2014 'Code of practice for noise and vibration control on construction and open sites – Part 1: Noise' which is summarised in Table 9.7.

BS 5228:2009+A1:2014 does not contain any significance criteria, although examples of how limits of acceptability have been applied historically and some examples of assessing significance are presented. In this case Example Method 2, which refers to change of 5 dBA in the ambient noise level, has been used to assess the effects at residential receptors.

The magnitude of construction noise impacts has been determined in accordance with Annex E of BS 5228-1:2009+A1:2014. The significance criteria for assessing noise impact from construction works have considered example Method 2 contained within Annex E.3.3 of BS 5228-1:2009+A1:2014, as referred indicates that:

"Noise levels generated by site activities are deemed to be potentially significant if the total noise (preconstruction ambient plus site noise) exceeds the pre-construction ambient noise by 5dB or more, subject to lower cut off values of 65dB, 55dB and 45dB L_{Aeq} from site noise alone, for the daytime, evening, and night-time periods, respectively, and a duration of one months or more, unless works of a shorter duration are likely to result in a significant effect."

For the majority of noise-sensitive receptors, pre-construction ambient noise levels are relatively low, resulting in the criteria set within the lower cut-off levels given in BS5228, applying the most stringent limits. As such the lower cut-off levels are used throughout the construction assessment to all noise-sensitive receptors.

This daytime threshold is mirrored when an ABC method of establishing construction noise criteria is followed. Typical daytime noise level (50 – 55 dBA) is less than the Category A threshold limit, therefore the Category A threshold limit (i.e. 65dBA daytime) applies. Note that, as construction will take place during the daytime only, evening and night-time criteria are not relevant to this Project.

This classifies the magnitude of effect based on the sound level difference between the ambient noise level with and without construction. This is calculated by finding the difference between the baseline ambient level and the total level (construction noise plus baseline ambient level) at each location.

Table 9.7: Magnitude of Impact: Construction Noise Daytime (Ref: BS 5228 Part 1)

Sound Level Difference between Ambient Noise and Total Noise (dB, L_{Aeq})	Total Daytime Noise Level (dB $L_{Aeq, 12h}$) (Ambient and Construction Noise)	Magnitude of Impact
< 0 dB	< 65 dB (lower cut-off level)	Negligible
0 - 5 dB	65 - 70 dB	Low
5 – 10 dB	70 –75 dB	Medium
> 10 dB	> 75 dB	High

On account of the temporary nature of construction activities, higher noise threshold limits apply to construction phase activities as compared to permanent operational phase activities.

9.2.2.3.2 Operational Noise Magnitude of Impact

Magnitude of impact can be determined with reference to the outcome of the operational noise assessments, which are categorised based on the type of noise source. Each assessment methodology implemented in this chapter and their associated assignments of magnitude of impact are shown below.

Plant and Equipment Noise

In the case of noise from plant and equipment, BS4142 offers an indication of magnitude of impact based on the predicted rating level relative to the existing background L_{90} sound pressure level. These should be taken in context and consider factors such as the receiving sound environment, the nature of the noise source and the noise-sensitive receptors.

BS4142 advises to obtain an initial estimate of impact of the specific sound by subtracting the measured background sound level from the rating level.

a. Typically, the greater this difference, the greater the magnitude of the impact.
b. A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
c. A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
d. The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.

Where the rating level does not exceed the background sound level, this is an indication of the sound source having a low impact, depending on the context.

How these BS4142 classifications align with the EIA magnitudes of impact/effect requires professional judgment. The assignment of the magnitude of impact should take in to account all pertinent factors, including absolute sound level, character and level of residual sound compared to that of the specific sound and the sensitivity of the receptors.

The IEMA guidelines cite several examples which highlight different changes in ambient noise level and the associated effect when taking into consideration various features of the noise source level and operation as well as the receiving environment. Once such example suggests the following criteria to describe the change in noise level exposure:

Table 9.8: IEMA Example of Noise Level Exposure Categorisation

	Large	Medium	Small	Negligible
Relative Change in Sound Level	Great than 10 dB(A)	5 to 9.9 dB(A)	3 to 4.9 dB(A)	2.9 dB(A) or less

These should be taken in the context of the individual site assessment, however they are a useful benchmark which reflects the phenomenon of human sound perception whereby an increase of 1 to 2 dB is not perceptible under normal conditions, with an increase of 3 dB typically the minimum perceptible change in noise levels.

Operational Traffic Noise

When considering operational traffic, 'magnitude of effect' is quantified by the long-term change in traffic noise level based on the guidance in the 'Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 7, LA 111, Noise and Vibration'.

As discussed in relation to Table 9.8, it is generally accepted that changes in noise levels of 1 dBA or less are imperceptible, and changes of 1 to 3dBA are not widely perceptible.

The operational traffic magnitudes of effect are given in Table 7.15.

Table 9.15: Magnitude of Impact: Operational Traffic

Change in Traffic Basic Noise Level (dB $L_{A10,18h}$ or L_{night})	DMRB Classification	Magnitude of Impact
Less than 3.0	Negligible	Negligible
3.0 - 4.9 dB	Minor	Low
5.0 - 9.9 dB	Moderate	Medium
10+ dB	Major	High

Car Parking

Although no specific criteria apply to car parking, absolute noise levels may be assessed using guidance provided in other relevant standards and guidance documents. The WHO Guidelines for Community Noise and BS8233 offer criteria for annoyance.

In the WHO guidelines, an L_{Aeq} threshold daytime noise limit of 55 dB is suggested for outdoor living areas in order to protect the majority of people from being seriously annoyed. A second daytime limit of 50 dB is also given as a threshold limit for moderate annoyance.

The WHO guidance is reflected in the BS8233 guidance values for a range of ambient noise levels within residential properties as shown in Table 9.9 The BS8233 values, assuming an open window providing 10-15 dB attenuation, are broadly in line with the WHO external guidance values.

Magnitude of Impact has been determined based on the WHO external L_{Aeq} criteria, as shown in Table 9.16.

Table 9.16: Magnitude of Impact: External Noise Levels

External $L_{Aeq,\ 1hr}$, dB (Daytime)	WHO Classification	Magnitude of Impact
<50	Few People Moderately Annoyed	Low
50 – 55	Few People Seriously Annoyed	Medium
55 +	-	High

The impact of L_{AMax} sound pressure levels due to the impulsive noise associated with car doors slamming will take into account the relevant criteria within WHO guidance and BS8233. These criteria primarily apply to the night-time period, therefore defined criteria levels and equivalent magnitude of impact have not been presented for daytime L_{AMax} assessment.

9.2.3 Significance of Effects

Following the identification of receptor importance and magnitude of the effect, it is possible to determine the significance of the effect.

The significance of effect is determined as a function of the sensitivity of the receptor and the magnitude of impact the receptor is exposed. The significance of effects for receptors of high sensitivity are summarised in Table 9.17.

Table 9.9: Assessment of Significance Matrix

Sensitivity	Magnitude of Impact			
	Negligible	Low	Medium	High
Negligible	Negligible	Negligible or minor	Negligible or minor	Minor
Low	Negligible or minor	Negligible or minor	Minor	Minor or moderate
Medium	Negligible or minor	Minor	Moderate	Moderate or major
High	Minor	Minor or moderate	Moderate or major	Major

Definitions are shown below in relation to the Matrix in Table 9.17.

- ***Substantial***: Only adverse effects are normally assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
- ***Major***: These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.
- ***Moderate***: These beneficial or adverse effects may be important, but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse effect on a particular resource or receptor.
- ***Minor***: These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process but are important in enhancing the subsequent design of the project.
- ***Negligible***: No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

Following initial assessment, if the impact does not require additional mitigation (or none is possible), the residual impact will remain the same. If, however, additional mitigation is proposed there will be an assessment of the post-mitigation residual impact.

9.3 Characteristics of the Project

The EIAR is provided in support of the Project which comprises of two main elements, namely:

(a) The Data Centre, comprising 6 no. two storey Data Centre buildings, an administration/management building, car parking, landscaping, energy infrastructure and other associated works.

(b) The substation, comprising a grid substation and 110kV transmission connection.

9.4 Baseline

Total site area of the subject site of the Project is 38.64 ha, The subject lands are located on the western side of the M7 motorway, positioned between Junctions 9a and 10. The site is bound to the north by the R409 road which provides a direct link to the centre of Naas, c.2.5km to the east.

There has been significant development in the locality in recent years, particularly light industry, logistics and services. The site is located between the existing 'M7 Business Park' and 'Osberstown Business Park'. The Osberstown Wastewater Treatment Plant is located nearby to the north. The site is bounded to the east by the M7 motorway and to the west by agricultural lands. The 'Newhall Retail Park' is located to the south of the site, on the east side of the M7 motorway.

The site is currently in agricultural use and comprises a number of fields which are bounded by hedgerows, mature and semi-mature trees. A watercourse, the *Bluebell Stream*, is located to and bounds the southern boundary of the Project site.

9.4.1 Noise Sensitive Receptors

Noise-sensitive receptor locations were obtained from aerial imagery and mapping. The noise-sensitive receptor locations[1] are shown in Volume III, Appendix 9.2, as a list of their identification references (ID's), and location coordinates. These receptors are relevant to both construction and operational phases.

All noise-sensitive receptors identified within the noise and vibration study area are residential properties. 42 properties in the vicinity of the Project Site have been selected as noise-sensitive receptors. All receptors at a greater distance from the Project are expected to experience a lower noise impact than the 42 receptors included in this noise impact assessment.

9.4.2 Baseline Noise Monitoring Survey

9.4.2.1 Survey Methodology

A baseline noise monitoring survey consisting of attended and unattended noise measurements was conducted within the vicinity of the Project Site.

The noise monitoring locations (NML) were chosen to be representative of the closest noise receptors in the vicinity of the Project site. The purpose of the noise monitoring survey was to determine the representative baseline noise levels at the nearest noise sensitive receptors and to assess these levels in accordance with the relevant guidance to inform the following assessments:

The details of the unattended noise monitoring surveys including a description of the noise monitoring locations, date, time and sound level meter used are summarised in Table 9.18.

[1] (N. B. Addresses of the construction noise receptors have not been included due to General Data Protection Regulations (GDPR) and publication of personal data).

Table 9.18: Unattended Noise Monitoring Summary

Noise Monitoring Location	Description of Noise Monitoring Location	Date Range	Sound Level Meter
NML 1	In a field at the northern side of the site boundary, to the east of 2 houses on Carragh Road.	02/02/2023 – 09/02/2023	Norsonic 140
NML 2	In a field at the north western corner of the site boundary, close to Carragh Road.	02/02/2023 – 09/02/2023	Rion NL-52
NML 3	In a field at the south western boundary of the site	02/02/2023 – 09/02/2023	Norsonic 140
NML 4	To the south west of the site boundary, adjacent a residential property located on the L2030 Newhall Road	12/06/2023 – 20/06/2023	Larson Davis LXT
NML 5	To the west of the site boundary, adjacent a farming/residential property on the R409 Road	12/06/2023 – 20/06/2023	Larson Davis LXT

Noise measurements were made with a microphone height of 1.2 – 1.5 m above ground level. Noise data was captured in 15-minute time intervals. The weather conditions were in accordance with the requirements of ISO 1996: *Acoustics - Description, Measurement and Assessment of Environmental Noise*.

The following parameters were recorded during each monitoring period:

L_{Aeq} The continuous equivalent A-weighted sound pressure level. This is an ‘average’ of the sound pressure level

L_{Amax} This is the maximum A-weighed sound level measured during the sample period

L_{Amin} This is the minimum A-weighted sound level measured during the sample period

L_{A10} This is the A-weighted sound level that is exceeded for noise for 10% of the sample period

L_{A90} This is the A-weighted sound level that is exceeded for 90% of the sample period

The ‘A’ suffix for the noise parameters 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 pressure levels in this report are expressed in terms of decibels (dB) relative to $2x10^{-5}$ Pa.

Further details of the noise monitoring methodology, instrumentation, photographs, calibration certificates and results are illustrated in Volume III, Appendix 9.1.

9.4.2.2 Baseline Noise Monitoring Results

The results of the baseline noise monitoring are summarised in Table 9.19, including daytime and night-time periods. Note that the averaging time for daytime sound pressure levels was 1hr, with night-time samples taken over 15-minute periods. These results show the 'typical' background (L_{A90}) and ambient (L_{Aeq}) sound pressure level at each noise monitoring location, following detailed analysis of the survey results.

Table 9.10: BS4142 Assessment Background Sound Level Summary

Noise Monitoring Location	Sound Pressure Level, dB L_{A90}		Sound Pressure Level, dB L_{Aeq}	
	Daytime	Night-time	Daytime	Night-time
1	58	44	59	52
2	51	41	57	48
3	49	40	51	44
4	44	41	47	46
5	46	42	50	44

9.4.3 Baseline Traffic Survey

As per Chapter 12: Traffic and Transportation, baseline traffic flow surveys were carried out to determine the existing levels of traffic on the surrounding road network. The surveys were undertaken at the following locations:

- North Arm of the Millennium Roundabout; and
- West Arm of the Bundle of Sticks Roundabout.

These surveys were undertaken on 18th January 2023 between 0700 – 1000 and 1600 – 1900 hours. The surveyed traffic flows, which represent weekday morning and evening peak traffic flows are summarised in Table 9.20 below.

Table 9.20: Baseline Traffic Survey Analysis Summary

	Location 1 – Bundle of Sticks R'about	Location 2 – Millennium Park R'about
18th January 2023 07:00 – 10:00 hrs		
Minimum no. vehicle movements in any 1-hour period	1042	791
Maximum no. vehicle movements in any 1-hour period	1660	1183
Total Vehicle Movements	4069	2949
18th January 2023 16:00 – 19:00 hrs		
Minimum no. vehicle movements in any 1-hour period	1143	877
Maximum no. vehicle movements in any 1-hour period	1825	1252
Total Vehicle Movements	4697	3302

9.5 Impact Assessment

The noise and vibration impact assessment considered the following aspects of environmental noise:

- Assessment of construction noise and vibration impact (with reference to BS5228[2]).
- Assessment of operational noise relative to existing background sound levels (with reference to BS4142[3]);
- Assessment of absolute operational noise levels (with reference to e.g BS8233[4], World Health Organisation Guidance);

There are no significant sources of operational vibration associated with the Project. Gas turbines and gas generators are supplied within bespoke enclosures and fitted with anti-vibration mounts onto concrete slab, which are designed to reduce noise and vibration emissions. As equipment is not expected to cause significant levels of vibration at source (and therefore at receptors), operational vibration has been scoped out of the noise and vibration impact assessment.

The functional interdependence that exists between the Project and the GNI Gas Connection dictates the need for a cumulative assessment to be undertaken of the required gas infrastructure works. For noise, this includes the construction phase only, as there is no operational noise associated with the gas connection.

9.5.1 Construction Noise and Vibration Effects

The likely significant noise impacts have been considered for the construction activities. The predicted construction noise effects are assessed in accordance with BS 5228 threshold limits. The proposed construction works will include construction activities which have the potential to impact the noise environment such as piling and excavation.

The Construction Environmental Management Plan (CEMP) includes a requirement for a Noise Management Plan (NMP), Traffic & Navigation Management Plan (TNMP) and a Method Statement (MS) to be prepared by the successful Contractor after Contract Award and provided by Kildare County Council.

The Planning Schedule of Conditions should include a requirement for a NMP, TNMP & MS prior to construction commencing in the usual manner.

During the construction phase, the methods of working will comply with all relevant legislation and best practice in reducing the environmental impacts of the proposed works. By their nature, construction phase impacts will be short-term and localised. These impacts will be reduced as far as practicable through compliance with the mitigation measures identified within this EIAR and the relevant industry standards and guidelines.

The proposed construction phasing, noise predictions and the applicable BS 5228 noise limits are detailed in Volume III, Appendix 9.3.

It is anticipated that construction will take place over a period of approximately 9 years. Noise impacts identified in the construction noise assessment have considered worst-case construction scenarios. The noise impacts will not be continuous and will vary by phase and by construction activity or combination of activities taking place.

9.5.1.1 Construction Phasing, Duration and Hours

The programme of construction for the Project has been developed whereby construction is expected to last for just over under 9 years. The works will be undertaken in a ten-stage programme, commencing on completion of the tender processes and the discharge of pre-commencement planning conditions. Table 9.21 provides a high-level breakdown of the program by the key construction stages, with an assumed start date of January 2025, for indication only.

[2] BS5228:2009: Noise and Vibration Control on Open Construction Sites

[3] BS4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound

[4] BS8233:2014 Sound Insulation and Noise Reduction for Buildings – Code of Practice

Table 9.21: Indicative Construction Programme

Phase	Overall Construction Programme	08/01/2025	27/09/2033
Phase 1	Enabling Works Overall Construction Programme	08/01/2025	27/07/2025
	ESB Substation Overall Construction Programme	01/06/2025	28/03/2026
	AGI Building Overall Construction Programme	01/06/2025	28/07/2026
	DC 1 Overall Construction Programme	01/06/2025	17/07/2027
	DC 2 Overall Construction Programme	16/07/2026	01/09/2028
Phase 2	DC 3 Overall Construction Programme	31/08/2027	16/10/2029
	DC 5 Overall Construction Programme	15/10/2028	30/11/2030
Phase 3	DC 6 Overall Construction Programme	27/11/2029	13/07/2032
	DC 4 Overall Construction Programme	11/01/2031	27/08/2033
	Site Wide Works Overall Construction Programme	01/03/2032	27/09/2033

The proposed site working hours will be as follows:

- 0800 to 1800 hours on Mondays to Fridays.
- 0800 to 1300 hours on Saturdays.
- No working on Sunday or Bank Holidays unless authorised by the Kildare County Council.

Peak traffic periods (0800-0900 and 1700-1800 hours on Monday to Friday and 1500-1600 hours on Saturdays) will be avoided wherever possible when booking delivery vehicles.

Where additional or alternative working hours are required, a request for derogations to work outside the permitted working hours will be submitted to KCC at least five working days in advance. The request will be supported by a detailed case including an Engineering report explaining the requirement to work outside the permitted working hours and listing proposed dates with commencement and finishing times.

All affected residents and stakeholders shall be notified on receipt of any approved derogations including the rationale for the extended working hours.

9.5.1.2 Construction Activities

The key construction activities and associated noise sources are shown below:

Demolition

The existing dwellings and farm buildings on this site will require demolition. Demolition will be undertaken using mechanical plant and craneage.

Vegetation Clearance

Primary noise sources associated with Vegetation clearance are expected to be chainsaws, excavators/tracked excavators and lorries to remove vegetation for processing/repurposing or disposal.

Earth Works

Cut and fill earth works are expected to involve noise sources such as dozers, tracked excavators, lorries and loaders.

Piling and Excavation

Bored piles are to be installed for the new building foundations. In terms of noise impact, the bored piling technique is generally more favourable than percussive piling, however there are several noise sources associated with the bored piling method which must be considered, including:

- Crane
- Drilling rig
- Concrete pump
- Excavators

Data Centre Buildings sub-structure, super-structure and fit-out

Construction of substructure will require installation of several cranes at the beginning of the phase, then laying of concrete floor slab and core. Primary noise sources associated with these operations are cranes, concrete mixers and lorries.

Construction of the building frames will use standard hot rolled steel girders tied into steel columns and the flooring will be metal deck slab with concrete. The girders will be brought by lorry to the site and loaded from the loading area in the site.

Noise sources for this construction operation will include lorries, cranes, concrete mixers, and hand tools.

9.5.1.3 Construction Noise Effects

Construction noise sources will include plant and equipment activity on site, as well as construction traffic noise; materials and staff traveling to and from the Project construction site. The effect of noise at noise-sensitive receptors during construction activities will be highly dependent upon the particular construction activities, techniques, equipment occurring simultaneously, as well as the location of works and the number of activities/items of plant and equipment in use. There will also be wide variations in noise impact across the construction programme.

The proposed construction phasing shown in Table 9.15 indicates, in broad terms, which construction stages are likely to overlap within each phase and the construction phase map (please see Appendix 9.3) shows approximate locations for each of the construction phases.

The construction activities which are likely to be employed during each phase have been used to predict the received sound pressure levels at the closest noise-sensitive receptor to the construction activity. The source data and assumptions used for the construction noise predictions are detailed in Appendix 9.3.

These indicative predictions apply to a single item of each equipment/plant type and are intended to enable a review the of proposed activities and identify potential noise sources associated with the construction programme which may have an adverse impact. Using these predictions, the, activities, time periods or locations of construction activity with the potential to negatively affect noise-sensitive receptors are highlighted. This is useful for recommending suitable construction noise mitigation measures and to inform a construction noise management plan.

The results of the construction noise predictions, which can be found in Appendix 9.3, are summarised in Table 9.22 for each stage of the three phases. Predictions show indicative results for 50% and 100% utilisation of one of each individual item of plant and equipment within each stage.

Table 9.22: Construction Noise Modelling Results Summary

		Predicted Sound Pressure Level at Closest Receptor, dB $L_{Aeq,T}$ 100 % Utilisation	50 % Utilisation
Phase 1	Enabling Works Overall Construction Programme	83	80
	ESB Substation Overall Construction Programme	61	58
	AGI Building Overall Construction Programme	68	65
	DC 1 Overall Construction Programme	61	58
	DC 2 Overall Construction Programme	60	57
Phase 2	DC 3 Overall Construction Programme	63	60
	DC 5 Overall Construction Programme	61	58
Phase 3	DC 6 Overall Construction Programme	60	57
	DC 4 Overall Construction Programme	70	67
	Site Wide Works Overall Construction Programme	64	61

Construction noise criteria has been derived from the BS5228 ABC method. The typical daytime noise level (50 – 55 dBA) is less than the Category A threshold limit, therefore the Category A threshold limit (i.e. 65dBA) applies.

The highest predicted sound pressure levels at the closest receptor are associated with the site preparation works within Phase 1, which has been assumed to include high-noise activities such as rock breaking. During site preparation works at the closest receptor, exceedance of the 65 dBA construction noise threshold is predicted. This is a worst case in terms of proximity of plant to receptors and the predicted level at all other receptors will be lower. Site preparation works are expected to be complete within the first 6 months of the construction programme and would therefore be considered to be short-term temporary works. Higher construction noise levels are more likely to tolerated if they are of a temporary nature.

The majority of the construction works programme will involve the erection of the Data Centre buildings and the associated fit-out, with each building constructed over a period of approximately 2-3 years. The construction noise predictions show that noise levels for building construction are expected to be highest during construction of DC4. Noise levels from during construction of DC4 are predicted to be higher than those for other buildings due to the proximity of DC4 to receptor 1. It should be noted noise sources have not been defined or quantified at this stage, therefore the absolute levels here are not truly representative but nevertheless, relative predicted noise levels can be informative and provide a focus for noise mitigation measures and construction programme planning.

Predicted construction noise levels for some construction activities and processes are expected to exceed the construction noise threshold of 65 dBA. For singular items of plant and equipment in use, this included site preparation, in particular rock breaking, and construction of Data Centre building 4 (DC4), due to its close proximity to receptor 1.

The predicted sound pressure levels, assuming operation of single items of plant and equipment, are at least 60 dBA in all phases/stages of construction. The combination of multiple construction noise sources and concurrent construction activities, stages and phases is likely to give rise to an increase of 5 dB at receptors, therefore exceeding the criterion level of 65 dBA at time during construction.

Significant construction effects could arise from a multitude of combinations of noise sources throughout the construction programme. These should be taken into consideration when developing the construction noise management plan, with mitigation employed as necessary. This is discussed further in Section 9.5.5 Mitigation.

9.5.1.4 Construction Traffic Noise Effects

The effect of construction traffic noise has been assessed in the context of the existing environment. Construction traffic will be managed in terms of access routes and delivery scheduling. Full details can be found in Volume III, Appendix 4.6 Construction Traffic Management Plan.

Transportation of Materials

Numerous types of delivery vehicles will be used to bring materials to and from the site. These will typically include:

- Muck away wagons for soil arising's from foundations.
- Skip lorries. These will include standard 8-yard skips for waste (approx. size 7m long and 2.4m wide.
- Ready mix concrete lorries. (approx. size 8.25m long and 2.45m wide).
- Flatbed delivery vehicles for the delivery of various materials including scaffolding, steelwork, reinforcement, bricks/blocks, timber, roofing materials, plaster, joinery etc. (approx. size 8.5m long and 2.45m wide).
- Articulated Lorries, for delivery of steel framing, cladding components, reinforcement, major M&E plant and materials, tower cranes and other major plant and equipment.

The projected vehicle movements are approximately 47 per day during the main contract works/ peak construction period (and will be considerably less outside of these peak periods of construction).

Staff Trips

The forecast for these busiest construction months (months 7 and 30) an estimated maximum of 1100 construction staff will require to travel to and from the site per day. Based on all construction staff travelling by car, with an average of 1.5 staff to each car. This will result in 733 car trips to and from the site per day, with estimated 40% (293 car trips) travelling to and from the site during the traditional peak hours. It is estimated that site staff will generate 425 car trips on an average day, with 175 travelling during the traditional peak hours.

The effect of construction traffic noise on receptors will vary and depend upon traffic volumes relative to the existing baseline and the time of day that vehicles arrive or depart. Existing traffic flows are shown in Table 9.15 with further details of existing traffic available in Chapter 12: Traffic and Transportation.

Construction staff travelling to and from site are expected to generate an additional 175 trips during peak hours. It is anticipated that there will be 47 delivery vehicles travelling to and from the site daily, with 7 of these occurring during the peak hour.

Construction Traffic Noise Assessment

As a worst-case, it is assumed that all 54 vehicle movements occur within the peak traffic period with the minimum number of vehicles surveyed (791 in any 1-hour period). An increase of 54 vehicles within this 1-hour period would equate to a <7 % increase in traffic during the peak traffic period. This increase is temporary and worst-case for the construction period only.

HD213/11, part of the Design Manual for Road and Bridges states that it takes a 25% increase or a 20% decrease in traffic flows in order to get a 1 dBA change in traffic noise levels. On this basis, the change in traffic noise levels associated with all road links during the operational phase of the Project will be significantly less than 1dB(A).

The NRA (now TII) guidelines for the Treatment of Noise and Vibration in National Road Schemes state that it takes an approximate 3 dB(A) increase in noise levels to be perceptible to the average person, therefore the likely effect of construction traffic noise increases on all other roads local road network will be imperceptible.

9.5.1.5 Construction Vibration Effects

At this stage, prior to planning consent and appointment of a contractor, there is insufficient detail available to conduct a full analysis of vibration effects. Further assessment of construction vibration should be carried out when construction methodology is finalised. It is expected that any vibration effects are most likely to arise from activities such as piling and demolition. It is understood that rotary bored piling will be employed. Although this piling technique tends to generate lower levels of vibration than pile driving, transient vibrations can also occur when the auger strikes the base of the borehole. If it is necessary to insert an appreciable length of temporary casing to support the boring, a casing dolly can be used and, as with the impact bored piling method, this will give rise to intermittent vibrations. The use of special tools, such as chisels, will also result in intermittent vibrations.

Assessment of construction vibration should reference thresholds for building damage are higher than threshold for human perception so the effect and significance of vibration levels should be set based on human perception thresholds.

9.5.1.6 Construction Noise and Vibration Impact Assessment Summary

Construction noise predictions were calculated for each construction activity as detailed in Volume III Appendix 9.3. Construction noise criteria has been derived from the BS5228 ABC method. The typical daytime noise level is less than the Category A threshold limit, therefore the Category A threshold limit (i.e. 65dB) applies.

There is potential for significant construction noise impacts at the nearest noise sensitive receptors if worst-case construction activities take place without mitigation measures in place. While BS 5228:2009+A1:2014 does not contain significance criteria the exceedance of the daytime noise threshold limit of 65dB(A) by 15 dB(A) would equate to a temporary major adverse impact during the time that such activities are carried out simultaneously at the Project site boundary.

While construction works will extend over a period of years, the duration over which noise will be produced in the vicinity of any individual receptor or group of receptors will be for shorter periods. Work generating peak levels of noise will be carried out intermittently over this time and will not be constant for those periods. Nevertheless, on the basis of the predicted worst-case construction noise levels from the Project, it is clear that there will be a requirement for mitigation measures to be put in place in order to ensure that construction noise levels are reduced as much as practicable. The target for mitigation measures is a reduction in daytime construction noise to achieve the daytime noise threshold limit of 65dB(A)

Noise mitigation measures for construction activities are outlined in section 9.5.5.

9.5.2 Operational Noise and Vibration Effects

Details of the Project are outlined in Chapter 4: Description of the Project. The operational aspects of the Project which have potential to generate noise have been assessed in accordance with the appropriate guidance and standards outlined in Section 9.2.1 and include:

- Assessment of operational plant and equipment noise;
- Assessment of operational traffic noise;
- Assessment of car parking noise.

9.5.2.1 Assessment of Operational Plant and Equipment Noise

Predicted operational noise levels from the Project Site have been assessed relative to the existing noise environment using the methodology within BS4142:2014 and IEMA Guidelines. In order to carry out these assessments, a detailed acoustic model of all operational plant and equipment has been developed, with noise levels at receptors predicted for worst-case operational scenarios during daytime and night-time periods. A summary of the operational noise model inputs is shown in the sections that follow. For full details, please refer to Appendix 9.4: Noise Propagation Modelling.

9.5.2.1.1 Plant and Equipment Noise Modelling

Noise levels have been predicted at receptors for the operational plant and equipment associated with the Project. An acoustic model has been developed which includes all primary plant and equipment noise sources as follows:

- Data Hall Cooling System
  - AHU air intake fans;
  - AHU exhaust fans.
- Power Generation
  - Gas turbines including exhaust stack (as per operating scenario);
  - Gas engines including exhaust stack;
  - Battery storage inverters.
- 110kV substation.

Sound pressure levels during operation of plant and equipment have been predicted at the 42 representative noise-sensitive receptors, as detailed in Volume III Appendix 9.2. All noise model inputs and assumptions can be found in Volume III Appendix 9.4: Noise Propagation Modelling.

Operational Scenarios

The Project will operate 24/7. Operational scenarios have assumed that all 56no. duplex Air Handling Units (AHUs) will operate continuously through the daytime and night-time periods. Operating conditions which have the greatest influence on the noise output from the Project are the gas turbines and gas engines within the external plant compound.

The power requirements of the Data Centres will typically be met by a minimum of 30% renewable energy from wind/solar farms annually. The remaining energy demands will be fulfilled by a combination of gas turbines and reciprocating gas engines. As such, the number of gas turbines and engines will be variable.

To ensure that the worst-case daytime and night-time noise scenarios have been considered, the noise output from various combinations of gas turbines and engines was considered. This only included actual scenarios where the power requirements were being met. The worst-case power scenarios are typically situations where renewable energy was not readily available and the power generation plant is more heavily relied upon to power the Data Centres. The worst-case power generation scenario has been identified for both daytime and night-time noise and summarised in Table 9.23.

These power generation operating conditions will apply to a small percentage of the total operating time, with power generation noise outputs at all other times lower than those assumed.

Note that these scenarios consider operational noise from all 6 Data Centre buildings operating simultaneously, with the assumptions and operating conditions applicable to all 6 buildings.

All other plant and equipment noise sources are assumed to be operating with a 100% on time in each noise model scenario.

Table 9.23: Operational Noise Model Power Scenarios

	No. of Gas Turbines Operating per DC Compound	No. of Gas Engines Operating per DC Compound	No. of BESS Inverters Operating per DC Compound
Worst-Case Daytime Power Scenario	8	0	40
Worst-Case Night-Time Power Scenario	7	0	35

Noise Modelling Results

Noise modelling results for each of the 42 noise-sensitive receptors are presented in Volume III Appendix 9.4 for both daytime and night-time worst-case operations. Predicted sound pressure level contours maps are in Volume II (Figures 9.1 – 9.3).

The predicted daytime and night-time sound pressure level at each receptor represent the BS4142 Specific Sound Level for daytime and night-time.

9.5.2.1.2 BS4142:2014 Assessment

An assessment has been conducted of received sound levels due to operational plant and equipment noise compared with the existing sound environment. This assessment has been carried out using the methodology described in BS4142:2014, which involves comparison of predicted received level of the proposed noise source (Specific Sound Level L_{Aeq}) with the existing Background Sound Level (L_{A90}) to determine if there is likely to be a noise impact. Acoustic features associated with the proposed noise source are subject to a penalty which is added to the Specific Sound Level to determine the Rating Level. Further details of this assessment methodology can be found in 9.2.1. The BS4142 assessment process and outcome are presented below.

Specific Sound Level

The specific sound level of the external plant and equipment associated with the Project has been predicted based on the available acoustic data, as detailed in Volume III Appendix 9.4. The worst-case specific sound level has been predicted for the 42 closest residential properties to the Project site boundary.

Acoustic Feature Correction

Tonality

With regards to tonality, BS4142:2014 states: "*For sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0 dB and +6 dB for tonality. Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible and 6 dB where it is highly perceptible*."

The bespoke acoustic enclosures and silencers which have been installed across the site have been designed to reduce noise emissions and tonality from plant and equipment and manufacturer data for all items of plant and equipment show no indication of tonality. The substation has been considered as a potentially tonal noise source, however the contribution of substation noise to predicted sound pressure levels in negligible at all noise-sensitive receptors, therefore any tonality would not be audible or distinguishable at receptors. Therefore, no penalty for tonality has been applied.

Impulsivity

With regards to impulsivity, BS4142:2014 states: "*A correction of up to +9dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively this can be converted to a penalty of 3dB for impulsivity which is just perceptible at the noise receptor, 6dB where it is clearly perceptible, and 9dB where it is highly perceptible*."

Impulsivity is not considered to be a relevant sound characteristic of the Project noise sources.

Intermittency

The intermittency of the sound source needs to be considered when it has identifiable on/off conditions with regards to intermittency, BS4142:2014 states: "*If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied*."

The dominant sources associated with the Project are the gas turbines/gas engines and the AHU fans. All of these are steady-state noise sources which will operate continuously daytime and night-time, constantly monitored and carefully controlled. The number of gas turbines or gas engines required will vary with factors such as renewable energy requirements and ambient temperature. When turbines or engines are brought online, this procedure will be carefully carried out with an inherent soft-start as equipment works up to operational capacity. Similarly, when equipment is taken offline, this will not be a step down, but rather a ramping down of power and therefore of noise level.

It is not expected that any noise source associated with the Project will be intermittent. As such, no intermittency correction has been applied.

Overall Acoustic Feature Correction

No additional acoustic characteristics have been identified as relevant for the proposed noise sources. Therefore, the overall acoustic feature correction is 0 dB.

Rating Level

The rating level is the specific sound level with the addition of any relevant acoustic feature correction. As no acoustic feature corrections apply to the Project; the rating level is equal to the specific sound level.

Background Sound Level

The background sound level for each receptor has been established from the results of the baseline noise monitoring survey, as described in Volume III Appendix 9.1.

One of the five Noise Monitoring Locations (NMLs) has been assigned to each noise-sensitive receptor, as detailed in Volume III Appendix 9.2. The selection of representative NML has been based on both distance between NML and receptor (typically the closest NML representing a receptor), and also on proximity to existing noise sources. With road traffic noise the predominant noise source in the vicinity of the Project, distance from the M7 motorway and industrial developments close to the M7 was carefully considered when electing a representative NML for each receptor. For the purposes of the assessment, the background sound level L_{A90} for the representative NML was adopted for each noise-sensitive receptor.

Daytime BS4142 Assessment

The assessment of daytime operational plant and equipment noise, as per BS4142, is shown in Table 9.24. The rating level at all 42 receptors has been compared with the representative background sound level to show the excess over background. Where the excess over background is negative, the predicted sound pressure level is below the existing background sound level.

The results are shown by receptor and have been ordered by 'excess over background', with the predicted level closest to the existing background in the first row of the table.

Table 9.24: Daytime BS4142 Assessment (Worst Case)

Receptor	Representative NML	Representative Background Sound Level (Daytime) $L_{90, 1hr}$, dB	Specific Sound Level, $L_{Aeq, T}$ dB	Acoustic Feature Correction, dB	Rating Level, dB	Excess Over Background, dB	Magnitude of Impact
10	4	44	40.4	0	40.4	-3.6	Low
21	4	44	40.1	0	40.1	-3.9	Low
20	4	44	39.9	0	39.9	-4.1	Low
11	4	44	39.3	0	39.3	-4.7	Low
17	4	44	39.3	0	39.3	-4.7	Low
18	4	44	39.2	0	39.2	-4.8	Low
9	4	44	39.1	0	39.1	-4.9	Low
16	4	44	39	0	39	-5	Low
19	4	44	38.9	0	38.9	-5.1	Low
15	4	44	37.9	0	37.9	-6.1	Low
12	4	44	37.4	0	37.4	-6.6	Low
22	4	44	37.2	0	37.2	-6.8	Low
14	4	44	37	0	37	-7	Low
8	5	46	35.6	0	35.6	-10.4	Negligible
35	5	46	35.3	0	35.3	-10.7	Negligible
34	5	46	35.1	0	35.1	-10.9	Negligible
30	5	46	35	0	35	-11	Negligible
26	5	46	34.3	0	34.3	-11.7	Negligible
25	5	46	34.1	0	34.1	-11.9	Negligible
27	5	46	33.6	0	33.6	-12.4	Negligible
24	5	46	33.5	0	33.5	-12.5	Negligible
29	5	46	33.4	0	33.4	-12.6	Negligible
32	5	46	32.9	0	32.9	-13.1	Negligible
31	5	46	32.2	0	32.2	-13.8	Negligible
23	5	46	32.1	0	32.1	-13.9	Negligible
33	5	46	32.1	0	32.1	-13.9	Negligible
28	5	46	31.7	0	31.7	-14.3	Negligible
39	2	51	36	0	36	-15	Negligible
37	2	51	35.8	0	35.8	-15.2	Negligible
1	1	58	42.7	0	42.7	-15.3	Negligible
38	2	51	35.7	0	35.7	-15.3	Negligible
36	2	51	35.6	0	35.6	-15.4	Negligible

Receptor	Representative NML	Representative Background Sound Level (Daytime) $L_{90, 1hr}$, dB	Specific Sound Level, $L_{Aeq, T}$ dB	Acoustic Feature Correction, dB	Rating Level, dB	Excess Over Background, dB	Magnitude of Impact
2	1	58	39	0	39	-19	Negligible
3	1	58	38.1	0	38.1	-19.9	Negligible
4	1	58	37.8	0	37.8	-20.2	Negligible
5	1	58	37.3	0	37.3	-20.7	Negligible
6	1	58	36.9	0	36.9	-21.1	Negligible
7	1	58	36	0	36	-22	Negligible
13	1	58	35.8	0	35.8	-22.2	Negligible
40	1	58	33.5	0	33.5	-24.5	Negligible
42	1	58	33.3	0	33.3	-24.7	Negligible
41	1	58	32.4	0	32.4	-25.6	Negligible

The worst-case daytime rating level did not exceed the background level at any of the 42 receptors. At 29 of the receptors, the rating level was 10 dB or more below the existing background. The noise effect will be equal to or lower than the values in Table 9.19 at all other receptors in the vicinity of the Project Site , due to the increased distance from the site.

This indicates that daytime operational noise from plant and equipment within the Project will have a **low to negligible** noise effect.

Night-Time BS4142 Assessment

The assessment of night-time operational plant and equipment noise, as per BS4142, is shown in Table 9.25. The rating level at all 42 receptors has been compared with the representative background sound level to show the excess over background. Where the excess over background is negative, the predicted sound pressure level is below the existing background sound level.

The results are shown by receptor and have been ordered by ‘excess over background’, with the predicted level closest to the existing background in the first row of the table.

Table 9.25: Night-Time BS4142 Assessment (Worst Case)

Receptor	Representative NML	Representative Background Sound Level (Night-Time) $L_{90, 15min}$, dB	Specific Sound Level, $L_{Aeq, T}$ dB	Acoustic Feature Correction, dB	Rating Level, dB	Excess Over Background, dB	Magnitude of Impact
10	4	41	40.9	0	40.9	-0.1	Low
1	1	44	43.6	0	43.6	-0.4	Low
11	4	41	40.3	0	40.3	-0.7	Low
9	4	41	40.1	0	40.1	-0.9	Low
21	4	41	40	0	40	-1	Low
20	4	41	39.9	0	39.9	-1.1	Low
17	4	41	39.5	0	39.5	-1.5	Low
18	4	41	39.4	0	39.4	-1.6	Low
16	4	41	39.2	0	39.2	-1.8	Low
19	4	41	39.1	0	39.1	-1.9	Low
15	4	41	38.2	0	38.2	-2.8	Low

Receptor	Representative NML	Representative Background Sound Level (Night-Time) $L_{90,\ 15min}$, dB	Specific Sound Level, $L_{Aeq,\ T}$ dB	Acoustic Feature Correction, dB	Rating Level, dB	Excess Over Background, dB	Magnitude of Impact
22	4	41	37.5	0	37.5	-3.5	Low
14	4	41	37.4	0	37.4	-3.6	Low
12	4	41	37.1	0	37.1	-3.9	Low
2	1	44	39.4	0	39.4	-4.6	Low
37	2	41	35.8	0	35.8	-5.2	Low
39	2	41	35.7	0	35.7	-5.3	Low
36	2	41	35.6	0	35.6	-5.4	Low
38	2	41	35.6	0	35.6	-5.4	Low
8	5	42	36.2	0	36.2	-5.8	Low
3	1	44	38	0	38	-6	Low
34	5	42	35.8	0	35.8	-6.2	Low
4	1	44	37.7	0	37.7	-6.3	Low
35	5	42	35.5	0	35.5	-6.5	Low
30	5	42	35.4	0	35.4	-6.6	Low
5	1	44	37.1	0	37.1	-6.9	Low
6	1	44	36.6	0	36.6	-7.4	Low
26	5	42	34.3	0	34.3	-7.7	Low
25	5	42	34	0	34	-8	Low
27	5	42	34	0	34	-8	Low
7	1	44	35.8	0	35.8	-8.2	Low
24	5	42	33.8	0	33.8	-8.2	Low
29	5	42	33.8	0	33.8	-8.2	Low
13	1	44	35.6	0	35.6	-8.4	Low
32	5	42	32.8	0	32.8	-9.2	Low
28	5	42	32.2	0	32.2	-9.8	Low
31	5	42	32.1	0	32.1	-9.9	Low
23	5	42	32	0	32	-10	Negligible
33	5	42	31.9	0	31.9	-10.1	Negligible
40	1	44	33.2	0	33.2	-10.8	Negligible
42	1	44	33.2	0	33.2	-10.8	Negligible
41	1	44	32	0	32	-12	Negligible

The worst-case night-time rating level did not exceed the background level at any of the closest 42 receptors. At 5 of the receptors, the rating level was 10 dB or more below the existing background. The noise effect will be equal to or lower than the values in Table 9.20 at all other receptors in the vicinity of the Project Site due to the increased distance from the site.

This indicates that night-time operational noise from plant and equipment within the Project Site will have a **low** noise effect. The

Assessment of Relative L_{Aeq} Sound Pressure Levels

In addition to the BS4142 methodology, which compares existing L_{A90} with predicted rating level, it is also useful to compare predicted future ambient sound pressure level during the operational phase with the existing ambient sound pressure level (L_{Aeq}) at receptors. This methodology, which is referenced in (IEMA) Guidelines for Environmental Noise Impact Assessment, is somewhat subject to professional judgement, however it is generally accepted that there are thresholds of change of noise level which are perceptible to the human ear. There is variability in this perceptibility where noise sources are irregular or intermittent or have other characteristics such as tonality. For steady-state noise sources with no acoustic features, typically an increase in noise level of < ±3 dB is imperceptible to most people, with changes of around ±3 dB just perceptible.

The plant and equipment associated with the Project is expected to be continuous with no acoustic features (as discussed in Section 9.5.2.1.2).

A summary of the existing daytime and night-time ambient L_{Aeq} sound pressure levels in the vicinity of the Project Site are shown in Table 9.21 and Table 9.22 respectively, along with the maximum predicted daytime sound pressure levels from the noise propagation modelling (See Appendix 9.4)

The typical existing daytime and night-time ambient values have been determined from the background noise monitoring survey, as per Section 9.4.2 and Appendix 9.1. Modelling results are shown for each noise monitoring location as these represent the closest receptors and the range of ambient noise levels in the vicinity of the site. By assessing the highest predicted sound pressure levels for each representative NML, a robust assessment has been carried out, with all lower predicted levels having a lower noise impact.

Predicted sound pressure levels have been logarithmically added to existing ambient levels to predict the future ambient sound pressure level. The existing ambient has been arithmetically subtracted from the future ambient to give the change in ambient sound pressure level.

The noise effects shown in Table 9.26 and Table 9.27 have been determined with reference to example assessment tables within the IEMA guidelines.

Table 9.26: Summary of Daytime Ambient and Predicted Sound Pressure Levels

Receptor with Highest Predicted L_{Aeq} and Relevant NML[5]	Typical Ambient $L_{Aeq,\ 1hr}$ dB	Highest Predicted Total $L_{Aeq,\ T}$ dB	Predicted Future Ambient $L_{Aeq,\ T}$ dB	Predicted Change in Ambient Sound Pressure Level L_{Aeq}, dB	Noise Effect
Receptor 1 NML1	59	42.7	59.1	+0.1	Negligible
Receptor 39 NML2	57	36	57	+0.0	Negligible
Receptor 10 NML4	47	40.4	47.9	+0.9	Negligible
Receptor 8 NML5	50	35.6	50.2	+0.2	Negligible

[5] NML3 not presented as all receptors are more accurately represented by the other Noise Monitoring Locations

The results shown in Table 9.27 indicate that the highest predicted sound pressure levels at the noise-sensitive receptors will cause a change in daytime $L_{Aeq,\ T}$ of less than 1 dB when compared with the existing ambient sound pressure levels at the relevant noise monitoring locations. This change will be imperceptible and the effect of operational daytime noise will be **negligible**.

Table 9.27: Summary of Night-Time Ambient and Predicted Sound Pressure Levels

Receptor with Highest Predicted L_{Aeq} and Relevant NML[6]	Typical Ambient $L_{Aeq,\ 15min}$ dB	Highest Predicted Total $L_{Aeq,\ T}$, dB	Predicted Future Ambient $L_{Aeq,\ T}$ dB	Predicted Change in Ambient Sound Pressure Level L_{Aeq} dB	Noise Effect
Receptor 1 NML1	52	43.6	52.6	0.6	Negligible
Receptor 36 NML2	48	35.6	48.2	0.2	Negligible
Receptor 9 NML4	46	40.1	47.0	1.0	Negligible
Receptor 8 NML5	44	36.2	44.7	0.7	Negligible

The results shown in Table 9.23 indicate that the highest predicted sound pressure levels at the noise-sensitive receptors will cause a change in night-time $L_{Aeq,\ T}$ of 1 dB when compared with the existing ambient sound pressure levels at the relevant noise monitoring locations. This change will be imperceptible and the effect of operational night-time noise will be **negligible**.

It should be noted that the changes shown in Table 9.21 and Table 9.22 represent operational scenario predictions which assume the worst-case power generation scenarios for daytime and night-time. Operational noise levels will be lower when higher proportions of renewable energy are available and therefore when fewer gas turbines or gas engines are in operation;

Additionally, the assessment locations represent the closest noise-sensitive receptors, with all other receptors predicted to have a lower noise effect due to increased distance from the Project site.

9.5.2.1.3 Plant and Equipment Noise Impact Assessment Summary

A relative noise impact assessment has been carried out, comparing predicted daytime and night-time L_{Aeq} sound pressure levels against measured background L_{A90} sound pressure levels as per the methodology within BS4142:2014.

The rating level at all noise-sensitive receptors was below the representative background sound level. As such, the noise impact of the plant and equipment associated with the Project was found to be **low to negligible** for daytime and low for night-time periods.

The change in ambient L_{Aeq} sound pressure levels was assessed by predicting the future ambient sound pressure levels at receptors during worst-case operational scenarios for daytime and night-time and comparing

[6] NML3 not presented as all receptors are more accurately represented by the other Noise Monitoring Locations

with existing ambient levels. The predicted change in daytime and night-time ambient level did not exceed 1dB. This change in ambient level will be imperceptible and therefore the effect is negligible.

Overall, the effect of operational plant and equipment noise is **low to negligible** for the closest receptors with all other receptors in the vicinity of the Project site also experiencing a **low to negligible** effect.

9.5.2.2 Assessment of Operational Road Traffic Noise

Operational traffic noise was assessed using the criteria and guidance contained within the DMRB LA 111 and CRTN.

The anticipated number of HGV and car trips to and from the site are shown below and are based on staffing numbers for the Data Centre site. Note that these do not account for shift patterns etc;

- 225no. total staff at Project site;
- ~125 – 175no. visitors daily;
- 56no. person arrivals during the AM peak hour period;
- 56no. person departures during the PM peak hour period.
- Operational HGVs – 26no. total trips per day.

It is anticipated that the operation of the Project will generate an additional 56 trips during both the AM and PM peak periods. 92.7% (52) of these trips are expected to be car trips.

Once operational, it is estimated that each of the Data Centre buildings would generate 2 HGV trips per day (4 two-way trips), with the administration building generating 1 HGV trip per day (2 two-way trips). This would equate to 26 daily two-way HGV trips being generated by the Project once operational, however, it is understood that HGV trips will typically fall outside of peak traffic hours.

For full details of traffic volumes, please refer to Chapter EIAR Volume I Chapter 12 Traffic and Transportation.

The link flow assessment, as per Chapter 12 Traffic and Transportation, indicates that the Project is expected to increase traffic volumes on the west arm of the Bundle of Sticks Roundabout by approximately 1%, and by approximately 4% on the north arm of the Millennium Park Roundabout.

As a worst-case assessment of road traffic noise, the % increase in traffic movements has been calculated assuming that all additional 56 trips take place during the 1-hour period with lowest volume of traffic flow. An increase of 56 traffic movements during the 1-hour period with the lowest traffic flows would equate to a maximum increase in traffic flow of 6.6% (at Millennium Park Roundabout) compared with measured traffic flows.

The TII guidelines state that it takes a 25% increase or a 20% decrease in traffic flows in order to get a 1 dBA change in traffic noise levels. On this basis, the change in traffic noise levels associated with all road links during the operational phase of the Project will be significantly less than 1dB(A).

It is generally accepted that it takes an approximate 3 dB(A) increase in noise levels to be perceptible to the average person, therefore the likely effect of traffic noise increases on all other roads local road network will be imperceptible.

9.5.2.3 Car Parking

It is proposed that 30 car parking spaces would be provided at each of the six Data Centre buildings, with an additional 30 car parking spaces located at the administration / management building. This would equate to a total of 210 car parking spaces across the Project.

The site will operate 24/7, therefore the car parks may be in use at any time of night or day. Night-time car park activity is expected to consist mainly of staff arrivals and departures, and with the majority of vehicles remaining parked for the duration of a work shift.

It is anticipated that staff shift patterns will fall into the following categories:

- Security and Cleaning staff – 12 hour shifts, typically 7am-7pm and 7pm-7am;
- General and Landlord Management staff – Typically more conventional hours such as 8:30am - 5:30pm. Arrivals and departures can be variable as they may be attending other facilities;

- Maintenance staff – May work across multiple facilities and working patterns will be primarily out of hours shift work and therefore arrive and depart the campus outside typical peak hours; and
- Visitors, Customers and Subcontractors – Attendance will be variable dependent upon the tenants of each building and their needs. These would typically arrive and depart the facility outside of peak traffic hours given the site is 24 hours operated.

From the information available at this stage regarding staff numbers, expected shift patterns and working hours – based upon similar colocation Data Centre facilities and with the exception of Administration staff, the daily occupancy typically equates to 40% of the total staff numbers and a total daytime occupancy of 98 staff for the whole campus.

It is expected that staff and site visitors will primarily use the car park during the daytime period, during the evening if arriving for a 7pm- 7am night shift, and between 6:30am and 7am, when arriving for the daytime 7am -7pm shift. As such, both the daytime and night-time situations have been assessed below.

There is no specific guidance in relation to car parking noise. Operational car park noise is not covered in the scope of BS 4142:2014+2019. The L_{Aeq} and L_{AMax} due to car parking events have been estimated below and assessed against the absolute criteria in BS8233/WHO, with reference to the existing background sound pressure level as per BS4142.

The closest car parking to a residential property is the DC4 car park which has 30 spaces; receptor 1 is located approximately 85m from the closest DC4 car parking space.

9.5.2.3.1 Car Park L_{Aeq} Predictions

Using a measured LAE value of 59 dB @ 10m for car doors being closed (free-field) and 57 dB(A) @ 10m for a car engine being started and driving off (free-field), which combined is 61 dB(A) @ 10m, the calculation formula is as follows:

Where N is the number of events over the 1-hour period and T is the number of seconds in an hour.

A distances of 85m has been assumed, representing the range of distances across the DC4 car park to receptor 1. Distance attenuation for a line source assumes cylindrical spreading and is calculated by using the calculation:

Where d = distance from source to receptor in metres and d_0 is the reference distance in metres.

The maximum number of parking events is based on the number of spaces in the DC4 car park (30) and assumes that there are 2 car parking events in a one-hour period for each space (60 total). The simplified model has assumed that all 60 parking events take place at the closest parking space, which is located at a distance of 85m from receptor 1. This scenario assumes that 100% of DC4 car parking events will take place at the closest point of the car park to receptor 1. Obviously this is extremely unlikely, but represents a worst-case scenario.

Predicted sound pressure levels have been calculated, assuming that a car park event includes a car door being closed and a car engine being started and driving off at the closest DC4 parking space to receptor 1. The predicted external car parking L_{Aeq} sound pressure levels are shown in Table 9.28.

Table 9.28: Predicted External Car Parking Noise Levels (dB L_{Aeq}) at Nearest Existing Noise Sensitive Receptor

Distance to Receptor 1, m	Distance Attenuation, dB	Single Parking Event LAE, dB @ 10m	$L_{Aeq, 1hr}$ Sound Pressure Level at 10m, dB (60 Car Parking Events)	$L_{Aeq, 1hr}$ Sound Pressure Level at Receptor 1, dB (60 Car Parking Events)
85m	19	61	43	34

Worst-case predicted sound pressure level at receptor 1 due to parking is 15 dB below existing daytime (Lowest recorded L_{A90} measurement) of 49 dB and 6 dB below the lowest existing background night-time sound pressure level, as established in the background noise monitoring survey.

The predicted 1-hour L_{Aeq} from car parking noise is 34 dB externally, equivalent to an internal bedroom sound pressure level of 19 – 24 dB , assuming a 10-15 dB sound reduction through an open window. This is 11 dB below the BS8233 and WHO guidance internal night-time criteria of 30 dBA for restful sleep.

It is unlikely that the worst-case scenario considering all car parking spaces in use will be applicable, particularly at night.

It should also be noted that in the simplified model above, the DC4 car park has been assumed to be at capacity and all parking events assumed to take place at the closest location to receptor 1. This is a conservative overestimation which will not happen in reality, with the number of events lower than assumed in the predictions above, and the distance from source to receptor 1 increased for the vast majority of parking events.

All other receptors are a minimum of 350 m from parking facilities, many benefiting from the screening effect of the Data Centre buildings for sound reduction in addition to the attenuation afforded by the increased distance from car parking noise sources. As such, the received L_{Aeq} sound pressure level at all other receptors due to car parking will be significantly lower than those predicted for receptor 1.

9.5.2.3.2 Car Park L_{AMax} Predictions

Impulsive noise, measured in terms of L_{Amax}, could have an effect depending on the levels at the dwellings and the number of events. A distance of 85m has been used for prediction purposes. Distance attenuation for a point source assumes hemispherical spreading and is calculated by using the calculation:

Where d = distance from source to receptor in metres and d_0 is the reference distance in metres.

Noise levels from closing car doors and staff talking could range from 60 – 70 dB L_{Amax} resulting in 21 - 31 L_{AMax} externally at 85m distance, as shown in Table 9.29.

Table 9.11: Predicted Car Park Noise Levels (L_{Max}) at Nearest Existing Noise Sensitive Receptors

Distance, m	Distance Attenuation, dB	Predicted External Receptor Noise Level (Based on car doors closing /staff talking 60 dB $L_{Amax\ at}$ 1m)	Predicted External Receptor Noise Level (based on car doors closing /staff talking 70 dB $L_{Amax\ at}$ 1m)
85	39	21	31

Taking into account a sound level difference of a partially open window (-10-15dB); the range of predicted L_{Amax} noise levels would be 6 - 21 dB internally, based on the car park activity events taking place at the proposed parking bays assuming 85m distance from existing residential properties.

Suitable targets for controlling peak noise events inside dwellings are generally accepted to be controlling and for this level to be exceeded typically no more than 10 - 15 times per night. This is based in WHO ‘Guidelines for community noise’ (1999) research. On this basis, any peak noise events at the nearest residential properties would not be expected to exceed the 45 dB L_{Amax} guidance level.

Given how unlikely it is like vehicles would consistently use the spaces closest to the dwellings during the night-time and that the number of events during the night-time is likely to be very low, noise impact from the car park during the night-time is unlikely to cause any adverse impact.

The car parking facilities within the Project will be in use primarily during the day. As it is possible that night-time use may be required by staff, night-time scenarios have also been considered, however these are very much worst-case.

Noise impact from car parking at all other Data Centre buildings and the administration building is expected to be lower than those predicted for DC4, due to increased distance between car parking activity and noise-sensitive receptors. The results of the assessment of car parking noise indicate that the magnitude of impact will be Negligible or Low for all receptors.

9.5.3 Cumulative Effects

Projects with the potential to have cumulative operational and construction noise impacts have been reviewed to identify any requirement for cumulative noise impact assessment. The construction phase of the proposed Gas Networks Ireland Gas Connection has the potential to have a cumulative noise impact with the construction of the Data Centre and Substation and therefore a cumulative construction noise impact assessment has been carried out.

9.5.3.1 Gas Connection

As identified in Chapter 1 of the EIAR (Section 1.4.4), the Project will require a physical connection to the gas network to supply the on-site gas turbines. The GNI Infrastructure Upgrade Outline Report, identifying the specification and most likely route for the connection and a description of the works required to provide same, is included in Volume II, Appendix 1.2. The report provides sufficient detail and information to allow a robust cumulative impact assessment to be conducted.

The GNI Infrastructure Upgrade Outline Report notes that the proposed works will likely include the construction of a new circa 300mm dia. high pressure gas pipeline which is likely to follow the existing pipeline route from the Glebe West AGI to the Naas Town AGI. From there it will most likely closely follow the existing low-pressure distribution network around the Southern Link Road to the junction with the R445 Newbridge Road, cross the Grand canal and follow the existing public foul sewer network wayleave across agricultural lands in a north-westerly direction towards the Project site.

An GNI Infrastructure Upgrade Outline Report has been used to assess the potential for cumulative effects with the Project.

The construction works associated with the proposed gas pipeline will take place during Phase 1 of the construction programme for the Project, as the gas connection will be required in order to bring Data Centres online.

The cumulative construction noise impact of the Project construction programme and the GNI Gas Connection has been reviewed, considering the concurrent Phase 1 construction and Gas Connection construction at the relevant noise-sensitive receptors.

As noted in the GNI Infrastructure Upgrade Outline Report, a large portion of the construction works for the GNI Gas Connection will likely take place across agricultural lands. Works will likely involve a construction corridor of 14m width, centred on the pipeline.

Access to the works on agricultural lands will typically be provided at public road crossing locations. It is not expected that construction traffic for the Gas Connection will be significant in the context of existing traffic flows (see Section 9.5.1.4).

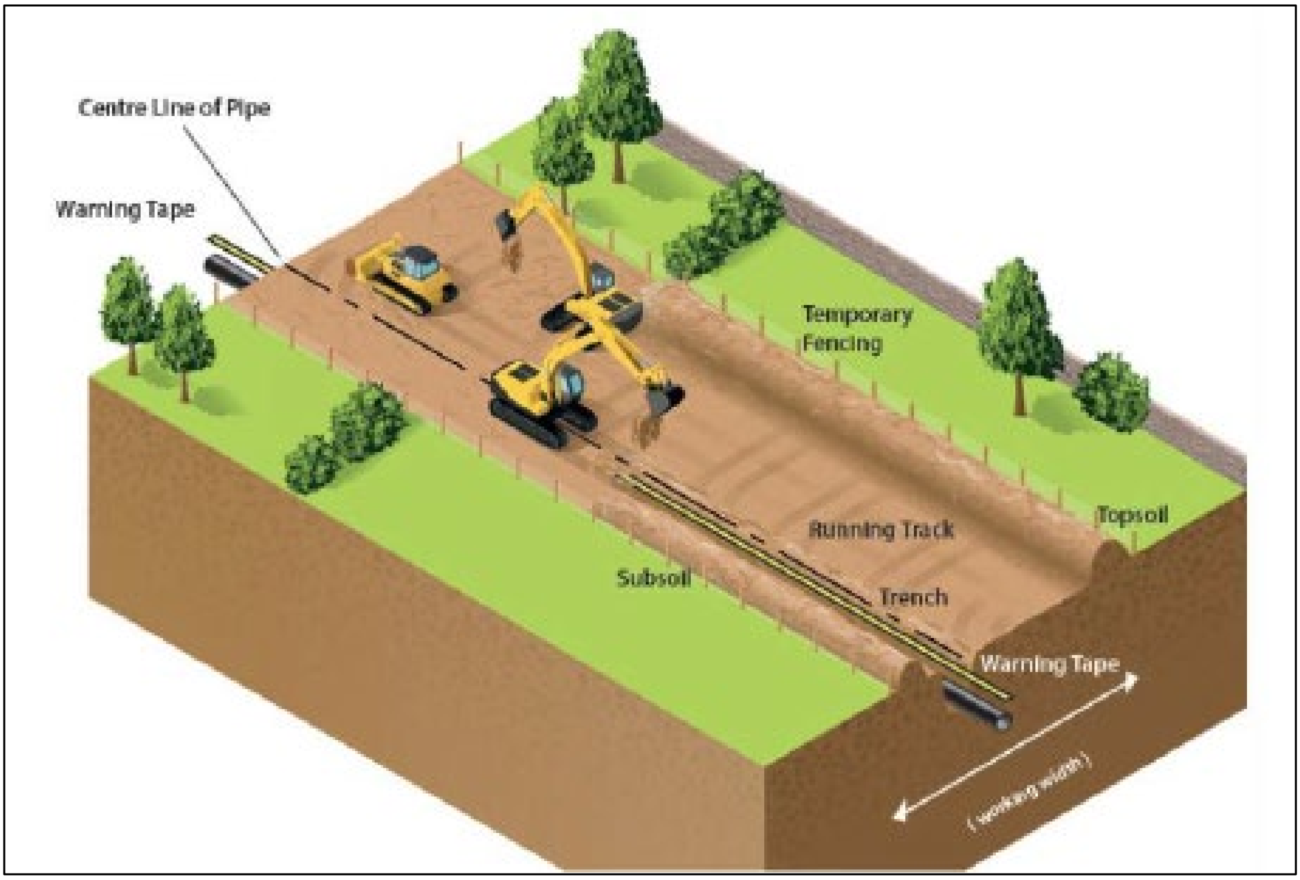

Figure 9.1: Typical pipeline installation working arrangement across agricultural lands

The receptors which have the potential to experience a cumulative impact from the Project construction programme and the GNI Gas Connection construction works have been identified, summarised in Table 9.30. All other noise-sensitive receptors considered within the EIAR are located more than 300m from the Gas Connection potential route. The potential Gas Connection route and within the Gas Networks Ireland Infrastructure Upgrade Outline Report (included in Volume II, Appendix 1.2).

Table 9.30: Potential Cumulative Impacts Receptors

Receptor	Distance to Gas Connection, m
1	50
2	50
3	75
4	85
5	165
6	250
7	295

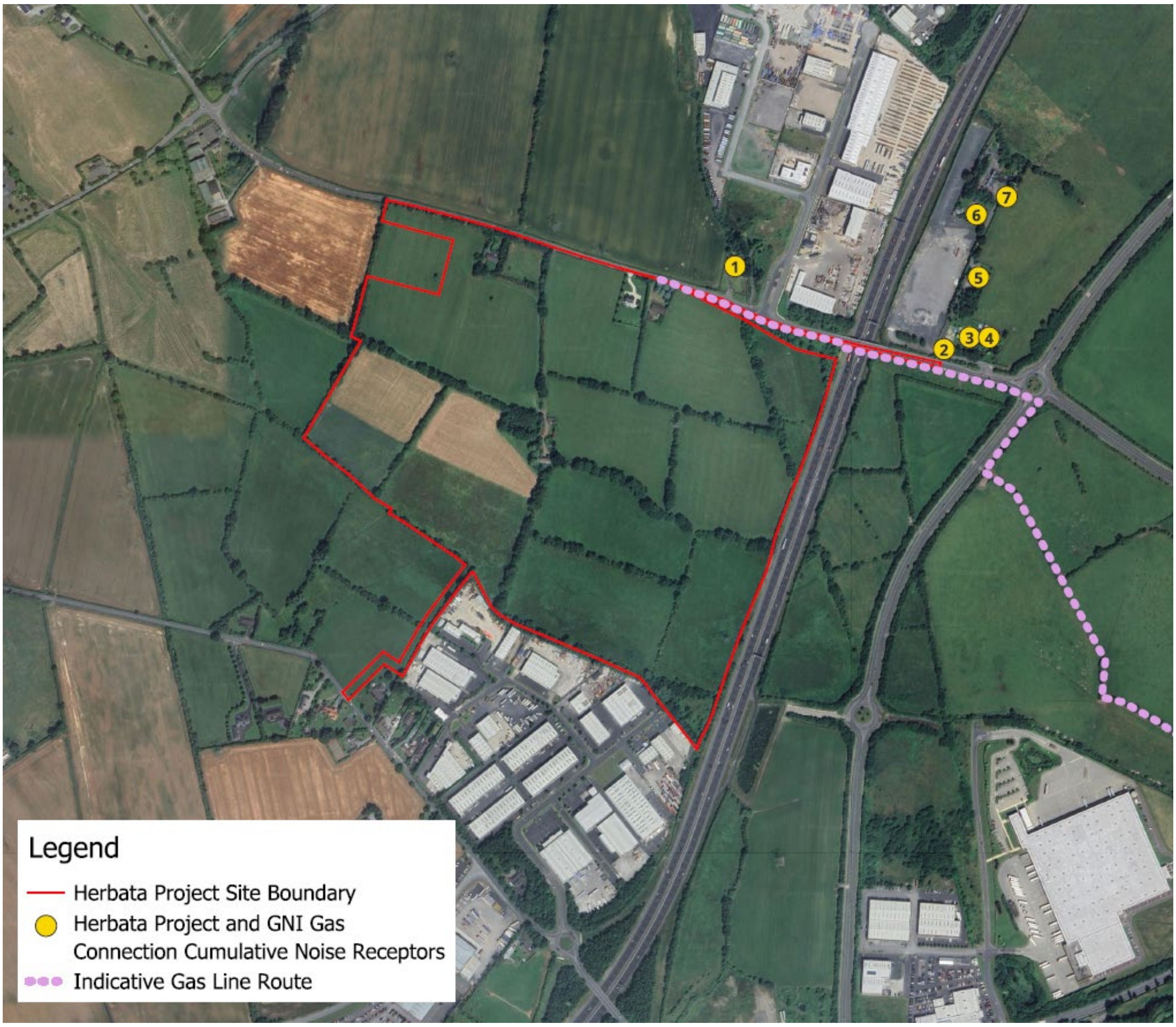

Figure 9.2: Indicative GNI Gas Line Route and Cumulative Receptors

It is anticipated that the majority of excavation works will be carried out using tracked excavator and dozers and that rockbreaker(s) and water pumps may also be required. Indicative sound pressure levels for each item of equipment is shown in Table 9.30, as taken from BS5228.

Table 9.30: Construction Plant Noise Levels (REF: BS 5228:2009+A1:2014)

Plant	Reference from Annex C & D BS5228	Sound Pressure Level at 10m dB(A)
Rock Breaker	C.9.12	93
Tracked Excavator	C.2.3	80
Dozer	C.2.1	79
Water Pump	C.4.88	68

The predicted sound pressure level at each of the 7 receptors included in the cumulative assessment are shown in Table 9.25. These are based on the distance from the construction area to each receptor, as per Table 9.23 and assume one item of plant operational at the closest distance to the receptor with 100% 'on-time'. Cumulative predicted sound pressure levels are shown in Table 9.31 which include Phase 1 works and the Gas Connection works.

Table 9.31: Predicted Sound Pressure Levels- Gas Connection Construction Works

Plant	Sound Pressure Level at 10m dB(A)	Sound Pressure Level at Noise Sensitive Receptor, dB L_{Aeq}						
		1	2	3	4	5	6	7
Rock Breaker	93	79	79	75	74	69	65	64
Tracked Excavator	80	66	66	62	61	56	52	51
Dozer	79	65	65	61	60	55	51	50
Water Pump	68	54	54	50	49	44	40	39
Total		79	79	76	75	69	65	64

Table 9.32: Cumulative Predicted Construction Sound Pressure Levels

	Maximum Predicted Sound Pressure Level (Phase 1 Construction), dB L_{Aeq}		Maximum Predicted Sound Pressure Level (Gas Connection Construction), dB L_{Aeq}		Maximum Cumulative Sound Pressure Level (Phase1 and Gas Connection Construction), dB L_{Aeq}	
	100% Utilisation	50% Utilisation	100% Utilisation	50% Utilisation	100% Utilisation	50% Utilisation
Site Clearance and Preparation	83	80	79	76	84	81
Construction of DC1	61	58	79	76	79	76
Construction of DC2	60	57	79	76	79	76
Construct AGI	68	65	79	76	79	76
Construct ESB SUB	61	58	79	76	79	76
Construct Underground Services	62	59	79	76	79	76
Construct Internal Roads and Parking	64	61	79	76	79	76
R409 Improvement Works	78	75	79	76	82	79

The predictions shown in Table 9.32 consider several possible construction scenarios whereby some Phase 1 construction activities and Gas Connection construction activities take place concurrently.

The construction programme for the Gas Connection is expected to take 7-8 months for the upgrade of approximately 10km of gas pipeline. The duration of the Gas Connection works in the vicinity of the Project receptors would be expected to take place over a shorter duration within the 7-8 month programme, with any cumulative impact at receptors 1 – 7 occurring only temporarily.

It is anticipated that phase 1 construction will take place over approximately 44 months. The variation construction in activities and location of construction works throughout each of the construction programmes will determine the actual cumulative construction noise impact and it is possible that construction works across both programmes do not occur concurrently.

As a worst case, as shown in Table 9.26, predicted cumulative construction noise levels for some construction activities and processes are expected to exceed the construction noise threshold of 65 dBA temporarily during concurrent construction of Phase 1 and the Gas Connection.

The predicted sound pressure levels, assuming operation of single items of plant and equipment, are at least 60 dBA in all phases/stages of construction. The combination of multiple construction noise sources and concurrent construction activities, stages and phases is likely to give rise to an increase of 5 dB at receptors, therefore exceeding the criterion level of 65 dBA at time during construction.

Significant cumulative construction effects could arise from combinations of noise sources throughout the construction programmes, if works take place concurrently, however these are expected to impact receptors in the short-term only. Combined construction noise effects should be taken into consideration when developing the construction noise management plan for both the Project and the GNI Gas Connection, with mitigation employed as necessary, as discussed in Section 9.5.5 Mitigation.

9.5.4 Do Nothing Scenario

In the ‘do nothing’ scenario, the Project site is likely to continue to be retained for agricultural use. Noise levels at receptors would be expected to remain similar to those established in the baseline noise monitoring surveys (see Appendix 9.1). The dominant noise source in the vicinity of the Project site is road traffic noise, in particular from the M7 motorway, and it would be expected that this would continue to dominate the noise environment in the area.

9.5.5 Likely Significant Effects

The noise impacts, or effects, have been assessed in terms of magnitude of impact. The noise effects for construction and operational noise are taken in the context of the sensitivity of the receptor to determine the significance of the effects.

9.5.5.1 Likely Significant Construction Noise Effects

While construction works will extend over a period of years, the duration over which noise will be produced in the vicinity of any individual receptor or group of receptors will be for shorter periods. Work generating peak levels of noise will be carried out intermittently over this time and will not be constant for those periods. Nevertheless, based on the predicted worst-case construction noise levels from the Project, it is clear that there is a potential for significant construction noise effects and that there will be a requirement for mitigation measures to be put in place in order to ensure that construction noise levels are reduced as much as practicable. Without appropriate mitigation, there is the potential for adverse noise impact during peak periods of construction.

9.5.5.2 Likely Significant Operational Noise Effects

Operational noise has been assessed and found to have a negligible to low noise effect on noise-sensitive receptors. This includes operation of all plant and equipment associated with the Project as well as operational traffic noise and car parking.

The closest noise-sensitive receptors are residential properties. As such, and considering the continuous 24/7 operation of the Data Centre, all receptors are considered to have a high sensitivity to operational noise.

With reference to the significance matrix Table 9.17, the negligible/low effect of operational noise is of **Minor Significance.**

9.5.6 Mitigation

9.5.6.1 Construction Phase

Worst case construction noise predictions can be reduced through use of appropriate mitigations as detailed below in Section Construction Mitigation. The target for mitigation measures is a reduction in daytime construction noise to achieve the daytime Category A threshold limit (i.e. 65dBA).

BS 5228-1 states that:

> "…*if the site noise level exceeds the appropriate category value, then a potential significant effect is indicated. The assessor then needs to consider other project specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect*."

These factors have therefore been considered to determine the effect significance.

As a summary of proposed construction works:

1. Construction works will be temporary and limited in duration;
2. Construction plant and machinery have been assessed as operating for the full working period of the day, i.e. 100% duty cycle. Due to natural pauses in activity and rest breaks equipment will not be fully operational during the working day; and
3. Construction works are not proposed to occur during night-time or on Sundays, unless for emergency works. Therefore, there will be no associated construction noise impact during these times at construction noise receptors.
4. Temporary construction noise barriers will be used to achieve attenuation of noise levels between ground based construction plant and the nearest noise-sensitive properties.

Specific Construction Mitigation

Construction mitigation measures will be put in place to ensure construction noise levels are attenuated and reduced where necessary.

Best practice measures will be employed to ensure that construction phase noise levels are reduced to the lowest possible levels.

BS5228:2009+A1:2014 – Noise and vibration control on construction and open sites outlines a range of measures that can be used to reduce the impact of construction phase noise on the nearest noise sensitive receptors. These measures will be applied by the contractor where appropriate during the construction phase of the Project. Construction best practice measures which will be implemented included below:

1. Ensuring that mechanical plant and equipment used for the purpose of the works are fitted with effective exhaust silencers and are maintained in good working order;
2. Careful selection of quiet plant and machinery to undertake the required work where available;
3. Machines in intermittent use will be shut down in the intervening periods between work;
4. Ancillary plant such as generators, compressors and pumps will be placed behind existing physical barriers, and the direction of noise emissions from plant including exhausts or engines will be placed away from sensitive locations, in order to cause minimum noise disturbance. Where possible, in potentially sensitive areas, temporary construction barriers or enclosures will be utilised around noisy plant and equipment;
5. Handling of all materials will take place in a manner which minimises noise emissions; and
6. Audible warning systems will be switched to the minimum setting required by the Health & Safety Executive.

The use of the proposed construction noise mitigation measures will ensure that construction noise levels are controlled to the lowest levels practicable.

Construction traffic noise will be controlled through management of parking, loading and traffic arrangements. These will be managed by the contractor to reduce traffic volumes and in and around the site prevent congestion.

Piling Noise and Vibration Mitigation

Particular attention should be paid to piling noise when piling strategy is developed, in terms of location, scheduling and pile type. It is understood that rotary bored piling will be employed. Although this piling technique tends to generate lower levels of vibration than pile driving, transient vibrations can also occur when the auger strikes the base of the borehole. If it is necessary to insert an appreciable length of temporary casing to support the boring, a casing dolly can be used and, as with the impact bored piling method, this will give rise to intermittent vibrations. The use of special tools, such as chisels, will also result in intermittent vibrations.

Occupants of residential properties should be advised of likely piling and demolition schedules; awareness of when and where these works will be taking place can help residents and businesses to prepare for potential impacts.

Construction Environmental Management Plan

Further details of all environmental mitigation measures are included in the Construction Environmental Management Plan (CEMP) (Volume II, Appendix 4.5).

Prior to construction, a specific Noise Management Plan will be produced and implemented by the final appointed contractor of the project. The CEMP and subsequent noise management plan will set out the mitigation measures that will be employed to reduce the noise and vibration impacts of the development during the construction phase.

9.5.6.2 Operational Phase

Mitigation measures have been considered and implemented in the design and engineering of the Project, including factors such as selection of plant and equipment, noise control at source, selection of construction materials, orientation of buildings and site layout. The benefit of these mitigation measures has been included in the noise predictions and subsequent operational noise impact assessment in Section 9.5.2.

Operational conditions have been carefully considered to ensure that operational requirements are fulfilled in terms of power generation and cooling, whilst minimising noise impact. This is particularly important for the night-time period. There will be controlled use of gas turbines/gas engines during the night, with the number of gas turbines or engines online minimised where possible. The number of gas turbines or engines online should not exceed the 'worst-case' scenarios for daytime and night-time which have been assessed in this chapter. Routine maintenance works, such as testing and servicing will be limited to daytime periods where there is potential for increased noise outputs.

9.5.7 Residual Impacts

9.5.7.1 Construction Phase

Pre-mitigation, the predicted construction noise impacts are anticipated to result in effects ranging from negligible to major at construction noise receptors. The Construction Environmental Management Plan (CEMP) and Noise Management Plan (as produced by the contractor) include specific noise and vibration control measures. Construction noise monitoring may be requested by Kildare County Council, if deemed necessary. Mitigation by careful scheduling of the works, timing of activities and using best practicable will be implemented such that no significant effects arise, and levels are as low as possible.

Residents will be informed of the timing and duration of activities that may produce high noise or vibration. Elevated levels can be tolerated if prior notification and explanation is given. Temporary slight adverse impacts due to construction noise have been identified at the closest receptors to proposed construction works. No permanent residual noise and vibration impacts are predicted during construction of the Project. With construction mitigation measures in place the noise impact of construction activities is predicted to be reduced to temporary minor / moderate.

9.5.7.2 Operational Phase

The design of the Project, including layout and selection of equipment have carefully considered the noise impact on noise-sensitive receptors. The operational noise assessment presented within this chapter includes the benefit of noise control mitigation.

The ongoing operational management of the site will include controlled use of plant and equipment. Daytime and night-time operations should not exceed the 'worst-case' operational scenarios which have been assessed in this chapter. This will be achieved through careful monitoring and control of plant and equipment operation, particularly power generation equipment.

The operational noise and vibration impact, including the relevant mitigation measures within this EIAR, will be **negligible/low** with **minor significance.**

9.6 Limitations of the Assessment

The assessments carried out in this noise and vibration chapter have been based on the latest information made available to RPS. Uncertainties are inherent in aspects of the assessment, such as determination of background noise levels and prediction of noise levels. These uncertainties have been reduced as far as possible, with every aspect of the project considered in detail and represented as accurately as possible with the information available. Limitations of the assessment remain where assumptions have been relied upon, as detailed within the chapter, and where there are inherent uncertainties.

9.7 References

- Institute of Environmental Management and Assessment (IEMA) Guidelines for Environmental Noise Impact Assessment (2014);
- World Health Organisation (WHO) – Guidelines for Community Noise (1999);
- British Standard BS4142:2014+A1:2019 Methods for Rating and Assessing Industrial and Commercial Sound;
- Design Manual for Roads and Bridges Volume 11, Section 3, Part 7, LA 111 Noise and Vibration;
- Guidelines for the Treatment of Noise and Vibration in National Road Schemes – National Roads Authority (now Transport Infrastructure Ireland);
- Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes;
- Calculation of Road Traffic Noise (CRTN) - Department of Transport Welsh Office 1988;
- British Standard BS 8233:2014 Sound Insulation and Noise Reduction for Buildings – Code of Practice;
- British Standard BS5228: 2009+A1:2014, Code of Practice of Noise and Vibration Control on Construction and Open Sites. Part 1: Noise;
- British Standard BS5228: 2009+A1:2014, Code of Practice of Noise and Vibration Control on Construction and Open Sites. Part 2: Vibration;
- Environmental Protection Agency (EPA) Guidelines on the Information to be contained in Environmental Impact Assessment Reports;
- British Standards BS 7445-1:2003 Description and Measurement of Environmental Noise – Part 1: Guide to Quantities and Procedures (BS, 7445-1)and
- ISO9613: Attenuation of Sound during Propagation Outdoors Part 2 General Method of Calculation.