10 NOISE AND VIBRATION

10.1 Introduction

10.1.1 Background and Objectives

This chapter of the EIAR describes the assessment undertaken of the potential noise and vibration impact from the Proposed Project on local residential amenity. The Proposed Project comprises solar photovoltaic array, inverters, battery storage compound, access roads and parking, site compounds and security fencing, amenity trails and landscaping, peat and spoil storage areas, site drainage and all associated works. It will also include the construction of a 110 kV substation within the Proposed Project site. It is then envisaged to connect from this substation to the Derryiron-Maynooth 110 kV overhead line that traverses the southern section of the Timahoe North site. There are approximately 106 no. noise sensitive receivers located within 1 kilometres of the Proposed Project site. A list of receivers and coordinates is provided in Appendix 10.1. A map of these is included in Figure 10.3. A full description of the Proposed Project is provided in Chapter 4 of this EIAR.

Baseline noise levels have been measured at locations representative of the nearest noise sensitive properties. Noise predictions have been determined for the construction and operational phases of the Proposed Project in relation to the nearest properties to the proposed project site.

10.1.2 Statement of Authority

This chapter of the EIAR has been prepared by Leo Williams of AWN Consulting.

Leo Williams holds a BA, BAI (Mechanical and Manufacturing Engineering) and a MAI (Mechanical and Manufacturing Engineering). He is an Associate Member of the Institute of Acoustics (IOA) and has completed the IOA Diploma in Acoustics and Noise Control. He has prepared numerous environmental impact assessment chapters for various developments such as infrastructural developments, mixed use developments and specialises in renewable energy development projects.

10.2 Methodology

The methodology adopted for this noise impact assessment is as follows:

- Review of appropriate guidance and specification of suitable construction and operational noise / vibration criteria;
- Characterisation of the receiving noise and vibration environment;
- Characterisation of the proposed Project;
- Prediction of the noise and vibration impact and cumulative impacts associated with the proposed Project, and;
- Evaluation of noise and vibration impacts and effects.

10.3 Fundamentals of Acoustics

A sound wave travelling through the air is a regular disturbance of the atmospheric pressure. These pressure fluctuations are detected by the human ear, producing the sensation of hearing. To take account of the vast range of pressure levels that can be detected by the ear, it is convenient to measure sound in terms of a logarithmic ratio

of sound pressures. These values are expressed as Sound Pressure Levels (SPL) in decibels (dB).

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

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

An indication of the level of some common sounds on the dB(A) scale is presented in Figure 10.1, which shows a quiet bedroom at around 35 dB(A), a nearby noisy HGV at 90 dB(A) and a pneumatic drill at about 100 dB(A).

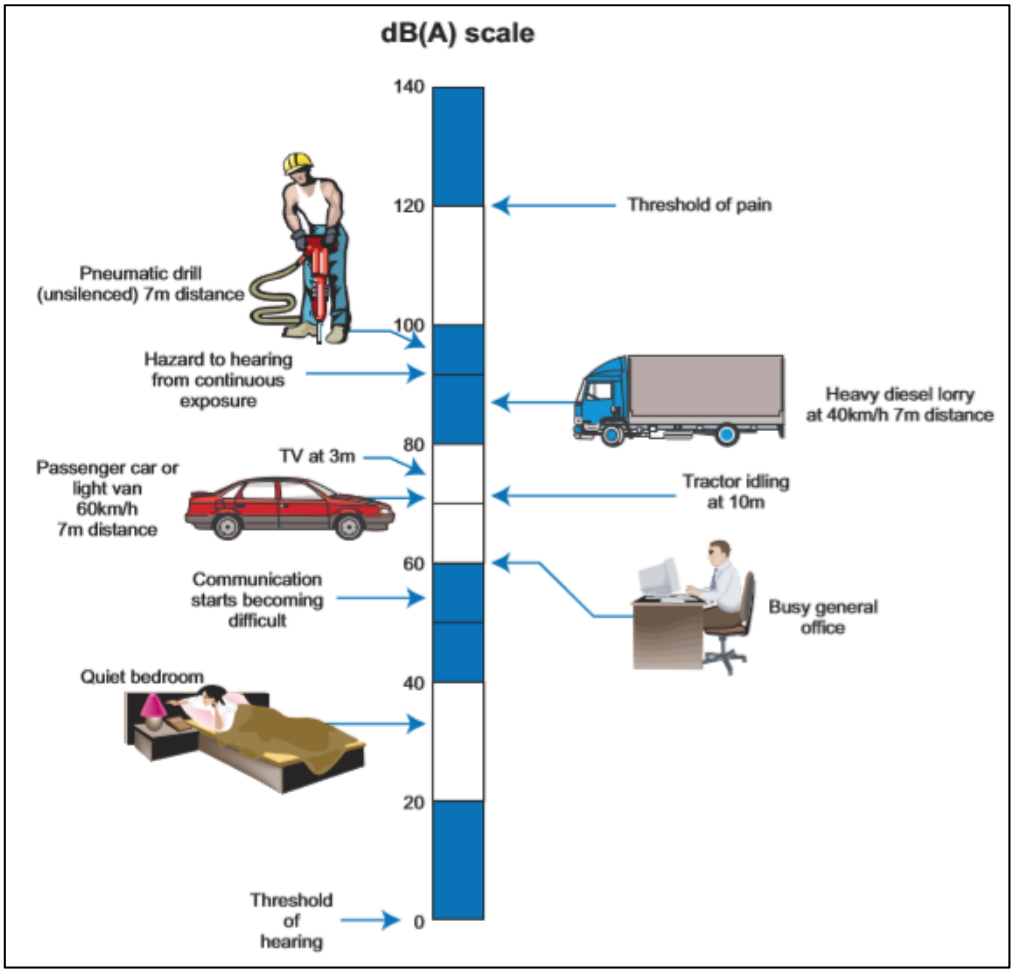


Figure 10.1 The level of typical common sounds on the dB(A) scale (TII Guidelines for the Treatment of Noise and Vibration in National Road Schemes, 2004)

For a glossary of terms used in this chapter please refer to Appendix 10-2.

10.4 Guidance Documents and Adopted Criteria

The following sections review best practice guidance that is commonly adopted in relation to developments such as the one under consideration here.

10.4.1 Construction Phase

10.4.1.1 Construction Noise

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. Local authorities normally control construction activities by imposing limits on the hours of operation and may consider noise limits at their discretion.

In the absence of specific noise limits, appropriate criteria relating to permissible construction noise levels for a development of this scale may be found in the British Standard *British Standard* BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise.*

The approach adopted here calls for the designation of a noise sensitive location into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. This then sets a threshold noise value that, if exceeded, indicates a significant noise impact is associated with the construction activities.

Table 10.1 sets out the values which, when exceeded, potentially signify a significant effect at the facades of residential receptors as recommended by BS 5228 – 1. These levels relate to construction noise only.

Table 10.1 Example Threshold of Potential Significant Effect at Dwellings

Assessment category and threshold value period ($L_{Aeq,T}$)	Threshold value, in decibels (dB)		
	Category A Note A	Category B Note B	Category C Note C
Night-time (23:00 to 07:00hrs)	45	50	55
Evenings and weekends Note D	55	60	65
Daytime (07:00 – 19:00hrs) and Saturdays (07:00 – 13:00hrs)	65	70	75

Note A Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.
Note B Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.
Note C Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.
Note D 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

It should be noted that this assessment method is only valid for residential properties. The following method should be followed:

For the appropriate period (e.g. daytime) the ambient noise level is determined and rounded to the nearest 5 dB. In this instance, with the rural nature of the site, all properties in the vicinity of the development have existing ambient noise levels in the

environment of less than 65dB L_{Aeq}. Therefore, all properties will be afforded a Category A designation.

See Section 10.6.2 for the detailed assessment in relation to this site. If the specific construction noise level exceeds the appropriate category value (e.g. 65dB $L_{Aeq,T}$ during daytime periods) then a potentially significant effect is deemed to have occurred.

10.4.1.2 Additional Vehicular Activity on Public Roads during Construction

There are no specific guidelines or limits relating to traffic related sources along the local or surrounding roads. In this instance to assist with the interpretation of the noise associated with vehicular traffic on public roads, the contribution of construction traffic noise is predicted based on the number of vehicle movements in a time period and the distance to the nearest receiver.

10.4.1.3 Vibration

Vibration standards come in two varieties: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. With respect to this development, the range of relevant criteria used for building protection is expressed in terms of Peak Particle Velocity (PPV) in mm/s.

Guidance relevant to acceptable vibration within buildings is contained in the following documents:

- *BS 7385 – "Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration" (1993)*; and
- *BS 5228 – "Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration" (2009+A1:2014).*

BS 7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15 mm/s at low frequencies rising to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz and above. These guidelines relate to relatively modern buildings and should be reduced to 50% or less for more critical buildings.

BS 5228 recommends that, for soundly constructed residential property and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e. non-structural) damage should be taken as a peak particle velocity of 15 mm/s for transient vibration at frequencies below 15 Hz and 20 mm/s at frequencies above 15 Hz. Below these vibration magnitudes minor damage is unlikely, although where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is such that resonances are excited within structures the limits discussed above may need to be reduced by 50%.

The Transport Infrastructure Ireland (TII) document *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* also contains information on the permissible construction vibration levels during the construction phase as shown in Table 10.2.

Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of:

Table 10.2 Allowable Vibration at Properties

Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

10.4.2 Operational Phase

10.4.2.1 Noise

There are no specific noise criteria relating to the operation of solar farms and associated infrastructure. This section presents several relevant criteria relating to noise generated and appropriate noise levels set at, and within noise sensitive receivers, i.e. residential properties.

10.4.2.1.1 EPA Guidance Note for Noise

Based on a review of the EPA document *Guidance Note for Noise: License Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) - 2016*, the following noise criteria may be considered appropriate at the nearest noise sensitive locations considering expected background noise levels in the area:

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

10.4.2.1.2 WHO Guidance

Recommended external daytime noise levels may be taken from the World Health Organisation (WHO) publication *"Guidelines for Community Noise"* 1995, B. Berglund & T. Lindvall and is summarised in Table 10.3.

"The World Health Organisation (WHO) recommends guideline values for noise levels in specific environments and states that "to protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55 dB L_{Aeq} on balconies, terraces and in outdoor living areas. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level should not exceed 50 dB L_{Aeq}. Where it is practical and feasible, the lower outdoor sound level should be considered the maximum desirable sound level for new development……The effects of noise in dwellings, typically, are sleep disturbance, annoyance and speech interference. For bedrooms the critical effect is sleep disturbance. Indoor guideline values for bedrooms are 30 dB L_{Aeq} for continuous noise and 45 dB L_{Amax} for single sound events. Lower noise levels may be considered depending on the nature of the noise source. At night-time, outside sound levels about 1 metre from facades of living spaces should not exceed 45 dB L_{Aeq}, so that people may sleep with bedroom windows open. This value was obtained by assuming that the noise reduction from outside to inside with the window open is 15 dB. To enable casual conversation indoors during daytime, the sound level of interfering noise should not exceed 35 dB L_{Aeq}".

Table 10.3 WHO Guideline Noise Levels

Specific Environment	Guideline Noise Levels
Outdoor Living Area	55dB[1] $L_{Aeq(16hr)}$
Outside Bedrooms	45dB $L_{Aeq(8hr)}$ and 60dB L_{AFmax}

A few important subtleties that are often overlooked in relation to the WHO guideline noise levels are:

- The 55dB $L_{Aeq(16hr)}$ daytime noise level is an overall average for a 16 hour period between 07:00 to 23:00hrs;
- The 45dB $L_{Aeq(8hr)}$ night-time noise level is an overall average for an 8-hour period between 23:00 to 07:00hrs, and;
- Both guideline levels are long term averages (i.e. represent noise levels over extended periods of months and years). The fact that a noise source causes a brief excess of either noise guideline level (e.g. a one minute, five minute or one hour sample during night-time periods) does not necessarily infer an unacceptable noise impact has occurred.

Other guidance in relation to night time noise levels is contained in the World Health Organization (WHO) document "*Night Noise Guidelines for Europe*" (2009). In the first instance it should be noted that the guidance levels stated in this document typically relate to long term averages rooted in terms of the $L_{night,outside}$ parameter. The document outlines a night noise guideline (NNG) and an Interim Target (IT) for noise $L_{night,outside}$ as detailed below:

Table 10.4 WHO Guideline Night-time Noise Levels

Specific Environment	Guideline Noise Levels
Night Noise Guideline (NNG)	$L_{night,\ outside} = 40dB$
Interim Target (IT)	$L_{night,\ outside} = 55dB$

10.4.2.1.3 British Standard BS 8233

The British Standard *BS 8233: 2014: Guidance on sound insulation and noise reduction for buildings* sets out recommended internal noise levels for several different building types from external noise sources such as road traffic. The recommended indoor ambient noise levels in dwellings are as follows:

Table 10.5 Recommended Indoor Ambient Noise Levels for Dwellings from BS8233: 2014

Activity	Location	Daytime (07:00 to 23:00hrs)	Night (23:00 to 07:00hrs)
Resting	Living Room	35dB $L_{Aeq,16hr}$	--
Dining	Dining Room/Area	40dB $L_{Aeq,16hr}$	--
Sleeping (daytime resting)	Bedroom	35dB $L_{Aeq,16hr}$	30dB $L_{Aeq,8hr}$

For the purposes of this assessment method, it is appropriate to derive external limits based on the internal criteria noted in the paragraph above. This is done by factoring

[1] Based on the existing ambient noise levels in the area it is considered that a guideline noise level of 55dB $L_{Aeq(16hr)}$ is appropriate in this instance.

in the degree of noise reduction afforded by a partially open window. This is commonly taken to be 15dB. In summary, the following external noise levels are applied in order to achieve the recommended internal noise levels in Table 10.5 at the façades of residential properties closest to the Proposed Project site:

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

10.4.2.2 Summary of Assessment Criteria

10.4.2.2.1 Comment on Hours of Assessment

Taking into account the nature of the solar panels, it is anticipated that the panels and associated inverters will not operate during hours of darkness, however during summer months sunrise can occur during the night-time period (23:00hrs to 07:00hrs) and sunset can occur during the evening period (Evening (19:00hrs to 23:00hrs).

As such the following periods of operation will be assessed:

- Daytime (07:00hrs to 19:00hrs)
- Evening (19:00hrs to 23:00hrs)
- Night (23:00hrs to 07:00hrs)

10.4.2.2.2 Comment on Relevant Criteria

Upon review of the various relevant noise criteria previously discussed, it is proposed to carry out the following noise impact assessment in line with the most onerous of these criteria. In this instance the noise criteria set out in British Standard BS 8233 are most onerous and predicted noise levels from sources associated with the proposed Project will be compared to the following criteria:

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

10.4.2.3 Vibration

No source of vibration is anticipated during the operational phase of the Proposed Project and therefore has not been assessed any further.

10.5 Receiving Environment

This stage of the assessment was completed to determine typical background noise levels in the vicinity of the noise sensitive locations in closest proximity to the Proposed Project site. This was done through installing unattended sound level meters at two locations and taking attended measurements at one location, in the surrounding area.

10.5.1 Choice of Measurement Locations

The noise monitoring locations were identified through review of preliminary Proposed Project layouts at an early stage of the assessment. The selection of monitoring locations was supplemented by reviewing aerial images of the study area and other online sources of information (e.g. Google Earth) and verified on the ground.

The selected locations for the noise monitoring and specific details of the noise monitoring installations are outlined in the following sections. Coordinates for the noise monitoring locations are detailed in Table 10.6.

Figure 10.2 Proposed Project Boundary and Monitoring Locations

Table 10.6 Measurement Location Coordinates

Location	Coordinates - Irish Grid (IG)	
	Easting	Northing
Location A (H007)	275,353	237,426
Location B (H040)	277,744	235,354
Location C	275,069	232,985

10.5.2 Instrumentation

The following equipment was used over the survey period.

Table 10.7 Noise Measurement Periods

Location	Manufacturer	Model	Serial Number
Location A (H007)	Larson Davis	820	800
Location B (H039)	Bruel & Kjaer	2238	2638294
Location C	Bruel & Kjaer	2250	2446897

10.5.3 Measurement Periods

Noise measurements were conducted at each of the monitoring locations over the following periods:

Table 10.8 Noise Measurement Periods

Location	Start Date	End Date
Location A (H007)	11:30hrs 15th February 2018	11:15hrs 20th February 2018
Location B (H039)	12:00hrs 15th February 2018	11:00hrs 20th February 2018
Location C	10:00hrs 20th February 2018	12:05hrs 20th February 2018

Unattended measurements were made at Location A and Location B. A secure location for equipment was not found in the vicinity of Location C and attended measurements were taken.

10.5.4 Baseline Survey Results

The data collected during the attended and unattended measurements, during the survey periods is summarised below. Periods are defined as follows:

- Daytime - 07:00hrs to 19:00hrs
- Evening - 19:00hrs to 23:00hrs
- Night – 23:00hrs to 07:00hrs

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

L_{Aeq} is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period. It is typically used as a descriptor for ambient and/or residual noise.

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

The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing. All sound levels in this report are expressed in terms of decibels (dB) relative to 2×10^{-5} Pa.

10.5.4.1 Location A (H007)

The data collected during the unattended monitoring at Location A is summarised below.

Table 10.9 Summary of Survey Results

Date	Period	$L_{Aeq,}$	L_{A90}
15th	*Day	46	41
	Evening	41	36
16th	Night	44	40
	Day	46	39
	Evening	42	35
17th	Night	45	40
	Day	47	36
	Evening	40	29
18th	Night	46	37
	Day	46	36
	Evening	34	30
19th	Night	49	40

Date	Period	$L_{Aeq,}$	L_{A90}
	Day	47	37
	Evening	43	38
	Night	49	40
20th	Night	52	46
	*Day	53	45
Average	Day	48	39
	Evening	41	38
	Night	47	41

* denotes partial period, i.e. monitor removed part way through a period, e.g. during daytime period.

10.5.4.2 Location B (H039)

The data collected during the unattended monitoring at Location B is summarised below.

Table 10.10 Summary of Survey Results

Date	Period	$L_{Aeq,}$	L_{A90}
15th	*Day	58	43
	Evening	44	34
16th	Night	41	33
	Day	48	40
	Evening	41	33
17th	Night	38	31
	Day	43	33
	Evening	53	26
18th	Night	38	28
	Day	42	33
	Evening	44	29
19th	Night	38	32
	Day	45	34
	Evening	40	33
20th	Night	45	37
	*Day	46	40
Average	Day	51	37
	Evening	47	31
	Night	41	32

* denotes partial period, i.e. monitor removed part way through a period, e.g. during daytime period.

10.5.4.3 Location C

The data collected during the attended monitoring at Location C is summarised below.

Table 10.11 Summary of Survey Results

Date	Time	$L_{Aeq,}$	L_{A90}
20th	10:25	49	32
	10:42	47	32
	11:49	47	31

10.6 Likely Significant Effects and Associated Mitigation Measures

10.6.1 Do-Nothing Scenario

If the development is not progressed the existing noise environment (as measured in the baseline assessment) in the vicinity of the Proposed Project site and noise sensitive receivers will remain largely unchanged.

10.6.2 Construction Phase

10.6.2.1 Construction Noise - Overview

This section presents the predicted noise levels associated with the construction of the various elements of the proposed Project, namely:

- The Solar Farm (including associated infrastructure, battery storage and Amenity Trail);
- The Substation and Grid Connection; and,
- The proposed Project as a whole.

The layout of the Proposed Project is presented in Figure 4.1 of this EIAR

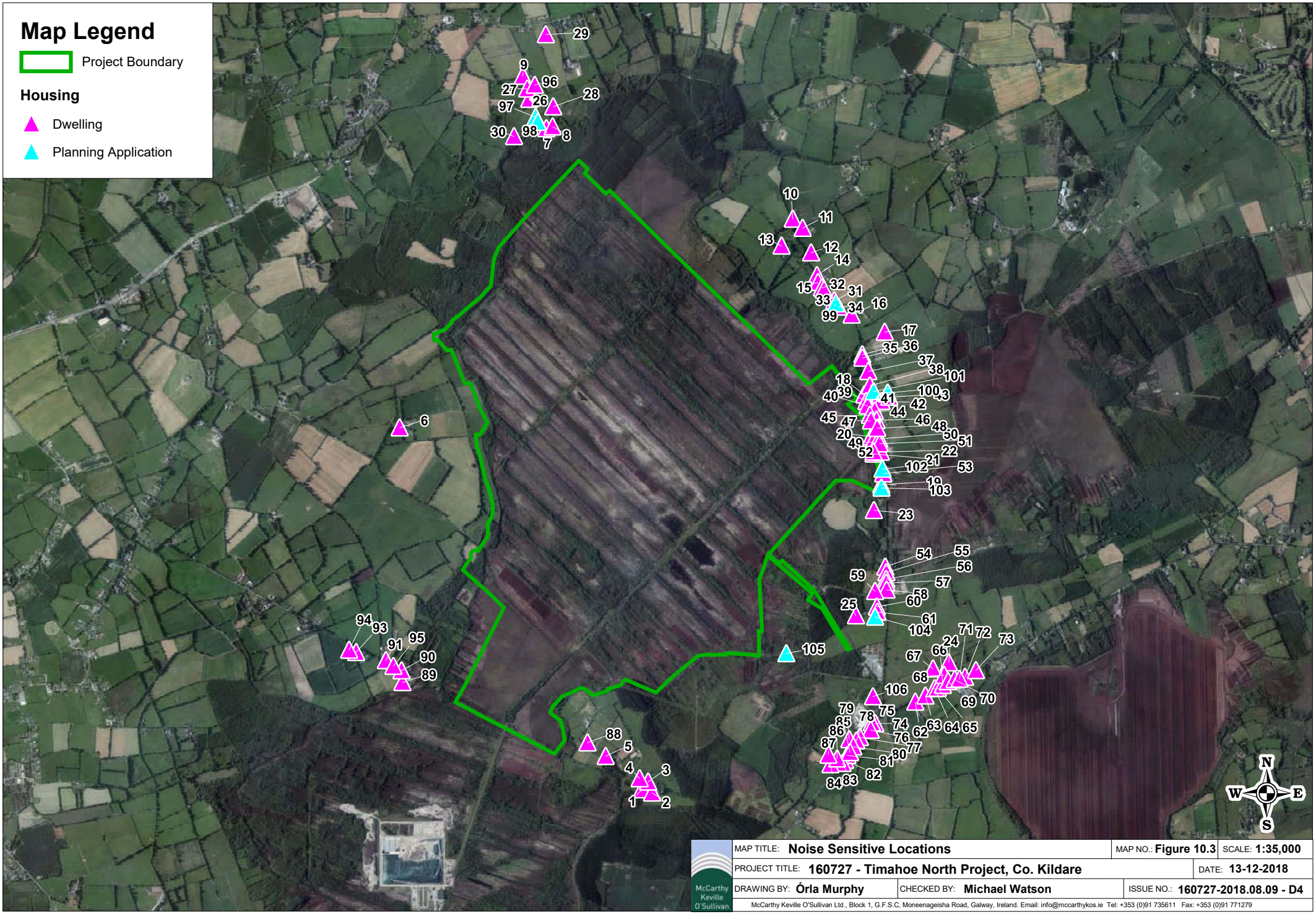
10.6.2.2 Construction Noise - Solar Farm

A variety of items of plant will be in use for the purposes of site preparation, construction of the compound, solar array and other site works. There will be vehicular movements to and from the Proposed Project site that will make use of existing roads. Assumed construction hours are weekdays 07:00 – 19:00hrs and 07:00 to 13:00 on Saturday. Due to the nature of these activities, there is potential for generation of noise.

In order to best predict the noise levels generated by construction activities, reference has been made to the Construction Environmental Management Plan (CEMP) with respect to methodologies, phasing, etc. Taking this information into consideration, it is possible to predict typical noise levels using guidance set out in British Standard *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise*.

In this instance, the noise-sensitive locations surrounding the Proposed Project site are located at varying distances with the closest dwelling located approximately 500 metres from the nearest proposed solar array (i.e. Location H018), and some 150m from the amenity trail. All noise sensitive locations are shown in Figure 10.3

Several indicative sources that would be expected on a site of this nature have been identified and noise predictions of their potential impacts on nearby houses have been prepared. The assessment is considered representative of a worst-case scenario, with construction noise decreasing with increased distance from the works.



MAP TITLE: **Noise Sensitive Locations**		MAP NO.: **Figure 10.3**	SCALE: **1:35,000**
PROJECT TITLE: **160727 - Timahoe North Project, Co. Kildare**			DATE: **13-12-2018**
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Table 10.12 Typical Construction Noise Emission Levels

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise Level at 10m Distance (dB $L_{Aeq,T}$) [2]	Predicted Noise Level at 150 m (dB $L_{Aeq,T}$)	Predicted Noise Level at 500 m (dB $L_{Aeq,T}$)	Predicted Noise Level at 800 m (dB $L_{Aeq,T}$)
HGV Movement (C.2.30)	Movement of spoil and transporting fill and other materials.	79	54	43	39
Tracked Excavator (C.4.64)	Movement of soil and rubble in preparation for foundation.	77	52	41	37
Piling Operations (C.12.14)	Standard pile driving.	88	Note A	52	45
General Construction (Various)	All general activities plus deliveries of materials and plant.	78	53	42	38
Dewatering Pumps (D.7.70)	If required.	80	55	44	40
JCB (D.8.13)	For services, drainage and landscaping.	82	57	46	42
Roller (C.2.38)	Road surfacing.	73	48	37	33
Total Construction Noise (cumulative for all activities)			61	55	51

Note A Piling will not occur within 150m of the nearest residence and therefore no predicted noise level is calculated.

Table 10.12 outlines the noise levels associated with typical construction noise sources assessed in this instance along with typical sound pressure levels and spectra from BS 5228 – 1:2009+A1:2014. The predicted noise levels from construction activities at the nearest receiver are in the range of 52 to 57dB $L_{Aeq,1hr}$ with a cumulative level of the order of 61dB $L_{Aeq,T}$.

In all instances, the predicted noise levels are below the appropriate Category A value (i.e. 65dB $L_{Aeq,T}$) and therefore a potential significant effect is not predicted in relation to the nearest noise sensitive locations in terms of construction noise.

Note that the predicted noise levels referred to in this section are indicative only and are intended to demonstrate that it will be possible for the contractor to comply with current best practice guidance. It should also be noted that the predicted "worst case"

[2] All plant noise levels are derived from BS 5228: Part 1

levels are expected to occur for only short periods of time at a very limited number of properties. Construction noise levels will be lower than these levels for the majority of the time at the majority of properties in the vicinity of the proposed Solar Farm.

There are no items of plant that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the levels outlined in Table 10.1.

In terms of these construction activities, the associated effect is:

Quality	*Significance*	*Duration*
Negative	Moderate	Short-term

10.6.2.3 Construction Noise – Substation

A variety of items of plant will be used for construction of the substation. As previously stated, in order to best predict the noise levels generated by construction activities, reference has been made to the Construction Methodology Document with respect to methodologies, phasing, etc. Taking this information into consideration, it is possible to predict typical noise levels using guidance set out in British Standard *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise*.

The distance between the nearest noise-sensitive locations and the proposed substation is approximately 1,100 m (H088). Therefore, it is expected that the noise levels from construction activities associated with the substation will be in the order of 30 - 41 dB $L_{Aeq,T}$ with a cumulative level of 44dB $L_{Aeq,1hr}$ at this location. This level of noise is significantly below the construction noise criterion outlined in Table 10.

In terms of the substation construction, the potential effects are:

Quality	*Significance*	*Duration*
Negative	Slight	Temporary

10.6.2.4 Construction Noise - Grid Connection

The grid connection will be routed via overhead line within the Proposed Project site, supported by wood poles and steel towers and join the existing line within the site. The full description of the grid connection arrangement for the Proposed Project is outlined in Section 4 of this EIAR. Construction activities will be carried out during normal daytime working hours (i.e. weekdays 0700 – 1900hrs and Saturdays 0700 – 1300hrs).

Construction noise predictions have been carried out using guidance set out in British Standard BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*.

Table 10.13 outlines the noise levels associated with typical construction noise sources assessed in this instance along with typical sound pressure levels and spectra from BS 5228 – 1: 2009+A1:2014 at various distances from these works.

Table 10.13 Indicative Noise Levels from Construction Plant at Various Distances from the Grid Connection Works

Item (BS 5228 Ref.)	Highest Predicted Noise Level at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)	
	500m	1,000m
Tracked excavator (C.3.43)	41	35
Dump truck (C.3.60)	43	37
Water pump (C.2.45)	29	23
Concrete mixer truck (C.4.27)	43	37
Poker Vibrator (C.4.33)	42	36
Cumulative	49	43

The noise levels presented are all below the potential significant noise impact threshold (i.e. 65dB $L_{Aeq,T}$) as outlined in Table 10.1, for daytime periods, at distances of 500m or greater from the works. Consequently, a potential significant effect is not predicted in relation to the nearest noise sensitive locations (which are located approximately 500 m from the works) in terms of this aspect of potential construction noise. The predicted impact will likely be:

Quality	*Significance*	*Duration*
Negative	Slight	Temporary

10.6.2.5 Haul Routes

This section has been prepared in order to review potential noise impacts associated with construction traffic on the local road network. Section 13 of this EIAR presents an assessment of traffic and transportation.

Predicted noise levels along the proposed route have been estimated and is commented upon. The following assumptions have been made in relation to the calculation of traffic noise levels on the local road network due to the additional construction traffic volumes based on the scenarios and assumptions outlined in Table 10.14 below.

In the first instance the daily construction traffic has been added to the existing traffic along the proposed haul roads (i.e. the R402 and L5025) to determine the relative change in noise level.

Table 10.14 Traffic generated by Proposed Project by construction stage, average per day (2-way vehicle movements)

Construction stage	Duration (days)	Trips	
		HGVs	Staff
Stage 1 - Advance work, site preparation	110	25	18
Stage 2 - Site clearance & civils	100	164	39
Stage 3 - Main construction stage	110	74	127
Stage 4 - Substation and commissioning	80	12	31

The existing flows on the two road links are presented below.

Table 10.15 Traffic volumes on study network by vehicle type, 2021

Link	24 hour vehicles	% HGV	HGVs	Cars LGVs
R402	6,192	9.4%	582	5,610
L-5025	1,438	9.4%	135	1,302

The predicted change in noise level associated with construction traffic added to existing traffic flow along the two roads is presented below for each phase of the construction process.

Table 10.17 Predicted Change in Noise Level - Daily Traffic Volumes on Study Network

Construction stage	Road Link	Predicted Change in Noise Level (dB)
Stage 1 - Advance work, site preparation	R402	+0.3
	L-5025	+1.1
Stage 2 - Site clearance & civils	R402	+1.7
	L-5025	+4.8
Stage 3 - Main construction stage	R402	+0.9
	L-5025	+2.9
Stage 4 - Substation and commissioning	R402	+0.2
	L-5025	+0.6

The predicted change in noise levels associated with construction traffic ranges from +0.3dB to +4.8dB. with reference to Table 10.17 this represents an impact as follows:

Quality	*Significance*	*Duration*
Negative	Negligible to Moderate	Temporary

In the next instance, traffic flows have been assessed over a peak hour, which represents a worst-case scenario in which twice the hourly average HGV movements and half the total staff trips occur over one hour. Peak values have been provided for the L-5025 road link. The predicted change in noise levels associated with peak construction traffic added peak hour flows are presented below.

Table 10.18 Traffic volumes on study network by vehicle type, 2021

Construction stage	Road Link	Predicted Change in Noise Level (dB)
Stage 1 - Advance work, site preparation	L-5025	+1.4
Stage 2 - Site clearance & civils	L-5025	+5.3
Stage 3 - Main construction stage	L-5025	+4.1
Stage 4 - Substation and commissioning	L-5025	+0.8

Considering the large number of HGVs expected during Phase 2 and Phase 3 in particular, with reference to Table 10.18, the associated change in noise levels, when considering peak hour periods is categorised as major. Therefore, the potential impact is as follows:

Quality	*Significance*	*Duration*
Negative	Significant	Temporary

The predicted impact of construction traffic during Phase 1 and Phase 4 is:

Quality	*Significance*	*Duration*
Negative	Negligible to Minor	Temporary

The assessment has determined during the Stage 2 and Stage 3 works, highest increases in noise levels will be experienced along the L-5025 due to the relatively low volumes of traffic along this road and the temporary increase in construction traffic along it.

The relative change in noise levels are assessed against the DMRB 'short term' change in traffic noise tables, which present a worst-case analysis of response to traffic increases. Whilst the assessment has indicated that the additional traffic will be perceptible and of moderate to major impact, the duration is temporary.

It is also important to consider the overall noise levels associated with traffic volumes when considering the impacts. During the Stage 2 works where highest construction

traffic will occur, traffic noise levels are calculated to be in the range of 65dB at a distance of 10m from the road. Whilst this represents an increase in noise levels above the ambient noise environment, it is broadly in line with allowable construction related noise levels for large construction projects detailed in Table 10.1.

10.6.2.6 Predicted Cumulative Project Construction Noise

The Construction Methodology document outlines the construction phase of the Proposed Project. As noted above, it is indicated that construction of the various elements will happen in sequence and not at the same time. Therefore, cumulative construction noise levels associated with the construction of the entire Project simultaneously, have not been assessed.

10.6.2.7 Construction Phase General Mitigation Measures – Proposed Project

With regard to construction activities, reference will be made to British Standard BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*, which offers detailed guidance on the control of noise & vibration from demolition and construction activities. In particular, it is proposed that various practices be adopted during construction, including:

- limiting the hours during which site activities likely to create high levels of noise or vibration are permitted;
- establishing channels of communication between the contractor/developer, Local Authority and residents;
- appointing a site representative responsible for matters relating to noise and vibration;
- in the instance that a noise complaint is received, it is recommended that monitoring of noise and vibration is carried out at sensitive locations;
- keeping site access roads even to mitigate the potential for vibration from lorries.

Furthermore, a variety of practicable noise control measures will be employed. These include:

- selection of plant with low inherent potential for generation of noise and/ or vibration;
- placing of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints, and;
- regular maintenance and servicing of plant items.

10.6.2.8 Mitigation Measures for Proposed Project – Noise

The contract documents will clearly specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of British Standard BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise.* The following list of measures will be considered, where necessary, to ensure compliance with the relevant construction noise criteria:

- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.

- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate outside of general construction hours will be surrounded by an acoustic enclosure or portable screen.
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Table 10.1 using methods outlined in British Standard BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 7:00hrs and 19:00hrs weekdays and between 7:00hrs and 13:00hrs on Saturdays. However, to ensure that optimal use is made of good weather periods or at critical periods within the programme it could occasionally be necessary to work out of these hours.
- On the subject of construction traffic noise, it is difficult to mitigate impacts off site. Often, good Public Relations, whereby residents are informed of the duration of the phase and frequency of vehicle movements, has been demonstrated to reduce the likelihood of annoyance.

10.6.2.9 Mitigation Measures for Proposed Project – Vibration

It is recommended that vibration from construction activities be limited to the values set out in Table 10.2. It should be noted that these limits are not absolute, but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage. Magnitudes of vibration slightly greater than those in the table are normally unlikely to cause cosmetic damage, but construction work creating such magnitudes should proceed with caution. Where there is existing damage these limits may need to be reduced by up to 50%.

10.6.3 Operational Phase

10.6.3.1 Noise Model

A series of computer-based prediction models have been prepared in order to predict the noise level associated with the operational phase of the proposed Project site. This section discusses the methodology behind the noise modelling process and presents the results of the modelling exercise.

10.6.3.2 Brüel & Kjær Predictor

Proprietary noise calculation software was used for the purposes of this impact assessment. The selected software, Brüel & Kjær *Predictor*, calculates noise levels in accordance with ISO 9613*: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation, 1996*.

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

- the magnitude of the noise source in terms of A weighted sound power levels (L_{WA});

- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m).

10.6.3.3 Input Data and Assumptions

Contour and information available for the Proposed Project site has been inputted into our Brüel & Kjær *Predictor* noise modelling software using the ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors: General method of calculation*.

10.6.3.3.1 Operational Phase - Solar Farm

There will be inverters installed at intervals throughout the Solar Farm. Solar Farm inverters have the potential to generate noise when operational. As solar panels produce power only when the sun is shining, inverters will be completely silent for the hours of darkness at night. The assumed noise level data used for this aspect of the assessment are presented in Table 10.16 below.

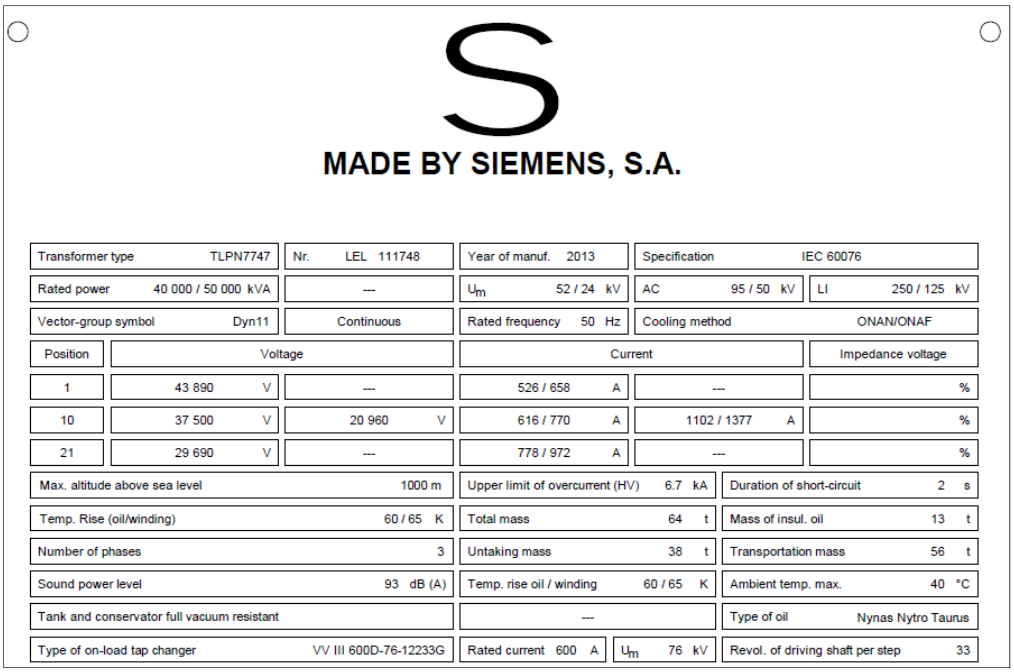
Table 10.16 L_{wA} Spectra Used for Prediction Model

Octave Band Centre Frequencies (Hz)								L_w (dB(A))
63	125	250	500	1k	2k	4k	8k	
86	90	96	89	85	81	73	70	92[3]

10.6.3.3.2 Operational Phase - Substation and Grid Connection

As part of the proposed Project the substation will be operational on a day to day basis. The noise emission level associated with a typical substation that would support a development of this nature is the order of 93dB(A) L_w.

[3] Overall level obtained from White Paper BU-U-018: Sunny Central Sound Power Measurements on SCxxxCP XT central inverters with spectrum shape obtained from AWN data.



MADE BY SIEMENS, S.A.

Transformer type	TLPN7747	Nr.	LEL 111748	Year of manuf.	2013	Specification	IEC 60076
Rated power	40 000 / 50 000 kVA		---	U_m	52 / 24 kV	AC 95 / 50 kV	LI 250 / 125 kV
Vector-group symbol	Dyn11		Continuous	Rated frequency	50 Hz	Cooling method	ONAN/ONAF
Position	Voltage			Current			Impedance voltage
1	43 890 V		---	526 / 658 A		---	%
10	37 500 V		20 960 V	616 / 770 A		1102 / 1377 A	%
21	29 690 V		---	778 / 972 A		---	%
Max. altitude above sea level	1000 m			Upper limit of overcurrent (HV)	6.7 kA	Duration of short-circuit	2 s
Temp. Rise (oil/winding)	60 / 65 K			Total mass	64 t	Mass of insul. oil	13 t
Number of phases	3			Untaking mass	38 t	Transportation mass	56 t
Sound power level	93 dB (A)			Temp. rise oil / winding	60 / 65 K	Ambient temp. max.	40 °C
Tank and conservator full vacuum resistant				---		Type of oil	Nynas Nytro Taurus
Type of on-load tap changer	VV III 600D-76-12233G			Rated current 600 A	U_m 76 kV	Revol. of driving shaft per step	33

Figure 10.4 Statement of L_w for Typical Sub Station Used for Assessment

10.6.3.4 Modelling Calculation Parameters[4]

Prediction calculations for noise have been conducted in accordance with ISO 9613*: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation, 1996*. In terms of calculation a ground attenuation factor (general method) of 1.0 and no metrological correction were assumed for all calculations. The atmospheric attenuation outlined in Table 10.17 was assumed for all calculations.

Table 10.17 Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

Temp (°C)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	70	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88

10.6.3.5 Additional Information

Noise Sensitive Locations (noted in Appendix 10-1 and Figure 10.3), ground topography, geographical features have been taken from survey information supplied by McCarthy Keville O'Sullivan and Ordnance Survey maps.

10.6.3.6 Noise Model Results

10.6.3.6.1 Solar Farm

The predicted noise levels associated with the operation of the Solar Farm and associated inverters are presented below at the 10 no. closest receivers. Receiver locations are noted in Appendix 10-1.

[4] See Appendix 10-3 for further discussion of calculation parameters and settings.

Table 10.18 Predicted Noise Levels Associated with Solar Farm Operation

Name	Height (m)	Predicted $L_{Aeq,T}$ dB
H013	4	24
H032	4	23
H015	4	23
H033	4	23
H099	4	23
H031	4	23
H014	4	23
H034	4	23
H018	4	23
H039	4	23

The predicted noise levels at the closest 10 no. receivers are presented above and are in the range 23 – 24 dB $L_{Aeq,T}$. The predicted levels at receivers further away is less, a full table of results are presented in Appendix 10.4.

This level is some 4dB below the lowest L_{A90} dB measured across the various measurement locations. Therefore, the associated noise impact from the operation of the Solar Farm inverters is summarised as follows:

Quality	*Significance*	*Duration*
Neutral	Not Significant	Long Term

10.6.3.6.2 Substation

The predicted noise levels associated with the operation of the substation presented below at the 10 no. closest receivers. Receiver locations are noted in Appendix 10-1 and shown on Figure 10.3.

Table 10.19 Predicted Noise Levels Associated with Substation Operation

Name	Height (m)	Predicted $L_{Aeq,T}$ dB
H088	4	21
H005	4	20
H004	4	18
H105	4	18
H003	4	18
H001	4	18
H002	4	17

Name	Height (m)	Predicted $L_{Aeq,T}$ dB
H090	4	17
H089	4	16
H095	4	16

The predicted noise levels at the closest 10 no. receivers are presented above and are in the range 16 – 21 dB $L_{Aeq,T}$. The predicted levels at receivers further away is less, a full table of results are presented in Appendix 10.5.

This level is some 5 dB below the lowest L_{A90} dB measured across the various measurement locations. Therefore, the associated noise impact from the operation of the substation is summarised as follows:

Quality	*Significance*	*Duration*
Neutral	Not Significant	Long Term

10.6.3.6.3 Proposed Project - Operational Levels

The predicted noise levels associated with the operation of the Project as a whole have been predicted. The table below presents the 10 no. receivers that experience the highest contribution from the Proposed Project operational noise. At greater distances, the contribution of the Proposed Project operations is less. Receiver locations are noted in Appendix 10-1 and shown on Figure 10.3.

Table 10.20 Predicted Noise Levels Associated with Combined Project Operation

Name	Height (m)	Predicted $L_{Aeq,T}$ dB
H013	4	24
H088	4	24
H032	4	24
H015	4	24
H033	4	24
H099	4	23
H018	4	23
H031	4	23
H034	4	23
H014	4	23

The predicted noise levels at the closest 10 no. receivers are presented above and are in the range 23 – 24dB $L_{Aeq,T}$. The predicted levels at receivers further away is less, a full table of results are presented in Appendix 10.6.

This level is some 4 dB below the lowest L_{A90} dB measured across the various measurement locations. Therefore, the associated noise impact from the operation of the Proposed Project, i.e. all elements, is summarised as follows:

Quality	*Significance*	*Duration*
Neutral	Not Significant	Long Term

10.6.3.7 Operational Phase Mitigation

No mitigation is proposed as the assessment has concluded the impact of the operational phase of the proposed Project as a whole, is not significant.

10.6.4 Monitoring

10.6.4.1 Construction Phase

Contractors will be required to prepare a construction management plan including methods for reducing noise and vibration emissions. As part of the management of the construction activity noise and vibration monitoring should be considered, for example in the instance that a complaint is received. Monitoring can then be undertaken to validate any complaint.

10.6.4.2 Operational Phase

Ongoing monitoring is not considered necessary given the insignificant noise impact expected during the operational phase.

10.6.5 Decommissioning Phase

The mitigation measures that will be considered in relation to any decommissioning of the Proposed Project site are the same as those proposed for the construction phase of the development, i.e. as per Section 10.6.2.

10.6.6 Cumulative Impacts

The Drehid Waste Management Facility (DWMF) south of the Proposed Project site has been considered for the cumulative impact assessment.

10.6.6.1 Construction Phase

A worst-case scenario has been considered which would cover the instance that the Proposed Project and the DWMF were constructed at the same time.

The nearest noise sensitive receivers to both areas where major works would be expected to take place are located along the Derrymahon Road, which runs along the southern boundary of the proposed Project site and north of the DWMF. These residential properties are approximately 800m from works relating to the proposed Solar Farm, 500m from grid connection works and at least 800m from areas where major works would be expected to take place on the DWMF site.

Construction noise predictions have been carried out in Section 10.6. Assuming a worst-case scenario whereby the works at the DWMF generate the same level of noise as those at the proposed Project site, the predicted cumulative construction noise levels would be in the range of 3 -5 dB higher than those presented in Table 10.12 at 800m i.e. resulting in a potential worst case cumulative noise level of 55dB. These predicted levels are well below the construction noise limit of 65dB $L_{Aeq,T}$.

10.6.6.2 Operational Phase

The baseline survey carried out for the proposed Project was carried out while the DWMF was operational. Therefore, considering the predicted noise levels for the operational phase of the proposed Project were lower than those collected during the baseline survey, (i.e. levels with the WMF in operation), it is considered that there will be no cumulative impact associated with existing operations. The proposed expansion of the DWMF was also considered in the cumulative assessment. That facility, should it be consented will operate under strict noise emissions limits as set in their EPA licence. Given the low levels of noise associated with the proposed project and the controls that will be in place at the DWMF, the cumulative impacts will be imperceptible.

10.6.7 Residual Impacts

10.6.7.1 Construction Phase

No significant residual on-site construction noise impacts are predicted as all construction activities are predicted to be below the construction noise limit in relation to a potential significant construction noise impact at residential properties.

There is the potential for significant effects based on predicted noise associated with construction traffic, at noise sensitive receivers at distances of less than 10m. However, this will be temporary in duration.

No significant decommissioning noise effects are predicted.

Vibration arising from construction or decommissioning of the wind farm will not be significant.

10.6.7.2 Operational Phase

Solar Farm

The predicted noise levels relating to the operation of the Solar Farm are below the baseline noise levels at the nearest noise sensitive locations and the impact is deemed to be not significant.

Substation

The predicted noise levels relating to the operation of the Substation are considerably below the baseline noise levels at the nearest noise sensitive locations and the impact is deemed to range from imperceptible to not significant.

The above effects should be considered in terms that the effect is variable, and that this assessment considers periods of the greatest potential effect.