AECOM Delivering a better world

CHAPTER 09
Airborne Noise and Groundborne Vibration

Shannon LNG Limited
August 2021

Shannon Technology and Energy Park
Environmental Impact Assessment Report

Table of Contents

Tables

9. Airborne Noise and Groundborne Vibration

9.1 Introduction

This chapter assesses the potential noise and vibration impacts associated with the Proposed Development. A full description of the Proposed Development is given in Chapter 02 – Project Description. Sound and vibration from Liquid Natural Gas Carriers (LNGC) used to refuel the Floating Storage and Regasification Unit (FSRU) and associated tugs are also considered.

This chapter does not cover underwater noise and vibration impacts. These are assessed in the appendix to Chapter 07. Noise and vibration impacts affecting ecological receptors are also not covered and instead are discussed in Chapter 07.

Noise and vibration emissions can potentially occur during the construction, operational and decommissioning phases of the Proposed Development.

Potential noise and vibration sources during the construction phase comprise mobile plant and construction processes such as earthworks and piling which can give rise to elevated sound and vibration levels.

Potential noise sources during the operational phase comprise plant and equipment associated with the operation of the power plant, Liquid Natural Gas (LNG) Terminal and Above Ground Installation (AGI). It also comprises plant associated with the FSRU and intermittent noise from LNGCs. No significant groundborne vibration sources are identified during the operational phase.

9.2 Competent Expert

The assessment has been carried out under the supervision of Chris Skinner. Chris Skinner has over 20 years' experience in Acoustics Consultancy and holds a MSci/ MA Physics from the University of Cambridge. He is a full corporate member of the Institute of Acoustics.

He has significant experience in modelling noise from a range of industrial facilities, including power generation plant. Chris Skinner works with a wide range of clients, from industrial site operators and developers to Local Authorities and provides expert technical advice to government departments on noise and nuisance.

Chris Skinner has strong experience in developing large complex acoustic models and undertaking predictions and has worked with many clients to use such models to understand noise impacts from industrial sites, design mitigation and provide acoustic design advice for site developments.

9.3 Methodology

9.3.1 Study Area

The study area for onsite construction and operational noise and vibration is defined as an area extending from the Proposed Development site up to and including the nearest sensitive receptor locations. If compliant levels of noise and vibration are predicted at the nearest sensitive receptor locations, it follows that compliant levels will be achieved at all other locations.

The study area for offsite traffic noise is the same as identified in the transport assessment, detailed in Chapter 11.

9.3.2 Determination of the Baseline Environment

The baseline acoustic environment has been determined via several long-term surveys conducted in and around the site. These surveys are discussed below.

9.3.3 Describing Potential Effects

The Environmental Protection Agency (EPA) Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, 2017) are draft Guidelines written to facilitate the implementation of Directive 2011/92/EU as amended by EU Directive 2014/52/EU in Ireland. This document covers the assessment and description of environmental impacts.

Effects are described under various headings, including Quality, Significance, Extent and Context, Probability, Duration and Frequency. Of particular relevance are the definitions of significance and duration, which are given in Table 9-1 and Table 9-2.

Table 9-1 Description of Significance of Effects

Aspect	Description
Imperceptible	An effect capable of measurement but without significant consequences
Not Significant	An effect which causes noticeable changes in the character of the environment but without significant consequences
Slight	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities
Moderate	An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends
Significant	An effect which, by its character, magnitude, duration or intensity, alters a sensitive aspect of the environment
Very Significant	An effect which, by its character, magnitude, duration or intensity, significantly alters most of a sensitive aspect of the environment
Profound	An effect which obliterates sensitive characteristics

Source: Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA 2017)

Table 9-2 Description of Duration of Effects

Aspect	Description
Momentary	Effects lasting from seconds to minutes
Brief	Effects lasting less than a day
Temporary	Effects lasting less than a year
Short-Term	Effects lasting from one to seven years
Medium-Term	Effects lasting from seven to 15 years
Long Term	Effects lasting from 15 to 60 years
Permanent	Effects lasting over 60 years
Reversible	Effects that can be undone, e.g. through remediation or restoration
Frequency	How often the effect will occur

Source: Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA 2017)

9.3.4 Significance of Effects Construction Phase

9.3.4.1 Introduction

To determine potential temporary noise and vibration impacts during the construction phase of the Proposed Development, the following matters have been considered:

- Noise and vibration caused by construction site activities; and
- Noise and vibration caused by increases in traffic on existing roads.

9.3.4.2 Criteria – Noise from Onsite Construction Activities

Transport Infrastructure Ireland (TII; formerly the National Roads Authority) is the only government body in Ireland to publish construction noise limits, which are presented in the document Guidelines for the Treatment of Noise and Vibration in National Road Schemes (NRA 2004) (NRA Guidelines).

It is acknowledged the limits presented relate to construction works for road schemes, however it is assumed that noise sensitive receptors are likely to be equally sensitive to construction noise from other project types.

The criteria presented in this document are given in Table 9-3.

Table 9-3 Maximum permissible noise levels at the façade of dwellings during construction

Period	$L_{Aeq,1hr}$ dB	$L_{p(max)\ slow}$ dB
Monday to Friday – 07:00 to 19:00	70	80
Monday to Friday – 19:00 to 22:00	60[1]	65[1]
Saturday – 08:00 to 16:30	65	75
Sundays and Bank Holidays – 08:00 to 16:30	60[1]	65[1]

[1] Construction activity at these times, other than that required in respect of emergency works, will normally require the
explicit permission of the relevant local authority

Source: Guidelines for the Treatment of Noise and Vibration in National Road Schemes *(NRA 2004)*

Potential construction noise impacts can also be assessed using BS 5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites' (BS5228).

The 'ABC' method (detailed in BS5228 Section E.3.2) has been used to develop criteria . Using this method, the construction noise limit for the Proposed Development are determined by rounding the ambient noise levels to the nearest 5 dB and then comparing this level to the Category A, B and C values given in BS5228, detailed in Table 9-4.

Table 9-4 BS5228 Construction Noise Criteria

Assessment category and threshold value period	Threshold Value L_{Aeq},T dB		
	Category A (a)	Category B (b)	Category C (c)
Night-time (23:00 – 07:00)	45	50	55
Evenings and weekends (d)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75

NOTE 1: A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.
NOTE 2 If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise.
NOTE 3: Applies to residential receptors only.

(a) Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.
(b) Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values.
(c) Category C: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.

Assessment category and threshold value period	Threshold Value L_{Aeq},T dB		
	Category A (a)	Category B (b)	Category C (c)

(d) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays, 07:00 – 23:00 Sundays.

For the purposes of this assessment, the criteria given in both the NRA Guidelines and BS5228 will be considered. Where the criteria differ, the more stringent of the two will be adopted.

9.3.4.3 Criteria – Vibration from Onsite Construction Activities

There are two types of construction vibration criteria: those dealing with human perception and those dealing with structural damage to buildings. Both criterion types are considered relevant to the Proposed Development.

Table B.1 in BS5228 presents vibration criteria with regards human perception. These are presented in Table 9-5 with descriptions of likely reactions.

Table 9-5 BS5228 Vibration Criteria - Human Perception

Peak Particle Velocity (PPV)	Description
>= 10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.
>1.0 mm/s	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.
>0.3 mm/s	Vibration might be just perceptible in residential environments.
>0.14 mm/s	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.

Table 2 of the NRA guidelines provide construction vibration criteria identified to ensure there is no potential for vibration damage during construction. These criteria are presented in Table 9-6.

Table 9-6 NRA Guidelines Vibration Criteria – Structural Damage

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

9.3.4.4 Criteria – Blasting

It is expected that blasting would be required during the initial construction phases to excavate some of the rock, which cannot be removed by rock breaking equipment mounted on tracked excavators. Full details of the blasting process and methodology are given in Chapter 2 Section 2 Construction.

With regard blasting operations BS5228 states:

> *Whenever blasting is carried out, energy is transmitted from the blast site in the form of airborne pressure waves. These pressure waves comprise energy over a wide range of frequencies, some of which are higher than 20 Hz and therefore perceptible as sound, whereas the majority are below 20 Hz and hence inaudible but can be sensed as concussion. It is the combination of the sound and concussion that is known as air overpressure.*

With regard air overpressure criteria, BS5228 goes on to state:

> *As the airborne pressure waves pass any single point the pressure of the air rises rapidly to a value above atmospheric pressure, falls to below atmospheric pressure, then returns to normal pressure after a series of oscillations. The maximum value above atmospheric pressure is known as peak air overpressure and is measured in pressure terms and generally expressed in linear decibels (dB lin) (see I.4).*
>
> *Routine blasting can regularly generate air overpressure levels at adjacent premises of around 120 dB (lin). This level corresponds to an excess air pressure which is equivalent to that of a steady wind velocity of 5 m·s−1 (Beaufort force 3, gentle breeze) and is likely to be above the threshold of perception.*
>
> *Windows are generally the weakest parts of a structure and research by the United States Bureau of Mines [65] has shown that a poorly mounted window that is prestressed might crack at 150 dB (lin), with most windows cracking at around 170 dB (lin), whereas structural damage would not be expected at levels below 180 dB (lin).*

Criteria for vibration caused by blasting activities are presented in BS6472-2:2008 Guide to evaluation of human exposure to vibration in buildings, Part 2: Blast Induced Vibration (BSI Group, 2008) (BS6472). These criteria are presented in Table 9-7.

Table 9-7 BS6472 Vibration Criteria - Blasting

Place	Time	Satisfactory Magnitude[A] PPV (mm/s)
Residential	Day[D]	6.0 to 10.0[C]
	Night[D]	2.0
	Other Times[D]	4.5
Offices[B]	Any Time	14.0
Workshops[B]	Any Time	14.0

NOTE 1 This table recommends magnitudes of vibration below which the probability of adverse comment is low (noise caused by any structural vibration is not considered).

NOTE 2 Doubling the suggested vibration magnitudes could result in adverse comment and this will increase significantly if the magnitudes are quadrupled.

NOTE 3 For more than three occurrences of vibrations per day see the further multiplication factor in 5.2.

A) The satisfactory magnitudes are the same for the working day and the rest of the day unless stated otherwise.

B) Critical working areas where delicate tasks impose more stringent criteria than human comfort are outside the scope of this standard.

C) Within residential properties people exhibit a wide variation of tolerance to vibration. Specific values are dependent upon social and cultural factors, psychological attitudes and the expected degree of intrusion. In practice the lower satisfactory magnitude should be used with the higher magnitude being justified on a case-by-case basis.

D) For the purpose of blasting, daytime is considered to be 08h00 to 18h00 Monday to Friday and 08h00 to 13h00 Saturday. Routine blasting would not normally be considered on Sundays or Public Holidays. Other times cover the period outside of the working day but exclude night-time, which is defined as 23h00 to 07h00.

9.3.4.5 Criteria – Noise from Increased Traffic Flows on Existing Roads during the Construction Period

The potential increase in noise levels resulting from changes to road traffic flows during the construction period have been determined in accordance with the NRA Guidelines which refer to the Calculation of Road Traffic Noise (CRTN) methodology.

The CRTN methodology is not accurate for very low traffic flows (below 1000 AAWT,18hr). Where flows of this magnitude are predicted, the Noise Advisory Council (NAC) prediction method detailed in the document A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level L_{eq} has been used.

No specific Irish guidance containing criteria for noise impacts from construction traffic has been published.

The impact of construction phase traffic has therefore been assessed in accordance with the short-term criteria provided in the Highways England document Design Manual for Roads and Bridges LA111 Noise and vibration (LA111). These criteria are given in terms of change in noise level and are presented in Table 9-8.

Table 9-8 Magnitude of Impact – Construction Phase Traffic

Change in Sound Level ($L_{A10,18hr}$ dB)	Magnitude of Impact (Short Term)
0	No Change
0.1 to 0.9	Negligible
1.0 to 2.9	Minor
3.0 to 4.9	Moderate
5+	Major

Source: Design Manual for Roads and Bridges LA111 Noise and vibration) Highways England, 2020)

9.3.4.6 Construction Phase – Candidate Special Area of Conservation (cSAC) and Other Ecological Receptors

The impact of construction phase noise and vibration emissions on the habitats and species of the cSAC and other ecological receptor positions are discussed in Chapter 07.

9.3.5 Significance of Effects Operational Phase

9.3.5.1 Introduction

To determine the potential noise and vibration impacts during the operational phase, the following matters have been considered:

- Sound and vibration caused by site operations; and
- Sound and vibration caused by increases in traffic on existing roads.

9.3.5.2 Criteria – Operational Phase Noise Emissions

The Proposed Development would be licensed by the Environmental Protection Agency (EPA) under an Industrial Emissions Directive (IED) Licence.

Guidance on permissible noise emission limits for licensed facilities is contained in the document Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) (EPA,2016) (NG4). NG4 refers to Best Available Techniques as a form of noise mitigation which is defined in Section 7 of the Protection of the Environment Act (2003) as:

> '*The most effective and advanced stage in the development of an activity and its methods of operation, which indicate the practical suitability of particular techniques for providing, in principle, the basis for emission limit values designed to prevent or eliminate or, where that is not practicable, generally to reduce an emission and its impact on the environment as a whole.*'

NG4 states that:

> ' *All reasonably practicable measures should be adopted at licensed facilities to minimise the noise impact of the activity, and BAT should be used in the selection and implementation of appropriate noise mitigation measures and controls.*'

NG4 also provides criteria for use in noise assessments which vary depending on whether the location of the development is in a 'Quiet Area' or an 'Area of Low Background Noise'.

A 'Quiet Area' is defined as a location that meets the following criteria:

- At least 3 km from urban areas with a population >1,000 people;
- At least 10 km from any urban areas with a population >5,000 people;
- At least 15 km from any urban areas with a population >10,000 people;
- At least 3 km from any local industry;
- At least 10 km from any major industry centre;
- At least 5 km from any National Primary Route, and;
- At least 7.5 km from any Motorway or Dual Carriageway.

An 'Area of Low Background Noise' is a location that meets the following criteria:

- Average Daytime Background Noise Level ≤40dB L_{AF90}, and;
- Average Evening Background Noise Level ≤35dB L_{AF90}, and;
- Average Night-time Background Noise Level ≤30dB L_{AF90}.

The criteria presented in NG4 are detailed in Table 9-9.

Table 9-9 Recommended Noise Limit Criteria

Scenario	Daytime Noise Criterion dB $L_{ar,T}$ (0700 to 1900 hours)	Evening Noise Criterion dB $L_{ar,T}$ (1900 to 2300 hours)	Night-time Noise Criterion dB $L_{ar,T}$ (2300 to 10700 hours)
Quiet Area	Noise from the licensed site to be at least 10 dB below the average daytime background noise level measured during the baseline survey	Noise from the licensed site to be at least 10 dB below the average evening background noise level measured during the baseline survey	Noise from the licensed site to be at least 10 dB below the average night-time background noise level measured during the baseline survey
Areas of Low Background Noise	45 dB	40 dB	35 dB
All other Areas	55 dB	50 dB	45 dB

Source: Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) (EPA,2016)

The criteria are given in terms of a Rated Noise Level ($L_{ar,T}$) which is defined in NG4 as:

> *The Rated Noise Level, equal to the LAeq during a specified time interval (T), plus specified adjustments for tonal character and/ or impulsiveness of the sound.*

The method for applying adjustments for tonal and/ or impulsive characteristics are described in NG4 and have been considered in this assessment.

The location of the Proposed Development does not meet the definition of a 'Quiet Area' due to its proximity to the N69 to the east and the Money Point Power Station to the north. However, the results of the baseline survey indicate that the site could be considered an 'Area of Low Background Noise' (this is discussed further below). Therefore, the criteria detailed for Areas of Low Background Noise' have been adopted for this assessment.

The acoustic character of this rural area may change in the future due to the area being zoned for marine-related industry as part of the Strategic Integrated Framework Plan for the Shannon Estuary which is supported by Kerry Co. Council as identified in the document 'Kerry County Development Plan 2015-2021' (adopted 16th March 2015). So, while the more stringent 'area of low background noise' criteria have been adopted in this assessment, it may be appropriate to review these criteria in due course.

9.3.5.3 Criteria – Noise from Increased Traffic Flows on Existing Roads during the Operational Period

The potential increase in noise levels resulting from changes to road traffic flows during the operational period have been determined in accordance with the NRA Guidelines which refer to the CRTN methodology.

The CRTN methodology is not accurate for very low traffic flows (below 1000 AAWT,18hr). Where flows of this magnitude are predicted, the NAC prediction method detailed in the document A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level L_{eq} has been used.

The only Irish guidance which discusses criteria for road traffic noise is the NRA guidelines, which identifies a criterion of 60 dB L_{den}.

This guidance is identified as applicable to new road schemes only. However, it may be considered applicable to this scheme given the absence of other guidance and the fact that the impact of increased road traffic noise from existing roads may be considered subjectively similar to road traffic noise from a new road link.

The impact of operational phase traffic can also be assessed in accordance with the short-term and long-term criteria provided in the Highways England document Design Manual for Roads and Bridges LA111 Noise and vibration (LA111). This document does not cover Ireland; however, it has historically been used to assess this area.

LA111 presents criteria in terms of the change in noise level in the short term (year of opening) and long term (typically 15 years after opening) The criteria are given in Table 9-10 and Table 9-11.

Table 9-10 Magnitude of Impact – Operational Phase Traffic – Short Term

Change in Sound Level ($L_{A10,18hr}$ dB)	Magnitude of Impact (Short Term)
-0	No Change
0.1 to 0.9	Negligible
1.0 to 2.9	Minor
3.0 to 4.9	Moderate
5+	Major

Source: Design Manual for Roads and Bridges LA111 Noise and vibration (Highways England, 2020)

Table 9-11 Magnitude of Impact – Operational Phase Traffic – Long Term

Change in Sound Level ($L_{A10,18hr}$ dB)	Magnitude of Impact (Short Term)
-0	No Change
<3.0	Negligible
3.0 to 4.9	Minor
5.0 to 9.9	Moderate
10+	Major

Source: Design Manual for Roads and Bridges LA111 Noise and vibration (Highways England, 2020)

The assessment refers to both sources of criteria.

9.3.5.4 Operational Phase cSAC and other Ecological Receptors

The impacts of operational phase noise emissions on the cSAC and other ecological receptors are discussed in Chapter 07.

9.3.6 Limitations and Assumptions

The following limitations and assumptions apply to the assessment:

- The sound levels measured during the acoustic survey are representative of the baseline acoustic environment generally.
- Prior to construction start, a commercial tendering process will be held to supply the Power Plant and FSRU. The tendering process will result in a contract for a particular model of power plant and FSRU. Therefore, the precise size, configuration, performance, and layout of the equipment will be finalized following the award of the contract. For the purposes of this planning application and EIAR, consideration of environmental impacts is on the basis of the largest anticipated size of Power Plant and FSRU envisaged while accommodating equipment from the handful of major equipment suppliers capable of providing this type of generation equipment.
- The calculated sound levels presented in the report have been established using CadnaA 3D sound modelling software which adopts the calculation methodologies detailed in ISO 9613-2:1996 Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation, BS 5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites and the Department of Transport Welsh Office document Calculation of Road Traffic Noise. The assessment is therefore subject to the assumptions and limitations detailed within these standards.

9.4 Baseline Environment

9.4.1 Baseline Measurements

Three long-term acoustic surveys were carried out in and around the site to determine baseline levels: between 14th and 18th February 2020, between 20th and 28th October 2020 and between 27th November and 11th December 2020. All surveys were conducted in accordance with BS 7445-1:2003 Description and measurement of environmental noise Guide to quantities and procedures.

The three surveys were conducted to ensure sufficient data was collected during weather conditions suitable for measurement. The measurement locations used during the surveys are shown in Figure F9-1, Vol. 3.

The existing acoustic environment is rural in nature. Sound sources identified included birdsong, farm animals and weather induced sound (e.g. the wind ‘rustling’ vegetation). Some intermittent road traffic sound was present, mainly from the L1010.

The results of the long-term measurement surveys, excluding measurements affected by adverse weather[1] are given in Table 9-12.

Table 9-12 Measured Baseline Levels

Date	Period	$L_{Aeq,T}$ (dB)	$L_{A90,15min}$ (modal) (dB)
04.02.20	Day	-	-
	Evening	32	23
	Night	30	23
05.02.20	Day	36	29
	Evening	31	22
	Night	25	23
20.10.20	Day	-	-
	Evening	-	-

[1] Defined as windspeeds greater than 5 m/s and/or precipitation. Weather data obtained from https://www.met.ie/climate/available-data/historical-data. Data for Shannon airport was used as this was the most representative location where hourly data was available. Only results where acceptable weather was present for the full period (i.e. day, evening or night) are presented and used in the assessment.

Date	Period	$L_{Aeq,T}$ (dB)	$L_{A90,15min}$ (modal) (dB)
	Night	42	34
21.10.20	Day	-	-
	Evening	44	41
	Night	43	40
22.10.20	Day	49	39
	Evening	-	-
	Night	-	-
27.11.20	Day	-	-
	Evening	33	29
	Night	41	38
28.11.20	Day	42	38
	Evening	40	36
	Night	36	29
29.11.20	Day	42	28
	Evening	27	21
	Night	43	35
30.11.20	Day	56	51
	Evening	43	43
	Night	-	-
01.12.20	Day	47	35
	Evening	52	45
	Night	-	-
02.12.20	Day	68	46
	Evening	-	-
	Night	-	-
03.12.20	Day	-	-
	Evening	37	34
	Night	-	-
06.12.20	Day	45	33
	Evening	37	35
	Night	41	39
07.12.20	Day	37	27
	Evening	42	34
	Night	-	-
08.12.20	Day	-	-
	Evening	48	41
	Night	32	30

In addition to the long-term survey, concurrent short term attended measurements were taken at three locations in proximity to nearby sensitive receptor positions during the February 2020 survey. The

measurement locations are also shown in Figure F9-1, Vol. 3. The results of the measurements are given in Table 9-13.

Table 9-13 Short Term Attended Measurements

Location	Date	Period	Time	$L_{Aeq,T}$ (dB)	$L_{A90,15min}$ (dB)
ST1	04.02.20	Day	1500-1600	57	28 – 31
	04.02.20	Night-time	2300-2330	46	24-25
ST2	04.02.20	Day	1500-1600	57	26 – 30
	04.02.20	Night-time	2345-0015	46	24-25
ST3	05.02.20	Day	1015-1115	59	37-38
	05.02.20	Night-time	0040-0110	28	23

It can be seen from a comparison of the long term and short-term data that average sound levels ($L_{Aeq,T}$) are generally higher in proximity to the receptor positions than at the long-term monitoring location. This is likely due to the receptors being closer to the L1010 than the long-term monitoring location. Background sound levels ($L_{A90,T}$) are similar to or slightly lower than the background levels measured at the long-term monitoring location.

9.4.2 Existing Receptors

The location of the nearest noise sensitive receptor locations to the Proposed Development are shown in Figure F9-1, Vol. 3.

9.5 Characteristics of the Proposed Development

Sound and vibration emissions from the proposed development will occur in three distinct phases: construction operation and decommissioning.

The construction period is expected to last approximately 32 months. During this period sound ard vibration levels are expected to vary depending on the work being carried out.

Sound levels will be highest during the initial enabling period whilst louder activities such as earthworks and piling take place. As the construction phase develops, sound levels are expected to reduce as less noisy works (plant installation, internal works within structures) take over.

Vibration levels are expected to be highest during blasting operations, however these will be carefully managed. No more than three blasts are envisaged to occur in any given day and associated noise and vibration levels will be transient and very short lived. Some vibration may occur during piling works, however piling operations will take place around the jetty at significant distance from nearby receptors.

Sound levels during the operational phase will be caused principally by mechanical plant such as the open cycle gas turbines and gas processing equipment onshore and onboard the FSRU. Intermittent sound from movement and operation of LNGC's is also expected. Noise emissions during the operational phase will be subject to stringent limits, particularly during the night-time. Sound emissions are expected to be low level and present no distinctive characteristics such as tonality or impulsiveness. If these characteristics do occur, more stringent limits will apply.

Depending on the phasing of construction works, it is possible some noise sources associated with operation will occur concurrently with construction activities. This is discussed further below. If this does occur, no change to the outcomes of this assessment are expected. This is because the noise limits for operation phase noise are significantly more stringent than those applied to construction phase sources. As a result, any operational phase noise emissions that occur during the construction phase will not contribute to overall levels.

As outlined in Chapter 02 – Project Description, in the event of decommissioning, measures would be undertaken by the Applicant to ensure that there would be no significant, negative environmental effects during the decommissioning phase. Examples of the measures that would be implemented are outlined in Section 2.9, Chapter 02 – Project Description. As a result, additional potential impacts and associated

effects arising during the decommissioning phase are not anticipated above and beyond those already assessed during the construction phase.

9.6 Embedded Mitigation

The proposed topographical changes which form part of the Proposed Development will give rise to a natural acoustic barrier, shielding existing sensitive receptors from sound emissions.

9.7 Assessment of Impact and Effect

9.7.1 Construction Phase – Site Operations

By comparison of the measured baseline levels presented in Table 9-12 and Table 9-13 and the threshold values presented in Table 9-4 this site is classified as 'Category A' with regard the ABC criteria presented in BS5228.

Category A BS5228 criteria are more stringent than the NRA guideline limits presented in Table 9-3 and therefore have been adopted for this assessment.

Details of the proposed construction programme have been provided by Sisk Ltd. The construction working hours are understood to be 0730-1800 Monday to Friday and 0800-1400 on Saturdays. Therefore, only the daytime and weekend noise limits apply. If construction works are required to take place outside of these times, this will be agreed in advance with the prior agreement of Kerry Co. Council, and subject to communication with the local community.

The criteria adopted for the assessment are presented in Table 9-14. The criteria apply at one metre from the façade of sensitive receptor positions.

Table 9-14 Construction Noise Criteria

Period	Time	Criteria
Monday to Friday	0730 – 1800	65 dB $L_{Aeq,10.5hr}$[1]
Saturday	0800 – 1300	65 dB $L_{Aeq,5hr}$[1]
Saturday	1300 - 1400	55 dB $L_{Aeq,1hr}$[1]

1. Criteria time periods chosen to align with working hours

The construction programme is understood to last approximately 32 months, comprising five sections as detailed in Table 9-15. The dates presented are understood to be indicative at this stage.

Table 9-15 Construction Programme

Area	Start Onsite	Duration (months)	Completion	Duration from Start Date (Months)
Enabling	Jan 2023	10	Oct 2022	10
LNG Terminal	+6 months	12	Jun 2023	18
Substation	+8 months	12	Sep 2023	21
CCGT - 2 Blocks	+9 months	21	Jun 2024	30
CCGT - 1 Block	+ 11 months	18	Aug 2024	32

Sisk Limited have advised that, with regard site operations, two 'peak' periods are expected to occur:

- 'Peak 1' around June/ July 2023 when site clearance, enabling works, piling and heavy civil engineering operations related to the LNG Terminal are expected to occur concurrently; and
- 'Peak 2' around May-September 2023 when CSA, mechanical and electrical works are to be carried out.

During Peak 1, night-time operations in and around the jetty will take place 24 hours a day.

These peaks represent the worst case (i.e. highest) construction phase noise emissions. Noise levels at all other times will be lower.

Details of mechanical plant operating onsite during these peak periods have been provided by Sisk Ltd. Sound power levels for each plant item present have subsequently been assigned from archive data presented in BS5228. The plant and associated sound levels for Peak One are presented in Table 9-16 and Table 9-17. The plant and associated sound levels for Peak Two are presented in Table 9-18.

Table 9-16 Peak 1 Plant and Associated Sound Pressure Levels – Main Construction and Access Road

Plant Item	No.	BS5228 reference	Octave Band Sound Pressure Levels (dB)								$L_{Aeq,T}$ 10m dBA	L_w dB(A)
			63	125	250	500	1k	2k	4k	8k		
Tracked Excavator w breaker	2	C.9.6	95	93	89	89	86	82	76	74	91	119
Tracked Excavator	2	C.2.16	72	71	74	73	69	66	63	58	75	103
Tracked Excavator w breaker	5	C.9.11	91	89	85	89	87	87	84	80	93	121
Semi Mobile Crusher	1	C.appendix4	91	91	88	87	85	83	78	68	90	118
Dump Trucks	8	C.2.31	86	79	79	79	79	84	69	60	87	115
Dozer	2	C.6.30	79	87	79	78	82	80	73	66	86	114
Dozer	1	C.6.28	80	84	76	77	79	81	69	59	85	113
Rollers	2	C.2.38	80	75	77	72	67	62	54	46	73	101
Loading Shovel	1	C.9.8	89	87	84	82	81	81	72	65	86	114
Road Grader (&Tipper)	1	C.6.31	88	87	83	79	84	78	74	65	86	114
Teleporter (Diesel)	1	C.2.35	85	79	69	67	64	62	56	47	71	99
Track Machine	1	C.2.25	77	65	67	67	63	61	57	47	69	97
Mobile Crane	1	C.5.37	85	73	67	71	72	69	63	56	76	104
Site Dumper	1	C.4.4	82	76	75	74	68	68	64	55	76	104
Fuel Tanker	1	C.4.16	75	70	67	67	69	66	60	53	72	100
Concrete Truck	1	C.4.28	79	80	73	72	69	68	59	53	75	103
Poker Vibrator	1	C.4.33	82	80	80	73	69	72	70	65	78	106

Plant Item	No.	BS5228 reference	Octave Band Sound Pressure Levels (dB) 63	125	250	500	1k	2k	4k	8k	$L_{Aeq,T}$ 10m dBA	L_w dB(A)
MEWP - Boom (Diesel)	1	C.4.57	78	76	62	63	60	59	58	49	67	95
Con Saw	2	C.4.70	72	89	81	80	80	82	86	85	91	119
Generator (Diesel)	1	C.4.82	64	61	59	53	49	47	42	35	56	84
Generator (Diesel)	3	C.4.85	69	69	67	60	59	60	56	53	66	94
Water Pump	1	C.4.88	70	65	66	64	64	63	56	46	68	96
Track machine w Breaker	1	C.5.2	79	75	73	74	77	77	75	70	83	111
Kango Hammer	2	C.5.3	82	75	73	68	63	67	80	69	82	110
Roller	1	C.5.27	85	70	62	62	61	59	53	45	67	95
Whacker Plate	1	C.5.29	76	78	74	77	77	77	73	70	82	110
Skilsaw	2	C.4.72	69	75	77	74	71	70	74	69	79	107
Drills	4	C.2.44	67	80	74	72	72	72	68	61	77	105

Table 9-17 Peak 1 Plant and Associated Sound Pressure Levels – Jetty and Jetty Access

Plant Item	No.	BS5228 reference	Octave Band Sound Pressure Levels (dB) 63	125	250	500	1k	2k	4k	8k	$L_{Aeq,T}$ 10m dBA	L_w dB(A)
400T Crawler Crane	1	C.4 38	80	79	73	74	73	73	64	55	78	106
70T Mobile Crane	1	C.3.30	80	72	71	67	65	62	57	49	70	98
Hydraulic Hammer	1	C.3.8	83	82	79	82	84	82	77	67	88	116
Drill Rig	1	C.6.35	85	93	78	79	80	79	76	74	86	114
Excavator	1	C4.17	81	72	68	68	66	64	60	55	67	95
Generator (for office)	1	C.4.78	64	67	68	65	57	54	49	42	66	94
Tug	4	Other[1]	88	83	75	67	59	57	55	-	-	105
Tracked Cranes[2]	4	C.3.28	81	77	66	62	59	57	51	46	67	95
Compressors[2]	4	C.5.5	84	73	64	59	57	55	58	47	65	93

1. *Based on AECOM archive data for tug with 2 x 2000kW diesel engines. This is understood to be an overestimate.*

Plant Item	No.	BS5228 reference	Octave Band Sound Pressure Levels (dB)								$L_{Aeq,T}$ 10m dBA	L_w dB(A)
			63	125	250	500	1k	2k	4k	8k		

2. *Jetty Access area only, do not operate during the night time.*

Table 9-18 Peak 2 Plant and Associated Sound Pressure Levels

Plant Item	No.	BS5228 ref	Octave Band Sound Pressure Levels (dB)								$L_{Aeq,T}$ 10m dBA	L_w dB(A)
			63	125	250	500	1k	2k	4k	8k		
Teleporter Diesel	6	C.4.54	79	73	66	65	78	66	54	47	79	107
Teleporter 360	2	C.4.54	79	73	66	65	78	66	54	47	79	107
Consaws	6	C.4.70	72	89	81	80	80	82	86	85	91	119
Poker Vibrators	6	C.4.33	82	80	80	73	69	72	70	65	78	106
Skilsaws	6	C.4.72	69	75	77	74	71	70	74	69	79	107
Concrete Trucks	10	C.4.28	79	80	73	72	69	68	59	53	75	103
Concrete Pumps	2	C.4.24	69	64	64	66	63	59	53	47	67	95
Tracked Excavator	4	C.10.2	82	75	72	73	71	70	66	58	76	104
Tracked Excavator	2	C.6.12	84	74	71	71	68	66	61	55	74	102
Tracked Excavator	4	C.4.67	87	79	76	70	68	64	57	48	74	102
Tracked Excavator	2	C.4.68	71	71	66	59	59	58	54	48	65	93
Site Dumpers	6	C.4.4	82	76	75	74	68	68	64	55	76	104
Mobile Crane	6	C.4.39	87	82	78	74	71	67	60	52	77	105
MEWP Booms	16	C.4.57	78	76	62	63	60	59	58	49	67	95
MEWP Scissor Lifts (Diesel)	8	C.4.59	80	77	74	74	74	71	65	63	78	106
Kango Hammers	6	C.5.6	90	79	75	78	78	83	91	92	95	123
Impact Guns	6	C.4.69	75	74	75	72	74	75	80	80	85	113
Generator Diesel	6	C.4.85	69	69	67	60	59	60	56	53	66	94
Water Pumps	2	C.4.88	70	65	66	64	64	63	56	46	68	96
Hilti Nail Guns	4	C.4.95	63	65	65	66	65	69	64	61	73	101

The Peak 1 construction plant is listed in two tables as some plant would operate within the access road, Power Plant and LNG Terminal footprint and some plant would operate around the jetty access and jetty. These sources are input differently into the associated noise model (discussed below) so are listed separately.

To determine the impact of construction noise on existing receptors in the area, a 3D sound model was constructed using CadnaA 2020 acoustic modelling software. The inputs to the model are as follows:

- Topographical Information for the site and surrounds from Ordnance Survey Ireland;
- Vector Mapping Data from Ordnance Survey Ireland;
- Site location and layout drawing provided by Black and Veatch; and
- Plant sound power data provided by Sisk Ltd.

The following assumptions were made:

- All plant is assumed to operate 100% of the time. This is a highly conservative assumption which is unlikely to ever occur in practice. However, in lieu of detailed information, this assumption is made to provide a robust assessment;

- Construction noise sources were input at a height 1.5 m from the existing ground level (ignoring the potential acoustic screening provided by proposed topographical changes);
- Construction noise sources input as a spatially averaged area source extending over the construction site;
- Ground absorption is assumed to be 'acoustically soft' as defined in BS5228. Water, the Proposed Development footprint, and roads are assumed to be acoustically hard/ reflective; and
- It is likely that a number of the Peak 2 sources would be used internally or in locations screened from nearby receptors by newly constructed structures. For robustness, no attenuation provided by this screening has been included in the predictions.

Full details of the sound modelling and associated noise maps are given in Appendix A9-2 , Vol. 4 and Figures F9-2 through to F9-4, Vol. 3. The results of the construction noise emission predictions are summarised in Table 9-19.

Table 9-19 Calculated Construction Noise Levels – Daytime

Receptor Position	Calculated Peak 1 Sound Pressure Level ($L_{Aeq,T}$)	Calculated Peak 1 Sound Pressure Level (Road) ($L_{Aeq,T}$)	Calculated Peak 2 Sound Pressure Level ($L_{Aeq,T}$)	Criteria	Below Criteria?
R1	56	53	52	65 dB $L_{Aeq,10.5hr}$ Mon-Fri 65 dB $L_{Aeq,5hr}$ Sat 0800-1300 55 dB $L_{Aeq,1hr}$ Sat 1300-1400	Y Y N
R2	53	50	49	65 dB $L_{Aeq,10.5hr}$ Mon-Fri 65 dB $L_{Aeq,5hr}$ Sat 0800-1300 55 dB $L_{Aeq,1hr}$ Sat 1300-1400	Y Y Y
R3	54	58	51	65 dB $L_{Aeq,10.5hr}$ Mon-Fri 65 dB $L_{Aeq,5hr}$ Sat 0800-1300 55 dB $L_{Aeq,1hr}$ Sat 1300-1400	Y Y N
R4	54	53	50	65 dB $L_{Aeq,10.5hr}$ Mon-Fri 65 dB $L_{Aeq,5hr}$ Sat 0800-1300 55 dB $L_{Aeq,1hr}$ Sat 1300-1400	Y Y Y
R5	58	45	54	65 dB $L_{Aeq,10.5hr}$ Mon-Fri 65 dB $L_{Aeq,5hr}$ Sat 0800-1300 55 dB $L_{Aeq,1hr}$ Sat 1300-1400	Y Y N
R6	50	45	47	65 dB $L_{Aeq,10.5hr}$ Mon-Fri 65 dB $L_{Aeq,5hr}$ Sat 0800-1300 55 dB $L_{Aeq,1hr}$ Sat 1300-1400	Y Y Y
R7	48	46	44	65 dB $L_{Aeq,10.5hr}$ Mon-Fri 65 dB $L_{Aeq,5hr}$ Sat 0800-1300 55 dB $L_{Aeq,1hr}$ Sat 1300-1400	Y Y Y

Table 9-20 Calculated Construction Noise Levels – Night-Time

Receptor Position	Calculated Peak 1 Night-Time Sound Pressure Level ($L_{Aeq,T}$)	Criteria	Below Criteria?
R1	39	45 dB $L_{Aeq,T}$	Y
R2	35	45 dB $L_{Aeq,T}$	Y
R3	35	45 dB $L_{Aeq,T}$	Y
R4	33	45 dB $L_{Aeq,T}$	Y
R5	42	45 dB $L_{Aeq,T}$	Y
R6	35	45 dB $L_{Aeq,T}$	Y
R7	30	45 dB $L_{Aeq,T}$	Y

It can be seen the above that construction sound levels are below the criteria at all identified receptors during all periods, except for receptors R1,R3 and R5 where there is a predicted exceedance between 1300 and 1400 on Saturdays. Exceedances during this period will be avoided through the careful scheduling of works.

No significant adverse impact is expected at residential receptor positions with regards construction phase sound levels generated by onsite activities.

9.7.2 Construction Phase – Vibration

The main sources of vibration associated with the construction of the Proposed Development (excluding blasting which is discussed below) are the piling rigs used in the construction of the jetty.

The transmission of ground-borne vibration is highly dependent on the nature of the intervening ground between the source and receiver and the activities being undertaken.

The principal potential source of vibration associated with the construction phase is the piling rig used in the construction of the jetty. It is not envisaged that any of the other proposed construction activities are likely to generate vibration levels, with the exception of blasting activities which are discussed separately in section 9.7.3.2.

The piling rig would be located on a jack up barge adjacent to the location of the proposed jetty and the distance between the proposed piling and nearest receptor position (R1) is approximately 600 m. It is understood the piling methodology would be a combination of bored and driven piles. To ensure the robustness of the assessment, driven piling has been assumed, being the piling method that gives rise to the highest vibration levels.

The bedrock geology of the area surrounding the proposed jetty location is soft becoming stiff gravelly clay above sandstone/ siltstone, as identified in the Halcrow document ‘Shannon LNG Offshore Geotechnical Investigation’ (2007).

To gain an indication of the potential vibration impact of the proposed piling, reference is made to the historical data presented in BS5228. The data covering piling activities in areas with similar ground conditions are presented in Table 9-21.

Table 9-21 Vibration Levels – Historical Data

BS5228 Table and Row	Soil Conditions	Piling Mode/ Dimensions	Mode	Distance (M, plan)	PPV mm/s
D.2.20	Fill/ soft material/ clay becoming stiff	450 mm diameter 10 m depth with enlarged base	Driving tube	4	8.4
				20	5.0
			Expelling plug	4	6.1
				20	4.8
			Enlarging base	4	4.0
				20	4.4

BS5228 Table and Row	Soil Conditions	Piling Mode/ Dimensions	Mode	Distance (M, plan)	PPV mm/s
D.2.22	Peaty, silty alluvia over shale and sandstone	350 mm diameter 7.5 m to 8 m depth	Driving tube	21	2.9
				28	2.7
				35	2.4
			Extracting tube	21	3.2
				28	3.9
				35	3.1

It can be seen from the above that the majority of the historical data presents vibration levels below the most stringent criterion of 8mm/s PPV presented in Table 9-6 (relating to building damage) but above the 0.14mm/s criterion presented in Table 9-5 (relating to human perception).

To estimate vibration levels at the closest receptor positions, these measured levels were used in conjunction with the Hillier and Crabb empirical predictor for percussive piling presented in Table E.1 of BS5228. These calculations indicate that vibration levels would be below the 0.14 mm/s criterion presented in Table 9-5 and significantly below the 8 mm/s criterion at receptor positions, even when basing predictions on these worst-case measured vibration levels from Table 9-21.

In summary, **no adverse impact** is predicted as a result of piling induced vibration.

9.7.3 Construction Phase – Blasting

9.7.3.1 Noise and Air Overpressure

It is expected that blasting would be required to excavate some of the rock, which cannot be removed by rock breaking equipment mounted on tracked excavators. It is understood that only single blasts will take place in each event. This will only take place during the enabling phase.

With regards the prediction of air overpressure, BS6472 states:

> *Accurate prediction of air overpressure is almost impossible due to the variable effects of the prevailing weather conditions and the large distances often involved.*
>
> *Control of air overpressure should always be by its minimization at source through appropriate blast design.*

In light of this, to mimimise the impact of air overpressure and blasting it is recommended that:

- Blasting is carried out in accordance with the principles set out in BS 5607:2017 Code of practice for the safe use of explosives in the construction industry;
- Ensuring appropriate burden to avoid over or under confinement of the charge;
- Accurate setting out and drilling;
- Appropriate charging;
- Appropriate stemming with appropriate material such as sized gravel or stone chippings;
- Using delay detonation to ensure smaller maximum instantaneous charges (mics);
- Using decked charges and in-hole delays;
- Blast monitoring to enable adjustment of subsequent charges;
- Designing each blast to maximize its efficiency and reduce the transmission of vibration;
- Avoiding the use of exposed detonating cord on the surface in order to minimize air overpressure – if detonating cord is to be used in those cases where down-the-hole initiation techniques are not possible, it should be covered with a reasonable thickness of selected overburden; and
- A protocol for community relations with regards blasting is adopted such that prior warning of blasting operations is given to members of the public.

Provided the above measures are adopted during the blasting stage of the construction phase, the impact of air overpressure would be minimised as far as practicable.

9.7.3.2 Vibration

It is expected that blasting would be required to excavate some of the rock, which cannot be removed by rock breaking equipment mounted on tracked excavators. Table 9-7 details appropriate criteria for blasting induced vibration. It is understood that no more than 3 blasts per day are envisaged (a prerequisite for the Table 9-7 criteria to apply).

The blasting vibration limits will be achieved by limiting the Maximum Instantaneous Charge (MIC) used in the blasting process.

To determine the MIC for the site, a number of trial blasts will be carried out such that a site-specific scaled distance graph can be developed. Using this graph, the MIC limit required to achieve the Table 9-7 criteria can be determined in accordance with the procedure detailed in BS6472.

No adverse impact is therefore expected because of blast induced vibration.

9.7.4 Construction Phase – Traffic on Existing Roads

The traffic flows on the surrounding road network with and without construction traffic are presented in Table 9-22.

Table 9-22 Construction Phase Traffic

Link Number	Link Name	2024 without Construction Traffic		2024 with Construction Traffic	
		AAWT,18hr	% HGV	AAWT,18hr	% HGV
1	L1010 – Site entrance to Ballylongford	357	0.4%	357	0.4%
2	L1010 – Site entrance to Tarbert	357	0.4%	1,055	0.4%
3	N67 (Ferry Port Road)	1,627	2.6%	1,657	2.6%
4	Bridewell Street	5,327	2.4%	5,995	2.4%
5	N69 (to Limerick)	5,912	3.6%	6,412	3.6%
6	N69 (to Listowell)	4,945	2.8%	5,113	2.8%
7	R551	2,946	2.5%	2,946	2.5%

Calculations have been carried out in accordance with the Basic Noise Level methodology presented in CRTN to determine the change in road traffic noise levels resulting from these changes in flows.

The CRTN methodology is not accurate for very low traffic flows (below 1000 AAWT,18hr). Where flows of this magnitude are predicted, the Noise Advisory Council method has been used.

The results of these calculations alongside the associated magnitude of impact are presented in Table 9-23.

Table 9-23 Change in Road Traffic Noise Level Resulting from Construction Traffic

Link	Change in Noise Level	Magnitude of Impact
1	0.0 dB	No Change
2	5.2 dB	Major
3	0.2 dB	Negligible
4	0.5 dB	Negligible
5	0.4 dB	Negligible
6	0.1 dB	Negligible
7	0.0 dB	No Change

Link	Change in Noise Level	Magnitude of Impact

It can be seen from the above that **no significant increase** in road traffic noise is expected on any link during the construction phase, except for Link 2 (L1010 – Site entrance to Tarbert) where a **major impact** is predicted.

This impact is limited to the relatively small number of noise sensitive properties located along this stretch of existing road.

The following contextual factors should be borne in mind when considering this impact:

- The absolute noise levels from Link 2 with and without construction traffic are low. Noise levels from this road, inclusive of construction traffic, are expected to be in the vicinity of 57 dB $L_{Aeq,16hr}$ at 10 metres from the road side. This is not a particularly high noise level and therefore the impact of the change in noise level may be less than indicated.
- It is understood that Link 2 would be resurfaced prior to the commencement of the Proposed Devleopment. This may assist in reducing noise levels (E.g. by removing potholes, roughness etc.). However, it is not possible to quantify this change.

9.7.5 Operational Phase – Site Operations

9.7.5.1 Criteria

The assessment evaluates potential adverse impact from sound emissions using criteria derived from existing baseline noise levels ($L_{A90,T}$) around the site.

Analysis of the measured baseline levels presented in Table 9-12 and Table 9-13 indicate there is variance in prevailing background sound levels; some survey periods indicate the site should be classed as an area of low background noise, whereas other periods indicate otherwise.

It is possible that the acoustic character of the area may change in the future due to the area being zoned for marine-related industry as part of the Strategic Integrated Framework Plan for the Shannon Estuary which is supported by Kerry Co. Council as identified in the document 'Kerry County Development Plan 2015-2021' (adopted 16th March 2015).

To assess the impact of the Proposed Development with regard to operational noise, the more stringent 'area of low background noise' criteria have been adopted. However, it may be appropriate to review these criteria in due course.

The adopted criteria are presented in Table 9-24.

Table 9-24 Operational Phase Noise Criteria

Location	Daytime Noise Criterion dB $L_{ar,T}$ (0700 to 1900 hours)	Evening Noise Criterion dB $L_{ar,T}$ (1900 to 2300 hours)	Night-time Noise Criterion dB $L_{ar,T}$ (2300 to 0700 hours)
Areas of Low Background Noise	45 dB	40 dB	35 dB

It is understood that operations are of a 24/7 nature i.e. the assessment is based on the LNG Terminal and Power Plant operating at any time throughout the day, evening or night. Therefore, the most stringent noise criterion of 35 dB $L_{ar,T}$ for the night-time at the nearest sensitive receptor location has been adopted. Compliance with this night-time criterion will therefore ensure compliance with the higher criteria for daytime and evening periods.

For the purposes of the noise assessment, the Proposed Development is considered in three parts:

- The Power Plant and LNG Terminal;
- The Pipeline Above Ground Installation; and
- The Floating Storage Regasification Unit (FSRU), Liquid Natural Gas Carrier (LNGC) and tugs.

These are discussed in turn below.

9.7.5.2 The Power Plant and LNG Terminal

Prior to construction start, a commercial tendering process will be held to supply the Power Plant and FSRU. The tendering process will result in a contract for a particular model of power plant and FSRU. Therefore, the precise size, configuration, performance, and layout of the equipment will be finalized following the award of the contract, however this will not affect the design of the buildings or emissions as described in this EIAR.

Indicative details of the noise generating mechanical plant associated with the Power Plant and LNG Terminal have been provided by Shannon LNG Limited and their Project Engineers Black and Veatch. They are detailed in Table 9-25.

Table 9-25 Power Plant and LNG Terminal Sound Levels

Plant	QTY	SPL/L_w	Sound Pressure/Power Levels dB(A)									
			31.5	63	125	250	500	1K	2K	4K	8K	Total
Air Intake Filter House	6	L_w	77	91	96	97	91	89	86	94	88	102
GT Enclosure Vent Outlet Fans	6	L_w	65	78	91	98	102	100	95	87	78	106
GT Enclosure Vent Outlet	6	L_w	64	57	55	55	51	44	38	31	18	66
Generator 2-p 50 Hz	6	L_w	-	65	100	106	107	106	103	100	90	112
Generator Cooling Inlet (air cooled)	6	L_w	70	82	90	94	99	98	99	96	88	105
Generator Cooling Outlet (air cooled)	6	L_w	66	75	91	83	86	85	88	84	78	95
Exhaust Duct	6	L_w	81	91	98	91	86	83	86	85	87	100
Oil Mist Outlet	9	L_w	45	59	68	72	78	79	72	64	56	83
Stack Outlet	6	L_w	83	89	105	106	109	116	110	99	79	118
HRSG Total (Duct + Body)	6	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Steam Turbine	3	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Air Cooled Condenser Fans (12 fans per unit)	3	SPL at 100 metres	19.7	33.8	40.6	41.5	44.8	45.3	38.1	32.6	23.6	50
ST Gland Steam Condenser	3	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Duct Burner Skid	6	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85

Plant	QTY	SPL/L_w	Sound Pressure/Power Levels dB(A)									
			31.5	63	125	250	500	1K	2K	4K	8K	Total
CT GSU Transformer	3	SPL at 2 metre	-	37.1	66.5	51.4	56.5	59.8	55.6	55.5	52.2	70
BESS Step Up transformer	1	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
CT Auxiliary Transformer	6	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Boiler feed pumps & motors	12	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 92
LP Recirculation Pumps	6	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Closed Cycle Cooling Water Pumps	6	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Closed Cycle Cooling Water Fin-Fan Coolers (24 per unit)	3	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Steam Jet Air Ejectors units	3	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Vacuum Pumps	3	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Condensate Pumps	9	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Aux Boiler Components	1	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Aux Boiler Stack Discharge	1	L_w	-	-	-	-	-	-	-	-	-	110
Other pumps, valves, blowers, etc.	--	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Sewage Treatment Package	1[1]	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Instrument Air Package	2[1]	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Nitrogen Generation Package	2[1]	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 85
Nitrogen Compressors	3[1]	SPL at 1 metre	-	-	-	-	-	-	-	-	-	≤ 110

Plant	QTY	SPL/L_w	Sound Pressure/Power Levels dB(A)								
			31.5	63	125	250	500	1K	2K	4K	8K	Total

1. Does not include standby units present.

A number of the plant items listed above are to be housed within the proposed turbine halls which are to be constructed from ~100 mm vertical profiled modular steel cladding. This cladding is assumed to be similar to the Kingspan KS1000RW cladding panels and will be lined with 18 mm cement board (or similar) if/ where required to reduce noise emissions. This will be determined via prediction once details of the specific plant items to be installed are known.

The facade sound insulation performance used for the assessment is detailed in Table 9-26.

Table 9-26 Sound Insulation Performance of Turbine Hall Facades

Source	R,w (dB)								
	63	125	250	500	1K	2K	4K	8K	Total (dB Rw)
Facade Sound Insulation	22	26	30	33	29	32	47	-	32

Three combustion turbine power generators (CTG) are to be installed within the LNG Terminal (two operational and one back up). The purpose of these CTGs is to provide energy to the LNG Terminal prior to the Power Plant being constructed and/ or as a back-up power for the LNG Terminal if grid connection is lost. These CTGs will not be operated (except for test purposes) when the Power Plant is operating. Noise sources associated with these CTGs are presented Table 9-27.

Table 9-27 LNG Terminal CTG Sound Levels

Source	Sound Power Levels dBA									
	31.5	63	125	250	500	1K	2K	4K	8K	Total (dBA)
Driver Enclosure	-	84	91	90	87	93	90	87	75	98
Combustion Exhaust	-	111	105	101	97	94	89	97	102	113
Combustion Intake		83	83	76	69	67	69	79	77	88
Vent Intake	-	72	74	77	70	66	63	76	78	83
Vent Exhaust	-	79	83	81	77	77	78	90	84	93
Alternator Vent Intake (each)	-	60	73	79	78	82	85	79	72	89
Alternator Vent Exhaust	-	54	67	74	79	86	89	87	82	93
Oil Cooler Inlet[1]	-	58	71	77	76	80	83	77	70	87
Oil Cooler Outlet[1]	-	58	71	77	76	80	83	77	70	87
CT Breather Outlet[1]	-	82	82	78	72	69	72	78	78	87
PT Breather Outlet[1]	-	76	75	74	72	70	76	78	68	84
Oil Mist Coalescer Exhaust[1]	-	61	68	70	80	66	60	61	51	81

Indicative data based on a Centrax CX400 CTG
1. Sound power levels calculated from sound pressure levels given in the associated datasheet assuming hemispherical point source propagation.

Source	Sound Power Levels dBA									
	31.5	63	125	250	500	1K	2K	4K	8K	Total (dBA)

The locations of these plant items are indicated on drawing reference198291-1GSU-G2001-r0 and 198291-1GSU-G2002-r0.

In addition, there are noise sources which would operate intermittently. These intermittent sources are:

- Firewater Pumps: 85 dB $L_{Aeq,T}$ at 1 metre;
- Firewater Jockey Pumps: 85 dB $L_{Aeq,T}$ at 1 metre; and
- Black Start Diesel Generators: 85 dB $L_{Aeq,T}$ at 7 metres.

These sources only operate during emergency conditions and for testing. The Black Start diesel generators will be run every two weeks for 30 minutes and for maintenance outside of emergency conditions. The pumps will be tested once a day for approximately 30 minutes. This will only occur during the daytime. They have not been included in the assessment.

9.7.5.3 Above Ground Installation

It is understood that noise generating plant associated with the Above Ground Installation (AGI) comprises the following:

- Odorant New Blend Pump Unit;
- Package Boiler Units;
- Gas Fired Generator; and
- Pressure Regulating Stream.

9.7.5.4 The Floating Storage Regasification Unit, Liquid Natural Gas Carrier and Tugs

Information regarding sound emissions from the FSRU and LNGC have been provided by Shannon LNG Limited. The sound levels used in the assessment are presented in Table 9-28.

Table 9-28 FSRU and LNGC Sound Levels

Source	Number per Ship	Sound Power Levels dB								
		63	125	250	500	1K	2K	4K	8K	Total (dB)
Engine Room Exhaust Stacks	4	130	130	130	119	122	110	95	-	135
Regas Boiler Exhaust	2	101	96	90	89	87	85	85	-	103
Engine Room Internal Level	-	94	99	102	104	101	100	100	89	109
Engine Room Ventilation Fans	2	89	93	92	87	79	79	79	82	97
Control Valves	14	52	60	68	76	84	89	88	-	92
Bosun Store Fan	1	-	-	-	-	-	-	-	-	109

It is understood that the LNGC and FSRU are similar, with the FSRU simply being a modified LNGC which also houses regassification equipment. Sound sources from both vessels has been modelled to include all noise sources listed in Table 9-28, apart from the Regas boiler exhaust which is only present on the FSRU.

Noise transmission to the environment from the engine room would be attenuated by the ship's hull. At its thinnest, the hull is understood to be constructed from 12 mm steel. The attenuation provided by 12 mm steel has been calculated using Marshall Day Acoustic's partition modelling software package INSUL v9.0 and is presented in Table 9-29.

Table 9-29 Sound Insulation Performance of Ship Hull

Source	Sound Reduction Index, R (dB)								
	63	125	250	500	1K	2K	4K	8K	Total (dB Rw)
12 mm Steel	31	35	39	43	39	44	53	53	43

It is also understood that the engine room exhaust stacks for both the FSRU and LNGC would be fitted with attenuators. The assumed performance is presented in Table 9-30 based on indicative data provided by potential suppliers[2].

Table 9-30 Engine Room Exhaust Stack Attenuator

Source	Insertion Loss (dB)							
	63	125	250	500	1K	2K	4K	8K
Stack Attenuator	28	44	53	66	61	59	54	51

A notable noise source onboard the vessel would be high velocity gas flowing through the control valves. Control valves regulate flow by increasing or decreasing the fluid pressure drop across an element. Pressure drop adjustments are usually accompanied by noise generation.

In is understood from liaison with GOLAR LNG that there would typically be approximately fourteen such control valves on each vessel and that these valves would be distributed along the full length of the ships. Noise emissions from these valves would be at or below the noise limits set out in the International Maritime Organization IMO Code of Noise Levels On Board Ships[3] which states that noise levels should not exceed 85 dB $L_{Aeq,T}$ in open deck work spaces. It has been assumed that each valve would be at least one metre from an open deck workspace and therefore subject to a noise limit of 85 dB $L_{Aeq,T}$ at one metre.

The operation of the Proposed Development requires the use of four tugs used for FSRU and LNGC mooring operations. Noise emissions data for the tugs has been obtained from AECOM archive data and is presented Table 9-31. The data used has been cross referenced with other similar assessments and has been confirmed as a conservative estimate.

Table 9-31 Tug Sound Levels

Source	Number	Sound Power Levels dB								
		63	125	250	500	1K	2K	4K	8K	Total (dB)
Tugs	4	116	111	103	95	87	85	83	-	117

9.7.5.5 Assessment

To determine the potential noise impact of the Proposed Development on the noise sensitive receptor locations identified, all of the noise sources identified above were input into the 3D sound model

[2] This data has been provided by one of the major FSRU providers.
[3] The Code on noise levels on board ships has been developed to provide international standards for protection against noise regulated by regulation II-1/3-12 of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended. Although the Code is legally treated as a mandatory instrument under the SOLAS Convention, certain provisions of the Code remain recommendatory or informative.

discussed in section 9-16. Details of the sound modelling methodology is given in Appendix A9-2, Vol. 4 with noise maps given in Figures F9-5 through F9-9, Vol. 3.

The locations of the various noise sources were taken from drawing reference 98291-1GSU-G2001-r0, 198291-1GSU-G2002-r0, the Moffat and Nichol drawing 'Shannon LNG – FSRU Analysis' and through direct input from the Project Engineers Black and Veatch and from GOLAR LNG.

The following modelling approaches were adopted:

- Ground absorption is assumed to be 'acoustically soft' as defined in ISO 9613-2:1996 Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation. Areas of water, the Proposed Development footprint and roads assumed to be acoustically hard/ reflective.
- As a conservative approach, it is assumed that all sound sources identified as not exceeding a given sound pressure/ power level would emit a level equal to the defined limit.
- Where spectral data was not available for certain sources, the sound power/ pressure level has been input in the 500 Hz band.
- It is assumed that sound pressure levels within the turbine hall would not exceed 85 dB $L_{Aeq,T}$ at the internal perimeter (i.e. incident on the inner face of the façade walls). It was confirmed with Black and Veatch that this limit would be adopted at the detailed design stage and, if this limit proves unachievable in certain areas, the façade walls of the turbine halls could be acoustically upgraded (above the levels presented in Table 9-26) such that the external emissions remain the same.
- Where sound pressure level input data has been provided for external sources of small dimension (condensate pumps, vacuum pumps, steam jet air injectors, closed cycle cooling water pumps, oil mist outlet and control valves), the sound power levels have been calculated assuming hemispherical propagation over a reflective plane. The same approach has been applied to the various exhausts and intake/ discharge points associated with the Proposed Development. These sources have been input as point sources within the 3D model.
- Where sound pressure level input data has been provided for larger external sound sources (e.g. Transformers, Nitrogen Compressors), sound power levels have been calculated in accordance with the methodology detailed in BS EN ISO 3746:2010 Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane (ISO 3746:2010). It is assumed that the sound pressure level provided is representative of all measurement positions. These sources have been input as area sources within the 3D model.
- Sound sources within the AGI are to be designed to not exceed 45 dB $L_{Aeq,T}$ at the boundary. Sound sources from this area of the Proposed Development were input as an area source at a height of two metres set one metre in from the boundary of the AGI and calibrated within the model to result in a sound level of 45 dB $L_{Aeq,T}$ at the boundary.

Section 5 of NG4 details the assessment of noise sources with tonal or impulsive elements and the appropriate penalties/ corrections to apply where sources present these characteristics. In this instance, it is assumed that all sources can be designed such that they do not present tonal or impulsive characteristics at the location of nearby receptor positions. Therefore, no corrections have been applied. This has been discussed with Black and Veatch and it was confirmed this was a reasonable assumption.

The 3D sound model was used to calculate operational phase sound pressure levels at the various receptor locations identified. Calculations were carried out in two scenarios: with the CTG operational but without sources associated with the Power Plant (Scenario 1); and with the Power Plant operational but without the sources associated with the CTGs (Scenario 2). The results of the modelling calculations are presented in Table 9-32.

Table 9-32 Operational Sound Levels - Unmitigated

Receptor	Criterion ($L_{Ar,T}$)	Predicted Level – Scenario 1 ($L_{Ar,T}$)	Compliant? (Y/ N)	Predicted Level – Scenario 2 ($L_{Ar,T}$)	Compliant? (Y/ N)
R1	35 dB	42	N	53	N
R2	35 dB	40	N	53	N
R3	35 dB	39	N	54	N
R4	35 dB	37	N	53	N
R5	35 dB	43	N	53	N
R6	35 dB	40	N	50	N
R7	35 dB	34	Y	46	N

It can be seen from the above that, unmitigated, noise emissions from the Proposed Development do not comply with the relevant criteria.

This was discussed with the wider design team and the following mitigation requirements were identified.

Table 9-33 Proposed Noise Mitigation Measures

Plant Item	Reduction Required	Form of Mitigation
Air Intake Filter House	13 dB	Silencers
Stack Outlet	35 dB	Silencers/ attenuators
CT GSU Transformer	10 dB	Re-specification to a quieter model. An acoustic barrier around the units may also be required.
Closed Cycle Cooling Water Pumps	10 dB	Re-specification to a quieter model.
Closed Cycle Cooling Water Fin-Fan Coolers (24 per unit)	8 dB	Re-specification to larger units allowing the fans to run at lower speeds. An acoustic barrier around the units may also be required.
Aux Boiler Stack Discharge	25 dB	Re-specification to a quieter model and inclusion of an attenuator.
Sewage Treatment Package	5 dB	Re-specification to a quieter model.
Nitrogen Compressors	44 dB	Unit to be housed in a masonry construction
CTG Combustion Exhaust	15 dB	Re-specification to a quieter model and inclusion of an attenuator.
Bosun Store Fan	10 dB	Silencers/ attenuators

The above requirements were discussed and confirmed as technically achievable with Black and Veatch and GOLAR LNG.

It is not clear at this stage whether acoustic barriers and/ or enclosures would be required to mitigate noise emissions. To retain flexibility, a seven-metre-high barrier around the Closed Cycle Cooling Water Fin-Fan Coolers, a six-metre-high barrier around the CT GSU Transformer and an enclosure around the nitrogen compressors have been included in the 3D sound model and associated planning drawings. Whether these barriers are required and their specific dimensions should be confirmed at the detailed design stage.

The 3D sound model was used to calculate operational phase sound pressure levels at the various receptor positions including the mitigation measures identified in Table 9-33. The results of these calculations are presented in Table 9-34.

Table 9-34 Operational Sound Levels – Mitigated – Residential Receptors

Receptor	Criterion ($L_{Ar,T}$)	Predicted Level – Scenario 1 ($L_{Ar,T}$)	Compliant? (Y/ N)	Predicted Level – Scenario 2 ($L_{Ar,T}$)	Compliant? (Y/ N)
R1	35 dB	35	Y	37	N
R2	35 dB	30	Y	32	Y
R3	35 dB	28	Y	33	Y
R4	35 dB	27	Y	32	Y
R5	35 dB	33	Y	34	Y
R6	35 dB	30	Y	29	Y
R7	35 dB	23	Y	26	Y

It can be seen from Table 9-34 that, including the mitigation measured detailed in Table 9-33, operational phase noise emissions comply with the most stringent criteria at all residential receptor positions, with the exception of a 2 dB exceedance at receptor R1 during the night time.

However, there are various contextual factors which indicate that this exceedance may not give rise to a significant impact. They are:

- The predicted sound levels are readily compliant with the NG4 daytime and evening criteria at all receptor locations. The predicted levels also comply with the night-time criteria at all other receptors apart from R1.
- A 2 dB exceedance is relatively small. It is often considered difficult to detect a change in sound level of less than 3 dB outside of laboratory conditions. Therefore, the levels predicted at R1 are likely to be subjectively no different from compliant levels.
- A sound level of 37 dB $L_{Ar,T}$ is relatively low, identified in NG4 as comparable to the ambient levels you would expect in an empty bedroom or in a rural setting with no wind.
- The Power Plant is only expected to operate approximately 5820 hours per year initially and is expected to drop to 3354 hours per year by 2050. Therefore, sound emissions will not be constantly present.
- BS 8233:2014 Guidance on sound insulation and noise reduction for buildings defines acceptable internal levels within bedrooms as being 30 dB $L_{Aeq,T}$ during the night-time. It also states that a façade with an open window will provide approximately 15 dB of sound attenuation. Oh this basis, sound levels from the Proposed Development within the bedrooms of R1 will be 22 dB $L_{Ar,T}$ with windows open and even lower with windows shut.
- With windows shut it is highly likely that sound from the proposed development will be inaudible within bedrooms at R1. With windows open sound levels from the Proposed Development will be 8 dB below the BS8233 criterion. It is noted that the BS8233 criterion is applicable to anonymous sources only, however it is used in this context for reference.
- The criteria used are derived from sound level measurements taken in accordance with the weather condition requirements detailed in NG4 (i.e. low wind speeds and no rain). However, weather conditions during the survey periods indicate that these weather conditions are not typical for the area. Significantly higher ambient sound levels were measured during periods of wind and/ or rain. If sound levels during periods of wind and rain were factored into baseline levels, a different category of NG4 criteria would apply and the predicted levels would be readily compliant.
- There is indication that the acoustic character of the area may change due to surrounding area being zoned for marine-related industry as part of the Strategic Integrated Framework Plan for the Shannon Estuary which is supported by Kerry Co. Council as identified in the document ‘Kerry County Development Plan 2015-2021’ (adopted 16th March 2015). If this were to happen, the criteria adopted for the assessment may need further consideration.
- NG4 makes significant reference to the application of Best Available Techniques (BAT). Significant work has been undertaken to reduce noise emissions from the Proposed Development. The

mitigation measures and attenuation levels detailed in Table 9-33 are costly and, in some cases, are at the limit of what is achievable with current technology. The noise mitigation strategy as currently proposed is considered to be an application of BAT.

- Prior to construction start, a commercial tendering process will be held to supply the Power Plant and FSRU. The tendering process will result in a contract for a particular model of power plant and FSRU. Therefore, the precise size, configuration, performance, and layout of the equipment will be finalized following the award of the contract, however this will not affect the design of the buildings or emissions as described in this EIAR. The assessment assumes the largest anticipated size of Power Plant and FSRU. It is therefore possible that sound levels from the Proposed Development, once specified in detail, will be quieter than indicated in this assessment.

Considering these contextual factors, **no significant impact** associated with operational phase noise levels resulting is expected.

9.7.6 Operational Phase – Traffic on Existing Roads

The traffic flows on the surrounding road network with and without construction traffic are presented in Table 9-35.

Table 9-35 Operational Phase Traffic Flows

Link No	Link Name	2025 Without Development		2025 With Development		2040 With Development	
		AAWT,18hr	% HGV	AAWT,18hr	% HGV	AAWT,18hr	% HGV
1	L1010 – Site entrance to Ballylongford	361	0.4%	375	0.4%	399	0.4%
2	L1010 – Site entrance to Tarbert	361	0.4%	490	0.4%	514	0.3%
3	N67 (Ferry Port Road)	1,645	0.4%	1,667	0.4%	1,775	0.4%
4	Bridewell Street	5,387	2.6%	5,495	2.6%	5,851	2.6%
5	N69 (to Limerick)	5,978	2.4%	6,035	2.4%	6,431	2.4%
6	N69 (to Listowell)	4,999	3.6%	5,050	3.6%	5,381	3.6%
7	R551	2,978	2.8%	2,978	2.8%	3,175	2.8%

Calculations have been carried out in accordance with the Basic Noise Level methodology presented in CRTN to determine the change in road traffic noise levels resulting from changes in flows. The results of these calculations alongside the associated magnitude of impact are presented in Table 9-36.

Table 9-36 Change in Road Traffic Noise Level Resulting from Operational Traffic

Link	Short Term Change in Noise Level	Short Term Magnitude of Impact	Long Term Change in Noise Level	Long Term Magnitude of Impact
1	0.2 dB	Negligible	0.4 dB	Negligible
2	1.3 dB	Minor	1.5 dB	Negligible
3	0.1 dB	Negligible	0.5 dB	Negligible
4	0.1 dB	Negligible	0.4 dB	Negligible
5	0.0 dB	No Change	0.3 dB	Negligible
6	0.0 dB	No Change	0.3 dB	Negligible
7	0.0 dB	No Change	0.3 dB	Negligible

It can be seen from the above that all increases in road traffic noise during the operational phase are negligible, except for Link 2 (L1010 – Site entrance to Tarbert) where a minor impact is predicted in the short term. LA111[4] defines a minor impact as not significant.

Traffic noise from Link 2 was calculated to be 53 dB $L_{A10,18hr}$ at a distance of 10m from the carriageway, and is expected to be below the NRA guidelines of 60 dB L_{den} at all receptors.

In light of the above, **no significant impact** associated with change in road traffic noise levels resulting from operational traffic is expected.

9.8 Mitigation and Monitoring Measures

9.8.1 Construction Phase

The assessment of construction noise and vibration detailed above indicates no adverse effects. Nonetheless, to ensure sound and vibration levels are kept to a minimum and to reduce the risk of cumulative impacts, it is recommended that the following measures are adopted during the construction phase:

- Good community relations shall be established and maintained throughout the construction process. This shall include informing residents on progress and ensuring measures are put in place to minimise noise and vibration impacts.
- Fixed and semi-fixed ancillary plant such as generators, compressors and pumps shall be located away from sensitive receptors wherever possible.
- All plant used onsite shall be regularly maintained, paying attention to the integrity of silencers and acoustic enclosures.
- All noise generating construction plant shall be shut down when not in use.
- The loading and unloading of materials shall take place away from residential properties, ideally in locations which are acoustically screened.
- Materials shall be handled with care and placed rather than dropped where possible. Drop heights of materials from lorries and other plant shall be kept to a minimum.
- Modern plant shall be selected which complies with the latest European Commission noise emission requirements. Electrical plant items (as opposed to diesel powered plant items) shall be used wherever practicable. All major compressors shall be low noise models fitted with properly lined and sealed acoustic covers. All ancillary pneumatic percussive tools would be fitted with mufflers or silencers of the type recommended by the manufacturers.
- Site operations and vehicle routes shall be organised to minimise the need for reversing movements, and to take advantage of any natural acoustic screening present in the surrounding topography.
- No employees, subcontractors and persons employed on the site shall cause unnecessary noise from their activities e.g. excessive 'revving' of vehicle engines, music from radios, shouting and general behaviour etc. All staff inductions at the site shall include information on minimising noise and reminding them to be considerate of the nearby residents.
- As far as practicable, noisier activities shall be planned to take place during periods of the day which are generally considered to be less noise sensitive i.e. not particularly early or late in the day.
- Measures shall be put in place to ensure that employees know that minimisation of noise will be important at the site; and
- Blasting vibration limits will be achieved by limiting the Maximum Instantaneous Charge (MIC) based on the results of trial blasts carried out in accordance with the procedure detailed in BS6472. It is noted there may be blasting charge limits imposed as a result of the underwater acoustic assessment. If these limits differ, the more stringent limit of the two will be adopted.

[4] Highways England (2020) Design Manual for Roads and Bridges LA111 Noise and vibration

- A commitment is made to ensure construction traffic from this and other concurrent development (i.e. Pipeline and Grid Connections, see below for details) will be coordinated to minimise traffic and site noise impacts where possible.

In addition to the above measures, a regime of noise and vibration monitoring will be undertaken during the construction phase to determine compliance with the nominated criteria and to provide a feedback mechanism so that corrective action can be taken in the event of exceedances.

Approximately three to four long term noise monitoring stations and one to two long term vibration monitors will be set up on the construction site boundary. The exact location of these stations will be determined in due course and will be chosen to best represent noise and/ or vibration emissions in the direction of nearby receptor positions. Monitoring will continue throughout the entire construction phase.

Long term noise monitoring stations will be equipped with an SMS and/ or email alert system so that site staff can be informed of potential exceedances. The results of the monitoring will be recorded and reported to relevant stakeholders in an appropriate manner and frequency, to be agreed in due course.

Any noise complaints received during the construction phase will be investigated thoroughly. The results of the investigation, including measured noise and vibration levels at the time of the complaint, onsite activities and any corrective action taken, will also be reported to relevant stakeholders.

9.8.2 Operational Phase

A commitment is made to adopt the operational noise limits detailed in this assessment as requirements in final design, including the need to address distinctive acoustic characteristics and/ or adjust the noise limits accordingly. Mitigation measures are anticipated to include the following:

- Silencers;
- Attenuators;
- Specification of low noise plant wherever possible; and
- Inclusion of acoustic barriers where required.

Furthermore, compliance with the nominated criteria will be confirmed via long term noise monitoring.

Long term monitoring will be undertaken for a period of at least 12 months from the commencement of site operations and again following any subsequent substantive change in site operations. After 12 months the need for long term monitoring will be reviewed with the relevant authority. Indicative monitoring locations are shown in Figure F9-1, Vol. 3 but may change as more detailed information becomes available.

In addition to the above, short-term attended noise measurements will be taken at or near to the receptor locations identified in this chapter. Measurements will be taken and reported in accordance with the guidance provided in NG4. Short term measurements will take place at the commencement of site operations and again following any subsequent substantive change in site operations. They will then be repeated no less than once a year. As a minimum, measurements will comprise a 30-minute measurement at each location during the daytime, evening and night time (as defined in NG4).

If exceedances of the predicted levels are identified by either the long term or short-term monitoring, the causes will be thoroughly investigated, and corrective action will be taken.

The Proposed Development would be licensed by the Environmental Protection Agency (EPA) under an Industrial Emissions (IE) licence, the terms and conditions of which are anticipated to be requiring a noise monitoring protocol to be adopted.

9.9 Cumulative Impacts

The developments considered with regard to cumulative impacts are listed in Table 9-37. Committed developments further away than 5 km from the site have not been considered with regard to noise and vibration.

Table 9-37 Developments Considered for Cumulative Impacts

Planning Reference	Location	Received Date	Decision Date	Decision	Description
13138	Kilpaddoge, Tarbert, Co. Kerry	13.03.2013	17.09.2013	Granted	Construct an electricity peaker power generating plant.
PL08.GA0003	Townlands of Ralappane, Carhoonakineely,	14.8.2008	17.2.2009	Granted	Permission approved for a gas pipeline to connect Shannon LNG Terminal to the existing natural gas network at Leahy's Co. Limerick.
13477	Tarbert Island, Tarbert, Co. Kerry	31.07.2013	23.09.2013	Granted	Alter existing 220 kV station consisting of new single storey control building, new diesel generator building, 3 no. single storey modular buildings, 6 no. gantry support structures, 8 no. control and protection kiosks, 6 no. surge arrestors, 6 no. cable sealing ends, existing compound chain link fence and gates to be replaced with new palisade fence and gates, new holding tank.
14816	Gurteenavallig, Tarbert, Co. Kerry	28.11.2014	28.04.2015	Granted	The extension of a portion of the permitted access road, the provision of a new substation compound with a single storey substation building and associated underground services.
155	Kilpaddoge, Tarbert, Co. Kerry	08.01.2015	03.03.2015	Granted	Alterations to the existing station consisting of 1 no. 110/ 20 kV transformer, 3 no. 110 kV surge arrestor, 3 no. 110 kV cable sealing ends, 1 no. neutral earth resistor, 1 no. lightning mast, new retaining wall with handrail, new single story mv switchgear building and associated drainage and site works.
17466	Meelcon and Gurteenavallig, Ballylongford, Co. Kerry	22.05.2017	14.07.2017	Granted	The modification of the permitted northern access, junction to Leanamore wind farm.
18392	Tarbert Island, Tarbert, Co. Kerry	27.04.2018	15.01.2019	Granted	For a 10 year permission to construct a battery storage facility within a total site area of up to 2.278ha.
18878	Kilpaddoge, Tarbert, Co. Kerry	10.09.2018	23.09.2019	Granted	For a 10 year permission to construct a battery energy storage system (bess) facility on a total site area of up to 0.6ha that will provide gird balancing services to the Irish electrical grid. Third Party Appeal to Appeal to ABP (305739-19). ABP granted permission.
19115	Kilpaddoge, Tarbert, Co. Kerry	12.02.2019	07.02.2020	Granted	For a 10 year permission for a grid stabilisation facility comprising of: the construction up to 4 no. rotating stabilisers, 5 no. battery storage containers, 1 no. control room, 2 transformers and ancillary equipment within a site area of approximately 1.46 hectares.
304807-19	Townlands of Aghanagran Middle, Aghanagran Lower, Ballyline West, Tullahennell South,	02.07.2019	06.01.2020	Granted	Construction of a Windfarm consisting of up to 6 Wind Turbines. Previously refused by Kerry Co. Council (19381)

Planning Reference	Location	Received Date	Decision Date	Decision	Description
	Ballylongford, Co. Kerry				
20850	Kilpaddoge, Tarbert, Co. Kerry	18.09.2020	12.11.2020	Granted	For changes to the previously permitted peaker power plant development (planning ref. 13/138). It is proposed to change the energy source for the charging of the battery energy storage system (bess) containers from diesel to charging off the national grid and to change the permitted layout for electrical equipment.
11457	Carrowdotia South, Co. Clare	24.06.2011	03.08.2011	Granted	Permission for the development of electrical transmission infrastructure and associated works at the existing Moneypoint Power Station complex.
PL 03.241624 (1274)	Carrowdotia North and, Carrowdotia South, Killimer, Co Clare	19.02.2013	12.12.2013	Granted	10-year planning permission for a Wind Farm Project (5 wind turbines) at Moneypoint Generating Station refused by Clare Co. Council but granted by An Bord Pleanála following a first party appeal.
14190	Moneypoint Power Station, Carrowdotia South, Co. Clare	10.04.2014	28.05.2014	Granted	A new indoor Gas Insulated Switchgear (GIS) 400 kV substation building (3463 m^2), 17m high, two new 400/ 220 kV transformers with associated Switchgear, three new 30 m high lightning masts, and associated drainage and site works. The application relates to previous grant of planning permission reg. ref. P11-457.
PL 03.243842 (14373)	Carrowdotia North, and South, Killimer, Co. Clare	15.09.2014	29.01.2015	Granted	20-year planning permission for works to the existing 32 ha ash repository site located within the Moneypoint generating station complex granted by Clare Co. Council and granted by An Bord Pleanála following a first party appeal relating to a condition regarding a development contribution.
1581	Carrowdotia North & South, Killimer, Co. Clare	18.02.2015	10.04.2015	Granted	10-year permission primarily for an electrical transformer station. The proposed development is an amendment to the previously approved electrical transformer station at Moneypoint Wind Farm (CCC Ref: 12-74 APB Ref: PL03.241624)
161011	Moneypoint, Co.Clare	22.12.2016	24.08.2017	Granted	Refurbishment of the Moneypoint – Oldstreet 400 kV overhead line.
19746	Moneypoint Generating Station, Carrowdotia North, Kilimer , Co Clare	26.09.2019	20.11.2019	Granted	10-year planning permission for a synchronous condenser and supporting items of plant, with the largest building being approximately 962 sq.m. and standing approximately 15m high.

None of the above developments are considered likely to give rise to cumulative impacts with regard to noise and/ or vibration due to the distance between them and the Proposed Development site, with the exception of planning reference PL08.GA0003 which relates to the natural gas pipeline from the Proposed Development and the existing Bord Gáis Éireann national gas transmission network near Foynes, Co. Limerick.

No cumulative impacts are expected to arise from the Proposed Development, either during the construction or operational phases for the following reasons:

- Noise emissions from construction works for the pipeline were assessed in The Shannon Pipeline Environmental Impact Statement. No adverse impact from construction noise was predicted for receptors within the study area for the Proposed Development and construction sound levels were predicted to exceed 50 dB $L_{Aeq,T}$ for no longer than eight days. Due to the short time period and relatively low predicted levels, no construction phase cumulative impact is considered likely.
- No quantitative assessment has been carried out with regards the proposed pipeline, However, no significant operational phase sound sources are proposed as part of the pipeline application in the vicinity of the proposed development, except for the AGI which is covered and assessed quantitatively in the above assessment.

The pipeline development is not expected to generate significant traffic during its operational phase, however there is the potential that, if construction phases overlap, there will be a cumulative impact arising from construction phase traffic.

It is expected that there will be a forthcoming application for a 220 kV grid connection and medium voltage (10/ 20 kV) connection in relation to the Proposed Development. No cumulative noise or vibration impacts are expected to arise from this development in combination with the Proposed Development for the following reasons:

- Construction works for the grid connections will progress relatively quickly along a linear corridor, any noise emitted will be localised and temporary and would not be expected to be of sufficient magnitude to create any disturbance or displacement impacts outside of areas contiguous or adjacent to the corridor. Site activity will be limited, involving between 5 and 15 site workers and less than 4 peak construction movements.
- Mitigation measures, such as timing of works and the implementation of a Construction Environmental Management Plan (CEMP) and Construction Traffic Management Plan (CTMP) will ensure that construction activities, so far as is practical, do not occur concurrently with the peak construction periods for the Proposed development. An Outline Construction Environmental Management Plan (OCEMP) and Outline Traffic Management Plan (OCTMP) have been prepared for this application.

The development is not expected to generate significant traffic during its operational phase, however there is the potential that, if construction phases overlap, there will be a cumulative impact arising from construction phase traffic. A commitment is made to ensure construction traffic from all developments (i.e. the Proposed Development, Pipeline and grid connections) will be coordinated to minimise noise impacts.

9.10 Do Nothing Scenario

If the Proposed Development were to not go ahead, the temporary and long-term noise and/ or vibration sources would not be introduced into the area.

However, the Tarbert-Ballylongford land bank is zoned for marine-related industry as part of the Strategic Integrated Framework Plan for the Shannon Estuary with support from Kerry Co. Council as identified in the document ‘Kerry County Development Plan 2015-2021’ (adopted 16th March 2015).

It is therefore possible that, in the absence of the Proposed Development, a different industrial development could be forthcoming which could contain its own array of noise and/ or vibration sources.

Nonetheless, any other development proposed in this location would be subject to the same noise and vibration criteria and therefore, its emissions and impact on existing receptors would need to be addressed in a similar manner to those described above.

Alternatively, no development could be forthcoming and as a result the existing acoustic environment (as quantified during the baseline survey and described above) would be expected to continue with little change.

9.11 Residual Impacts and Effects

Post mitigation, the only residual impacts are those arising from changes in traffic flows on existing roads during the construction phase.

The impact is short term and the spatial extent is small, being restricted to one road link. Furthermore, although the change in noise from this road is sufficient to constitute an impact, absolute levels are not high and as such the impact may be less than indicated by the assessment methodology.

9.12 Decommissioning

As outlined in Chapter 02 – Project Description, in the event of decommissioning, measures would be undertaken by the Applicant to ensure that there would be no significant, negative environmental effects during the decommissioning phase. Examples of the measures that would be implemented are outlined in Section 2.9, Chapter 02 – Project Description. As a result, additional potential impacts and associated effects arising during the decommissioning phase are not anticipated above and beyond those already assessed during the construction phase.

9.13 Summary

The Proposed Development has been assessed with regard to the following areas:

- Short term impacts during the construction phase, including:
  - Noise and vibration generated by onsite construction activities;
  - Noise, vibration and air overpressure generated by blasting activities; and
  - Noise generated by changes to traffic flows on existing roads.
- Long term impacts during the operational phase, including:
  - Noise generated by the Proposed Development once complete;
  - Noise generated by changes to traffic flows on existing roads.

Subject to the adoption of the mitigation measures detailed in this chapter, **no adverse impacts** are predicted in any of these areas, with the exception of **one likely short-term significant impact** with regard to increased traffic flows during the construction phase on the L1010 between the site entrance and Tarbert.

A regime of noise and vibration monitoring will be undertaken during the construction phase to determine compliance with the nominated criteria and provide a feedback mechanism so that corrective action can be taken in the event of exceedances.

Approximately three to four long term noise monitoring stations and one to two long term vibration monitors will be set up on the construction site boundary. The exact location of these stations will be determined in due course and will be chosen to best represent noise and/ or vibration emissions in the direction of nearby receptor positions. Monitoring will continue throughout the entire construction phase.

Long term noise monitoring stations will be equipped with an SMS and/ or email alert system so that site staff can be informed of potential exceedances. The results of the monitoring will be recorded and reported to relevant stakeholders in an appropriate manner and frequency, to be agreed in due course.

Any noise complaints received during the construction phase will be investigated thoroughly. The results of the investigation, including measured noise and vibration levels at the time of the complaint, onsite activities and any corrective action taken, will also be reported to relevant stakeholders.

Long term monitoring will be undertaken for a period of at least 12 months from the commencement of site operations and again following any subsequent substantive change in site operations. After 12 months the need for long term monitoring will be reviewed with the relevant authority. Indicative monitoring locations are shown in Figure F9-1, Vol. 3 but may change as more detailed information becomes available.

In addition to the above, short-term attended noise measurements will be taken at or near to the receptor locations identified in this chapter. Measurements will be taken and reported in accordance with the guidance provided in NG4. Short term measurements will take place at the commencement of site operations and again following any subsequent substantive change in site operations. They will then be repeated no less than once a year. As a minimum, measurements will comprise a 30-minute measurement at each location during the daytime, evening and night-time (as defined in NG4).

If exceedances of the predicted levels are identified by either the long term or short-term monitoring, the causes will be thoroughly investigated, and corrective action will be taken.

Table 9-38 Summary

Proposed Development Stage	Aspect/Impact Assessed	Existing Environment/Receptor Sensitivity	Effect/Magnitude	Significance (Prior to Mitigation)	Mitigation and Monitoring Measures (the Proposed Development design embedded environmental controls and all mitigation and monitoring measures detailed herein are included in the OCEMP)	Residual Impact Significance
Construction	Construction Noise	Sensitive	Negative	Significant	Scheduling of works such that noisy activities do not occur between 1300- and 1400 on Saturdays, and to comply with noise limits and criteria set out in Chapter 09 during weekdays. Fixed and semi-fixed ancillary plant will be located away from sensitive receptors wherever possible. All plant shall be regularly maintained and shut down when not in use. Approximately three to four long term noise monitoring stations and one to two long term vibration monitors will be set up on the construction site boundary.	Not Significant
	Construction Vibration	Sensitive	Neutral	Imperceptible	None required. See below for mitigation measures associated with blasting.	Imperceptible
	Construction Traffic Noise on Existing Roads	Sensitive	Negative	Significant	Construction traffic from this and other concurrent development will be coordinated to minimise traffic and site noise impacts where possible.	Significant
	Blasting Induced Noise/Air Overpressure	Sensitive	Negative	Significant	Process management and community liaison including a dedicated Public Liaison Officer. A protocol for community relations with regards to blasting will be adopted such that prior warning of blasting operations is given to members of the public. All noise complaints will be logged and followed up in a prompt fashion by the Liaison Officer. Only single blasts will take place in each event and monitoring will be in place as described in Chapter 09.	Not Significant
	Blasting Induced Vibration	Sensitive	Negative	Significant	Limiting of Maximum Instantaneous Charge (MIC). It is noted there may be blasting charge limits imposed as a result of the underwater acoustic assessment. If these limits differ, the more stringent limit of the two will be adopted.	Not Significant
Operational	Operational Noise	Sensitive	Negative	Significant	Various forms of mitigation (inc. silencers, plant selection, relocation,	Not Significant

					barriers enclosures) as detailed in the relevant chapter. Long term monitoring will be undertaken for a period of at least 12 months from the commencement of site operations and again following any subsequent substantive change in site operations. After 12 months the need for long term monitoring will be reviewed with the relevant authority. Indicative monitoring locations are provided in Figure F91-, Volume 3. In addition to the above, short-term attended noise measurements will be taken at or near to the receptor locations identified in Chapter 09 at the commencement of site operations and again following any subsequent substantive change in site operations. The Proposed Development will comply with the conditions of the Industrial Emissions licence, which will be required to operate the site.	
	Operational Traffic Noise on Existing Roads	Sensitive	Negative	Not Significant	Best practice measures will be adhered to during operation, including avoiding vehicle idling and adhering to speed limits on internal roads.	Not Significant

9.14 References

ARUP Consulting Engineers (2008) Shannon LNG Shannon Pipeline Environmental Impact Statement

BSI Group, (2003) BS 7445-1:2003 Description and measurement of environmental noise. Guide to quantities and procedures.

BSI Group, (2008) BS6472-2:2008 Guide to evaluation of human exposure to vibration in buildings, Part 2: Blast Induced Vibration

BSI Group (2014) BS 5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites')

BSI Group (2014) BS 8233:2014 Guidance on sound insulation and noise reduction for buildings

Department of Transport Welsh Office (1988) Calculation of Road Traffic Noise

Environmental Protection Agency (2016) Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities

Environmental Protection Agency (2017) Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports

European Parliament, Council of the European Union (2014) EU Directive 2014/52/EU

Halcrow (2007) 'Shannon LNG Offshore Geotechnical Investigation'

Highways England (2020) Design Manual for Roads and Bridges LA111 Noise and vibration

International Maritime Organization (2012) Cod of Noise Levels On Board Ships

International Standards Organisation (1996) ISO 9613-2:1996 Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation

International Standards Organisation (2010) BS EN ISO 3746:2010 Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane

Kerry County Council (2015) 'Kerry County Development Plan 2015-2021'

Moffat and Nichol drawing (2020) 'Shannon LNG – FSRU Analysis'

National Roads Authority (2004) Guidelines for the Treatment of Noise and Vibration in National Road Schemes

Noise Advisory Council, (1978); A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level Leq,

Sunbo Industries (2012) SB-S2056ESM351300.

TRL Abbott P., Nelson P. (2002) 'Converting the UK traffic noise index LA10,18hr to EU noise indices for noise mapping'.

aecom.com