



Chapter 09

Noise & Vibration

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9 Noise & Vibration

9.1 Introduction

This Chapter of the Environmental Impact Assessment Report (EIAR) has considered the potential noise and vibration impacts associated with the Construction and Operational Phases of the BusConnects Galway: Cross-City Link (University Road to Dublin Road) Scheme, hereafter referred to as the Proposed Scheme.

During the Construction Phase, the potential noise and vibration impacts associated with the development of the Proposed Scheme are assessed. This included construction activities such as utility diversions, road resurfacing and road realignments as well as construction traffic construction access routes.

During the Operational Phase, the potential noise and vibration impacts associated with altered traffic flows along the Proposed Scheme, realigned traffic lanes and displaced traffic flows are assessed.

The assessment is carried out according to best practice standard and guidelines relating to environmental noise and vibration.

The aim of the Proposed Scheme when in operation is to provide enhanced walking, cycling and bus infrastructure in the city centre of Galway, which will enable and deliver efficient, safe, and integrated sustainable transport movement along the city. The objectives of the Proposed Scheme are described in Chapter 1 (Introduction) of this EIAR. The Proposed Scheme, which is described in Chapter 4 (Proposed Scheme Description) of this EIAR has been designed to meet these objectives.

The design of the Proposed Scheme has evolved through comprehensive design iteration, with particular emphasis on minimising the potential for environmental impacts, where practicable, whilst ensuring the objectives of the Proposed Scheme are attained. In addition, feedbacks received from the comprehensive consultation programme undertaken throughout the option selection and design development process have been incorporated, where appropriate.

9.2 Methodology

The assessment has been undertaken with reference to the most appropriate guidance documents relating to environmental noise and vibration which are set out in the following sections of this chapter.

An overview of the methodology undertaken for this noise and vibration impact assessment is outlined below:

- A baseline noise study has been undertaken in order to characterise the environment at areas most likely to be affected by noise associated with the Proposed Scheme. This has been undertaken through site-specific noise monitoring at Noise Sensitive Locations (NSLs) along the Proposed Scheme;

- A review of the most applicable standards and guidelines has been undertaken in order to set a range of acceptable noise and vibration criteria for the Construction and Operational Phases of the Proposed Scheme;
- Predictive calculations and impact assessments relating to the likely Construction Phase noise and vibration impacts have been undertaken at the NSLs closest to the construction work areas associated with the Proposed Scheme;
- Predictive calculations have been performed to assess the potential noise and vibration impacts associated with changes in predicted traffic associated with the operation of the Proposed Scheme at the most sensitive locations; and
- A schedule of mitigation measures has been incorporated to reduce, where necessary, the identified potential significant noise and vibration impacts associated with the Proposed Scheme.

9.2.1 Study Area

The study area for this assessment covers the length of the Proposed Scheme, from University Road in the west, across Galway City Centre to the College Road/Lough Atalia Junction in the east, including the area either side of the Proposed Scheme and other diverted routes up to a maximum distance of 300 m during the Construction Phase and up to 1 km during the Operational Phase. A detailed description of the Proposed Scheme can be found in Chapter 4 (Proposed Scheme Description).

The study area for potential noise and vibration impacts during both Construction and Operational Phases relate to areas of potentially impacted NSLs, which include areas where people spend significant periods of time and where concentration, sleep and amenity are important considerations. Examples of these NSLs include residential dwellings, schools and other educational establishments, hospitals and nursing homes, hotels and other short-term accommodation buildings, buildings of religious sensitivity, recreational and noise sensitive amenity areas and offices. Vibration sensitive locations (VSLs) include buildings with vibration sensitive equipment (sensitive equipment within laboratories, highly sensitive medical equipment etc.) and structures that are structurally unsound. Further details regarding specific NSLs are provided in Section 9.2.3.

For the Construction Phase, the assessment of the study area is focused on NSLs and VSLs adjacent to the works, e.g., utility diversions, road widening works, road excavation works (where required), road reconfiguration and resurfacing works, and construction traffic access routes within the study area. The extent of the overall study area is typically up to 300 m from a specific area of construction work with the key impacted study areas focused within 50 m to 100 m depending on the noise and vibration sources in question and the local area under consideration.

For the Operational Phase, the focus of the assessment is on NSLs that bound the Proposed Scheme and those along diverted traffic routes. Potential noise impacts relate to alterations to traffic patterns, with particular attention on roads where traffic is diverted because of road closures associated with the Proposed Scheme.

The key impacted study areas for the Operational Phase are within 50 m to 100 m of the Proposed Scheme and roads affected by redistributed traffic which captures those locations where potential significant impacts can occur. Roads modelled as part of the Transport Impact Assessment (TIA) of the Proposed Scheme have been included in the noise impact assessment study area for the Operational Phase assessment.

9.2.2 Relevant Guidelines, Policy and Legislation

Guidelines, policy and legislation specifically relevant to the population assessment are outlined in Table 9.1.

Table 9.1: Relevant Guidelines, Policies and Legislation

Guidance	Description	Relevance to Assessment
Environmental Protection Agency (EPA) Guidelines on the information to be contained in Environmental Impact Assessment Reports (hereafter referred to as the EPA Guidelines) (EPA 2022)	This document outlines EPA guidance for conducting Environmental Impact Assessments (EIAs) / EIARs and provides the fundamental requirements of the EIAR.	This guidance has been used to inform the significance of effect for all topics in the population assessment.
British Standard Institute (BSI) British Standard (BS) 5228-1:2009 +A1 2014 Code of Practice for noise and vibration control of construction and open sites - Part 1: Noise	A code of practice for assessing noise from construction sites	Informs construction noise limits and assessment
BS 5228-2:2009+A1:2014 Code of Practice for noise and vibration control of construction and open sites - Part 2: Vibration (hereafter referred to as BS 5228 – 2)	Code of practice for assessing vibration from construction sites	Informs construction vibration limits and assessment
BS 7385: 1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration	Guide to assessing building damage from vibration	Informs vibration limits for buildings
BS 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings, Part 1 Vibration sources other than blasting	Guide to assessing vibration with respect to the human response	Informs vibration limits for humans

Guidance	Description	Relevance to Assessment
UK Highways Agency (UKHA) Design Manual for Roads and Bridges (DMRB) LA 111 Sustainability & Environmental Appraisal LA 111 Noise and Vibration Revision 2	Guide to assessing noise and vibration from roads projects to nearby sensitive receptors	Informs noise and vibration assessment methodology
Galway City Council Draft Noise Action Plan 2019 – 2023	Noise action plan for Galway City Council for the years 2019 to 2023	Informs noise assessment methodology
S.I. No. 549/2018 – European Communities (Environmental Noise) Regulations 2018	Guidance for implementing a common noise strategy across Europe, specifically for Ireland	Informs noise assessment methodology
S.I. No. 241/2006 - European Communities Noise Emission by Equipment for Use Outdoors (Amendment) Regulations 2006	Provides guidance for outdoor equipment noise	Informs noise assessment methodology
International Organization for Standardization (ISO) 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors - Part 2: General method of calculation	Guidance for how to calculate noise propagation outdoors	Used in noise assessment calculations
ISO 1996-1:2016 Acoustics - Description, measurement and assessment of environmental noise. Part 1: Basic quantities and assessment procedures	Guidance for undertaking noise measurements for environmental noise	Informs noise measurement methodology
ISO 1996-2:2017 - Description, measurement and assessment of environmental noise - Part 2: Determination of sound pressure levels	Guidance for undertaking noise measurements for environmental noise	Informs noise measurement methodology
Transport Infrastructure Ireland (TII) (previously National Roads Authority (NRA)) Guidelines for the Treatment of	Guidance for assessing road traffic noise in Ireland	Informs noise assessment methodology

Guidance	Description	Relevance to Assessment
Noise and Vibration in National Road Schemes		
Good Practice Guide for the Treatment of Noise during the Planning of National Road Schemes (hereafter referred to as the TII Noise Guidelines 2014) (NRA 2014)	Guidance for assessing road traffic noise in Ireland	Informs noise assessment methodology
The UK Department of Transport Calculation of Road Traffic Noise (hereafter referred to as the CRTN) (UK Department of Transport 1998)	Guidance for the calculation of road traffic noise levels	Informs traffic noise calculation methodology
World Health Organization (WHO) Environmental Noise Guidelines for the European Region (2018)	Guidance for appropriate noise levels for human health	Informs noise assessment methodology
Institute of Acoustics (IOA) ProPG: Planning and Noise. Professional Practice Guidance on Planning and Noise. New Residential Development. 2017	Guidance for appropriate noise levels for residential properties	Informs noise assessment methodology

9.2.2.1 Galway City Council Noise Action Plan (2019 – 2023)

No limits exist for environmental noise in Ireland, however, the Galway City Council Noise Action Plan references the recommended proposed levels from the EPA. The noise levels recommended for assessment of noise mitigation measures for noise due to road traffic are as follows:

- 70 dB, L_{den}
- 57 dB, L_{night}

The scheme is only proposed to operate during the day time period, so only L_{den} will be considered in this assessment.

9.2.3 Data Collection and Collation

9.2.3.1 Baseline Noise Surveys

Baseline noise surveys have been conducted at locations representative of the nearest noise sensitive areas which have the potential to be impacted during the Operational Phase of the Proposed Scheme. Baseline noise measurements were undertaken using attended surveys. Attended surveys were undertaken at a total of 16 locations in the vicinity of the Proposed Scheme in January 2022. The selection, number and type of surveys undertaken are in line with those prescribed in the TII Noise Guidelines 2004 (NRA 2004) and TII Noise Guidelines 2014 (NRA 2014) as far as practicable.

Details of the noise monitoring locations are presented in Table 9.2.

Table 9.2: Noise monitoring locations

Location	Description of Survey Location
University Road	On pavement outside residential receptor to the south of University Road. 1 m from road edge. Cars parallel parked on street with traffic beyond that.
232 Corrib Park	On pavement outside terrace houses. Approximately 15 m north of Seamus Quirke Road. Corrib Park is a quiet, residential street. Seamus Quirke Road is a heavily trafficked road. The houses on Corrib Park are slightly screened from Seamus Quirke Road by a small earth berm.
81 Ardiluan Road	On pavement outside houses. Approximately 17 m east of Thomas Hynes Road. Ardilaun Road is a quiet, residential street. Thomas Hynes Road is a busy road. This location is representative of Moyola Park.
24 Inchagill Road	On pavement outside houses. Approximately 13 m south-east of R338. Inchagill Road is a quiet cul-de-sac. The R338 is a heavily trafficked road. The houses on Inchagill Road are screen from the R338 by a 1.5 m high wall.
N6/Upper Newcastle Road	On pavement outside terrace houses approximately 1 m from the road edge, north-east of the junction. Upper Newcastle and the N6 are both busy roads.
188 Dun Na Coiribe	On pavement outside houses. Approximately 30 m north of N6. Dun Na Coiribe is a residential street with a constant stream of pedestrian traffic. The N6 is a heavily trafficked road.
120 College Road	On pavement outside residential receptor to the south of College Road. 1 m from road edge. Cars parallel parked on street with traffic beyond that.
Lough Atalia Road (behind 118 College Road)	On pavement outside residential receptor to the north of Lough Atalia Road. 3 m from road edge.
Presentation Road/Mill Street	On pavement outside residential receptor to the east of Mill St, just south of the junction with New Road. 1 m from road edge.
Woodquay	On pavement outside residential receptor to the south of Dalys Place. 1 m from road edge.
Eyre Street	On pavement outside residential receptor to the south of Eyre Street. 1 m from road edge. Cars parallel parked on street with traffic beyond.

Location	Description of Survey Location
Bothar na mBan	On pavement outside Sleepzone Galway Hostel to the west of Bothar na mBan. 1 m from road edge.
Coach Station	On pavement outside the Forster Court Hotel to the west of Fairgreen Road, opposite Galway Coach Station. 1 m from road edge.
Fairgreen Road/ Lough Atalia Road	On pavement outside the Galmont Hotel to the north of Lough Atalia Road. 2 m from road edge.
Middle Street	On pavement outside the residential receptor to the south of Middle Street. 1 m from road edge.

Full details of the baseline surveys, including methodologies, survey dates, terminology and glossary, and results are included in Appendix 9.1 (Noise and Vibration Survey) in Volume 4 of this EIAR.

Figure 9.1 in Volume 3 of this EIAR illustrates the baseline noise monitoring locations. These noise monitoring locations have been selected based on the representative noise sensitive locations for the Proposed Scheme, as presented in Figure 9.2 in Volume 3 of this EIAR.

9.2.4 Appraisal Method for the Assessment of Impacts

The significance of impacts has been assessed in accordance with the EPA Guidelines (EPA 2022). The relevant definitions relating to quality, significance and duration of impacts are defined as per the EPA Guidelines and are set out in Chapter 1 (Introduction) of this EIAR. These have been used to define the category of impacts throughout this chapter. The assessment of impacts is discussed in terms of a range of acoustic parameters.

The key terms discussed in the following sections are summarised as follows:

- **L_{Aeq,T}** is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T). The time period T referred to in this section include the following:
 - **L_{Aeq,16hr}**: the daytime ambient noise level between 07:00hrs and 23:00hrs;
 - **L_{Aeq,18hr}**: the daytime ambient noise level between 06:00hrs and 00:00hrs;
 - **L_{Aeq,12hr}**: the daytime ambient noise level between 07:00hrs and 19:00hrs, which is defined as the **L_{day}** parameter.
- **L_{ASmax}** is the maximum root mean squared (RMS) A-weighted sound pressure level occurring within a specified time period, measured using the ‘Slow’ time weighting;
- **L_{den}** is the 24hour noise rating level determined by the averaging of the **L_{day}** with the **L_{evening}** (plus a 5dB penalty) and the **L_{night}** (plus a 10dB penalty). **L_{den}** is calculated using the following formula, as defined within the Environmental Noise Regulations (S.I.140 / 2006):

$$L_{den} = 10 \log \left(\frac{1}{24} \right) \left(12 * \left(10^{\frac{L_{day}}{10}} \right) + 4 * \left(10^{\frac{L_{evening}+5}{10}} \right) + 8 * \left(10^{\frac{L_{night}+10}{10}} \right) \right)$$

Where:

- **L_{day}** is the A-weighted long-term average sound level as defined in ISO 1996-2:2017 Part 2: Determination of sound pressure levels (hereafter referred to as ISO 1996-2) (ISO 2017), determined over all the day periods of a year. The 12hr daytime period is between 07:00 to 19:00hrs;
- **L_{evening}** is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the evening periods of a year. The 4hr evening period is between 19:00 to 23:00hrs;
- **L_{night}** is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all the night periods of a year. The 8hr night-time period is between 23:00 to 07:00hrs.
- **Peak Particle Velocity (PPV)** is a measure of the velocity of vibration displacement in terms of millimetres per second (mm/s). It is defined as follows within BS 7385-2 (BSI 1993) as ‘the maximum instantaneous velocity of a particle at a point during a given time interval’; and
- **Vibration Dose Value (VDV)** is an evaluation of human exposure to vibration in buildings. It defines a relationship that yields a consistent assessment of continuous, intermittent, occasional and impulsive vibration and correlates well with subjective response. It is defined as follows within BS 6472-1 (BSI 2008), as:

‘The VDV is the fourth root of the integral of the fourth power of acceleration after it has been frequency-weighted (as defined in BS6472: 2008). The frequency-weighted acceleration is measured in m/s² and the time period over which the VDV is measured is in seconds. This yields VDV in m/s^{1.75}.’

As the EPA Guidelines do not quantify the criteria for assessing impacts specifically for noise or vibration, reference has been made to relevant guidelines and standards relating to noise and vibration to further define significance ratings. These are discussed in the following sections.

9.2.4.1 Construction Phase Appraisal of Impacts

Criteria for Rating Construction Noise Impacts

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the Construction Phase of a project. Local authorities normally control construction activities by imposing limits on the hours of operation and consider noise limits at their discretion. In general, higher noise levels are tolerated during a Construction Phase of a project compared to its long-term Operational Phase, as construction works are temporary to short term and are varied over the course of the work duration.

In the absence of specific statutory guidance, reference has been made to the TII Noise Guidelines 2004 (NRA 2004), TII Noise Guidelines 2014 (NRA 2014) and

BS 5228–1 (BSI 2014a) in order to review and set appropriate noise construction criteria.

TII Guidelines

The TII Noise Guidelines 2004 (NRA 2004) and TII Noise Guidelines 2014 (NRA 2014) specify noise levels that are deemed acceptable in terms of construction noise for national road projects. These limits have been derived for the construction of new national road projects which predominately pass through rural environments with quieter ambient noise levels compared to those in urban setting. In this instance, these limits are typically lower than those typically used for urban infrastructure projects. These limits are set out in Table 9.3.

Table 9.3: TII Construction Noise Levels at the Façade of Dwellings during the Construction Phase

Days and Times	Noise Levels (dB re 2 x 10 ⁻⁵ Pa)	
	L _{Aeq}	L _{ASmax}
Monday to Friday 07:00hrs to 19:00hrs	70	80
Monday to Friday 19:00hrs to 22:00hrs	60*	65*
Saturdays 08:00hrs to 16:30hrs	65	75
Sundays and Bank Holidays 08:00hrs to 16:30hrs	60*	65*

Note * Construction activity at these times, other than that required for emergency works, will normally require the explicit permission of the local authority.

British Standard BS 5228 – 1: 2009+A1:2014

Potential noise impacts during the construction stage of a project are often assessed in accordance with BS 5228–1 (BSI 2014a). Various mechanisms are presented as examples of recommended threshold values for determining if an impact is occurring, these are discussed in the following paragraphs.

Potential Significance Based on Noise Change - ABC Method

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

Table 9.4 sets out the values which, when exceeded, signify a potential significant effect at the facades of residential receptors.

Table 9.4: BS 5228-1 Example of Thresholds of Potential Significant Effect

Assessment Category & Threshold Value Period (LAeq)	Threshold Value (dB)		
	Category A ^A	Category B ^B	Category C ^C
Night-time (23:00 to 07:00hrs)	45	50	55
Evenings & Weekends (19:00 – 23:00hrs weekdays) (13:00 - 23:00hrs Saturdays) (07:00 – 23:00hrs Sundays)	55	60	65
Daytime (07:00 – 19:00hrs) and Saturdays (07:00 – 13:00hrs)	65	70	75
Notes: ^A threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values ^B threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values. ^C threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.			

It should be noted that this assessment method is only valid for residential properties and if applied to commercial premises without consideration of other factors may result in an excessively onerous thresholds being set.

Potential Significance Based on Fixed Noise Limits

Section E.2 of BS 5228-1 (BSI 2014a) sets out recommended threshold levels using a fixed limit value set depending on the setting of the noise environment. For example, paragraph E.2 states: -

“Noise from construction and demolition sites should not exceed the level at which conversation in the nearest building would be difficult with the windows shut.”

Paragraph E.2 goes on to state: -

“Noise levels, between say 07.00 and 19.00 hours, outside the nearest window of the occupied room closest to the site boundary should not exceed:-

70 decibels (dBA) in rural, suburban areas away from main road traffic and industrial noise;

75 decibels (dBA) in urban areas near main roads in heavy industrial areas”.

These limits apply to daytime working outside living rooms and offices. The document notes that where works occur outside other noise sensitive situations with daytime sensitivities, e.g., near hospitals and educational establishments or if works are occurring outside of normal daytime working hours, reduced construction noise levels may be more appropriate.

Proposed Threshold Noise Levels for Proposed Scheme

Taking into account the documents outlined above, the linear and transient nature of construction works associated with the Proposed Scheme, and making reference to the baseline noise environment, Table 9.5 sets out the Construction Noise Threshold (CNT) levels proposed for the construction stage of this development.

Table 9.5: Construction Noise Threshold (CNT) Levels for Proposed Scheme

Period over Which Criterion Applies	Location	Construction Noise Threshold (CNT) (L_{Aeq} , period)
Monday to Friday: Daytime (07:00 – 19:00hrs)	Residential properties & sensitive commercial buildings (e.g., offices) in urban areas near main roads in heavy industrial areas:	75 dB
Monday to Friday: Evening: (19:00 – 23:00hrs)	Residential Properties	65 dB
Monday to Friday: Night-time (23:00 – 07:00hrs)	BS 5228-1: Category A locations BS 5228-1: Category B Locations BS 5228-1: Category C Locations	45 dB 50 dB 55 dB
Saturdays (08:00 – 16:30hrs)	Residential Properties Urban and Suburban	65 dB
Sundays and Bank holidays (08:00 – 13:00hrs)	Residential Properties Urban and Suburban	60 dB

In order to assist with interpretation of CNTs, Table 9.6 includes guidance as to the likely magnitude of impact associated with construction activities, relative to the CNT. This guidance is derived from Table 3.16 of DMRB: Noise and Vibration (UKHA 2020) and adapted to include the relevant significance effects from the EPA Guidelines (EPA 2022).

In accordance with the DMRB Noise and Vibration (UKHA 2020), construction noise and construction traffic noise impacts shall constitute a significant effect where it is determined that a major or moderate magnitude of impact will occur for a duration exceeding:

- Ten or more days or night in any 15 consecutive day or nights;
- A total number of days exceeding 40 in any six consecutive months.

Table 9.6: Construction Noise Significance Ratings

Guidelines for Noise Impact Assessment Significance (DMRB)	CNT per Period	EPA EIAR Significance Effects	Determination
Negligible	Below or equal to baseline noise level	Not Significant	Depending on CNT, duration & baseline noise level

Guidelines for Noise Impact Assessment Significance (DMRB)	CNT per Period	EPA EIAR Significance Effects	Determination
Minor	Above baseline noise level and below or equal to CNT	Slight to Moderate	
Moderate	Above CNT and below or equal to CNT +5 dB	Moderate to Significant	
Major	Above CNT +5 to +15 dB	Significant, to Very Significant	
	Above CNT +15 dB	Very Significant to Profound	

The adapted DMRB guidance outlined is used to assess the predicted construction noise levels at NSLs and comment on the likely impacts during the construction stages.

Section 9.3 sets out the baseline noise levels surveyed along the Proposed Scheme. The typical measured daytime baseline noise levels are between 58 to 77 dB_{L_{Aeq,T}} at distances within 1 m to 20 m from the road edge. At the closest properties impacted by the Construction Phase (typically between 1 m and 30 m from construction activities), the average daytime baseline noise level is 67 dB_{L_{Aeq,T}}. Based on review of the baseline survey results, the average evening noise level is 2 dB lower than the daytime noise level. In order to categorise the relevant construction noise significance impacts in line with Table 9.6 a daytime baseline noise level of 67 dB_{L_{Aeq,12 hr}} and an evening baseline noise level of 65 dB_{L_{Aeq,4hr}} has been used when assessing construction noise impacts in Section 9.4.2.2.

Criteria for Rating Construction Traffic Noise Impacts

In order to assist with the interpretation of construction traffic noise, Table 9.7 includes guidance as to the likely magnitude of impact associated with changes in traffic noise levels along an existing road. This is taken from Table 3.17 of the DMRB Noise and Vibration (UKHA 2020).

Table 9.7: Magnitude of Impact Relating to Changes in Road Traffic Noise Level - Construction Phase

Magnitude of Impact	Increase in Traffic Noise Level (dB)	Duration	Initial Significance Rating
Major	Greater than or equal to 5.0	>10 days/nights over 15 consecutive day/nights & >40 days over 6 consecutive months	Significant
Moderate	Greater than or equal to 3.0 and less than 5.0		Significant
Minor	Greater than or equal to 1.0 and less than 3.0		Not Significant
Negligible	Less than 1.0		Not Significant

The overall significance rating is determined taking account of the change in road traffic noise levels in addition to the specific absolute noise level. Further discussion relating to road traffic noise levels and overall significance rating tables are included in Section 9.2.5 dealing with operational traffic noise.

Criteria for Rating Vibration Impacts

Vibration standards deal with two issues: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. In both instances, it is appropriate to consider the magnitude of vibration in terms of PPV for construction activities.

Building Response Criteria

BS 7385 - 2 (BSI 1993) gives guidance regarding acceptable vibration in order to avoid damage to buildings. BS 5228 – 2 (BSI 2014b) reproduces these same guidance values.

These standards differentiate between transient and continuous vibration. Both documents recommend that, for soundly constructed residential property and similar light framed structures that are generally in good repair, a threshold for minor or cosmetic damage (i.e., non-structural damage) should be taken as a PPV (in frequency range of predominant pulse) of 15 mm/s at 4 Hertz (Hz) increasing to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz and above. The standard also notes that below 12.5 mm/s PPV the risk of damage tends to zero. Where the dynamic loading caused by continuous vibration is such that it will give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in BS 5228 – 2 (BSI 2014b) may need to be reduced by up to 50%. On a cautious basis, therefore, continuous vibration limits are set as 50% of those for transient vibration across all frequency ranges. Historically important buildings that are difficult to repair might require special consideration on a case-by-case basis, but buildings of historical importance should not be assumed to be more sensitive unless they are structurally unsound.

If a building is in an unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other groundborne disturbance. The vibration limit range for protected and historical buildings is equal to or up to 50% of those for light framed buildings, depending on their structural integrity. Where no structural defects are noted, the same limit as those for light framed buildings apply. For other structures and buildings that are determined to be potentially vulnerable to vibration due to significant structural defects, a further stringent criteria have been applied for transient vibration. It is assumed that known buildings and structures of this kind will be subject to condition surveys well in advance of the works, and any identified defects repaired.

The results of the condition surveys will determine whether a building or structure is classed as “vulnerable”. Table 9.8 sets out the limits as they apply to vibration frequencies at 4 Hz where the most conservative limits are required.

At higher frequencies, the relevant limit values for transient vibration within Table B.2 and Figure B.1 of BS5228-2 (BSI 2014b) will apply, with similar

reductions applied for continuous vibration and those for protected structures. For line 2 of Figure B.1. at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded. Taking the above into consideration the vibration criteria for building response is set out in Table 9.8.

Table 9.8: Recommended Construction Vibration Thresholds for Buildings

Vibration Limits for Buildings (PPV) at the closest part of building to the source of vibration, at a frequency of 4Hz		
Building Type	Transient Vibration	Continuous Vibration
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s	25 mm/s
Unreinforced or light framed structures. Residential or light commercial-type buildings	12.5 mm/s	6 mm/s
Protected and Historic Buildings *Note 1	6 mm/s – 12.5 mm/s	3 mm/s – 7 mm/s
Identified Potentially Vulnerable Structures and Buildings with Low Vibration Threshold	3 mm/s	

Note 1: The relevant threshold value to be determined on a case-by-case basis. Where sufficient structural information is unavailable at the time of assessment, the lower values within the range will be used, depending on the specific vibration frequency.

Human Response Criteria

Humans are sensitive to vibration stimuli, and perception of vibration at high magnitudes may cause concern to building occupants. BS 5228–2 (BSI 2014b) notes that vibration typically becomes perceptible at around 0.15 to 0.3 mm/s and may become disturbing or annoying at higher magnitudes.

Table 9.9 presents the significance table relating to potential impacts to building occupants during construction based on guidance from BS 5228 – 2 (BSI 2014b), DMRB Noise and Vibration (UKHA 2020). and associated EPA significance ratings.

Table 9.9: Human Response Vibration Significance Ratings

Criteria	Likely Effect (DMRB)	Significance Rating
≥10 mm/s PPV	Major	Significant to Very Significant
≥1 to <10 mm/s PPV	Moderate	Moderate to Significant
≥0.3 to <1 mm/s PPV	Minor	Not Significant to Slight
≥0.14 to 0.3mm/s PPV	Negligible	Imperceptible to Not significant
Less than 0.14 mm/s PPV		Imperceptible

Disturbance of Particularly Vibration Sensitive Equipment or Processes

There are no standard criteria for assessing the potential impacts of vibration on sensitive equipment or processes. BS 5228–2 (BSI 2014b) provides a guide of vibration sensitivities of differing types of sensitive equipment from microscopes

to microelectronic manufacturing equipment. However, these ranges are generic and relate to the sensitivity of the equipment as installed, not the external façade of the building. The most advisable approach for the control of potential vibration impacts at areas of vibration sensitive equipment or processes, was to review each location on its own merit to determine the site-specific vibration limits taking into account any building or machinery isolation already in place. In this instance, if a receptor was identified or made known within the study area for being potentially sensitive to vibration, this area would be highlighted for consideration.

9.2.5 Operational Phase Appraisal of Impacts

Changes in Traffic Noise

The Proposed Scheme will be located along the existing road network which will be reconfigured at various locations to facilitate the Proposed Scheme. Once operational, the Proposed Scheme will include a realigned road corridor comprising dedicated footpaths, cycle lanes, bus lanes, and other vehicular lanes. Given that sections of the existing road network already carry traffic, it is appropriate to consider the change in traffic noise level that will arise as a result of changes in traffic flow (in terms of volume and fleet mix) and the realignment of traffic lanes, where relevant.

In the absence of any Irish guidelines or standards describing the effects associated with changes in road traffic noise levels, reference has been made to the DMRB Noise and Vibration (UKHA 2020). The DMRB Noise and Vibration (UKHA 2020) document provides magnitude rating tables relating to changes in road traffic noise. The document suggests that during the year of opening the magnitude of impacts between the Do Minimum and the Do Something scenarios are likely to be greater compared to the longer-term period (fifteen years post opening) when people are used to the noise level change.

For the Proposed Scheme, the initial significance criteria are used to describe the magnitude of change for the short- and medium-term period (the year of opening up to 15 years post). For these assessment years, a 1 dB change between the Do Minimum and Do Something scenarios (refer to Chapter 6 (Traffic and Transport) of this EIAR for full description of these modelled traffic scenarios) is the smallest that is considered perceptible. Table 9.10 summarises the potential impact associated with defined changes in traffic noise level during the short to medium periods of the scheme's operation.

Table 9.10: Significance of Change Criteria – Short to Medium Term

Change in Noise Level, dB	Short to Medium Term Magnitude	Initial Significance Rating
Greater than or equal to 5.0	Major	Significant
3.0 to 4.9	Moderate	Significant
1.0 to 2.9	Minor	Not Significant
Less than 1.0	Negligible	Not Significant

Where changes in traffic noise levels at NSLs along the Proposed Scheme in the short to medium term are less than 3 dB, the impact is deemed Not Significant.

Where changes in traffic noise levels are greater than 3 dB, the impact is deemed to be potentially Significant.

Further consideration of the magnitude of change in noise levels are determined for the long-term period (i.e., between the year of opening Do Minimum and the design year Do Something).

For this assessment year (design year 2038), a 3 dB change is the smallest that is considered to have any notable impact when considered over the life span of the project (the long term 15 year period between year of opening and design year in accordance with the DMRB Noise and Vibration (UKHA 2020) guidance document). Table 9.11 summarises the significance criteria associated with defined changes in traffic noise level between the Do Minimum and Do Something scenarios during the long-term period.

Table 9.11: Significance of Change Criteria – Long-Term

Change in Noise Level, dB	Long-Term Magnitude	Initial Significance Rating
Greater than or equal to 10.0	Major	Significant
5 to 9.9	Moderate	Significant
3.0 to 4.9	Minor	Not Significant
Less than 3.0	Negligible	Not Significant

Absolute Noise Levels

The absolute noise level is an important consideration when determining the response to noise levels along affected roads within the study area. This is particularly valid for locations where a ‘moderate’ or ‘major’ magnitude of change rating applies against comparably low absolute noise levels.

There are no statutory guidelines associated with road traffic noise levels in Ireland. There are no new roads associated with the Proposed Scheme and therefore application of a road traffic noise design threshold is not appropriate in this instance. Notwithstanding, it is important to provide context for the range of traffic noise levels along the Proposed Scheme which includes an extensive existing road network with varying traffic volumes and associated varying levels of road traffic noise.

The most appropriate documentation for guidance on road traffic noise level ranges across the study area is the Galway City Council Noise Action Plan 2019-2023 (NAP). This document proposes the following thresholds for onset of assessment for noise mitigation measures due to road traffic:

- 70 dB, L_{den}
- 57 dB, L_{night}

The following thresholds are also used to define a Quiet Area:

- <55 dB L_{day}
- <45 dB L_{night}

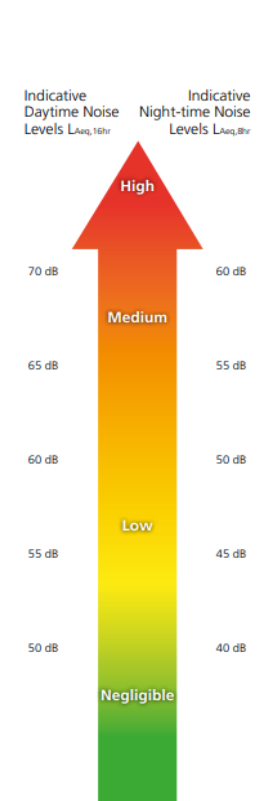
To further define noise levels between these thresholds reference is made to ProPG (IoA 2017). Whilst the scope of this document is used for the consideration of new residential development exposed to transport sources, the range of noise levels included provides a means of further categorising road traffic noise between the upper and lower threshold values described in the NAP with respect to noise sensitive properties.

This document categorises noise level ranges from Negligible ($< 50 \text{ dB } L_{Aeq,16hr} / < 40 \text{ dB } L_{Aeq,8hr}$) to High ($< 70 \text{ dB } L_{Aeq,16hr} / < 60 \text{ dB } L_{Aeq,8hr}$) in steps of 5 dBA to enable a site-specific risk assessment for an area to be undertaken depending on its noise exposure ranges.

It is noted that the daytime period within the ProPG (IoA 2017) document is described using the $L_{Aeq,16hr}$ parameter. This is the L_{Aeq} noise level between 07:00hrs and 23:00hrs which encompasses the L_{day} (07:00hrs to 19:00hrs) and $L_{evening}$ (19:00hrs to 23:00hrs) periods. The night-time period is described using the $L_{Aeq,8hr}$ parameter, i.e., the L_{Aeq} noise level between 23:00 and 07:00hrs which is equivalent to the L_{night} and used in the NAP.

Table 9.12 combines the threshold values from both documents to provide a combined range of noise level categories and their noise exposure levels. For the purposes of this assessment, the daytime period is defined as the $L_{Aeq,16hr}$ to capture both the L_{day} and $L_{evening}$ periods.

Table 9.12: Noise Level Ranges and Exposure Categorisation (ProPG 2017 & Galway City Council Noise Action Plan)

	Daytime: dB $L_{Aeq,16hr}$	Night-time: dB $L_{Aeq,8hr}$	Pro PG - Noise Risk Assess Pro PG - Noise Risk Assessment	Galway City Council Noise Action Plan
	>70dB	>60	High	High day level
	65 – 70	55 - 60	Medium – High	High night level
	60 – 65	50 - 55	Medium	
	55 – 60	45 - 50	Low – Medium	
	<55	<45	Negligible – Low	
	<50	<40	Negligible	Good day time level Good night level

Both documents define a daytime noise level below 55 dBL_{Aeq,16hr} as being Low/Good, and both define daytime noise levels above 70 dBL_{Aeq,16hr} as High. For night-time periods, noise levels below 45 dBL_{Aeq,8hr} are defined as being low with increasing magnitude of impact with higher noise levels.

As part of the noise impact assessment consideration is given to the magnitude of change in traffic noise levels in addition to the noise level category in which a road is defined.

WHO Environmental Noise Guidelines (WHO 2018)

The WHO Environmental Noise Guidelines (WHO 2018) provide recommendations for protecting human health from exposure to environmental noise originating from various sources. For road traffic, the WHO Environmental Noise Guidelines (WHO 2018) document recommends limiting traffic noise to below 53 dBL_{den} and below 45 dBL_{night}. The recommended road traffic noise levels within the WHO guidance are set on the basis of limiting annoyance and sleep disturbance.

The WHO Environmental Noise Guidelines (WHO 2018) guideline values are recommended to serve as the basis for policy-making process, to allow public health orientated recommendations to control noise exposure within populations on a European and national level.

The WHO Environmental Noise Guidelines (WHO 2018) document states the following regarding the implementation of the guidelines:

“The WHO guideline values are evidence-based public health-oriented recommendations. As such, they are recommended to serve as the basis for a policy-making process in which policy options are considered. In the policy decisions on reference values, such as noise limits for a possible standard or legislation, additional considerations – such as feasibility, costs, preferences and so on – feature in and can influence the ultimate value chosen as a noise limit. WHO acknowledges that implementing the guideline recommendations will require coordinated effort from ministries, public and private sectors and nongovernmental organizations, as well as possible input from international development and finance organisations.”

These guidelines are to be considered therefore in the context of national policy making to adopt and/or propose alternative noise limits for use, should they be deemed feasible, based on a range of factors which must be considered. In making these decisions, economic, physical, and social considerations all need to be factored in. It is important, therefore, to highlight that the WHO Environmental Noise Guidelines (WHO 2018) should be considered across populations as a whole and used to review and manage health related noise exposure across national and European populations. They set a guideline as to what is desirable at a population level. They are not always achievable and are not intended to be applied as a level on an individual receptor or project basis.

It is important to put the WHO Environmental Noise Guidelines (WHO 2018) recommended traffic noise limits into context with respect to the existing noise levels within Galway City. For the existing road network within Galway City, the

most recent NAP notes that the existing road network already contributes to road traffic noise above the recommended levels within the WHO Environmental Noise Guidelines (WHO 2018) for a large portion of the population.

An important part of the WHO guidelines relates to the recommended interventions or mitigation measures to be considered with respect to controlling and reducing road traffic noise exposure across populations. These include:

- changes in infrastructure;
- reduction in road traffic flows;
- pathway interventions (barriers), and
- quieter road surfaces.

The NAP includes further mitigation options to reduce traffic noise at exposed populations as part of the next 5-year plan. These include national and regional level strategies for improved public transport. Other key intervention strategies include but are not limited to; replacement of diesel fleet to electric / natural gas vehicles, restrictions to HGV / truck routes, traffic re-routing and / or road closures and road resurfacing.

The Proposed Scheme forms a key part of implementing the noise mitigation strategies discussed within the NAP which also aligns with the recommended interventions and overall policies of the WHO Environmental Noise Guidelines (WHO 2018) to reduce population exposure to road traffic noise.

The absolute noise levels within the WHO Environmental Noise Guidelines (WHO 2018) are not used to compare against at individual properties, however, changes in traffic noise levels are reviewed in the overall context of the Proposed Scheme to assess against the broad principles of the WHO Environmental Noise Guidelines (WHO 2018).

Significance Ratings

The following overall significance ratings for the Operational Phase of the Proposed Scheme are applied along the road network taking account of both the calculated changes in road traffic noise levels (Table 9.10 and Table 9.11) and the noise level ranges at NSLs. A daytime threshold value of 55 dB $L_{Aeq,16hr}$ and a night-time threshold value of 45 dB $L_{Aeq,8hr}$ has been applied for significance ratings, irrespective of the magnitude of change in noise levels. Operational traffic noise levels below these threshold levels during the Do Something scenarios are not considered to pose a significant noise impact such that overall significance ratings are not significant to slight depending on the change in noise levels.

The overall significance ratings are shown in Table 9.13 with the relevant L_{den} range in brackets. The L_{den} is converted from the $L_{Aeq,16hr}$ shown above by using the following formula:

$$L_{den} = 0.86(L_{Aeq,16hr} + 2) + 9.86$$

This is calculated assuming a conversion of $L_{A10,18hr} = L_{Aeq,16hr} - 2$, which is the average conversion across the Proposed Scheme, as calculated from the baseline noise measurements.

Table 9.13: Significance Ratings for Operational Phase Traffic Noise Impacts

Noise Level Range (day/night) (L_{den})	Magnitude of Change in Noise Levels (Short to Medium Term & Long Term)				
	No Change / Reduction	Negligible	Minor	Moderate	Major
Negligible (< 52 dBA)	Imperceptible / Positive	Not Significant	Not Significant	Not Significant	Not Significant - Slight
Negligible – Low (52 – 57 dBA)	Imperceptible / Positive	Not Significant	Not Significant	Not Significant - Slight	Slight
Low – Medium (57 – 62 dBA)	Imperceptible / Positive	Not Significant	Slight	Slight - Moderate	Moderate
Medium (62 – 67 dBA)	Imperceptible / Positive	Not Significant	Slight	Moderate	Moderate - Significant
Medium – High (67 – 72 dBA)	Imperceptible / Positive	Not Significant	Slight - Moderate	Moderate - Significant	Significant
High (> 72 dBA)	Imperceptible / Positive	Not Significant - Slight	Slight - Moderate	Significant	Very Significant

9.2.5.1 Operational Vibration

Magnitudes of vibration associated with road traffic are orders of magnitude below those associated with building or structural response to vibration. Operational phase impacts are therefore limited to human response to vibration where much lower magnitudes of vibration apply.

In terms of human response, vibration associated with road traffic is negligible and generally do not result in perceptible levels of vibration within buildings along normal maintained roads with no significant defects. Notwithstanding, reference is made to BS 6472–1 (BSI 2008) which provides the following VDV ranges which result in various probabilities of adverse comment resulting from exposure to vibration within residential buildings, refer to Table 9.14. An adverse comment is an unfavourable human reaction or response to vibration in accordance with BS 6472–1 (BSI 2008). Specific vibration data for the Operational Phase are included in Section 9.4.4.

Table 9.14: BS 6472 -1 VDV Ranges and Associated Impact Probabilities for Building Occupants (BSI 2008)

Place and Time	Low Probability of Adverse Comment $m \cdot s^{-1.75}$ (Note 1)	Adverse Comment Possible $m \cdot s^{-1.75}$	Adverse Comment Probable $m \cdot s^{-1.75}$ (Note 2)
Residential buildings 16-hour day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8-hour night	0.1 to 0.2	0.2 to 0.4	to 0.8

Note 1: Below these ranges adverse comment is not expected.

Note 2: Above these ranges adverse comment is very likely.

9.3 Baseline Environment

The baseline noise environment has been characterised with measured noise levels. The following sections summarise the results of the baseline noise surveys. Full details of the baseline surveys, including methodologies, survey dates, terminology and glossary, and results are included in Appendix 9.1 in Volume 4 of this EIAR.

The survey results are presented as the average daytime L_{Aeq} parameter, sampled over a three-hour daytime survey period and the calculated L_{den} parameter.

The noise survey results recorded during the baseline surveys in the study area are summarised in Table 9.15.

Table 9.15: Noise Monitoring Results

Attended Location	Average daytime, $L_{Aeq,T}$ (dB)	L_{den} (dB)
University Road	68	71
232 Corrib Park	58	62
81 Ardiluan Road	63	65
24 Inchagill Road	62	64
N6/Upper Newcastle Road	71	72
188 Dun Na Coiribe	63	65
120 College Road	67	70
Lough Atalia Road (behind 118 College Road)	76	77
Presentation Road	65	68
Woodquay	63	66
Eyre Street	60	63
Bothar na mBan	69	72
Fairgreen Road	67	78
Fairgreen Road/Lough Atalia Road	76	78
Middle Street	59	61

Noise at the measurement locations was dominated by road traffic noise in addition to localised urban noise sources (e.g., pedestrian conversations), and sporadic bird song.

Average daytime noise levels at the measurement locations ranged from 58 to 76 $dBL_{Aeq,T}$, with the higher values being recorded along highly trafficked roads.

L_{den} values calculated for the measurement locations ranged between 62 and 78 dBL_{den} .

9.4 Potential Impacts

9.4.1 Do Minimum Scenario

The Do Minimum scenario is a defined scenario within the traffic modelling exercise in the Traffic and Transport (Chapter 6) of this EIAR. The output of this analysis has been used for traffic noise calculations. The Do Minimum scenario considers a range of committed developments and transport plans within the study area for the year of opening (2023) and the design year (2038). Refer to the Traffic and Transport (Chapter 6) of this EIAR for a full description of the assumptions included in the Do Minimum scenario forecast years.

Traffic flows associated with the Do Minimum scenario have been assessed as part of the operational traffic noise impact assessment. This is set out in Section 9.4.3

9.4.2 Construction Phase

9.4.2.1 Construction Impact Assessment

The TII Noise Guidelines 2004 (NRA 2004) and TII Noise Guidelines 2014 (NRA 2014) specifically note that there is limited information available on specific construction methods, numbers and types of plant before the appointment of a Contractor, which will normally happen after a scheme has been approved. The guidelines note that it is more appropriate to address the way in which potential construction impacts will be assessed and how they will be managed, including forms of mitigation and codes of practices that will be applied.

Whilst the phasing of works and location of activities and work sites have been progressed to detailed stages as part of the EIAR, the specifics in terms of plant items, plant numbers, their locations and operational duration will be subject to site conditions, work scheduling and contractor proposals. Notwithstanding, it is possible to determine indicative noise levels associated with typical construction activities associated with the various phases of works.

The TII Noise Guidelines 2004 (NRA 2004) and TII Noise Guidelines 2014 (NRA 2014) note that in the absence of an Irish or international standard relevant to construction noise, reference can be made to BS 5228 – 1 (BSI 2014a) and BS 5228 – 2 (BSI 2014b). These standards include recommended methodologies for calculating Construction Noise Levels (CNL) and include a range of best practice mitigation and management measures for the control of noise and vibration from construction sites.

In terms of calculation, BS 5228 – 1 (BSI 2014a) sets out sound pressure levels for a wide range of plant items normally encountered on construction sites, which in turn enables the prediction of indicative noise levels at distances from the works. BS 5228 – 2 (BSI 2014b) also includes empirical data on vibration levels measured at set distances from specific vibration generating activities in different ground and site conditions.

9.4.2.2 Construction Activity Noise

Due to the nature of the activities undertaken on a construction site, there is the potential for high noise levels from some activities. The flow of vehicular traffic to and from a construction site is also a potential source of noise. The impact at nearby NSLs will depend upon a number of variables, including:

- the amount of noise generated by plant and equipment being used at any one time generally expressed as a sound power level;
- the periods of operation of the plant at the development site, known as the “on-time”;
- the distance between the noise source and the NSLs;
- the attenuation due to ground absorption or barrier screening effects; and
- reflections of noise due to the presence of hard vertical surfaces such as walls.

Using the typical noise levels for items of construction plant set out in BS 5228 – 1 (BSI 2014a), CNLs at specific distances have been calculated to determine a range of potential noise levels representative of the key Construction Phases of the Proposed Scheme. The following sections set out the calculated CNLs associated with the key phases of construction representing the closest NSLs to the likely work phases.

Along the Proposed Scheme, the key Construction Phases of the project are:

- General road works;
- Road widening and road surface upgrade activities;
- Utility diversions;
- Urban realm landscaping, including repaving and excavation for planting of trees;
- Construction Compounds, which will be used for storage of materials, plant and equipment, site offices, worker welfare facilities and limited car parking.

Items of plant and equipment that may be used during construction are identified in Chapter 5 (Construction) of this EIAR. Typical operating on-times have been developed for the purposes of construction noise calculation. The plant items along with their associated sound pressure levels taken from BS 5228 – 1 (BSI 2014a) are summarised in Table 9.16.

The calculations set out in the following sections do not include any attenuation from screening of site hoarding, buildings or structures, hence relate only to uninterrupted distance attenuation over hard ground.

NSLs located beyond the road edge, which are screened by intervening buildings and solid boundary treatments, therefore, will experience lower construction noise emissions than those presented at the varying distances set out in the following sections.

Table 9.16: Indicative Plant Noise Levels and Predicted CNL at Varying Distances

Plant Item (BS 5228 Ref.)	Plant Noise Level at 10m Distance (dB L _{Aeq,12hr} or L _{Aeq,4hr})	% Plant On-Time	Predicted CNL at Stated Distance from Edge of Works Based on % Plant On-Time (dB L _{Aeq,12hr} or L _{Aeq,4hr})						
			10 m	15 m	20 m	30 m	50 m	100 m	150 m
Lorry (Table C2.34)	80	40	76	72	70	66	62	56	52
Backhoe Mounted Hydraulic Breaker (Table C5.1)	88	20	81	77	75	71	67	61	57
Tracked Excavator 8t (Table C4.17)	71	100	71	67	65	61	57	51	47
Wheeled Excavator 14t (Table C4.56)	83	40	79	75	73	69	65	59	55
Wheeled Excavator 17t (Table C5.11)	73	40	69	65	63	59	55	49	45
Dumper (Table D3.98)	77	50	74	70	68	64	60	54	50
Road Planer (Table C5.7)	82	10	72	68	66	62	58	52	48
Road Sweeper (Table C4.90)	76	15	67	63	61	57	53	47	43
Asphalt Paver (Table C5.33)	75	15	66	62	60	56	52	46	42
Asphalt Roller (Table C5.20)	75	20	68	64	62	58	54	48	44
Roller 3t (Table C5.27)	67	50	64	60	58	54	50	44	40
Diesel generator (Table C4.79)	64	100	64	60	58	54	50	44	40
Crusher (Table C1.14)	81	40	81	78	75	71	67	63	61

General Road Works

This section assesses the indicative noise levels generated from general road works. As per the noise levels presented in Table 9.16, noise levels for plant types typically associated with general road works (lorries, dumpers, road planers, pavers and rollers), are typically in the range of 64 to 76 dBL_{Aeq,T} at 10 m taking account of their typical ‘on-time’ in a working area. Table 9.17 presents the predicted CNL at different distances associated road works activity. The plant noise level has been calculated accounting for the fact that plant items will be operating at varying distances from a NSL at any one time. The calculated levels relate to activities operating over a full day, full evening or Saturday period.

Table 9.17: Indicative Road Works Construction Noise Calculations at Varying Distances

Predicted CNL at Stated Distance from Edge of Works Based on % Plant On-Time and Plant Items Operating Simultaneously (dB L_{Aeq,12hr} or L_{Aeq,4hr})								
10m	15m	20m	30m	50m	75m	100m	150m	250m
79	76	73	69	65	61	59	55	51

During normal road work the daytime CNT value of 75 dBL_{Aeq,12hr} Monday through Friday (07:00 to 19:00hrs) is likely to be exceeded at distances of up to 15 m from the works boundary in the absence of any noise mitigation. The evening and weekend CNT value of 65 dBL_{Aeq,T} would be exceeded at distances up to 50 m in the absence of any mitigation. Noise mitigation will therefore be required to reduce CNLs from this type of activity, particularly during any evening and weekend works. The identified areas where this work will take place and calculated construction noise levels are presented in Table 9.18. The identified NSLs are those which bound the road edge and are not screened by other buildings. The identified NSL list in Table 9.18 is representative of all receptors but does not list each individual NSL.

Table 9.18: Road Works Construction Noise Calculations at Nearest Noise Sensitive Locations

Construction Section Reference	Nearest NSL to Edge of Works	Predicted Total Construction Noise Level at Stated Distance from Edge of Works (dB L_{Aeq,T})
Section A1	Residential NSLs south of University Road (<10m)	79
Section A2	SOTI Inc.to south-west of Gaol Road (<10m)	79
Section A3	Alastair Purdy & Co. Solicitors to east of Salmon Weir Bridge (<30m)	69
Section A4	Galway Diocesan Pastoral Centre to east of Newtownsmith Road (<10m)	79
Section A5	Residential NSLs to south of Corrib Terrace (<10m)	79
Section A6	Residential NSLs to east of Headford Road (<10m)	79
Section A7	Mercy Primary School to east of St. Francis Street (<10m)	79
Section A8	Residential NSLs to east of Woodquay Street (<10m)	79
Section B1	Residential NSLs to east of t. Brendan's Avenue (<10m)	79
Section B2	Residential and retail NSLs to east of the R336 (<10m)	79
Section B3	ESB Galway to east of Eyre Square (<10m)	79
Section B4	AIB Galway to east of Victoria Pl. (<10m)	79
Section B5	Eyre Square Hotel to east of Forster Street (<10m)	79

Construction Section Reference	Nearest NSL to Edge of Works	Predicted Total Construction Noise Level at Stated Distance from Edge of Works (dB L _{Aeq,T})
Section B6	Intreo Centre Galway south-east of junction, east of Fairgreen Road (<10m)	79
Section B7	SIPTU Galway to north-east of Bóthar Bhreandain Uí Eithir (<10m)	79
Section B8	Fairgreen house to west of Fairgreen Road (<10m)	79
Section C1	Residential NSLs to south of Forster Street (<10m)	79
Section C2	Residential NSLs to west of College Road (<10m)	79
Section C3	Residential NSLs to east of College Road (<10m)	79
Section C4	Residential NSL north of junction, west of Wellpark Road (<10m)	79
Section C5	The g Hotel & Spa, Wellpark to north of Dublin Road (<20m)	73

As summarised in Table 9.18, general road works realignments are within 10 m to 30 m of the nearest NSLs. The potential cumulative noise levels for these works at the closest NSL façades are between 69 to 79 dB L_{Aeq,T} in the absence of any noise mitigation. The potential noise impacts range between Negative, Slight to Significant, and Temporary during the daytime period and Negative, Moderate to Very Significant, and Temporary during the evening and weekend periods in the absence of noise mitigation.

Reference to Table 9.16 indicates that the highest noise levels will occur when road planers are operating near the NSLs. During specific periods when these activities are operating immediately outside NSLs, higher noise levels will occur compared to those discussed in Table 9.18. Specific plant will operate only intermittently at any one location over the course of a working day.

Road Widening, Road Upgrade and Utility Diversion Construction Works

This section assesses the indicative noise levels generated from road widening and utility diversion activities. Construction plant typically associated with road widening and utility diversion works (i.e., lorries, breakers, excavators (including vacuum excavators), dumpers, road planers, sweepers, pavers and rollers) will operate as required depending on the specific activity taking place. As per Table 9.16, noise levels associated with these activities are typically in the range of 64 to 82 dB L_{Aeq,T} at 10 m taking into account their typical 'on-time'. Table 9.19 presents the predicted CNL associated with the proposed works for this element of the construction phase, assuming six items of plant operating simultaneously. The calculated levels relate to activities operating over a full day, full evening or Saturday period.

Table 9.19: Indicative Road Widening and Utility Diversion Construction Work Noise Calculations at Varying Distances

Predicted CNL at Stated Distance from Edge of Works Based on % Plant On-Time and Plant Items Operating Simultaneously (dB L _{Aeq,12hr} or L _{Aeq,4hr})								
10m	15m	20m	30m	50m	75m	100m	150m	250m
84	81	78	74	70	66	64	60	56

During road widening and utility diversion works, the daytime CNT value of 75 dB L_{Aeq,12hr} Monday through Friday (07:00 to 19:00hrs) is likely to be exceeded at distances of up to 25 m from the works boundary in the absence of any noise mitigation.

The evening and weekend CNT value of 65 dB L_{Aeq,T} is likely to be exceeded at distances up to 75 m in the absence of any mitigation. Noise mitigation will therefore be required to reduce CNLs from this activity, particularly during any evening and weekend works. Potential construction noise levels at nearby NSLs are presented in Table 9.20.

Table 9.20: Road Widening, Road Upgrade and Utility Diversion Construction Noise Calculations at Nearest NSLs

Construction Section Reference	Nearest NSL to Edge of Works	Potential Total CNL at Stated Distance from Edge of Works (dB L _{Aeq,T})
Section A1	Residential NSLs south of University Road (<10m)	84
Section A2	SOTI Inc. to south-west of Gaol Road (<10m)	84
Section A3	Alastair Purdy & Co. Solicitors to east of Salmon Weir Bridge (<30m)	74
Section A4	Galway Diocesan Pastoral Centre to east of Newtownsmith Road (<10m)	84
Section A5	Residential NSLs to south of Corrib Terrace (<10m)	84
Section A6	Residential NSLs to east of Headford Road (<10m)	84
Section A7	Mercy Primary School to east of St. Francis Street (<10m)	84
Section A8	Residential NSLs to east of Woodquay Street (<10m)	84
Section B1	Residential NSLs to east of t. Brendan's Avenue (<10m)	84
Section B2	Residential and retail NSLs to east of the R336 (<10m)	84
Section B3	ESB Galway to east of Eyre Square (<10m)	84
Section B4	AIB Galway to east of Victoria Pl. (<10m)	84
Section B5	Eyre Square Hotel to east of Forster Street (<10m)	84
Section B6	Intreo Centre Galway south-east of junction, east of Fairgreen Road (<10m)	84
Section B7	SIPTU Galway to north-east of Bóthar Bhreandain Uí Eithir (<10m)	84
Section B8	Fairgreen house to west of Fairgreen Road (<10m)	84
Section C1	Residential NSLs to south of Forster Street (<10m)	84

Construction Section Reference	Nearest NSL to Edge of Works	Potential Total CNL at Stated Distance from Edge of Works (dB L _{Aeq,T})
Section C2	Residential NSLs to west of College Road (<10m)	84
Section C3	Residential NSLs to east of College Road (<10m)	84
Section C4	Residential NSL north of junction, west of Wellpark Road (<10m)	84
Section C5	The g Hotel & Spa, Wellpark to north of Dublin Road (<20m)	78

As summarised in Table 9.20 above, road widening works are within 10 m to 30 m of the nearest NSLs. The highest potential cumulative CNL for these works at the closest NSL façades are between 74 to 84 dBL_{Aeq,T} in the absence of any noise mitigation.

The potential noise impacts range between Negative, Slight to Significant and Temporary during the daytime period and Negative, Moderate to Very Significant, and Temporary during the evening and weekend periods in the absence of noise mitigation.

The calculations are based on six plant items operating simultaneously, in the absence of any noise mitigation along a given section of road. The plant noise levels have been calculated on the basis that plant will be operating at varying distances from a NSL at any one time. Reference to Table 9.16 indicates that highest noise levels will occur when breaking, excavators and road planers are operating near NSLs. During specific periods when this plant is operating immediately outside NSLs, higher noise levels will occur at these closest NSLs. These activities will only occur for intermittent periods at any one location.

Urban Realm Landscaping

This section assesses the indicative noise levels generated from urban realm landscaping, including repaving and excavation for planting of trees. As per Table 9.16, for plant typically associated with urban realm landscaping, including lorries, excavators and pavers, noise levels are typically in the range of 66 to 76 dBL_{Aeq,T} at 10 m taking into account typical 'on-time'. Table 9.21 outlines the predicted CNL associated with the proposed works, assuming three items of plant.

Table 9.21: Indicative Urban Realm Landscaping Construction Noise Calculations at Varying Distances

Predicted CNL at Stated Distance from Edge of Works Based on % Plant On-Time and Three Plant Items Operating Simultaneously (dB L _{Aeq,12hr} or L _{Aeq,4hr})								
10m	15m	20m	30m	50m	75m	100m	150m	250m
79	76	73	69	65	61	59	55	51

During urban realm landscaping works, the daytime CNT value of 75 dBL_{Aeq,12hr} Monday through Friday (07:00 to 19:00hrs) is likely to be exceeded at distances of up to 15 m from the works boundary in the absence of any noise mitigation.

The evening and weekend CNT value of 65 $\text{dBL}_{\text{Aeq,T}}$ would be exceeded at distances of up to 50 m in the absence of any mitigation. Noise mitigation will therefore be required to reduce CNLs from this activity, particularly during any evening and weekend works. The identified areas where this work will take place and calculated construction noise levels are presented in Table 9.22.

Table 9.22: Urban Realm Landscaping Construction Noise Calculations at Nearest NSLs

Construction Section Reference	Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works ($\text{dB L}_{\text{Aeq,T}}$)
Section A2	Residential NSL and County Club to the east of the existing Goal Road carriageway, south-east of Galway Cathedral (<20m)	73
Section A4	Galway Courthouse to the east of the Waterside Road (<10m)	79
Section A5	San Antonio Guesthouse to the east of Headford Road, at junction corner that intersects Bothar na mBan (<10m)	79
Section A8	Residential NSL to east of Woodquay (<10m)	79
Section B2	Mapfre Assistance east of Prospect Hill (<10m)	79
Section B3	McInerney Solicitors to north of An Fhaiche Mhor - North of the Liam Mellows Statue (<10m)	79
Section C2	Residential NSL to west of existing junction College Road (<10m)	79

During urban realm landscaping works the nearest NSLs are within 10 m to 20 m of the proposed works. The highest potential cumulative noise levels for these works are in the range of 73 to 79 dBL_{Aeq} in the absence of any noise mitigation. The potential noise impacts range between Negative, Slight to Significant, and Temporary during the daytime period and Negative, Moderate to Very Significant, and Temporary during the evening and weekend periods in the absence of noise mitigation.

Construction Site Compounds

For Construction Compound areas (used for storage, offices, generators and material handling) a total CNL of 78 $\text{dBL}_{\text{Aeq,T}}$ at 10 m has been used for the purposes of indicative calculations. Table 9.23 outlines the potential CNLs associated with the proposed works for this element of the construction.

Given the variations of on-site activities and noise levels over any one day and considering that all activities will not operate simultaneously, the values noted above are considered robust for the purposes of assessing potential construction impacts.

Table 9.23: Indicative Construction Compound Construction Noise Calculations at Varying Distances

Predicted CNL at Stated Distance from Edge of Works Based on % Plant On-Time (dB L _{Aeq,T})								
10m	15m	20m	30m	50m	75m	100m	150m	250m
78	75	72	68	64	60	58	54	50

The predicted values outlined in Table 9.23 indicate the daytime CNT value of 75 dB L_{Aeq, 12hr} Monday through Friday (07:00 to 19:00hrs) is likely to be exceeded within 15 m of the construction compound. The evening and weekend CNT value of 65 dB L_{Aeq,T} is also likely to be exceeded within 50 m of the construction compound.

The identified areas where this work will take place and calculated construction noise levels are presented in Table 9.24.

Table 9.24: Construction Site Compounds Construction Noise Calculations at Nearest NSLs

Construction Section Reference	Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works (dB L _{Aeq,T})
Section A2	SOTI Inc. to south-west of Gaol Road (<15m)	75
Galway Harbour Enterprise Park	Galway Bay Seafood Shop to north of New Docks Road (<150m)	54

9.4.2.3 Construction Vibration

The potential for elevated levels of vibration at sensitive locations during construction activities associated with the Proposed Scheme is typically associated with surface breaking activities and road widening.

During surface breaking activities, there is potential for vibration to be generated through the ground. Empirical data for this activity is not provided in BS5228-2, however, the likely levels of vibration from this activity will be significantly below any vibration criteria for building damage (based on experience from other sites).

Data from previous projects with similar activities shows that for breaker activities, a vibration level of between 1.5 and 0.25 mm/s PPV can be expected between 10 and 50 m away, respectively. These measurements are for a breaker working on a concrete slab. It is expected that for breakers working on road surfaces, the vibration levels will be less than these measured levels.

Widening and upgrading of existing footpaths and kerbs will involve careful deconstruction using controlled techniques. Vibration levels associated with this activity will be of similar or lower magnitude to breaking activities discussed above.

With reference to the vibration levels above and the significance ratings in Table 9.9, vibration impacts during ground-breaking activities have the potential to generate a moderate effect, with a moderate significance rating within 10m of the works. Beyond 50m, the effects are reduced to minor, with a not significant to slight significance rating for human perception. All construction activities will be temporary.

Vibration effects from vibratory rollers also have the potential to affect nearby sensitive receptors. It is expected that the vibration levels from the rollers will be similar to or lower than those from ground-breaking activities.

All construction works are orders of magnitude below limits values associated with any form of cosmetic or structural damage for structurally sound or protected or historical buildings or structures referred to in Table 9.8.

9.4.2.4 Construction Traffic Impact

The impact of construction traffic noise on the nearby NSLs has been considered.

During construction works, the major impact on traffic movements is rerouting due to road closures. The rerouted traffic will mirror traffic changes during the operational phase (in the “Do Something” scenario). As outlined in Chapter 6 (Traffic and Transport) (Section 6.5.6.2) of this EIAR, a maximum of 2-3 HGVs in the AM and PM hours are likely to be generated during the construction phase. The additional number of HGVs during the construction phase does not significantly impact the potential noise levels in the study area due to the projected low numbers relative to baseline traffic flow.

The noise impacts for this scenario have been assessed as part of the operational phase and are not assessed separately in this section.

9.4.2.5 Summary of Potential Construction Noise Impacts

It should be noted that the calculations set out in this section are indicative and are used for the purposes of comparison only with the adopted criteria. Where exceedance of the recommended criteria is expected, the use of noise mitigation measures will be used as part of the construction works. Further details of the noise mitigation measures are set out in Section 9.5.

The pre-mitigation construction noise significance ratings across the Proposed Scheme are summarised in Table 9.25. In line with Table 9.13, the significance ratings are defined taking into account the prevailing baseline noise environment and the potential CNL. The specific duration of construction activities at a NSL also influences the overall significance determination. In accordance with the DMRB Noise and Vibration (UKHA 2020), a significant effect occurs where a moderate or major magnitude of impact occurs for periods equal to or greater than 10 or more days in any 15 consecutive days or for a total number of days exceeding 40 in any 6 consecutive months. As this assessment is based on the programme presented in Chapter 5 (Construction) of this EIAR, the pre-mitigation construction noise significance ratings discussed in Table 9.25 relate to activities

that are expected to occur over periods equal to or greater than the durations discussed above.

According to the programme presented in Chapter 5 (Construction) of this EIAR, only daytime works are expected to be undertaken. This is reflected in the assessment presented in Table 9.25.

For ease of reference, general road works and landscaping are discussed under one heading to reflect that the range of noise levels are comparable for the two scenarios.

Table 9.25: Summary of Potential Construction Phase Noise Impacts

Assessment Topic	Period over Which Criterion Applies	Potential Impact
General Road Works, and Urban Realm Landscaping	Monday to Friday: Daytime (07:00 – 19:00hrs)	<ul style="list-style-type: none"> Negative, significant to very significant and temporary in the absence of noise mitigation at NSLs within 15 m of the works. Negative, moderate to significant and temporary in the absence of noise mitigation at NSLs between 15 and 30 m of the works. Slight – moderate and temporary in the absence of noise mitigation at NSLs between 30 and 150 m of the works. Not significant at NSLs further than 150 m from the works <p>All impacts noted above are in the absence of noise mitigation, including screening by intervening buildings.</p> <p>Refer to Section 9.5.1 for the range of noise mitigation measures which will be adopted at specific working areas to reduce noise impacts at NSLs. Particular emphasis is given to localised screening around high noise level plant items.</p>
	Saturdays (08:00 – 16:30hrs)	<ul style="list-style-type: none"> Negative, significant to very significant and temporary in the absence of noise mitigation at NSLs within 30 m of the works. Negative, moderate to significant and temporary in the absence of noise mitigation at NSLs between 30 and 50 m of the works. Slight – moderate and temporary in the absence of noise mitigation at NSLs between 50 and 250 m of the works. <p>All impacts noted above are in the absence of noise mitigation, including screening by intervening buildings.</p> <p>Refer to Section 9.5.1 for the range of noise mitigation measures which will be</p>

Assessment Topic	Period over Which Criterion Applies	Potential Impact
		adopted at specific working areas to reduce noise impacts at NSLs.
Road Widening / and Utility Diversion Works	Monday to Friday: Daytime (07:00 – 19:00hrs)	<ul style="list-style-type: none"> Negative, significant to very significant and temporary in the absence of noise mitigation at NSLs within 30 m of the works. Negative, moderate to significant and temporary in the absence of noise mitigation at NSLs between 30 and 50 m of the works. Slight – moderate and temporary in the absence of noise mitigation at NSLs between 50 and 250 m of the works. <p>All impacts noted above are in the absence of noise mitigation, including screening by intervening buildings. Refer to Section 9.5.1 for the range of noise mitigation measures which will be adopted at specific working areas to reduce noise impacts at NSLs. Particular emphasis is given to localised screening around high noise level plant items including breakers and excavators.</p>
	Saturdays (08:00 – 16:30hrs)	<ul style="list-style-type: none"> Negative, significant to very significant and temporary in the absence of noise mitigation at NSLs within 50 m of the works. Negative, moderate to significant and temporary in the absence of noise mitigation at NSLs between 50 and 100 m of the works. Slight – moderate and temporary in the absence of noise mitigation at NSLs between 100 and 250 m of the works <p>All impacts noted above are in the absence of noise mitigation, including screening by intervening buildings. Refer to Section 9.5.1 for the range of noise mitigation measures which will be adopted at specific working areas to reduce noise impacts at NSLs.</p>
Construction Compound	Monday to Friday: Daytime (07:00 – 19:00hrs)	<ul style="list-style-type: none"> Slight – moderate and temporary in the absence of noise mitigation at NSLs within 30 m of the works. Not significant at NSLs further than 30 m from the works <p>All impacts noted above are in the absence of noise mitigation, including screening by intervening buildings. Refer to Section 9.5.1 for the range of noise mitigation measures which will be</p>

Assessment Topic	Period over Which Criterion Applies	Potential Impact
		adopted at specific working areas to reduce noise impacts at NSLs. Particular emphasis will be given to positioning of crushers at a suitable set back distance from NSLs and localised screening around high noise level plant items, including crushers.
	Saturdays (08:00 – 16:30hrs)	<ul style="list-style-type: none"> Negative, moderate to significant and temporary in the absence of noise mitigation at NSLs within 10 m of the works. Slight – moderate and temporary in the absence of noise mitigation at NSLs between 10 and 200 m of the works. Not significant at NSLs further than 200 m from the works <p>All impacts noted above are in the absence of noise mitigation, including screening by intervening buildings.</p>
Construction vibration from general road works & construction activities	All Construction work periods	<ul style="list-style-type: none"> Negative, imperceptible to not significant and temporary
Construction vibration from ground-breaking and compacting activities within 10 m of occupied residential buildings	Ground-breaking during road widening and utility diversion works	<ul style="list-style-type: none"> Negative, slight to moderate and temporary
Construction Traffic	As per operational assessment – see Section 9.4.3.2.	N/A

9.4.3 Operational Phase Noise

9.4.3.1 Calculation of Road Traffic Noise Levels

The key principle of the operational noise impact assessment associated with the Proposed Scheme is to determine and categorise potential changes in road traffic noise between the Do Minimum and Do Something Scenarios.

Traffic flows have been modelled over the study area across Galway City as part of the traffic assessment for the Proposed Scheme. The output of the traffic modelling has been used to undertake a detailed analysis of traffic noise level

changes. The noise impact assessment has focused on all modelled roads along the Proposed Scheme and roads affected by diverted traffic flows.

There are two key assessment zones within the study area, the Proposed Scheme and the surrounding road network extending out from the Proposed Scheme. Traffic noise impacts associated with the Proposed Scheme are 'direct' impacts, while traffic noise impacts associated with the surrounding network are 'indirect'.

In both instances, changes in traffic volumes and changes in fleet composition (car, bus, LGV, HGV) is a key consideration when determining the change to the traffic noise environment.

Traffic Flow Data

Detailed traffic data have been provided for each modelled road within the study area for the Proposed Scheme. For each road, traffic flows are provided in terms of Annual Average Daily Traffic (AADT) with a percentage breakdown of cars, buses, LGVs and HGVs for each road.

Traffic flow data was provided for 2023 (the year of opening) and 2038 (the design year). Review of traffic volumes associated with 2023 are determined to be higher than those associated with the design year of 2038 for the majority of roads within the study area. This is predominately due to the modal shift towards public transport and the restriction of traffic on bus routes within the red line boundary of the Proposed Scheme in 2038.

Only daytime traffic data was considered for the noise assessment, as the Proposed Scheme will not be operational during the night-time periods.

A summary of the key potential noise impacts associated with the Proposed Scheme are summarised in the following sections.

Potential Noise Impacts Along Proposed Scheme

Along the Proposed Scheme the key changes affecting the noise environment relate to:

- Increased bus usage and an associated reduction in private traffic;
- Alterations to the cross section of the road to include footpaths, cycle and bus lanes where none presently exist, and;
- Addition or relocation of bus stops.

Potential Noise Impacts Along Surrounding Road Network

Along the surrounding road network, potential changes to road traffic noise are associated with traffic redistribution onto local roads due to the introduction of bus priority measures, restricted turning movements, and bus lanes along the Proposed Scheme, where relevant. As noted in Section 9.2.2.1, redistributed traffic onto the surrounding road network is determined to occur during daytime periods only. During night-time periods, scheme related traffic redistribution is negligible.

Source Noise Levels

The approach adopted for the study area involves calculation of noise emission levels associated with the key fleet composition types along the road i.e., buses, cars, LGVs and HGVs. Noise levels are calculated using the Annual Average Daily Traffic (AADT), as discussed in Chapter 6 (Traffic and Transport) of this EIAR using the methodology outlined in Calculation of Road Traffic Noise (CRTN).

This produces the traffic noise level quantified as $L_{A10,18hr}$, which can be converted to L_{den} for comparison to the EU criteria using the following formula from the NRA Guidelines:

$$L_{den} = 0.86L_{A10,18hr} + 9.86$$

These calculations have been based on vehicles with internal combustion engines. The source noise levels therefore take account of the combustion noise associated with the vehicle engine noise and rolling noise from the tyre and road interface, both of which make up the total noise associated with road traffic vehicles. At speeds of up to approximately 30 km/h, noise from light internal combustion engine (ICE) vehicles is dominated by engine noise. The contribution from engine noise for light ICE vehicles reduces above this speed and rolling noise becomes the dominant contributor to overall noise levels. For heavy vehicles including buses, the contribution of the engine noise remains a significant contributor to overall noise levels at speeds typically encountered in an urban environment (between 30 to 60 km/h).

It is understood that the number of ICEs in the vehicle fleet (both light vehicles and heavier vehicles such as buses) will reduce over the next 15 years, and therefore the calculated noise levels included within this study are therefore worst case and reflect a full fleet of ICE vehicles, refer to Chapter 8 (Climate) of this EIAR for further details. Due to the absence of reliable published sound emission data relating to electric vehicles (EVs) and heavy electric vehicles (HEVs), the approach for this EIAR is to assume a full fleet of ICE. Given the same fleet type is assumed for both the Do Minimum and Do Something scenarios, the relative change in noise levels between these scenarios will remain unchanged regardless of the fleet type used. Further comment on specific noise levels is discussed in Section 9.4.4.

Proposed Scheme

Using the calculation approach discussed above, the $L_{A10,18hr}$ traffic noise level was calculated along each road modelled as part of the traffic impact assessment (refer to Chapter 6 Traffic and Transport) of this EIAR within the Proposed Scheme boundary for the Do Minimum and Do Something scenarios. All calculations are made at a reference distance of 5 m from the road edge. Where relevant, the calculations have taken account of changes to the alignment of bus lanes and general traffic lanes during the Do Something scenario, specifically where these were identified to be located closer to NSLs compared to the existing cross section. In these identified scenarios, the reference distance of the traffic source is accounted for in the calculations. The calculations also account for potential speed increase of buses using the dedicated bus lanes, consistent with the traffic model.

Surrounding Road Network

For each modelled road within the surrounding road network outside of the Proposed Scheme, the associated $L_{A10,18hr}$ traffic noise level was calculated for the Do Minimum and Do Something scenarios. For all roads, calculations are made at a reference distance of 5m from the road edge. No changes to the alignment cross section occurs outside of the Proposed Scheme boundary.

9.4.3.2 Traffic Noise Impacts

Opening Year 2023

For the purposes of assessing and describing potential noise impacts, opening year traffic is assumed to be representative for the 15-year period from 2023 to the design year. The 'short-term' magnitude of change ratings from the DMRB (UKHA 2020) are therefore used to assess potential noise impacts associated with the opening year up to the design year. In this instance, these impacts are described as short to medium term in duration in accordance the EPA Guidelines (EPA 2022).

The assessment of potential traffic noise impacts has been undertaken using the following approach:

- Traffic noise levels have been calculated along each road within the study area of the Proposed Scheme;
- Noise levels have been calculated for the Do Minimum (DM) scenario for the opening year, 2023;
- Noise levels have been calculated for the Do Something (DS) scenario for the opening year, 2023; and
- The change in traffic noise levels between the DM and DS scenarios for the year 2023 have been calculated and the associated magnitude of change (Table 9.10) and noise level ranges (Table 9.12) have been presented.

Along the Proposed Scheme, a direct, positive, imperceptible to slight, short to medium term impact is calculated for most roads, with the exception of Fairgreen Road and Woodquay. This is as a result of reduction in overall traffic volumes through the incorporation of bus priority signals and junctions, restricted turning movements for private vehicles and the incorporation of dedicated bus lanes. The overall direct impact is determined to be Positive, Imperceptible to Slight and Short to Medium-term.

Along the majority of roads off the Proposed Scheme within the study area, impacts as a result of traffic redistribution are determined to be indirect, Positive, Imperceptible to Slight, and Short to Medium-term to Negative, Slight to Moderate, and Short to Medium-term once the Proposed Scheme becomes operational.

There are a small number of roads in the overall study area where there are potential initial significant negative impacts. These are defined as roads with a

traffic noise level above a daytime noise level of 57 dBL_{den} and an increase in noise level greater than 3 dB.

Further analysis of these roads was undertaken as follows:

- For each identified road above the potential initial significance threshold, the location or presence of NSLs was identified and distance from the road confirmed;
- The corrected traffic noise level at the closest NSL façade was calculated;
- The overall significance rating was determined taking account of the change in noise level during the short-term period and the noise level range, taking account of any distance corrections.

In general, mitigation measures such as noise barriers are not feasible at the affected NSLs due to the proximity of the façade of the NSL to the road edge.

The specific operational noise impacts during the daytime period for these roads are summarised in Table 9.26. A full overview of the potential daytime operational phase impacts for the opening year for the Proposed Scheme is presented in Figure 9.3 in Volume 3 of this EIAR, and the associated data is presented in Appendix 9.2 in Volume 4 of this EIAR.

Table 9.26: Summary of Potential Daytime Operational Phase Impacts – Opening Year 2023

Road	Potential increase above DM Scenario at nearest NSL, dBA	DMRB short term magnitude impact	Potential DS road traffic noise at nearest NSL, dBL _{den}	Noise level rating	Overall significance rating	Potential impact
Presentation Road	8.2	Major	71	Medium – High	Significant	Indirect, Negative, Significant, Short to medium term
Mill Street	3.7	Moderate	71	Medium – High	Moderate – Significant	Indirect, Negative, Moderate – significant, Short to medium term
Moyola Park	4.3	Moderate	61	Low – medium	Slight – moderate	Indirect, Negative, Slight – moderate, Short to medium term

Road	Potential increase above DM Scenario at nearest NSL, dBA	DMRB short term magnitude impact	Potential DS road traffic noise at nearest NSL, dBL _{den}	Noise level rating	Overall significance rating	Potential impact
Lough Atalia Road	3.3	Moderate	76	High	Significant	Indirect, Negative, Significant, Short to medium term
University Road	3.1	Moderate	71	Medium – High	Moderate – Significant	Indirect, Negative, Moderate – significant, Short to medium term
Corrib Park	3.2	Moderate	66	Medium	Moderate	Indirect, Negative, Moderate, Short to medium term
Woodquay Street	3.9	Moderate	67	Medium	Moderate	Indirect, Negative, Moderate, Short to medium term
Cross Street Lower	5.3	Major	68	Medium – high	Significant	Indirect, Negative, Significant, Short to medium term

In the opening year of 2023, the highest daytime potential noise impacts are calculated along Lough Atalia Road. The change in predicted traffic noise level along Lough Atalia Road is moderate, at 3.3 dB. The overall impact will potentially be Negative, Significant, and Short to Medium-term.

The most significant adverse traffic noise impacts are potentially along Presentation Road, Lough Atalia Road and Cross Street Lower. The noise levels along Presentation Road and Cross Street Lower will potentially be Medium-high, and the change in noise level along both streets is predicted to be more than 5 dB. The overall impact will potentially be Negative, Significant and Short to Medium-term at NSLs located along both roads.

The measured baseline noise level along Lough Atalia Road is equivalent to 77 dBL_{den}. The existing noise environment along the road is high and NSLs along Lough Atalia Road will be accustomed to a high noise environment. Additionally,

the DS traffic noise level has been calculated for the worst case NSLs along Lough Atalia Road, which include two properties that have buildings along the boundary line with the pavement of Lough Atalia Road. Most of the 23 properties along Lough Atalia Road are set back from the pavement boundary line by at least 5 – 10 m, which will result in a noise level reduction of approximately 2.5 dB below the calculated DS traffic noise level at the property façade.

For all roads across the study area, the potential impacts are expected to be conservative and will reduce with the further inclusion of electric vehicles to the fleet, as discussed in Section 9.4.3.

For all other roads across the study area, impacts are defined as Positive (beneficial), Imperceptible and Short-term to Negative, Not Significant to Slight, and Short to Medium-term. The majority of roads within the Proposed Scheme will experience a decrease in traffic noise due to the change in mode of traffic associated with the Proposed Scheme.

A full suite of calculated noise levels along roads within the study area is included in Appendix 9.2 of Volume 4 of this EIAR.

Design Year 2038

For the design year, the assessment of potential traffic noise impacts has been undertaken using the following approach:

- Traffic noise levels have been calculated along each road within the study area of the Proposed Scheme;
- Noise levels have been calculated for the DM scenario for the opening year, 2038;
- Noise levels have been calculated for the DS scenario for the opening year, 2038; and
- The change in traffic noise level between the DM and DS scenarios for the year 2038 has been calculated and the associated magnitude of change (Table 9.11) and noise level range (Table 9.12) have been presented.

Along the Proposed Scheme, a direct, Positive, Imperceptible to Slight, Short to Medium-term impact is calculated for most roads, with the exception of Fairgreen Road. This is as a result of reduction in overall traffic volumes through the incorporation of bus priority signals and junctions, restricted turning movements for private vehicles and the incorporation of dedicated bus lanes. The overall direct impact is determined to be Positive, Imperceptible to Slight and Long-term.

There are a small number of roads in the overall study area where there are potential significant impacts. These are defined as roads with a traffic noise level above a daytime noise level of 57 dBL_{den} and an increase in noise level greater than or equal to 5 dB.

The overall significance ratings are lower for the design year compared to the year of opening due to the following reasons:

- The magnitude of change ratings for the long-term period relate to greater changes in noise level compared to the year of opening due to the recognised habituation to traffic noise over time.
- Overall traffic volumes forecast along the Proposed Scheme and surrounding road network are reduced during the design year compared to the opening year due to modal shift to public transport due to the Proposed Scheme.

For the roads where potential initial significant impacts were identified, the long-term operational daytime noise impacts are summarised in Table 9.27. A full overview of the potential daytime operational phase impacts for the Proposed Scheme for the design year is presented in Figure 9.4 in Volume 3 of this EIAR, and the associated data is presented in Appendix 9.2 in Volume 4 of this EIAR.

Table 9.27: Summary of Potential Daytime Operational Phase Impacts – Design Year 2038

Road	Increase above DM Scenario at worst-case NSL, dBA	DMRB long term magnitude impact	Potential road traffic noise at worst-case NSL, dBL _{den}	Noise level rating	Overall significance rating	Potential impact
Lough Atalia Road	4.7	Moderate	77	High	Significant	Indirect, Negative, Significant, long term
Riverside	5.7	Major	65	Medium	Moderate – significant	Indirect, Negative, Moderate – significant, long term

In the design year of 2038, the highest daytime potential noise impacts are calculated along Lough Atalia Road. The change in the potential traffic noise level along Lough Atalia Road is moderate, at 4.7 dB. The overall impact will potentially be Negative, Significant, and Long-term.

Riverside will also potentially experience a significant impact in the design year of 2038. The increase in noise level is predicted to be 5.7 dB, with a medium noise level of 65 dBL_{den}. The overall impact will potentially be Indirect, Negative, Moderate – Significant and Long-term.

For all other roads across the study area, traffic noise impacts are not potentially significant, and are defined as from Positive, Imperceptible to Slight, and Long-term to Negative, Not Significant to Slight, and Long-term.

Comment on Future Electric Vehicle Fleet

For the roads assessed in Table 9.26 and Table 9.27, the majority of the fleet type is comprised of cars and light goods vehicles. Given the same power type (ICE) has been assumed for both the Do Minimum and Do Something scenarios, the relative change in traffic noise remains the same for these roads, irrespective of the vehicle power.

The range of traffic noise levels calculated along these roads have the potential to be lower during the future year scenarios as a result of the conversion from ICE to EVs and HEVs, particularly along residential roads with speeds lower than 30 km/hr. In addition, an overall reduction in engine noise will occur at junctions and roundabouts. The calculated traffic noise level for these roads is therefore considered a robust, worst-case analysis.

Along the Proposed Scheme the fleet type is a mixture of buses, cars, LGVs with a portion of HGVs. The change in noise levels is determined to be Imperceptible to Significant along the Proposed Scheme for both year of opening and the design year due to reduced overall traffic volumes. Given the same fleet type (ICE) has been assumed for both the DM and DS scenarios, the relative change in traffic noise remains the same for these roads irrespective of the vehicle power type.

Notwithstanding, it is likely that a further reduction in overall noise level will occur along the Proposed Scheme due to the transition towards a full EV and HEV bus fleet, this reduction will occur irrespective of the Proposed Scheme. An overall reduction in engine noise from buses will occur at junctions, roundabouts and bus stops. The calculated traffic noise level assuming ICEs for all fleet is therefore considered a robust analysis and to be worst-case. The overall noise impact remains Positive, Imperceptible to Significant and Long term.

9.4.4 Operational Vibration

Once operational, buses will use the dedicated bus lanes for the Proposed Scheme. Analysis of traffic data for the Proposed Scheme, however, indicates a reduction in overall AADT traffic flows along the Proposed Scheme.

Reference to the source vibration levels confirm that vibration levels associated with passing buses and other vehicular traffic at distances of 2.5 to 10 m from the road edge are negligible in terms of human perception and building response. Vibration levels associated with a passing bus were recorded at 0.1mm/s PPV or less under the monitored scenarios. These values are below the normal range of perceptible human response to vibration and would not pose any significant impact.

A review of the traffic data for the Proposed Scheme indicates that the maximum number of buses travelling in-bound or outbound is 650 over the 16hr daytime period. Using this number and the highest VDV event measured on a similar project during a bus pass-by at a reference distance of 5 m from the road edge ($0.0033 \text{ m/s}^{1.75}$), the daytime $\text{VDV}_{\text{b,day}}$ value is calculated as $0.016 \text{ m/s}^{1.75}$. Reference to Table 9.14 confirms this value is below those associated with a low

probability of adverse comment. The overall impact is Positive, Imperceptible and Long term.

9.4.5 Bus Stops

Noise sources associated with bus stops relate to idling engines, acceleration and deceleration from the stop and air brakes.

At close distances to a stop, these activities are perceptible over normal passing road traffic, however the level of perceptibility is masked to a greater extent along heavily trafficked routes with higher road traffic noise levels.

The majority of bus stops will be retained in their current position as part of the Proposed Scheme with no change in noise environment as a result. Whilst a small number of bus stops will be removed, a number of new bus stops will be installed as part of the Proposed Scheme. All new bus stops along the Proposed Scheme are along the Malahide Road and the prevailing noise environment is dominated by road traffic from cars, buses, light and heavy goods vehicles.

A review of the proposed relocated bus stop locations indicates that there will be no significant noise impact on NSLs.

9.4.6 Road Maintenance

The Proposed Scheme is expected to have an operational life span of 60 years. Once operational, the Proposed Scheme will be subject to the same maintenance programme as the existing road infrastructure. This will involve upgrade and / or replacement of road surfaces over the life span of the project). These activities will occur along sections of the Proposed Scheme as required. Noise impacts associated with these activities will be of similar magnitude to those described in Section 9.4.2.

9.4.6.1 Summary of Potential Impacts

The Operational Phase noise impacts associated with the Proposed Scheme are summarised in Table 9.28.

Table 9.28: Summary of Potential Operational Phase Impacts on NSLs

Assessment Topic	Potential Impact
Opening year (2023) traffic noise – Proposed Scheme	Direct, Positive, Imperceptible to Slight, Short to Medium-term except for Woodquay Street, which has an indirect, Negative, Moderate, Short to Medium-term potential impact
Opening year (2023) traffic noise – Surrounding road network	Indirect, Positive, Imperceptible to Slight, Short to Medium-term to indirect, Negative, Significant, Short to Medium-term
Design year (2038) traffic noise – Proposed Scheme	Direct, Positive, Imperceptible to Slight, Long-term

Assessment Topic	Potential Impact
Design year (2038) traffic noise – Surrounding road network	Indirect, Imperceptible to Slight, Long-term, to indirect, Negative, Moderate, Long-term
Operational Phase Vibration	Neutral, Imperceptible, Long-term
Bus stops – existing locations	Neutral, Imperceptible, Long-term
Bus stops – new locations	Negative, Slight to Moderate, Short-term to Negative, Not Significant to Slight, Short-term.

9.5 Mitigation and Monitoring Measures

9.5.1 Construction Phase

9.5.1.1 Noise

The appointed contractor will be required to take specific noise abatement measures to the extent required to comply with the recommendations of BS 5228–1 (BSI 2014a) and European Communities Noise Emissions by Equipment for Use Outdoors (Amendment) Regulations 2006 (S.I. No 241/2006). The mitigation measures outlined below for the Construction Phase have also been included in the Construction and Environmental Management Plan (Appendix 5.1 in Volume 4 of this EIAR).

These measures will ensure that:

- During the Construction Phase, the appointed contractor will be required to manage the works to comply with the limits detailed in Section 9.2.4.1 using methods outlined in BS 5228–1 (BSI 2014a); and
- The best practicable means of working, including proper maintenance of plant and equipment, will be employed to minimise the noise produced by on site operations.

BS 5228–1 (BSI 2014a) includes guidance on several aspects of construction site practices, which include, but are not limited to:

- Selection of quiet plant;
- Control of noise sources;
- Screening;
- Hours of work;
- Liaison with the public; and
- Monitoring.

The contractor will put in place the most appropriate noise control measures depending on the level of noise reduction required at individual working areas i.e.,

based on the construction threshold values for noise and vibration set out in Table 9.5 and Table 9.8.

Reference to Table 9.25 indicates that intrusive works occurring within 70 m of NSLs will need specific noise control measures to reduce impacts depending on the time period over which they will occur, i.e., daytime or evening.

Selection of Quiet Plant

The potential for any item of plant to generate noise will be assessed prior to the item being brought onto the site. The least noisy item of plant will be selected wherever practicable. Should a particular item of plant already on the site be found to generate unexpectedly high noise levels, the first action will be to identify whether or not the item can be replaced with a quieter alternative.

For static plant such as compressors and generators used at work areas such as Construction Compounds etc., the units will be supplied with manufacturers' proprietary acoustic enclosures where practicable.

The contractor will evaluate the choice of excavation, breaking or other working method taking into account various ground conditions and site constraints. Where possible, where alternative lower noise generating equipment are available that will provide structural / excavation / breaking results, these will be selected to minimise potential disturbance.

The decision regarding the type of excavation technique etc. to be used on a site will normally be governed by other engineering or environmental constraints. In these instances, it may not be possible for technical reasons to replace a noisy process by a quieter alternative. Even if it is possible, the adoption of a quieter method may prolong the overall process; the net result being that the overall disturbance to the community will not necessarily be reduced.

Noise Control at Source

The following measures will be implemented by the appointed contractor to control noise at source in order to remain below the threshold values for noise set out in Table 9.5, which relate to specific site considerations:

- For mobile plant items such as dump trucks, planers, excavators and loaders, the installation of an acoustic exhaust, utilising an acoustic canopy to replace the normal engine cover and/or maintaining enclosure panels closed during operation can reduce noise levels by up to 10 dB;
- For percussive tools such as pneumatic concrete breakers and tools a number of noise control measures include fitting muffler or sound reducing equipment to the breaker 'tool' and ensuring any leaks in the air lines are sealed;
- The Construction Compounds are necessarily located in close proximity to NSLs (refer to Table 9.24) and will therefore incorporate a strict noise control policy relating to materials handling. Noisy items of plant will be sited away from noise sensitive boundaries;
- Where compressors, generators and pumps are located in proximity to NSLs and have potential to exceed the construction noise thresholds, these will be

surrounded by acoustic lagging or enclosed within acoustic enclosures providing air ventilation; and

- Resonance effects in panel work or cover plates can be reduced through stiffening or application of damping compounds; rattling and grinding noises can be controlled by fixing resilient materials in between the surfaces in contact.

Screening

Screening is an effective method of reducing construction noise levels at a receiver location and can be used successfully as an additional measure to other forms of noise control. The effectiveness of a noise screen will depend on the height and length of the screen, its mass, and its position relative to both the source and receiver. BS 5228-1 (BSI 2014a) states that on level sites the screen should be placed as close as possible to either the source or the receiver. The construction of the barrier will be such that there are no gaps or openings at joints in the screen material.

Erection of localised demountable enclosures or screens will be used around breakers or drill bits, as required, when operating in proximity to NSLs with the potential to exceed the construction noise thresholds. Annex B of BS 5228-1 (BSI 2014a) (Figures B1, B2 and B3) provides typical details for temporary and mobile acoustic screens, sheds and enclosures that can be constructed on site from standard materials. A well placed and designed mobile temporary screen around a breaker or excavation can effectively reduce noise emissions by 10 dBA.

The appointed contractor will provide a site hoarding of 2.4 m height along noise sensitive boundaries, at a minimum, at the Construction Compounds. The length of the screen should in practice be at least five times the height, however, if shorter sections are necessary then the ends of the screen will be wrapped around the source.

In most practical situations the effectiveness of the screen is limited by the sound transmission over the top of the barrier rather than the transmission through the barrier itself. In practice, screens constructed of materials with a mass per unit of surface area greater than 10 kg/m² will give adequate sound insulation performance. The use of a standard 2.4 m high construction site hoarding, installed at a suitable position between the source and receiver, will provide a sufficient level of noise screening in most cases.

In addition, careful planning of the construction site layout will also be considered. Within the Construction Compounds, the placement of site buildings such as offices and stores between the site and sensitive locations can provide a good level of noise screening.

Hours of Work

It is generally envisaged that construction working hours will be between 07:00hrs and 19:00hrs on weekdays. Night-time, Saturday and Sunday working will be required during certain periods to minimise the impact on road traffic movements during the daytime, for example at busy road junctions and in commercial areas, and for such works as pavement / road surfacing.

Construction activities / plant items will be considered with respect to their potential to exceed construction noise thresholds at NSLs and will be scheduled according to their noise level, proximity to sensitive locations and possible options for noise control wherever practicable.

In situations where an activity with potential for exceedance of construction noise thresholds is scheduled (e.g., road widening and utility diversions or activities with similar noise levels identified in Table 9.25) other construction activities will be scheduled to not result in significant cumulative noise levels.

Liaison with the Public

For the Proposed Scheme, the major sources of noise are essentially mobile, and the noise received at any NSL will therefore vary from day to day as the work proceeds. The duration of excavation, breaking etc is usually short in relation to the length of construction work as a whole and the amount of time spent working near to sensitive areas can represent only a part of the overall period. GCC will establish clear forms of communication that will involve the contractor and NSLs in proximity to the works so that residents or building occupants are aware of the likely duration of activities likely to generate noise or vibration that are potentially significant as set out in Table 9.5 and Table 9.8.

Monitoring

During the Construction Phase noise monitoring will be undertaken at representative NSLs to evaluate and inform the requirement and/ or implementation of noise management measures. Noise monitoring will be conducted in accordance with ISO 1996–1 (ISO 2016) and ISO 1996–2 (ISO 2017). The selection of monitoring locations will be based on the nearest representative NSLs to the working area which will progress along the length of the Proposed Scheme.

9.5.1.2 Vibration

On review of the likely vibration levels associated with construction activities, it is considered that the construction of the Proposed Scheme is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or cosmetic damage to buildings.

Vibration from construction activities will be limited to the values set out in Table 9.8 to avoid any form of potential cosmetic damage to buildings and structures. Monitoring will be undertaken at identified sensitive buildings, where proposed works have the potential to be at or exceed the vibration limit values in Table 9.8.

In the case of vibration levels giving rise to human discomfort, to minimise such impacts, the following measures shall be implemented during the construction period:

- A clear communication programme will be established by GCC to inform adjacent building occupants in advance of any potential intrusive works which may give rise to vibration levels likely to result in significant effects as per

Table 9.9. The nature and duration of the works will be clearly set out in all communication circulars as necessary;

- Activities capable of generating significant vibration effects with respect to human response (as per Table 9.9) will be restricted to daytime hours only, as far as practicable; and
- Appropriate vibration isolation shall be applied to plant (such as resilient mounts to pumps and generators), where required and where feasible.

In the case of potentially vulnerable buildings, precondition surveys shall be carried out before any works commence.

9.5.1.3 Summary of Predicted Impacts

A reduction of 10 dB has been applied to construction noise calculations to account for the level of noise reduction available by applying the various noise mitigation measured outlined above.

At the closest properties impacted by the works (typically within 20m), the prevailing daytime baseline noise level is assumed as 67 dB $L_{Aeq,12hr}$ and evening baseline noise level is 65 dB $L_{Aeq,4hr}$. As discussed in Section 9.2.3.1, baseline noise levels measured as part of the baseline study are potentially 1 to 2 dB lower than those under normal conditions without restricted movements due to COVID-19. To allow for a conservative assessment, however, no correction has been made to these values when discussing the CNLs against the baseline noise environment.

Following mitigation, the highest predicted construction noise levels are between 67 to 73 dB $L_{Aeq,T}$ at the closest properties impacted by the most intrusive works. The higher impacts will be at those properties where the prevailing baseline is below the specific predicted construction works noise levels. Table 9.29 presents the predicted Construction Phase impacts pre and post the implementation of mitigation and monitoring measures and assumes that the construction activities have the potential to operate for periods equal to or greater than 10 or more days in any 15 consecutive days or for a total number of days exceeding 40 in any 6 consecutive months at impacted NSLs.

The results are summarised based on the distance of a NSL to a working area. The closest identified NSL to the edge of the works, unscreened by intervening buildings are identified in the relevant impact tables in Section 9.4.3.

Table 9.29: Summary of Predicted Construction Phase Impacts Pre and Post Mitigation

Assessment Topic	Period over Which Criterion Applies	Predicted Impact (Pre-Mitigation and Monitoring)	Predicted Impact (Post Mitigation and Monitoring)
General Road Works, and Urban Realm Landscaping	Monday to Friday: Daytime (07:00 – 19:00hrs)	<ul style="list-style-type: none"> • Negative, Significant to Very Significant and Temporary at NSLs within 15 m of the works. • Negative, Moderate to Significant and 	<ul style="list-style-type: none"> • Negative, Moderate to Significant and Temporary at NSLs within 15 m of the works. • Negative, Slight to Moderate and

Assessment Topic	Period over Which Criterion Applies	Predicted Impact (Pre-Mitigation and Monitoring)	Predicted Impact (Post Mitigation and Monitoring)
		<p>Temporary at NSLs between 15 and 30 m of the works.</p> <ul style="list-style-type: none"> Negative, Slight – Moderate and Temporary at NSLs between 30 and 150 m of the works. Negative, Not Significant at NSLs further than 150 m from the works 	<p>Temporary at NSLs between 15 and 50 m from the works.</p> <ul style="list-style-type: none"> Negative, Not significant and Temporary at NSLs further than 50 m from the works
	Saturdays (08:00 – 16:30hrs)	<ul style="list-style-type: none"> Negative, Significant to Very Significant and Temporary at NSLs within 30 m of the works. Negative, Moderate to Significant and Temporary at NSLs between 30 and 50 m of the works. Negative, Slight – Moderate and Temporary at NSLs between 50 and 250 m of the works. 	<ul style="list-style-type: none"> Negative, Moderate to Significant and Temporary at NSLs within 15 m of the works. Negative, Slight – Moderate and Temporary at NSLs between 15 and 150 m of the works. Negative, Not Significant and Temporary at NSLs further than 150 m from the works.
Road Widening / and Utility Diversion Works	Monday to Friday: Daytime (07:00 – 19:00hrs)	<ul style="list-style-type: none"> Negative, Significant to Very Significant and Temporary at NSLs within 30 m of the works. Negative, Moderate to Significant and Temporary at NSLs between 30 and 50 m of the works. Negative, Slight – Moderate and Temporary at NSLs between 50 and 250 m of the works. 	<ul style="list-style-type: none"> Negative, Significant to Very Significant and Temporary at NSLs within 10 m of the works. Negative, Moderate to Significant and Temporary at NSLs between 10 and 15 m of the works. Negative, Slight – Moderate and Temporary at NSLs between 15 and 75 m of the works. Negative, Not Significant and Temporary at NSLs further than 75 m from the works.
	Saturdays (08:00 – 16:30hrs)	<ul style="list-style-type: none"> Negative, Significant to Very Significant and Temporary at NSLs within 50 m of the works. Negative, Moderate to Significant and 	<ul style="list-style-type: none"> Negative, Significant to Very Significant and Temporary at NSLs within 15 m of the works. Negative, Moderate to Significant and

Assessment Topic	Period over Which Criterion Applies	Predicted Impact (Pre-Mitigation and Monitoring)	Predicted Impact (Post Mitigation and Monitoring)
		<p>Temporary at NSLs between 50 and 100 m of the works.</p> <ul style="list-style-type: none"> Negative, Slight – Moderate and Temporary at NSLs between 100 and 250 m of the works 	<p>Temporary at NSLs between 15 and 30 m of the works.</p> <ul style="list-style-type: none"> Negative, Slight – Moderate and Temporary at NSLs between 30 and 250 m of the works. Negative, Not Significant, Temporary at NSLs further than 250 m from the works.
Construction Compound	Monday to Friday: Daytime (07:00 – 19:00hrs)	<ul style="list-style-type: none"> Negative, Slight – Moderate and Temporary at NSLs within 30 m of the works. Negative, Not Significant and Temporary at NSLs further than 30 m from the works 	<ul style="list-style-type: none"> Negative, Slight – Moderate and Temporary at NSLs within 10 m of the works. Negative, Not Significant and Temporary at NSLs further than 10 m from the works
	Saturdays (08:00 – 16:30hrs)	<ul style="list-style-type: none"> Negative, Moderate to Significant and Temporary at NSLs within 10 m of the works. Negative, Slight – Moderate and Temporary at NSLs between 10 and 200 m of the works. Negative, Not Significant and Temporary at NSLs further than 200 m from the works 	<ul style="list-style-type: none"> Negative, Slight – Moderate and Temporary at NSLs within 30 m of the works. Negative, Not Significant and Temporary at NSLs further than 30 m from the works.
Construction vibration from general road works & construction activities	All Construction work periods	<ul style="list-style-type: none"> Negative, Imperceptible to Not Significant and Temporary 	<ul style="list-style-type: none"> Negative, Imperceptible to Not Significant and Temporary
Construction vibration from ground breaking activities within 10m of occupied residential buildings	Ground breaking during road widening and utility diversion works	<ul style="list-style-type: none"> Negative, Slight to Moderate and Temporary 	<ul style="list-style-type: none"> Negative, Slight to Moderate and Temporary

9.5.2 Operational Phase

Change in Road Traffic Noise

The impact assessment has determined that traffic noise impacts across the study area for the Proposed Scheme result in Positive, Imperceptible, Short and Long-term direct impacts along the Proposed Scheme and the majority of roads associated in the study area. A small number of roads are potentially going to experience Negative, Imperceptible to Significant, Short- and Long-term indirect impacts along the surrounding road network.

The range of noise level changes and overall noise levels calculated do not require any specific noise mitigation measures to be incorporated into the Proposed Scheme.

Bus Stops

The impact assessment has determined that noise impacts associated with relocated bus stops will have no significant impact on NSLs. No further noise mitigation measures are proposed.

Road Maintenance

Impacts associated with this activity will be controlled in line with best practice measures in line with regular road maintenance works across Galway City and County.

Impact Overview

The predicted Operational Phase impacts associated within the Proposed Scheme are summarised in Table 9.30.

Table 9.30: Summary of Predicted Operational Phase Impacts Following the Implementation of Mitigation and Monitoring Measures

Assessment Topic	Potential Impact (Pre-Mitigation and Monitoring)	Mitigation	Predicted Impact (Post Mitigation and Monitoring)
Opening year (2023) traffic noise – Proposed Scheme	Direct, Positive, Imperceptible to Slight, Short to Medium-term except for Woodquay Street, which has an indirect, Negative, Moderate, Short to Medium-term potential impact	No mitigation measures required due to range of impacts identified	Direct, Positive, Imperceptible to Slight, Short to Medium-term except for Woodquay Street, which has an indirect, Negative, Moderate, Short to Medium-term predicted impact
Opening year (2023) traffic noise – Surrounding road network	Indirect, Positive, Imperceptible to Slight, Short to Medium-term to indirect, Negative, Significant, Short to Medium-term	No mitigation measures required due to range of impacts identified	Indirect, Positive, Imperceptible to Slight, Short to Medium-term to Indirect, Negative, Significant, Short to Medium-term

Assessment Topic	Potential Impact (Pre-Mitigation and Monitoring)	Mitigation	Predicted Impact (Post Mitigation and Monitoring)
Design year (2038) traffic noise – Proposed Scheme	Direct, Positive, Imperceptible to Slight, Long-term	No mitigation measures required due to range of impacts identified	Direct, Positive, Imperceptible to Slight, Long-term
Design year (2038) traffic noise – Surrounding road network	Indirect, Negative, Imperceptible to Slight, Long-term, to indirect, Negative, Moderate, Long-term	No mitigation measures required due to range of impacts identified	Indirect, Negative, Imperceptible to Slight, Long-term, to indirect, Negative, Moderate and Long-term
Operational Phase Vibration	Neutral, Long-term	No mitigation measures required due to range of impacts identified	Neutral, Long-term
Bus stops – existing or relocated stops	Neutral, Long-term	No mitigation measures required due to range of impacts identified	Neutral, Long-term

9.6 Residual Impacts

9.6.1 Construction Phase

Given the linear nature of the works, noise emissions related to construction works will be of temporary impact at any one area as the works progress along the length of the Proposed Scheme. The application of the proposed noise thresholds and restricted hours of operation, along with implementation of appropriate noise control measures, will ensure that noise impact is controlled within acceptable limit values.

During the Construction Phase of the Proposed Scheme, noise levels at properties closest to working areas will be temporarily increased. Construction activities will, for the majority of activities, operate within 5 dB of the adopted noise thresholds at the nearest properties to the works once mitigation measures are incorporated. Given the linear nature of the works, the impact of construction works will be temporary in any one area as the works progress along the length of the Proposed Scheme. The most appropriate noise mitigation measures for each work area will be determined taking account of the various control measures included within Section 9.5, and the CEMP. The various mitigation measures will be selected in order to control CNLs to within the limit values included in Section 9.2.4.1 as far as practicable.

Once the various mitigation measures are put in place, noise impacts associated with the Construction Phase will be Negative, Not Significant to Significant, and Temporary during all key construction phases within 10 to 15m from the works during daytime construction periods.

As per DMRB Noise and Vibration (UKHA 2020) in cases of moderate to major magnitude of impacts, the duration of works determines the overall significance rating. As part of the mitigation measures, the durations advised in the DMRB Noise and Vibration (UKHA 2020) shall be followed, where feasible, to reduce overall significance effects (i.e., scheduling works to occur for periods of less than ten days over 15 consecutive periods and less than 40 days over six consecutive months where significant effects are identified). Once the CNL and duration of works is considered in line with the DMRB Noise and Vibration (UKHA 2020) all key Construction Phase residual noise levels are not significant.

The assessment has indicated that the use of standard construction activities can operate comfortably within the recommended vibration limits for standard residential and other light-framed buildings. With the adoption of best practice methodologies, vibration impacts at the most sensitive premises can be adequately mitigated to within acceptable levels relating to disturbance, whilst meeting the scheme objectives set out in Chapter 1 (Introduction) of this EIAR.

9.6.2 Operational Phase

Once operational, there will be a Positive to Neutral direct impact along the Proposed Scheme due to a reduction in traffic volumes during both the year of opening and the design year.

During the year of opening, there is expected to be an increase in traffic noise levels along a small number of roads adjacent to the Proposed Scheme as a result of traffic re-distribution during daytime periods. During this initial Short to Medium-term phase, residual indirect impacts are calculated as Negative, Slight to Moderate, with three roads predicted to have a Negative, Significant impact (Presentation Road, Cross Street Lower, and Lough Atalia Road). Along the remaining road network within the study area, a Positive, Imperceptible to Slight, Short to Medium-term impact to Negative, Slight to Moderate, Short to Medium-term impact is calculated. The overall prevailing Short to Medium-term impact associated with the Proposed Scheme is Positive to Negative, Moderate.

During the design year, increased traffic noise levels will occur along a small number of roads as a result of traffic re-distribution during daytime periods. During the Long-term phase, indirect impacts are calculated as Negative, Moderate to Significant, Long-term along Riverside, and Negative, Significant, Long-term along Presentation Road and Lough Atalia Road. Along the remaining road network within the study area, a Positive, Imperceptible to Slight, Long-term, indirect impact to Negative, Not Significant to Slight, Long-term, indirect impact is calculated. The overall prevailing Long-term impact associated with the Proposed Scheme is Positive to Negative and Slight.

The Proposed Scheme aligns with the policy objectives of the Galway City Council to reduce traffic noise exposure to populations across the city through the incorporation of improved public transport. The results of the noise assessment for the Operational Phase confirms that with the introduction of the various measures included as part of the Proposed Scheme, a reduction in traffic noise can be achieved along the majority of roads associated with the Proposed Scheme. The various design measures associated with the Proposed Scheme also align with the

various intervention measures recommended within the WHO Environmental Noise Guidelines (WHO 2018) to reduce traffic noise exposure across populations.

9.7 References

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- British Standard Institute (BSI) (2008) Guide to evaluation of human exposure to vibration in buildings, Part 1 Vibration sources other than blasting (BS 6472–1)
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- ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors - Part 2: General method of calculation
- ISO 1996-1:2016 Acoustics - Description, measurement, and assessment of environmental noise. Part 1: Basic quantities and assessment procedures
- ISO 1996-2:2017 - Description, measurement and assessment of environmental noise - Part 2: Determination of sound pressure levels
- TII (previously National Roads Authority (NRA)) (2004) Guidelines for the Treatment of Noise and Vibration in National Road Schemes
- TII (previously National Roads Authority (NRA)) (2014) Good Practice Guide for the Treatment of Noise during the Planning of National Road Schemes
- UK Department of Transport (1998) Calculation of Road Traffic Noise (CRTN)
- UKHA (2020) Design Manual for Roads and Bridges (DMRB) LA 111 Sustainability & Environmental Appraisal LA 111 Noise and Vibration Revision 2
- World Health Organisation (2018) WHO Environmental Noise Guidelines for the European Region