Chapter 09
Noise & Vibration

Contents

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 Lucan to City Centre Core Bus Corridor 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 standards 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 on this key access corridor in the Dublin region, which will enable and deliver efficient, safe, and integrated sustainable transport movement along the corridor. The objectives of the Bus Connects Dublin – Core Bus Corridor Infrastructure Works (hereafter referred to as the CBC Infrastructure Works), applicable to the Proposed Scheme are described in Chapter 1 (Introduction). The Proposed Scheme, which is described in Chapter 4 (Proposed Scheme Description) 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, feedback 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 detailed baseline noise study has been undertaken in order to characterise the baseline environment at areas most likely to be affected by noise associated with the Proposed Scheme. This has been undertaken through a review of available published data and site-specific noise monitoring at noise sensitive locations (NSLs) along the Proposed Scheme;
- Baseline vibration monitoring has been undertaken at representative locations along the existing road network to characterise baseline vibration levels associated with traffic flows;
- 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 to the construction work areas associated with the Proposed Scheme;
- Predictive calculations have been performed to assess the potential noise impacts associated with traffic alterations 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 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, approximately 10 kilometres (km) from the N4 Junction 3 and the Frank Sherwin Bridge in the City Centre, and the area either side of the Proposed Scheme (and other diverted routes) up to a maximum distance of 300m during the Construction Phase and extending out to 1km from the Proposed Scheme boundary during the Operational Phase. 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.

For the Construction Phase, the assessment of the study area is focused on NSLs and VSLs adjacent to the works required to construct the Proposed Scheme, 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 300m from a specific area of construction work with the key impacted study areas focused within 50m to 100m 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 and VSLs which bound the Proposed Scheme and those along diverted traffic routes. Potential noise impacts relate to alterations to traffic patterns (e.g. introduction of a new bus lane), with particular attention focused on those areas where the Proposed Scheme will be encroaching closer to NSLs, specifically where bus or traffic lanes are moving closer to noise sensitive areas in addition to roads where traffic is displaced onto, resulting in potential increased traffic noise levels.

The key impacted study areas for the Operational Phase will be focused within 50m to 100m 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) within 1km of the Proposed Scheme have been included in the noise impact assessment study area for the Operational Phase assessment. The range of noise and vibration sensitive locations along the Proposed Scheme for the three geographic sections are discussed in Table 9.1.

Table 9.1: Description of NSLs Across the Study Area

Geographic Section	Description of Study Area
N4 Junction 3 to M50 Junction 7	Within the study area of the N4 Junction 3 to M50 Junction 7 the key noise sensitive receptors are residential properties within 50 to 100m of the N4 alignment. These are located along Hillcrest Drive, Ardeevin Drive, Beech Grove, Cherbury Park Avenue and Hermitage Avenue. Additional sensitive receptors within this section include Saint Loman's Hospital and the Hermitage Medical Centre and the Hermitage Medical Clinic.
M50 Junction 7 to Con Colbert Road	Within this study area the key noise sensitive receptors are predominately residential dwellings which bound the north and south of the R148 Palmerstown and Chapelizod Bypass and along the Old Lucan Road. Sensitive residential housing estates within 50 to 100m of the road edge include The Coppice, Hollyville Lawn, Palmerstown Avenue, Palmerstown Drive, Chapelizod Court, Knockmaree Apartments at Chapelizod Hill Road and Liffey Street South. Other sensitive receptors include Stewarts Hospital, CDETB Ballyfermot Training Centre, Muscular Dystrophy Ireland and St Dominic's College Ballyfermot.
Con Colbert Road to City Centre	Within this study area the key noise sensitive receptors are predominately residential dwellings which bound the north and south of the R148 Con Colbert Road and St Johns Road West. There are a number of residential apartment buildings within 50 to 100m of the road adjacent to the junctions with the R111 (The Old Chocolate Factory Apartments) and the Military Road (Heuston South Quarter Development). Other sensitive receptors include St John of God School (special education school) and the grounds of St. Patrick's University Hospital.

9.2.2 Relevant Guidelines, Policy and Legislation

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. In addition to specific noise and vibration guidance documents, the following Environmental Protection Agency (EPA) guidelines were considered and consulted in the preparation of this Chapter:

- Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (hereafter referred to as the EPA Guidelines) (EPA 2022).

There are no statutory standards in Ireland relating to noise and vibration limit values for construction works or for environmental noise relating to the Operational Phase. In the absence of specific statutory Irish guidelines, the assessment has made reference to non-statutory national guidelines, where available, in addition to international standards and guidelines relating to noise and / or vibration impact for environmental sources. These are summarised below:

- 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 (hereafter referred to as BS 5228–1) (BSI 2014a);
- 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) (BSI 2014b);
- BS 7385: 1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration (hereafter referred to as BS 7385–2). (BSI 1993);
- BS 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings, Part 1 Vibration sources other than blasting (hereafter referred to as BS 6472–1) (BSI 2008);
- BS 8233:2014 Guidance on sound insulation and noise reduction for buildings (hereafter referred to as BS 8233–2) (BSI 2014c);
- United Kingdom (UK) Highways Agency (UKHA) Design Manual for Roads and Bridges (DMRB) Sustainability and Environmental Appraisal - LA 111 Noise and Vibration, Revision 2 (hereafter referred to as DMRB Noise and Vibration) (UKHA 2020);
- Dublin Local Authorities including Dublin City Council (DCC), Fingal County Council (FCC), South Dublin County Council (SDCC) and Dún Laoghaire Rathdown County Council (DLRCC) Dublin Agglomeration Third Environmental Noise Action Plan December 2018 – July 2023 (hereafter referred to as the Dublin Agglomeration NAP 2018 – 2023) (DCC; FCC; SDCC; DLRCC 2018);
- S.I. No. 549/2018 – European Communities (Environmental Noise) Regulations 2018 (hereafter referred to as the Noise Regulations);
- S.I. No. 241/2006 - European Communities Noise Emission by Equipment for Use Outdoors (Amendment) Regulations 2006;
- International Organization for Standardization (ISO) 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors - Part 2: General method of calculation (hereafter referred to as ISO 9613 – 2) (ISO 1996);
- ISO 1996-1:2016 Acoustics - Description, measurement and assessment of environmental noise. Part 1: Basic quantities and assessment procedures (hereafter referred to as ISO 1996 – 1) (ISO 2016);
- ISO 1996-2:2017 - Description, measurement and assessment of environmental noise - Part 2: Determination of sound pressure levels (hereafter referred to as ISO 1996 – 2) (ISO 2017);
- Transport Infrastructure Ireland (TII) (previously National Roads Authority (NRA)) Guidelines for the Treatment of Noise and Vibration in National Road Schemes (hereafter referred to as the TII Noise Guidelines 2004) (NRA 2004);
- 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);
- The UK Department of Transport Calculation of Road Traffic Noise (hereafter referred to as the CRTN) (UK Department of Transport 1998);
- World Health Organization (WHO) Environmental Noise Guidelines for the European Region (hereafter referred to as WHO Environmental Noise Guidelines)(WHO 2018);

- Institute of Acoustics (IOA) ProPG: Planning and Noise. Professional Practice Guidance on Planning and Noise. New Residential Development. 2017. (Hereafter referred to as ProPG) (IoA 2017); and
- European Commission (EC) Joint Research Centre Institute for Health and Consumer Protection. EUR 25379 EU. Publications office of the European Union, 2012. Common Noise Assessment Methods in Europe (CNOSSOS-EU) (hereafter referred to as CNOSSOS-EU) (EC 2012).

9.2.3 Data Collection and Collation

The baseline noise and vibration environment has been characterised through a desk study of publicly available published data sources and measured noise and vibration surveys.

9.2.3.1 Desk Study

The key sources of available baseline data comprise published noise mapping studies undertaken by Córas Iompair Éireann (CIE), TII and daa (formerly Dublin Airport Authority) which feed into the Dublin Agglomeration NAP 2018 – 2023 (DCC; FCC; SDCC; DLRCC 2018). The modelled noise maps are published on the EPA Geo Portal (EPA 2020) and include existing sources of major rail, road and aircraft noise within the Dublin Agglomeration area. This information provides a useful strategic high-level overview of noise levels in the study area. The parameters presented in terms of the noise mapping are the L_{den} and L_{night} noise parameters which are both long-term noise indicators based on annual traffic and transport modes.

L_{den} is the 24-hour noise rating level determined by the averaging of the L_{day} with the $L_{evening}$ (plus a 5 decibel (dB) penalty) and the L_{night} (plus a 10 dB penalty). L_{den} is calculated using the following formula, as defined within the Noise Regulations:

$$L_{\text{den}} = 10log\left(\frac{1}{24}\right)\left(12 * \left(10^{\frac{Lday}{10}}\right) + 4 * \left(10^{\frac{Levening+5}{10}}\right) + 8 * \left(10^{\frac{Lnight+10}{10}}\right)\right)$$

Where:

- **L_{day}** is the A-weighted long-term average sound level as defined in ISO 1996-2, determined over all day periods of a year. The 12 hour daytime period is between 07:00hrs and 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 four-hour evening period is between 19:00hrs and 23:00hrs; and
- **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 eight-hour night-time period is between 23:00hrs and 07:00hrs.

The existing mapping available is based on noise modelled data from 2016.

The relevant published noise maps are presented in Figure 9.1.1 to Figure 9.1.2, in Volume 3 of this EIAR for road traffic noise. The range of noise sources within the published contour mapping associated with road traffic, are discussed in the Section 9.3.1.

9.2.3.2 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 by construction works and / or those likely to be impacted during the Operational Phase of the Proposed Scheme. Baseline noise measurements were undertaken using both attended and unattended surveys to inform the assessment. Attended surveys were undertaken at a total of five locations along the length of the Proposed Scheme during July 2020. An unattended survey (one week in duration) was made at one location during August 2020 to supplement the attended survey locations and the desktop baseline noise study. 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) survey methodology for linear (road) projects as far as practicable, taking account of the availability of secure locations along the length of the Proposed Scheme for equipment installation.

Full details of the baseline surveys, including methodologies, survey dates, terminology and glossary, and results are included in Appendix A9.1 in Volume 4 of this EIAR.

A summary of the baseline noise monitoring positions is provided in Section 9.2.3.2.1 to Section 9.2.3.2.3. Figure 9.2 in Volume 3 of this EIAR illustrates the baseline noise monitoring locations. The monitoring survey results are discussed in Section 9.3.2.

9.2.3.2.1 N4 Junction 3 to M50 Junction 7

A total of one unattended monitoring location and one attended survey locations were surveyed within this study area. The location reference and a description of survey positions are included in Table 9.2.

Table 9.2: Noise Monitoring Locations – N4 Junction 3 to M50 Junction 7

Location	Description of Survey Location
Unattended Monitoring Locations	
CBC0006UNML001	On driveway in residential front garden to northwest of Mount Andrew Court, to south of N4. In line with closest residential facades to west in Hermitage Way estate, approximately 12m from N4 road edge.
Attended Monitoring Locations	
CBC0006ANML001	In a car park south of N4, to the east of Hermitage Gardens estate. In line with closest residential properties approximately 25m from N4 junction 3 slip road.

9.2.3.2.2 M50 Junction 7 to Con Colbert Road

A total of three attended locations were surveyed within this study area. The location reference and a description of survey positions are included in Table 9.3.

Table 9.3: Noise Monitoring Locations – M50 Junction 7 to Con Colbert Road

Location	Description of Survey Location
Attended Monitoring Locations	
CBC0006ANML002	Green area to southeast of R148 Palmerstown and Kennelsfort Road Upper, in line with closest facades in Palmerstown Avenue estate approximately 60m from R148 road edge.
CBC0006ANML003	On footpath to north of Chapelizod Hill Road, in line with closest residential facades approximately 30m from R148 Chapelizod Bypass road edge flyover.
CBC0006ANML004	On tarmac in Woodfield Place, in line with closest residential facades approximately 35m south of R148 Con Colbert Road and 8m from railway line, separated by a 1.8m wall.

9.2.3.2.3 Con Colbert Road to City Centre

One attended monitoring location was surveyed within this study area. The location reference and a description of the survey position is included in Table 9.4.

Table 9.4: Noise Monitoring Locations – Con Colbert Road to City Centre

Location	Description of Survey Location
Attended Monitoring Locations	
CBC0006ANML005	On footpath to southwest of R148 St Johns Road West / Military Road junction, opposite Heuston Station. In line with façade of commercial NSLs approximately 5m from R148 road edge.

9.2.3.3 Baseline Vibration Surveys

Attended baseline vibration surveys have been conducted during July and August 2020 as part of the overall CBC Infrastructure Works at a number of locations adjacent to existing bus lanes within Dublin City. The surveys were undertaken to obtain typical baseline vibration levels along roads with both mixed vehicular traffic lanes and

individual bus lanes. This information has been used to inform the operational vibration impact assessment for the Proposed Scheme and other Proposed Schemes under the CBC Infrastructure Works.

Surveys were also undertaken along an access road to the Harristown Bus Depot, Horizon Logistics Park, Swords, Co. Dublin, to obtain a measurement of vibration relating to specific bus drive bys in isolation at a controlled sampling location to characterise the specific vibration level associated with buses in the absence of other traffic.

Full details of the survey monitoring locations, methodologies, terminology and glossary, and results are included in Appendix A9.1 in Volume 4 of this EIAR. A summary of the baseline vibration monitoring positions is provided in Table 9.5.

Table 9.5: Vibration Monitoring Locations

Location	Description of Survey Location
Vibration Monitoring Locations	
AVML001	Harristown – Entrance Road to Bus Depot, midway along inbound road, 5m from road edge
AVML002	Harristown – Roundabout at Bus Depot entrance, buses entering depot, 5m from road edge
AVML003	Harristown – Roundabout at Bus Depot entrance, buses exiting depot, 5m from road edge
AVML004	Harristown – Entrance Road to Bus Depot, midway along outbound road, 5m from road edge
AVML005	Harristown – Entrance Road to Bus Depot, midway along inbound road, 7m from road edge
AVML006	Malahide Road / St. Johns Court – 5m from edge of Inbound Bus Lane
AVML007	Malahide Road / St. Johns Court – 10m from edge of Inbound Bus Lane
AVML008	Malahide Road / Donnycarney Church – 2.5m from edge of Inbound Bus Lane
AVML009	Malahide Road– 2.5m from edge of outbound Bus Lane

The monitoring survey results are discussed in Section 9.3.3.

9.2.4 Appraisal Method for the Assessment of Impacts

The significance of impacts has been assessed in accordance with the EPA Guidelines (EPA 20). 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) 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. A full glossary of terms used within the EIAR is included in Volume 2 of this EIAR and are further discussed in Appendix A9.1 in Volume 4 of this EIAR.

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; and
  - $L_{Aeq,12hr}$: 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;
- **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/s^2 and the time period over which the VDV is measured is in seconds. This yields VDVs 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

9.2.4.1.1 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.

9.2.4.1.1.1 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 infrastructural projects. These limits are set out in Table 9.6.

Table 9.6: TII Construction Noise Levels (CNLs) at the Facade 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.

9.2.4.1.1.2 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 9.7 sets out the values which, when exceeded, signify a potential significant effect at the facades of residential receptors.

Table 9.7: BS 5228-1 Example of Thresholds of Potential Significant Effect

Assessment Category and 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 and 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	Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values	Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.	Category 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 (CNLs) may be more appropriate.

9.2.4.1.1.3 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 9.8 sets out the Construction Noise Threshold (CNT) levels proposed for the construction stage of this development.

Table 9.8: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 and sensitive commercial buildings (e.g. offices) in urban areas near main roads in heavy industrial areas	75 dB

Period over Which Criterion Applies	Location	Construction Noise Threshold (CNT) (L_{Aeq}, period)
	Rural and suburban areas away from main roads	70 dB
Monday to Friday: Evening: (19:00 – 23:00hrs)	Residential Properties Urban and Suburban	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 9.9 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; and
- A total number of days exceeding 40 in any six consecutive months.

Table 9.9: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 and baseline noise level
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 CNLs at NSLs and comment on the likely impacts during the construction stages.

In order to determine the relevant construction noise significance ratings in line with Table 9.9:, a daytime baseline noise level of 70 dB $L_{Aeq,12\ hr}$ and an evening baseline noise level of 68 dB $L_{Aeq,4hr}$ has been used when describing construction noise significance ratings in Section 9.4.3 at the closest properties affected by the works. This is based on the measured baseline noise environment for the Proposed Scheme as set out in Section 9.3 and Appendix A9.1 in Volume 4 of this EIAR. Review of all schemes associated with the CBC Infrastructure Works confirms the average evening noise level is 2 dB lower than the daytime noise level at these distances from the Proposed Scheme.

9.2.4.1.2 Criteria for Rating Construction Traffic Noise Impacts.

In order to assist with the interpretation of construction traffic noise, Table 9.10 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 9.10: 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; and >40 days over six 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 9.4.4.1.1.5 dealing with operational traffic noise

9.2.4.1.3 Criteria for Rating Vibration Impacts

Vibration standards come in two varieties: 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.

9.2.4.1.3.1 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. Surface construction activities are transient because they occur for a limited period of time at a given location. 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 15mm/s at 4 Hertz (Hz) increasing to 20mm/s at 15Hz and 50mm/s at 40Hz and above. The standard also notes that below 12.5mm/s PPV the risk of damage tends to zero. Where the dynamic loading caused by continuous vibration is such as to 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) Table B.2 might 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 ground borne disturbance. The vibration limit range for protected and historical buildings are 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 to 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 has 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 defects identified repaired. The results of conditions surveys will determine whether a building or structure is classed as ‘vulnerable’.

Table 9.11 sets out the limits as they apply to vibration frequencies at 4Hz 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 4Hz, a maximum displacement of 0.6mm (zero to peak) should not be exceeded. Taking the above into consideration the vibration criteria for building response is set out in Table 9.11.

Table 9.11: Recommended Construction Vibration Thresholds for Buildings

Vibration Limits for Buildings (PPV) at the Closest Part of the 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	15 mm/s	7.5 mm/s
Protected and Historic Buildings *Note 1	6 mm/s – 15 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.

9.2.4.1.3.2 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 20148b) notes that vibration typically becomes perceptible at around 0.15mm/s to 0.3mm/s and may become disturbing or annoying at higher magnitudes.

Higher levels of vibration are typically tolerated for single events or events of short-term duration, particularly during construction projects and when the origin of vibration is known. For example, piling can typically be tolerated at vibration levels up to 2.5 mm/s during the daytime and the evening if those affected are aware of the time-frame and origin of the vibration.

Table 9.12 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 9.12: 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

9.2.4.1.3.3 Disturbance of Particularly Vibration Sensitive Equipment or Processes

There are no standard criteria for assessing the potential impact 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 facade 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 in order 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 as one for consideration.

9.2.4.2 Operational Phase Appraisal of Impacts

9.2.4.2.1 Changes in Traffic Noise

The Proposed Scheme will be located along the existing road network which will be reconfigured and widened at specific locations to facilitate the proposed layout. 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 the existing road network already carries traffic volumes, 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 become more habituated 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, (i.e. 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 & Transport) for full description of these modelled traffic scenarios) is the smallest that is considered perceptible. Table 9.13 summarises the potential impact associated with defined changes in traffic noise level during the short to medium periods of the schemes operation.

Table 9.13: 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 is 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 Opening Year (2028) Do Minimum and the Design Year (2043) Do Something). For this assessment year (Design Year (2043)), a 3 dB change is the smallest that is considered to pose any notable impact when considered over the life span of the project (i.e. over a long-term 15 year period between the Opening Year (2028) and the Design Year (2043)) in accordance with the DMRB Noise and Vibration (UKHA 2020) guidance document. Table 9.14 summarises the likely impact associated with defined changes in traffic noise level between the Do Minimum and Do Something scenarios during the long-term period.

Table 9.14: 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

9.2.4.2.1.1 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 Dublin Agglomeration NAP 2018 – 2023 (DCC; FCC; SDCC; DLRCC 2018). This document proposes the following thresholds for defining Desirable Low and Undesirable High sound levels across the Agglomeration of Dublin:

- Desirable Low: <55 dB(A) L_{day} / < 50 dB(A) L_{night}; and
- Undesirable High: >70 dB(A) L_{day} / >55 dB(A) L_{night}.

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

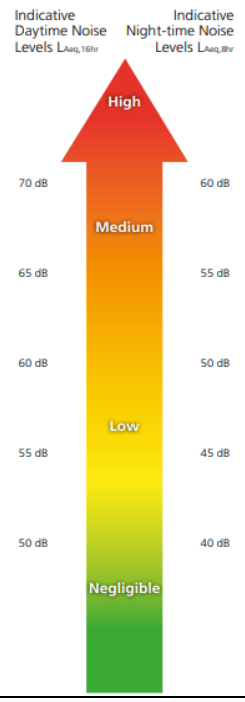
- <55 dB(A) L_{day}; and
- <45 dB(A) L_{night}.

To further define noise levels between 'Desirable Low' and 'Undesirable High' 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 dB $L_{Aeq,16hr}$ /< 40 dB $L_{Aeq,8hr}$) to High (< 70 dB $L_{Aeq,16hr}$ /< 60 dB $L_{Aeq,8hr}$) in steps of 5 dB(A) to enable a site specific risk assessment for an area to be undertaken depending on its noise exposure ranges.

It is noted, 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 as defined in Section 9.2.4. 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} in Section 9.2.4 and used in the Dublin Agglomeration NAP 2018 – 2023 (DCC; FCC; SDCC; DLRCC 2018).

Table 9.15 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 9.15: Noise Level Ranges and Exposure Categorisation (ProPG (IoA 2017) and Dublin Agglomeration NAP 2018 - 2023 (DCC; FCC; SDCC; DLRCC 2018))

	**Daytime: dB $L_{Aeq,16hr}$**	**Night-time: dB $L_{Aeq,8hr}$**	**Pro PG - Noise Risk Assess Pro PG - Noise Risk Assessment**	**Dublin Agglomeration Noise Action Plan**
	>70dB	>60	High	Undesirable high day
	65 – 70	55 - 60	Medium – High	Undesirable high night
	60 – 65	50 - 55	Medium	
	55 – 60	45 - 50	Low – Medium	Desirable Low night
	<55	<45	Negligible – Low	Desirable low daytime/ Quiet area threshold day and night
	<50	<40	Negligible	

Both documents define a daytime noise level below 55 dB(A) as being Low / Desirable Low, and both define daytime noise levels above 70 dB(A) as High / Undesirably High. For night-time periods, noise levels below 45 dB $L_{Aeq,8hr}$ are defined as being low with increasing magnitude of impact with higher noise levels. Night-time noise levels below 50 dB $L_{Aeq,8h}$ are defined as desirable low within the Dublin Agglomeration NAP 2018 – 2023 (DCC; FCC; SDCC; DLRCC 2018) with night-time noise levels greater than 55 dB $L_{Aeq,8h}$ as undesirable high.

As part of the noise impact assessment, therefore, 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 within.

WHO Environmental Noise Guidelines

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

The WHO Environmental Noise Guidelines, guideline values, are recommended to serve as the basis for a 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 state 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 organizations.'*

The WHO Environmental Noise 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 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 recommended traffic noise limits into context with respect to the existing noise levels within the Dublin Agglomeration. For the existing road network within the Dublin Agglomeration area, the most recent noise mapping prepared as part of the third round of the Dublin Agglomeration NAP 2018 – 2023 (DCC; FCC; SDCC; DLRCC 2018) notes that 72% of the population across the Dublin Agglomeration area are exposed to noise levels below 50 dB L_{night}. However, no further breakdown below this value is provided. The Dublin Agglomeration NAP 2018 – 2023 notes that 28% of the population are exposed to noise levels above 50 dB $L_{night.}$ In terms of the L_{den} parameter, the Dublin Agglomeration NAP 2018 – 2023 notes that 54% of the population are exposed to noise levels below 55 dB $L_{den.}$ However, no further breakdown below this value is provided. The document also notes that 46% of the population are exposed to noise levels above 55 dB $L_{den.}$ The range of existing road traffic noise at NSLs along the Proposed Scheme are all above WHO road traffic noise level recommendations in terms of both L_{den} and L_{night} (refer to Section 9.3) The existing road network, therefore, already contributes to road traffic noise above the recommended levels within the WHO Environmental Noise Guidelines for a large portion of the population.

An important part of the WHO Environmental Noise Guidelines relates to the recommended interventions or mitigation measure 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 Dublin Agglomeration NAP 2018 – 2023 notes that overall, population and dwelling noise exposures have improved compared to the second round of noise mapping (2013 – 2018), in that more people and dwellings have moved from higher noise level bands to lower bands. This has been partially attributed to intervention measures within each of the local authorities through improved public transport and cycling facilities, limiting heavy goods vehicles (HGVs) to designated routes, the introduction of speed limits and limits on hours for deliveries within built up areas.

The Dublin Agglomeration NAP 2018 – 2023 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 through increasing bus, train and bicycle journeys. At local authority level, key intervention strategies include, but are not limited to, the 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 Dublin Agglomeration NAP 2018 – 2023 which also align with the recommended interventions and overall policies of the WHO Environmental Noise Guidelines to reduce population exposure to road traffic noise.

The absolute noise levels within the WHO Environmental Noise Guidelines are therefore 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.

9.2.4.2.2 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 9.13 and Table

9.14) and the noise level ranges Table 9.16 at a noise sensitive location. 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.

Table 9.16: Significance Ratings for Operational Phase Traffic Noise Impacts

Noise Level Range (day/night)	Magnitude of Change in Noise Levels (Short Term and Long Term)				
	No Change / Reduction	Negligible	Minor	Moderate	Major
Negligible	Imperceptible / Positive	Not Significant	Not Significant	Not Significant	Not Significant - Slight
Negligible – Low	Imperceptible / Positive	Not Significant	Not Significant	Not Significant - Slight	Slight
Low – Medium	Imperceptible / Positive	Not Significant	Slight	Slight - Moderate	Moderate
Medium	Imperceptible / Positive	Not Significant	Slight	Moderate	Moderate - Significant
Medium - High	Imperceptible / Positive	Not Significant	Slight - Moderate	Moderate - Significant	Significant
High	Imperceptible / Positive	Not Significant - Slight	Slight - Moderate	Significant	Very Significant

9.2.4.2.3 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. An adverse comment is an unfavourable human reaction or response to vibration in accordance with BS 6472–1 (BSI 2008). Specific vibration monitoring data and Operational Phase analysis are included in Section 9.3.3 and Section 9.4.4.2 respectively.

Table 9.17: 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 through a desk study of publicly available published data sources and measured noise levels through field studies. The following sections summarise the data sources and 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 A9.1 in Volume 4 of this EIAR.

9.3.1 Desk Study of Published Noise Data

The key sources of publicly available baseline data comprise published noise mapping studies undertaken by TII, which feed into the Dublin Agglomeration NAP 2018 – 2023 (DCC; FCC; SDCC; DLRCC 2018). The available noise mapping includes existing sources of major road noise sources within the Dublin Agglomeration area. Figure 9.1.1 to Figure 9.1.2 in Volume 3 of this EIAR present the published road traffic noise contours in terms of the L_{night} and L_{den} parameters respectively for the Proposed Scheme. Whilst there is no set rule of thumb conversion, for road traffic noise, the L_{den} parameter is typically 1 to 3 dB higher than the L_{day} value. Table 9.18 presents a summary of the traffic noise levels relevant to the closest NSLs along the Proposed Scheme.

Table 9.18: Summary of Road Traffic Noise Levels from EPA Mapping

Reference	Geographical Section	Nearest NSL to Road Centre Line	Noise Contour Noise Levels at NSLs	
			dB L_{night}	dB L_{den}
Figure 9.1.1 to Figure 9.1.2	N4 Junction 3 to M50 Junction 7	Hermitage Way (15m)	60 – 64	65 – 69
		St Loman's Hospital (35m)	50 – 59	65 – 69
Figure 9.1.1 to Figure 9.1.2	M50 Junction 7 to Con Colbert Road	Residential properties along Herbert Road (25m)	55-59	60-64
		Residential properties along River Road (25m)	60-64	65-69
Figure 9.1.1 to Figure 9.1.2	Con Colbert Road to City Centre	Travelodge Dublin Phoenix Park (30m)	60-64	70-74
		Phoenix Park Apartments (30m)	60-64	65-69

The mapped road traffic noise levels for the geographical sections are discussed in the following sections.

9.3.1.1 N4 Junction 3 to M50 Junction 7

Road traffic along the N4 and from the M50 further east are the dominant noise sources in this section of the Proposed Scheme. Closest NSL's are located at Hermitage Gardens, Hermitage Way and those off Ballyowen Lane at distances of 15m to 25m from the existing road edge. At these properties, the traffic noise maps L_{den} contours (hereafter referred to as L_{den} contours) are between 60 dB and 69 dB L_{den}. The EPA road traffic night-time noise map contours (hereafter referred to as L_{night} contours) are between 55dB and 64dB depending on the proximity to the road edge and boundary treatments.

Other noise sensitive areas in this assessment zone include St Loman's Hospital (65 dB to 69 dB L_{den}), Hermitage Medical Clinic (55 dB to 64 dB L_{den}).

9.3.1.2 M50 Junction 7 to Con Colbert Road

Between the M50 Junction 7 and Con Colbert Road, road traffic along the R148 Road is the dominant noise source. Between the M50 Junction and the R112 Junction, NSL's are residential dwellings located off the R148 to the north and south at distances of 25m to 50m from the road edge. At these properties, the L_{den} contours are between 60 dB and 69 dB L_{den}. The L_{night} contours are between 60 dB and 69 dB depending on the proximity to the road edge and boundary treatments. At distances beyond 50m, traffic noise levels are typically mapped in the range of 55 dB to 59 dB L_{den}.

The EPA L_{night} contours (at these locations are between 55 dB and 59 dB depending on the proximity to the road edge and boundary treatments. Highest night-time noise levels are mapped at properties closest to the M50 Junction 7 and the R148 in the vicinity of The Coppice residential estate.

Along the R148 Chapelizod Bypass, closest residential dwellings are apartment buildings off Chapelizod Hill Road at distances of 10m from the existing road edge. The L_{den} contours mapped at these locations are between 60 dB and 64 dB L_{den}. The L_{night} contours are mapped as <50 dB.

Other noise sensitive areas in this assessment zone which are mapped include the CDETB Ballyfermot Training Centre (55 dB to 59 dB L_{den}), St Dominic's College Ballyfermot (55 dB to 59 dB L_{den}) and De La Salle National School (55 dB to 59 dB L_{den}).

9.3.1.3 Con Colbert Road to City Centre

Within this geographical zone road traffic along the R833 Con Colbert Road, the R148 Con Colbert Road and R148 St Johns Road West is the dominant noise source. The closest NSLs are predominately residential dwellings which bound the north and south of the R833 Con Colbert Road. There are a number of residential apartment buildings within 50m to 100m of the R148 Con Colbert Road west of the South Circular Road adjacent to the junctions with the R111 South Circular Road (The Old Chocolate Factory Apartments) and the Military Road (Heuston South Quarter Development). At these properties, L_{den} contours are between 55 dB and 69 dB L_{den}. The L_{night} contours are between 55 dB and 59 dB depending on the proximity to the road edge and boundary treatments.

Other noise sensitive areas in this assessment zone which are mapped with the L_{den} noise contours include the St John of God School and Gaelscoil Inse Chor (55 dB to 59 dB L_{den}).

9.3.2 Baseline Noise Surveys

The measured baseline noise survey results are summarised in the following sections. Full survey details and results are included in Appendix A9.1 in Volume 4 of this EIAR, while Figure 9.2 in Volume 3 of this EIAR illustrates the locations of noise monitoring surveys carried out for this assessment.

For unattended survey locations, results are presented in terms for the 16-hour daytime period (07:00hrs to 23:00hrs) in terms of the L_{Aeq} parameter, the eight hour night-time period (23:00hrs to 07:00hrs) in terms of the L_{Aeq} parameters (i.e. the L_{night} and the derived L_{den}).

For attended surveys, 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.

9.3.2.1 N4 Junction 3 to M50 Junction 7

The noise survey results recorded during the baseline surveys in this study area are summarised in Table 9.19

Table 9.19: Noise Monitoring Results – N4 Junction 3 to M50 Junction 7

Attended Location	Description	Average Daytime, $L_{Aeq,T}$		L_{den}
CBC0006ANML001	In a car park south of N4, to the east of Hermitage Gardens estate, approximately 25m from N4 junction 3 slip road.	67		68
Unattended Location	**Description**	**Average Daytime, $L_{Aeq,16hr}$**	**Average Night-time dB $L_{Aeq,8hr}$**	**L_{den}**
CBC0006UNML001	Northwest of Mount Andrew Court, to south of N4, approximately 12m from N4 road edge.	69	63	71

The noise survey results within this geographical section are dominated by road traffic noise from N4 Lucan Road.

During daytime periods, average ambient noise level was in the order of 69 dB $L_{Aeq,16hr}$ at the unattended survey position (UNML001). At the attended survey location (ANML001), daytime noise levels were in the order of 67 dB $L_{Aeq,T}$. The highest noise level was measured at the survey location approximately 12m to the N4 road edge (UNML001).

Night-time noise levels at the unattended survey location were dominated by road traffic noise from N4 Lucan Road. Average ambient night-time noise levels were in the order of 63 dB $L_{Aeq,8hr}$.

The measured L_{den} value from the long-term unattended survey location was in the order of 71 dB $L_{den.}$ At the attended survey location, the L_{den} value calculated in this area was in the order of 68 dB L_{den}. The calculated L_{den} noise levels align closely with those discussed in Section 9.3.1 at similar distances from the road edge.

9.3.2.2 M50 Junction 7 to Con Colbert Road

The noise survey results recorded during the baseline surveys in this study area are summarised in Table 9.20.

Table 9.20: Noise Monitoring Results – M50 Junction 7 to Con Colbert Road

Attended Location	Description	Average Daytime, $L_{Aeq,T}$	L_{den}
CBC0006ANML002	Green area to southeast of R148 Palmerstown and Kennelsfort Road Upper, approximately 60m from R148 road edge.	60	62
CBC0006ANML003	On footpath to north of Chapelizod Hill Road, approximately 30m from R148 Chapelizod Bypass.	64	68
CBC0006ANML004	On tarmac in Woodfield Place, approximately 35m south of R833 Con Colbert Road and 8m from railway line, separated by a 1.8m wall.	56	58

The noise survey results within this geographical section are dominated by road traffic noise from R148 Chapelizod Bypass and R148 Con Colbert Road, in addition to traffic along the surrounding road network, with a small contribution from local urban sources (e.g. pedestrian movements, train pass-by etc.).

The average daytime noise level ranged between 56 and 64 dB $L_{Aeq,T}$, with the highest noise levels measured at survey locations within 30m from the R148 Chapelizod Bypass (ANML003).

L_{den} values calculated in this geographical section ranged between 58 and 68 dB L_{den}. The calculated L_{den} noise levels align closely with those discussed in Section 9.3.1 at similar distances from the road edge.

9.3.2.3 Con Colbert Road to City Centre

The noise survey results recorded during the baseline surveys within this study area are summarised in Table 9.21.

Table 9.21: Noise Monitoring Results – Con Colbert Road to City Centre

Attended Location	Description	Average daytime, $L_{Aeq,T}$	L_{den}
CBC0006ANML005	On footpath to southwest of R148 St Johns Road West / Military Road junction, approximately 5m from R148 road edge.	72	73

The noise survey results within this geographical section are dominated by road traffic noise from R148 Con Colbert Road / St John's Road West, in addition to traffic along the surrounding road network, with a small contribution from local urban sources (e.g. pedestrian movements, faint construction noise etc.).

Average daytime noise level was in the order of 72 dB $L_{Aeq,T}$.

L_{den} values were calculated as 73 dB L_{den}. The calculated L_{den} noise levels align closely with those discussed in Section 9.3.1 at similar distances from the road edge.

9.3.2.4 Comment on Baseline Traffic Noise Levels during COVID-19 Restrictions

From 13 March 2020 the Irish Government stated that all schools, colleges and childcare facilities in Ireland would be closed due to the COVID-19 pandemic. People were also advised to work from home where possible. During April and May 2020 the restrictions were further extended with non-essential travel restricted nationwide. Restrictions were eased on 8 June in Phase 2 (i.e. non-essential retail reopened, employees were permitted to return to work in businesses if working from home was not an option). Baseline noise monitoring for the CBC

Infrastructure Works was undertaken between 18 June 2020 and 4 October 2020 when COVID-19 restrictions were minimised (i.e. schools reopened during September and October). Baseline noise monitoring for the Proposed Scheme was undertaken during June and September 2020.

As the baseline noise monitoring was carried out during Level 2 and Level 3 of the COVID-19 restrictions, a review has been carried out on logged L_{Aeq} raw data, provided by DCC, for noise monitors between June to October in 2019 and 2020 to identify any changes in noise levels across the two years. The DCC long term noise monitoring locations were positioned at:

- Ballyfermot Library – 10m from road edge on R833 Ballyfermot Road;
- Ballymun Library – 20m from road edge on R108 Ballymun Road;
- Navan Road residential location – 60m from road edge on R147 Navan Road; and
- Dolphin's Barn residential location – 115m from road edge on R110 Crumlin Road.

A review of the DCC noise monitoring data has indicated that the overall difference in average noise levels between June and October of 2019 and 2020 are between 1 dB to 2 dB lower.

To further review the impact of COVID-19 travel restrictions on the baseline measured noise levels, an analysis of published TII traffic counters along national roads in the Dublin region was undertaken to provide a comparison of traffic flows between June and October for the years 2019 and 2020 to inform the noise assessment. The traffic counts were taken from TII traffic counters at the two nearest locations to the Proposed Scheme (TMU N01 040.0 S, TMU R108 000.0 N), which were averaged to provide a factor for each baseline noise survey date specific to the Proposed Scheme. The Annual Average Daily Traffic (AADT) traffic flows for each baseline noise survey date was corrected by the relevant factor to calculate any change in traffic during the baseline noise monitoring on specific survey dates.

The analysis has determined that noise levels are likely to be 0.4 dB to 1.5 dB lower during the 2020 survey periods when compared to the same months during 2019 due to COVID-19 travel restrictions.

Based on the review of DCC noise monitoring data and analysis of TII traffic counter data, the overall difference in baseline measured noise levels is typically <1 dB to 2 dB lower when compared to normal conditions (i.e. June to October 2019), when COVID-19 travel restrictions were not in place.

The difference in noise levels is not significant in the overall context of describing the prevailing baseline noise environment. The measured noise levels align with those mapped by the EPA and discussed in Section 9.3.1.

The baseline noise environment is used to provide an overall description of noise conditions along the Proposed Scheme. It is important to note that the baseline noise levels do not form the basis for noise calculations. Noise levels associated with Construction Phase works are calculated using construction plant information and relate to construction related activities specifically. The CNLs are compared against the relevant CNTs to assess the potential noise significance. Reference is made to the baseline noise environment, however, as part of the overall determination of construction noise impacts. For this assessment, a conservative approach has been adopted which uses the measured baseline noise levels which may be up to 1 dB to 2dB lower than normal conditions. In this instance, the magnitude of impact is robustly assessed.

Construction traffic noise impacts are assessed using future traffic flows for both the Do Minimum and Do Something scenarios for the Construction Year (2024) (i.e. they relate to future forecast flows not those in the current environment). The calculations do not therefore include measured baseline noise levels as is the standard approach for all traffic noise impact assessments. Similarly for the Operational Phase, calculated road traffic noise levels are based on future traffic flows for the Opening Year (2028) and Design Year (2043) assessment years for the Do Minimum and Do Something scenarios. The baseline noise levels are used to provide context of the normal range of traffic noise levels experienced across the study area, particularly where changes in traffic noise levels with potential significance effects are identified. As the variation in traffic noise levels between normal conditions and those during restricted movements as a result of COVID-19 are very small, the baseline noise environment as measured provides a sufficient and robust data range for the purpose of assessment.

In summary, whilst there is the potential for a small variation in baseline noise levels compared to normal conditions with no movement restrictions, this variation does not affect the impact assessment set out in the following sections.

9.3.3 Baseline Vibration Surveys

The measured vibration survey results are summarised in the following sections. Full survey details and results are included in Appendix A9.1 in Volume 4 of this EIAR.

The survey results are presented in terms of the PPV parameter in mm/s, and in terms of the VDV parameter in $m/s^{1.75}$.

9.3.3.1 Harristown Bus Depot

Vibration measurements were made along the access road to Harristown Bus Depot, Swords, Co. Dublin to capture specific vibration data relating to specific bus drive-bys / pass-bys in isolation at a controlled sampling location. This location was chosen due its location which is set back from adjacent trafficked roads and is predominately used by buses only. The survey data was obtained in order to inform the operational vibration assessments for the CBC Infrastructure Works and the Proposed Scheme under consideration here. Monitoring periods were approximately 15 minutes at each location. Measurements were undertaken at four monitoring positions described in Table 9.5. The survey results are summarised in Table 9.22.

Table 9.22: Vibration Monitoring Results at Harristown Bus Depot

Monitoring Location	Monitoring Scenario	Measured PPV, mm/s Associated with Bus Pass By	Measured, $VDV_{,b}$, $m/s^{1.75}$ Associated with Bus Pass By
AVML001	Entrance Road to Bus Depot, midway along inbound road, 5m from road edge. Moderate speed. 7 bus movements.	0.03 – 0.08	0.0008 – 0.0028
AVML002	Roundabout at Bus Depot entrance, buses entering depot, 5m from road edge. Buses decelerating at slow speed. 6 bus movements.	0.03 – 0.09	0.0012 – 0.0024
AVML003	Roundabout at Bus Depot entrance, buses exiting depot, 5m from road edge. Buses accelerating at slow speed. 7 bus movements.	0.03 – 0.09	0.0014 – 0.0032
AVML004	Entrance Road to Bus Depot, midway along outbound road, 5m from road edge. Moderate speed, accelerating. 9 bus movements.	0.1 – 0.15	0.0046 – 0.0072
	Entrance Road to Bus Depot, midway along inbound road, 7m from road edge. Moderate speed. 9 bus movements.	0.03 – 0.06	0.0012 – 0.0021

The results of the survey confirm vibration levels associated with a bus pass by result in negligible vibration levels at the edge of the road both in terms of human perception and building response. The low vibration levels measured correspond with the subjective observations made during the survey where vibration from passing buses was not perceptible.

9.3.3.2 Malahide Road

Vibration measurements were made at four locations along the Malahide Road to measure vibration associated with a mixed fleet of cars, large goods vehicles (LGVs), HGVs along the central carriageways and buses along a dedicated bus lane. Monitoring periods were 30 minutes at each location. Measurements were undertaken at four monitoring positions described in Table 9.5. The survey results are summarised in Table 9.23.

Table 9.23: Vibration Monitoring Results along Malahide Road

Monitoring Location	Monitoring Scenario	Measured PPV, mm/s	Measured, $VDV_{,b}$, $m/s^{1.75}$
AVML006	Malahide Road / St. Johns Court – 5m from edge of Inbound Bus Lane. Results for specific bus pass by events (4 No.).	0.04 – 0.1	0.0015 – 0.0033
	Malahide Road / St. Johns Court – 5m from edge of Inbound Bus Lane. Results for all traffic including 7 HGVs	0.03 – 0.17	0.0015 – 0.0056
AVML007	Malahide Road / St. Johns Court – 10m from edge of Inbound Bus Lane. Results for specific bus pass bys events (7 No.).	0.02 – 0.05	0.0005 – 0.0009
	Malahide Road / St. Johns Court – 10m from edge of Inbound Bus Lane. Results for all traffic including 1 HGV.	0.02 – 0.06	0.0003 – 0.0012
AVML008	Malahide Road / Donnycarney Church – 3m from edge of Inbound Bus Lane. Results for specific bus pass by events (7 No.).	0.02 – 0.06	0.0004 – 0.0017
	Malahide Road / Donnycarney Church – 3m from edge of Inbound Bus Lane. Results for all traffic including 4 HGVs.	0.02 – 0.23	0.0003 – 0.0057
AVML009	Malahide Road– 2.5m from edge of outbound Bus Lane. Results for specific bus pass by events (10 No.).	0.03 – 0.05	0.0008 – 0.0016
	Malahide Road– 2.5m from edge of outbound Bus Lane. Results for all traffic including 3 HGVs.	0.03 – 0.09	0.0008 – 0.0030

The results of the survey confirm vibration levels associated with a heavily trafficked urban / suburban road with a mix of fleet, inclusive of a dedicated bus lane, result in negligible vibration levels at the edge of the road, both in terms of human perception and building response. The low vibration levels measured correspond with the subjective observations made during the survey where vibration from passing vehicles was not perceptible.

9.4 Potential Impacts

This Section presents potential impacts that may occur due to the Proposed Scheme, in the absence of mitigation. This informs the need for mitigation or monitoring to be proposed (refer to Section 9.5). Predicted 'residual' impacts taking into account any proposed mitigation is presented in Section 9.6.

9.4.1 Characteristics of the Proposed Scheme

The Proposed Scheme will involve the development of bus lanes, footpaths, cycle lanes and the implementation of traffic management measures over a defined construction period. When considering a development of this nature, the potential noise and vibration impact on the surroundings are considered for each of two distinct phases:

- Construction Phase; and
- Operational Phase.

9.4.1.1 Construction Phase

During the short-term Construction Phase of the Proposed Scheme, construction works will involve predominately general road works including road and junction reconfiguration and resurfacing works, and where required, road widening works, utility diversions, quiet street treatment, urban realm improvements including landscaping, boundary wall construction, and construction traffic including movement of machinery and materials within and to and from Construction Compounds along the Proposed Scheme.

Other works specific to the Proposed Scheme include the construction of:

- The existing R136 Ballyowen Road foot / cycle bridges along the R136 Ballyowen Road will be replaced with a wider version, which will require a crane to lift the old bridge out before lifting in the new bridge superstructure, and for other construction activities;
- The new Liffey Velley pedestrian bridge to facilitate connection with the proposed Liffey Valley public transport interchange;

- Road and bridge will be widened at the existing bridge over Chapelizod Hill Road, to facilitate construction of bus lay-bys in each direction;
- Retaining walls, gantries and gantry lighting; and
- Construction of a short length of new pedestrian / cyclist link from Ballyowen Lane to Hermitage Road.

A variety of items of plant will be in use during these construction works all of which have the potential to generate high levels of noise and potential levels of perceptible vibration. These will include breakers, excavators (including vacuum excavators), piling equipment, dump trucks, road planers and generators in addition to general road surfacing, road marking and levelling equipment. In general, road construction works are transient in nature, as the works will progress along the length of the route of the Proposed Scheme.

Chapter 5 (Construction) provides an indicative programme and construction methodology for the Proposed Scheme.

The potential noise and vibration impacts associated with the Construction Phase are set out within Section 9.4.3.1.

9.4.1.2 Operational Phase

Once operational, potential noise impacts associated with the Proposed Scheme relate to changes in traffic noise levels along the affected road network. Traffic noise levels have the potential to be increased or decreased resulting from the following scenarios:

- Reduction in private vehicles along the Proposed Scheme resulting from the inclusion of bus lanes, bus priority signalling, reduced private vehicle lanes within Proposed Scheme and modal shift to public transport;
- Increase in bus traffic along the Proposed Scheme;
- Location of bus lanes closer to the road edge / sensitive buildings; and
- Redistribution of private traffic off the Proposed Scheme onto the surrounding local road network.

In addition to traffic noise, potential impacts are associated with noise from bus activities at new or relocated bus stops. Commentary is also included on road maintenance once the Proposed Scheme is operational.

There are no expected perceptible changes to ambient vibration levels as a result of the Proposed Scheme. Potential impacts are, however, discussed within Section 9.4.4.2.

9.4.2 'Do Minimum' Scenario

The Do Minimum Scenario is a defined scenario within the traffic modelling exercise in Chapter 6 (Traffic & Transport). 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 Opening Year (2028) and the Design Year (2043). Refer to Chapter 6 (Traffic & Transport) for a full description of the assumptions included within 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 9.4.4.1.

9.4.3 Construction Phase

9.4.3.1 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 appointed 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 and TII Noise Guidelines 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 CNLs and includes 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.

9.4.3.2 Construction Noise

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

- 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 faces 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. Section 9.4.3.2.1 to Section 9.4.3.2.5 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 are:

- General road works, where existing road surfacing is showing signs of deterioration and the existing cross section will be replaced;
- Road widening and where required pavement rehabilitation of varying depths depending upon the condition of the existing pavement;
- Utility diversions, to account for likely service diversions where road widening works have taken place;
- Structural works (as outlined in Section 9.4.1.1);
- Urban realm landscaping, where repaving is carried out and excavation for planting trees;
- Construction Compounds, which will be used for storage of materials, plant and equipment, site offices, worker welfare facilities and limited car parking; and
- Boundary treatment works, where the relocation or rebuilding of replacement boundaries is required.

Other works including those associated with Urban Realm works, installation of new signage, bus stops etc are captured by other activities with similar noise levels at adjacent NSLs. Items of plant and equipment that may be used during construction are identified in Chapter 5 (Construction) and 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 9.24. The vacuum excavator proposed is the only plant item listed which does not have a BS 5228 – 1 (BSI 2014a) sound pressure reference level. To identify typical noise levels from this plant item, reference is made to Table 9.1 in the Federal Highway

Administration (FHWA) in the United States' Construction Noise Handbook (FHWA 2006). This document references a sound level of 85 dB $L_{AS,Max}$ relating to a distance of 15m. It is not possible to convert $L_{AS,Max}$ directly to L_{Aeq} but a reasonable assumption has been made that the excavator L_{Aeq} would be no more than 85 dB at 10m distance (i.e. no more than 2 dB higher than the noise level presented for the 14 tonne wheeled excavator).

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 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 9.24: 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 $L_{Aeq,4hr}$)						
			10m	15m	20m	30m	50m	100m	150m
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
Vacuum Excavator (FHWA Table 9.1)	85	10	75	71	69	65	61	55	51
Mobile Telescopic 55t Crane (Table C4.45)	82	10	72	68	66	62	58	52	48
CFA Piling Rig (Table C3.22)	80	50	77	73	71	67	63	57	53

As the Construction Phase progresses along the length of the Proposed Scheme, a variety of plant items will be required for the varying phases noted above (e.g. road works, road widening, utility works etc.). When works are occurring immediately outside NSLs, they will be clearly audible and will generate high levels of construction noise. The specific noise level associated with individual items of plant at stated distances are included for reference in Table 9.24. The nature of the works associated with the Proposed Scheme are, however, transient in nature and each activity will occur for intermittent periods at any one time. For example, the use of breakers, excavators and planers, some of the highest noise generating plant items will operate outside a NSL for a limited period as it progresses along the length of a working area.

For indicative calculation purposes, an average plant noise level has been calculated for each phase of work making reference to the plant list and 'on-times' in Table 9.24. The average value is used to account of the mobile element of works assuming plant items associated with any activity are operating within a 50m linear work area at any one time. The average CNL for each phase of work has been used to assess CNLs at the closest NSLs. The following sections present a range of indicative construction noise calculations associated with the key construction activities associated with the Proposed Scheme.

9.4.3.2.1 General Road Works

This Section assesses the indicative noise levels generated from general road works, where existing road surfacing is showing signs of deterioration and the existing cross section will be replaced. This also includes for

works at junctions for the installation of new signage and traffic signal poles. As per Table 9.24, for construction plant typically associated with general road works, including lorries, dumpers, road planers, pavers and rollers etc., noise levels are typically in the range of 64 to 76 dB $L_{Aeq,T}$ at 10m taking account of their typical 'on-time' in a working area. Table 9.25 outlines the typical CNL per period associated with typical road works, assuming six items of plant with an average noise level of 71 dB $L_{Aeq,T}$ at 10m. The average 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.

Table 9.25: Indicative Road Works Construction Noise Calculations at Varying Distances

Average Plant Noise Level at 10m Distance, (dB)	Predicted CNL at Stated Distance from Edge of Works Based on % Plant On-Time and Six Plant Items Operating Simultaneously (dB $L_{Aeq,12hr}$ or $L_{Aeq,4hr}$)								
	10m	15m	20m	30m	50m	75m	100m	150m	250m
71	79	76	73	69	65	61	59	55	51

During normal road works, the daytime CNT value of 75 dB $L_{Aeq,12hr}$ Monday through Friday (07:00hrs to 19:00hrs) is likely to be exceeded at distances of up to 15m from the works boundary in the absence of any noise mitigation. The evening and weekend CNT value of 65 dB $L_{Aeq,T}$ would be exceeded at distances up to 50m in the absence of any mitigation. The identified areas where this work will take place and calculated CNLs are presented in Table 9.26. The identified NSLs are those which bound the road edge and are not screened by intervening buildings. The identified NSL in Table 9.26 is not an exhaustive list of properties at varying distances.

Table 9.26: Road Works Construction Noise Calculations at Nearest NSLs

Geographical Section	Construction Section Reference	Chainage Reference		Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)
		Start	End		
N4 Junction 3 to M50 Junction 7	Section 1a	B0+100	B0+200	Residential NSLs to west of Ballyowen Road Bridge (50m)	65
	Section 1c	Offline south of Proposed Scheme, 600m along Hermitage Park.		Residential NSLs to north and south of Hermitage Park (<10m)	79
	Section 1d	A0+200	A1+600	Residential NSLs to south of N4 Lucan Road (20m)	73
		D0+000	D0+300	Residential NSLs to south of N4 Lucan Road (80m)	61
	Section 1e	G0+000	H0+295	Residential NSLs to north of Old Lucan Road (10m)	79
	Section 1f	A2+050	A2+800	Residential NSLs to north N4 Lucan Road (50m)	65
		A2+800	A3+650	Residential NSLs to north R148 Palmerstown Bypass (20m)	73
M50 Junction 7 to Con Colbert Road	Section 2a	J0+000	J0+886	Residential NSLs to north and south of Old Lucan Road (<10m)	79
	Section 2b	A3+700	Kennelsfort Road Lower	Residential NSLs to east of Kennelsfort Road Lower (<10m)	79
		A3+700	A4+200	Residential NSLs to south R148 Palmerstown Bypass (20m)	73
		A4+320	A4+500	Residential NSLs to south R148 Palmerstown Bypass (60m)	63
Con Colbert Road to City Centre	Section 3a	A7+550	A8+250	Residential NSLs to south of R148 Con Colbert Road Bypass (30m)	69
		A8+250	A8+450	St. John of God School (special education school) (10 - 20m)	73 - 79
	Section 3c	A9+150	A9+700	Office NSLs to south of St. John's Road West (<10m)	79

As summarised in Table 9.26, in the three geographical sections of the Proposed Scheme, general road works including junction realignments are within <10m to 60m of the nearest NSLs. The predicted cumulative noise levels for these works at the closest NSL façades are between 63 to 79 dB $L_{Aeq,T}$ in the absence of any noise mitigation. Making reference to the CNLs in Table 9.26 the potential noise impacts at the closest NSLs range between Negative, Not Significant to Significant, and Temporary during the daytime period and negative, Not Significant to Very Significant, and Temporary during the evening and weekend periods in the absence of noise mitigation.

Reference to Table 9.24 indicates that highest noise levels will occur when road planers are operating at the closest distance to NSLs. During specific periods when these activities are operating outside NSLs, higher noise levels will occur compared to those discussed in Table 9.26. These activities will occur, however, for intermittent periods of time at any one location over the course of a working day.

9.4.3.2.2 Road Widening, Road Upgrade and Utility Diversion Construction Works

This section assesses the indicative noise levels generated from road widening and utility diversion activities, where the quality of the existing road pavement is poor or where the existing road is being widened, full depth road foundation and pavement reconstruction will be carried out. This section also included for activities associated with utility diversions where road widening works have taken place. As per Table 9.24Table 9.24, construction plant typically associated with road widening and utility diversion works include lorries, breakers, excavators (including vacuum excavators), dumpers, road planers, sweepers, pavers and rollers etc., which will operate as required depending on the specific activity taking place at any one time. As per Table 9.24, noise levels associated with these activities are typically in the range of 64 to 81 dB $L_{Aeq,T}$ at 10m taking account of their typical 'on-time' in a working area. Table 9.27 outlines the typical CNL associated with the proposed works for this element of the Construction Phase, assuming six items of plant with an average noise level of 75 dB $L_{Aeq,T}$ at 10m.

The calculated levels relate to activities operating over a full day, full evening or Saturday period.

Table 9.27: Indicative Road Widening, Road Upgrade and Utility Diversion Construction Work Noise Calculations at Varying Distances

Average Plant Noise Level at 10m Distance (dB)	Predicted CNL at Stated Distance from Edge of Works Based on % Plant On-Time and Six Plant Items Operating Simultaneously (dB $L_{Aeq,12hr}$ or $L_{Aeq,4hr}$)								
	10m	15m	20m	30m	50m	75m	100m	150m	250m
75	83	80	77	73	69	65	63	59	55

During road widening and utility diversion works, the daytime CNT value of 75 dB $L_{Aeq,12hr}$ Monday through Friday (07:00hrs to 19:00hrs) is likely to be exceeded at distances of up to 25m 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 75m in the absence of any mitigation. The identified areas where this work will take place and calculated CNLs are presented in Table 9.28.

Table 9.28: Road Widening, Road Upgrade and Utility Diversion Construction Noise Calculations at Nearest NSLs

Geographical Section	Construction Section Reference	Chainage Reference		Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)
		Start	End		
N4 Junction 3 to M50 Junction 7	Section 1b	C0+000	C0+288	Residential NSLs to west R136 Ballyowen Road (50m)	69
	Section 1d	N0+040	N0+200	Residential NSLs to south of N4 Lucan Road (20m)	77
		A0+490	A0+930	Residential NSLs to south of N4 Lucan Road (50m)	69
		A1+020	A1+320	Hermitage Medial Clinic to north of N4 Lucan Road (75m)	65

Geographical Section	Construction Section Reference	Chainage Reference		Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)
		Start	End		
	Section 1e	G0+000	H0+295	Residential NSLs to north of Old Lucan Road (10m)	83
	Section 1f	A2+100	A2+270	Residential NSLs to north of N4 Lucan Road (100m)	63
		A2+950	A3+150	Residential NSLs to north of R148 (30m)	73
M50 Junction 7 to Con Colbert Road	Section 2a	A3+700	Kennelsfort Road Lower	Residential NSLs to east of Kennelsfort Road Lower (<10m)	83
		A4+000	Old Lucan Road	Residential NSLs to south of Lucan Road (20m)	77
	Section 2c	A5+550	A5+700	Residential NSLs to east and west of R148 Chapelizod Bypass/ C Chapelizod Hill Road (10-30m)	73 - 83
				Offices to west of Chapelizod Hill Road (50m)	69
Con Colbert Road to City Centre	Section 3a	A7+800	A7+880	Residential NSLs to south of R148 Con Colbert Road Bypass (30m)	73
	Section 3b	A8+450	A8+700	Residential NSLs to east of R148 Con Colbert Road/ South Circular Road junction (20m)	77
	Section 3c	A9+200	A9+450	Office NSLs to south of St John's Road West (<10m)	83
	Section 3d	A9+520	A9+600	Office NSLs to south of St John's Road West (30m)	73

As summarised in Table 9.28, in three of the geographical sections of the Proposed Scheme, road widening, upgrade or utility works are within 10m to 100m of the nearest NSLs. The highest predicted cumulative CNL for these works at the closest NSL façades are between 63 to 83 dB $L_{Aeq,T}$ in the absence of any noise mitigation. Making reference to the CNLs in Table 9.28 the potential noise impacts at the closest NSLs range between Negative, Not Significant to Very Significant, and Temporary during the daytime evening and weekend periods in the absence of noise mitigation.

The calculations are based on six plant items with an average noise level of 75 dB $L_{Aeq,T}$ at 10m operating simultaneously, in the absence of any noise mitigation, along a given section of road. The average plant noise level has been calculated on the basis that plant will be operating at varying distances from a NSL at any one time. Reference to Table 9.24 indicates that the highest noise levels will occur when breaking, excavators and road planers are operating at the closest distance to NSLs. During specific periods when these activities are operating outside NSLs, higher noise levels will occur compared to those discussed in Table 9.28. These activities will occur, however, for intermittent periods of time at any one location over the course of a working day.

9.4.3.2.3 Construction Compounds

For Construction Compound areas used for storage, offices and material handling, generators etc, a total CNL of 78 dB $L_{Aeq,T}$ at 10m has been used for the purposes of indicative calculations. This would include, for example plant typically with noise levels in the range of 70 to 75 dB L_{Aeq} at 10m. Table 9.29 outlines the typical CNL associated with the proposed works for this element of the construction, assuming six items of plant with an average noise level of 70 dB L_{Aeq} at 10m.

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 9.29: Indicative Construction Compound Construction Noise Calculations at Varying Distances

Average Plant Noise Level at 10m Distance (dB)	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
70	78	75	72	68	64	60	58	54	50

The predicted values outlined in Table 9.29 indicate the daytime CNT value of 75 dB $L_{Aeq, 12hr}$ Monday through Friday (07:00hrs to 19:00hrs) is likely to be exceeded at distances of up to 15m from the works boundary in the absence of any noise mitigation. The evening and weekend CNT value of 65 dB $L_{Aeq,T}$ would be exceeded at distances within 50m in the absence of noise mitigation. Noise mitigation will therefore be required to reduce CNLs from this type of activity, particularly during any scheduled evening and weekend works.

It is also anticipated that a mobile crusher will be located within the construction site compounds LU1a and LU3. Noise levels associated with this plant are typically of the order of 82 to 84 dB $L_{Aeq,T}$ at 10m when in operation (Source ref Table C.1. 14-15, BS 5228 – 1 (BSI 2014a)). This plant item will be used intermittently within the compound on an as-need basis. The specific on-time of the unit will therefore vary depending on the volume and type of materials required to be processed along the scheme.

There are four sites identified as potential Construction Compound sites across the Proposed Scheme. The Construction Compounds are listed in Table 9.30 with approximate distance to NSLs and general comments on potential noise impacts included.

Table 9.30: Construction Compound Potential Noise Impacts

Geographical Section	Location	Chainage Reference		Closest NSLs (m)	Predicted Total CNL at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)	Potential Impacts
		Start	End			
N4 Junction 3 to M50 Junction 7	LU1a Northeast of N4 Junction 2	G0+000	G0+0100	Fonthill Lodge Lucan childcare facility (50m)	64 (day to day activity) 60 – 70 (crusher 10 – 100% 'on-time respectively)	Potential exceedance of evening & weekend criteria with crusher in operation without noise mitigation.
				Residential NSLs to north of Lucan Road (125m)	56 (day to day activity) 52 – 62 (crusher 10 – 100% 'on-time respectively)	No significant impacts.
N4 Junction 3 to M50 Junction 7	LU1b Between N4 and Old Lucan Road	G0+0400	H0+075	Residential NSLs to north of Lucan Road (15m)	75 (day to day activity) No crusher proposed in LU1b	Potential exceedance of evening and weekend criteria without noise mitigation.
M50 Junction 7 to Con Colbert Road	LU2 north of R148 Palmerstown Bypass	A3+775	A3+930	Residential NSLs to north of Palmerstown Bypass (25m)	70 (day to day activity) No crusher proposed in LU2.	Potential exceedance of evening & weekend criteria without noise mitigation.
Con Colbert Road to City Centre	LU3 Within Liffey Gaels Park, south of Chapelizod Bypass, at the Con Colbert Road Junction	A7+450	A7+550	Residential NSLs to south of R833 Con Colbert Road (75m)	60 (day to day activity) 56 – 66 (crusher 10 – 100% 'on-time respectively)	Potential exceedance of evening & weekend criteria with crusher in operation without noise mitigation.

The Construction Compounds for the Proposed Scheme are between 15m to 125m proximity to NSLs. The highest predicted cumulative noise levels are between 56 to 75 dB $L_{Aeq, T}$ in the absence of any noise mitigation associated with day to day material handing activities. Making reference to the CNLs in Table 9.30 the potential noise impacts at the closest NSLs range between Negative, Not Significant, and Temporary during the daytime period and Negative, Not Significant to Significant, and Temporary during the evening and weekend periods in the absence of noise mitigation.

LU2 Construction Compound is not suitable for crushing activities. Where crushing plant is operating within the LU1a and LU3 Construction site Compounds, noise levels have the potential to exceed the daytime, evening and weekend CNT at the closest boundaries when unscreened, depending on the duration the plant is operated over. The use of construction site hoarding along noise sensitive boundaries (assumed to be 2.4m high) and siting of crushing plant away from noise sensitive boundaries, where possible, will form the noise mitigation measures for these sites.

9.4.3.2.4 Boundary Treatments

This section assesses the indicative noise levels generated from boundary treatment works, where the relocation or rebuilding of replacement boundary walls is required. For boundary treatment works, where road widening works are undertaken in advance of this activity and involve the removal of boundaries with mechanical excavators, dumpers etc this has been assessed under Section 9.4.3.2.2..Rebuilding works will require plant items such as excavation of new foundations, cement mixing and block laying. Table 9.31 outlines the typical CNL associated with the proposed works for this element of the construction, assuming three items of plant with an average noise level of 75 dB L_{Aeq} at 10m.

Table 9.31: Indicative Boundary Wall Construction Noise Calculations at Varying Distances

Average Plant Noise Level at 10m Distance (dB)	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
75	80	77	74	70	66	62	60	56	49

During boundary wall construction work, the daytime CNT value of 75 dB $L_{Aeq,12hr}$ Monday through Friday (07:00hrs to 19:00hrs) is likely to be exceeded at distances within 20m from the works boundary, in the absence of any noise mitigation. The evening and weekend CNT value of 65 dB $L_{Aeq,T}$ would be exceeded at distances up to 50m, in the absence of any mitigation.

The identified areas where this work will take place and calculated CNLs are presented in Table 9.32. For properties where boundary wall works are less than 10m from the property facade, the calculated noise level outlined in Table 9.32 is considered a valid representation of likely noise levels given the number of plant likely to operate simultaneously within this small working area will be limited at any one time.

Table 9.32: Boundary Walls Construction Noise Calculations at Nearest NSLs

Geographical Section	Construction Section Reference	Chainage Reference		Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)
		Start	End		
N4 Junction 3 to M50 Junction 7	Section 1b	C0+170	C0+288	Residential NSLs to west R136 Ballyowen Road (125m)	58
	Section 1d	D0+180	D0+260	Residential NSLs to south of N4 Lucan Road (90m)	61
		A0+490	A0+930	Residential NSLs to south of N4 Lucan Road (50m)	66

Geographical Section	Construction Section Reference	Chainage Reference		Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)
		Start	End		
M50 Junction 7 to Con Colbert Road	Section 2a	A3+700	Kennelsfort Road Lower	Residential NSLs to east of Kennelsfort Road Lower (<10m)	80
	Section 2c	A5+550	A5+710	Residential NSLs to east of R148 Chapelizod Bypass (20m)	74
Con Colbert Road to City Centre	Section 3d	A9+600	A9+700	Office NSLs to south of St John's Road West (70m)	62

As summarised in Table 9.32, the provision of boundary wall treatment works is proposed in three geographical sections During boundary wall treatment works in these specific geographical sections, the nearest NSLs are between 20m to 125m of the proposed works. The highest predicted cumulative noise levels for these works at the closest NSL façades are between 58 to 74 dB L_{Aeq} in the absence of any noise mitigation. Making reference to the CNLs in Table 9.32 the potential noise impacts at the closest NSLs will range between Negative, Not Significant to Significant, and Temporary During the daytime period and Negative, Not Significant To Very Significant, and Temporary during the evening and weekend periods, in the absence of noise mitigation.

9.4.3.2.5 Piling

As per Table 9.24, for plant typically associated with bored piling works, including CFA piling rig, lorries and cranes etc. noise levels are typically in the range of 65 to 77 dB $L_{Aeq,T}$ at 10m taking account of their typical 'on-time' in a working area. Table 9.33 outlines the typical CNL associated with the proposed works for this element of the construction, assuming four items of plant with an average noise level of 74 dB $L_{Aeq,T}$ at 10m.

Table 9.33: Indicative Bored / Auger Construction Noise Calculations at Varying Distances

Average Plant Noise Level at 10m Distance (dB)	Predicted CNL at Stated Distance from Edge of Works Based on % Plant On-Time and Four Plant Items Operating Simultaneously (dB $L_{Aeq,12hr}$ or $L_{Aeq,T}$)								
	10m	15m	20m	30m	50m	75m	100m	150m	250m
74	80	77	74	70	66	62	60	56	52

During normal bored piling construction works, the daytime CNT value of 75 dB $L_{Aeq,12hr}$ Monday through Friday (07:00hrs to 19:00hrs) is likely to be exceeded at distances within 15m 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 50m, in the absence of any mitigation.

The identified areas where this work will take place and calculated CNLs are presented in Table 9.34.

Table 9.34: Piling Construction Noise Calculations at Nearest NSLs

Geographical Section	Construction Section Reference	Chainage Reference		Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)
		Start	End		
N4 Junction 3 to M50 Junction 7	Section 1b Piled capping beam	C0+172	C0+277	Residential NSLs to west R136 Ballyowen Road (125m)	58
	Section 1d Secant pile	A0+546	A0+850	Residential NSLs to south of N4 Lucan Road (50m)	66
M50 Junction 7 to Con Colbert Road	Section 2c Contiguous Piled Wall	A5+628	A5+677	Residential NSLs to east and west of R148 Chapelizod Bypass (10m)	80
				Offices / Training College to west of Chapelizod Hill Road (50m)	66

During the construction of two new pedestrian (and cycle Ballyowen Road) bridges over the N4 within the Junction 3 to M50 Junction 7 geographical section, the provision of the retaining walls are proposed and will require bored pile foundations. The nearest NSLs are between 50m to 125m from the proposed bored piling works. The indicative predicted cumulative noise levels for these works at the closest NSL façades are between 58 to 66 dB $L_{Aeq,T}$ in the absence of any noise mitigation. Making reference to the CNLs in Table 9.34 the potential noise impacts at the closest NSLs are Negative, Not Significant, and Temporary during the daytime, evening and weekend periods in the absence of noise mitigation.

In the M50 Junction 7 to R148 Con Colbert Road geographical section, the provision of the Chapelizod Hill Road bridge is proposed. These works will require bored pile foundations. The nearest NSLs are between 10m to 50m from the proposed bored piling works. The indicative predicted cumulative noise levels for these works at the closest NSL façades are between 66 to 80 dB $L_{Aeq,T}$ in the absence of any noise mitigation. Making reference to the CNLs in Table 9.34 the potential noise impacts at the closest NSLs range between Negative, Not Significant to Significant, and Temporary during the daytime period and Negative, Not Significant to Very Significant, And Temporary during the evening and weekend periods in the absence of noise mitigation.

Reference to Table 9.24 indicates that the calculated noise levels are dominated by the piling rig when in operation at this distance. Other works associated with the construction of the bridge structures will have similar average noise levels as those discussed in Table 9.34 related to piling and will result in a similar magnitude of impact.

9.4.3.2.6 Retaining Walls

As per Table 9.24, for plant typically associated with retaining wall works, including excavators and dumpers etc., noise levels are typically in the range of 74 to 79 dB $L_{Aeq,T}$ at 10m, taking account of their typical 'on-time' in a working area. Table 9.35 outlines the typical CNL associated with the proposed works for this element of construction, assuming three items of plant with an average noise level of 76 dB $L_{Aeq,T}$ at 10m.

Table 9.35: Indicative Retaining Walls Construction Noise Calculations at Varying Distances

Average Plant Noise Level at 10m Distance (dB)	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	
76	81	78	75	71	67	63	61	57	53

During retaining wall construction work, the daytime CNT value of 75 dB $L_{Aeq,12hr}$ Monday through Friday (07:00hrs to 19:00hrs) is likely to be exceeded at distances within 20m 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 40m, in the absence of any mitigation. The identified areas where this work will take place and calculated CNLs are presented in Table 9.36.

Table 9.36: Retaining Walls Construction Noise Calculations at Nearest NSLs

Structure Reference	Geographical Section	Construction Section Reference	Chainage Reference		Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)
			Start	End		
RW06 (Piling)	N4 Junction 3 to M50 Junction 7	Section 1b	C0+172	C0+277	Residential NSLs to west R136 Ballyowen Road (125m)	59
RW01 (secant Pile)		Section 1d	A0+546	A0+850	Residential NSLs to south of N4 Lucan Road (50m)	67
RW07			A1+061	A1+168	Residential NSLs to south of N4 Lucan Road (75m)	63
RW05			A1+168	A1+250	Residential NSLs to south of N4 Lucan Road (80m)	63
					Hermitage Medial Clinic to north of N4 Lucan Road (80m)	63

Structure Reference	Geographical Section	Construction Section Reference	Chainage Reference		Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)
			Start	End		
					St, Loman's Hospital (80m)	63
RW08			A1+250	A1+315	Hermitage Medial Clinic to north of N4 Lucan Road (70m)	63
					St, Loman's Hospital (90m)	62
RW02		Section 1f	A2+115	A2+252	Residential NSLs to north of N4 Lucan Road (80m)	63
RW03 and RW04 (Contiguous Piled Wall RW03)	M50 Junction 7 to Con Colbert Road	Section 2c	A5+583	A5+677	Residential NSLs to east and west of R148 Chapelizod Bypass (10m)	81
					Offices / Training College to west of Chapelizod Hill Road (50m)	67

As summarised in Table 9.36, the provision of retaining walls is proposed in two geographical sections along the Proposed Scheme. In the N4 Junction 3 to M50 Junction 7 geographical section, the nearest NSLs are between 50m to 125m of the proposed works. The indicative predicted cumulative noise levels for these works at the closest NSLs are between 59 to 67 dB L_{AeqT}, in the absence of any noise mitigation. Making reference to the CNLs in Table 9.36 the potential noise impacts at the closest NSLs range between Negative, Not Significant, and Temporary during the daytime and evening periods in the absence of noise mitigation.

During retaining wall works in the M50 Junction 7 to Con Colbert Road geographical section, the nearest NSLs are between 10m to 50m of the proposed works. The indicative predicted cumulative noise levels for these works at the closest NSL façades are between 67 to 81 dB $L_{Aeq,T}$ in the absence of any noise mitigation. Making reference to the CNLs in Table 9.36 the potential noise impacts at the closest NSLs range Between Negative, Not Significant to Very Significant, And Temporary during the daytime, evening and weekend periods in the absence of noise mitigation.

A further summary of predicted impacts at NSLs located at varying distances from these activities are provided in Table 9.44.

9.4.3.2.7 Additional Works

Construction of additional works relate to the provision of a pedestrian bridge over the N4 at Liffey Valley Shopping Centre, Ballydowd pedestrian and cycle bridge over the N4 at Junction 3, parallel to Ballyowen Road bridge, widening of Chapelizod Hill Road bridge, and the construction of a short length of new pedestrian / cyclist link from Ballyowen Lane to Hermitage Road along the Proposed Scheme. These activities will require the use of different plant depending on the type of works involved. The more intrusive works at NSLs adjacent to these activities are assessed under road widening, piling and retaining wall sections of this document. For remaining or additional activities at these locations, a total CNL of 72 dB $L_{Aeq,T}$ at 10m has been used for the purposes of indicative calculations. This would include, for example plant with noise levels in the range of 68 to 73 dB $L_{Aeq,T}$. Table 9.36 outlines the typical CNL associated with the proposed works for this element of the construction, assuming six items of plant with an average noise level of 72 dB $L_{Aeq,T}$ at 10m. Erection of the bridges will be likely carried out by a crane during night-time or weekend work periods.

Table 9.37: Indicative Additional Works Construction Noise Calculations at Varying Distances

Average Plant Noise Level at 10m Distance (dB)	Predicted CNL at Stated Distance from Edge of Works Based on % Plant On-Time and Six Plant Items Operating Simultaneously (dB $L_{Aeq,12hr}$ or $L_{Aeq,4hr}$)								
	10m	15m	20m	30m	50m	75m	100m	150m	250m
72	80	77	74	70	66	62	60	56	52

For the additional works described above, 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 within 20m from the works boundary in the absence of any noise mitigation. The evening and weekend CNT value of 65 dB $L_{Aeq,T}$ would be exceeded at distances up to 50m in the absence of any mitigation. The night-time CNT value of 50 dB $L_{Aeq,T}$ would be exceeded at distances up to 300m in the absence of any mitigation. The identified areas where this work will take place and calculated construction noise levels are presented in Table 9.38.

Table 9.38: Additional Works Construction Noise Calculations at Nearest NSLs

Geographical Section	Construction Section Reference	Chainage Reference		Nearest NSL to Edge of Works	Predicted Total CNL at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)
		Start	End		
N4 Junction 3 to M50 Junction 7	Section 1a	C0+000	C+200	Residential NSLs to the south east and west (45m)	63
	Section 1c	A0+600	A0+700	Residential NSLs on Hermitage Way (20m)	74
	Section 1f	A2+100	A2+270	Residential NSLs to north of N4 Lucan Road (30m)	70
M50 Junction 7 to Con Colbert Road	Section 2c	A5+500	A5+700	Residential NSLs to east of R148 Chapelizod Bypass (10m)	80

As summarised above the construction of a short length of new pedestrian / cyclist link from Ballyowen Lane to Hermitage Road the Liffey Valley is proposed in the N4 Junction 3 to M50 Junction 7 geographical section. During the construction the nearest NSLs are 20m from the proposed works and a noise level of 74 dB $L_{Aeq,T}$ is estimated. The potential noise impacts at the closest NSLs are Negative, Slight to Moderate, and Temporary during the daytime period and Negative, Significant to Very Significant, and Temporary during the evening and weekend periods in the absence of noise mitigation.

A pedestrian bridge is also proposed in the N4 Junction 3 to M50 Junction 7 geographical section. During the less intrusive works, which includes assembly of the pre-fabricated bridge superstructure and approach ramps/stairs within the temporary land take boundary and erection of the structure, the nearest NSLs are within 30m of the proposed works. The highest predicted cumulative noise level for these works is in the order of 70 dB $L_{Aeq,T}$ in the absence of any noise mitigation. Making reference to the CNLs in Table 9.38 the potential noise impacts at the closest NSLs range between Negative, Not Significant, And Temporary during the daytime period and Negative, Moderate To Significant, and Temporary during the evening and weekend periods in the absence of noise mitigation.

The widening of the Chapelizod Hill Road bridge is proposed in the M50 Junction 7 to Con Colbert Road geographical section. During the less intrusive works, the nearest NSLs are within 10m of the proposed works. The highest predicted cumulative noise level for these works is in the order of 80 dB $L_{Aeq,T}$ in the absence of any noise mitigation. Making reference to the CNLs in Table 9.38 the potential noise impacts at the closest NSLs range between Negative, Moderate to Significant, and Temporary during the daytime period and Negative, Significant to Very Significant, and Temporary during the evening and weekend periods in the absence of noise mitigation.

A further summary of predicted impacts at NSLs located at varying distances from these activities are provided in Table 9.44.

9.4.3.2.8 Emergency Work

Emergency work may include the replacement of warning lights, signs and other safety items on public roads, the repair of water supplies and other services which have been interrupted, repair to any damaged temporary works and all repairs associated with working on public roads. These activities may be required to work outside of normal working hours. Where required, they will be subject to the same construction noise criteria outlined in Table 9.9:.

9.4.3.3 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 used for road widening and utility diversions. Depending on the method and equipment used, there is the potential for some vibration relating to piling operations. In terms of piling, low vibration methods involving bored or augured piles are proposed for the Proposed Scheme. This piling method significantly minimises the levels of both noise and vibration generated as it is a non-percussive piling technique. For the purposes of this assessment, the expected vibration levels during piling have been determined through reference to published empirical data. BS 5228–2 (BSI 2014b) includes measured magnitude of vibration associated with rotary bored piling using a 600mm pile diameter for bored piling into soft ground over rock (Table D.6, Ref. No. 106). Table 9.39 reproduces those associated with rotary bored piling using a 600mm pile diameter during varying aspects of the operation.

Table 9.39: Vibration Magnitudes Associated with Rotary Bored Piling

Scenario	Distance (m)	PPV (mm/s)
Auguring	5	0.54
Twisting in casing	5	0.22
Spinning off	5	0.42
Boring with rock auger	5	0.43

The vibration magnitudes outlined in Table 9.39 indicate that at distances of 5m, vibration magnitudes are orders of magnitude below those associated with any form of cosmetic damage to structurally sound and protected and historic buildings or structures (Refer to Table 9.11). The vibration magnitudes are also imperceptible to not significant in terms of human response to vibration at these distances. Referring to the vibration magnitudes above and Table 9.12, the impact is determined to be Negative, Imperceptible to Not Significant and Temporary.

During surface breaking activities, there is the potential for vibration to be generated through the ground. Empirical data for this activity is not provided in BS 5228–2 (BSI 2014b). However, the likely levels of vibration from this activity will be significantly below the vibration criteria for building damage based on monitoring data and experience from other sites. AWN Consulting has previously conducted vibration measurements under controlled conditions, during trial construction works on a sample site where concrete slab breaking was carried out. The trial construction works consisted of the use of the following plant and equipment when measured at various distances:

- 3 tonne hydraulic breaker on small CAT tracked excavator; and
- 6 tonne hydraulic breaker on large Liebherr tracked excavator.

Vibration measurements were conducted during various staged activities and at various distances.

Peak vibration levels during staged activities using the 3 tonne breaker ranged from 0.48 to 0.25 PPV (mm/s) at distances of 10m to 50m respectively from the breaking activities. Using a 6 tonne breaker, measured vibration levels ranged between 1.49 to 0.24 PPV (mm/s) at distances of 10m to 50m respectively.

Whilst these measurements relate to a solid concrete slab, the range of values recorded provides some context in relation to typical ranges of vibration generated by construction breaking activity.

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.

Referring to the vibration magnitudes above and in Table 9.12, vibration impacts during ground breaking activities using heavy breakers have the potential to generate a negative, slight to moderate, temporary effects at distances of 10m from the activity. Beyond 50m from this type of activity, impacts are reduced to not significant to slight and temporary. For all other works, vibration impacts will be below those associated with perceptible vibration and will be imperceptible to not significant and temporary. All construction works are orders of magnitude below limits values associated with any form or cosmetic or structural damage for structurally sound or protected or historical

buildings or structures referred to in Table 9.11. Notwithstanding the above, any construction activities undertaken on the site will be required to operate below the recommended vibration criteria set out in Table 9.11.

No vibration sensitive processes have been identified along the Proposed Scheme.

9.4.3.4 Construction Traffic

In addition to direct impacts from the construction works including activity at Construction Compounds, there is also the potential for noise impacts from construction traffic along public roads. A detailed analysis of construction traffic volumes has been conducted to determine the potential noise impacts associated with this phase of the Proposed Scheme.

Traffic flows have been modelled over an extensive study area across the Dublin Region 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 within 1km of the Proposed Scheme boundary to assess the potential noise impacts on the surrounding road network.

The Proposed Scheme will be constructed over several separate work stages and work fronts which will progressively move along the route, with different sections under construction at any given time during the construction programme. The works in some sections may only last for a number of weeks with others having longer durations. For the purpose of traffic modelling, a worst-case scenario has been determined for assessment purposes (that is a representation of the worst-case situation for construction and road network impacts, at both local and strategic levels, respectively), in order to capture the reasonable worst-case environmental impacts. Traffic flows associated with the Construction Phase represent a 'worst-case day' over a two-year construction period, assuming multiple sections are under construction simultaneously during the Construction Year (2024). This includes required traffic management measures associated with the works (e.g. road closures, one way systems, diverted routes etc.) In addition, HGV movements associated with the construction works have been added to the proposed construction access routes.

For this Proposed Scheme, peak haulage activities are expected to take place during the period of Year 1, Q3. During this period, works will be ongoing at Sections 1d, Section 1e, Section 3c. This has been used to determine a conservative value of 120 HGV movements (60 vehicles) over a peak construction day. Further information relating to construction traffic, construction sections and the construction working sequences is set out in Chapter 6 (Traffic & Transport)

Given the assessed traffic flows represent a 'worst-case day' peak scenario over the overall two-year construction period for the Proposed Scheme, the duration over which the calculated impacts described in Table 9.41.

Table 9.41 will occur will be less than one year and are categorised as Temporary.

The approach adopted for construction noise traffic analysis involves calculation of noise emission levels associated with the Do Minimum and Do Something traffic scenarios and determining the related increase in noise level as a result of the additional traffic on the road network. Calculations have been undertaken for each of the roads modelled within a 1km zone of the Proposed Scheme boundary using a breakdown of the fleet types along each (i.e. buses, cars, LGVs and HGVs). The calculated noise levels are then summed to obtain a total daytime ($L_{Aeq,16hr}$) value along each road within the study area.

Noise levels associated with a passing event such as road traffic may be expressed in terms of its Sound Exposure Level (L_{AX}). The Sound Exposure Level can be used to calculate the contribution of an event or series of events to the overall noise level in a given period using the following formulae:

$$L_{Aeq,T} = L_{AX} + 10\log_{10}(N) - 10\log_{10}(T)\ dB$$

where:

- $L_{Aeq,T}$ is the equivalent continuous sound level over the time period T (in seconds);
- L_{AX} is the "A-weighted" Sound Exposure Level of the event considered (dB); and
- N is the number of events over the course of time period T.

The following Sound Exposure Level (L_{AX}) reference values have been used for the assessment. The specific data has been obtained from specific source measurements undertaken for the Proposed Scheme EIAR and from AWN's in-house data base of road vehicle sound exposure levels measured under controlled conditions for other applications. The L_{AX} values relate to vehicles traveling at a low to moderate speed in an urban environment. The reference noise values are also comparable with those within the CNOSSOS-EU (EU 2012) document for road traffic noise for light, medium and heavy vehicles at urban speeds.

Table 9.40: Reference Sound Exposure Levels for Noise Calculations

Vehicle Type	L_{AX} at 5m from Road Edge, dB
Car	72
LGV	75
Bus	78
HGV	85

For each modelled road within study area, the associated daytime $L_{Aeq,16hr}$ traffic noise level was calculated for the Do Minimum and the Do Something scenario (Construction Phase) for the Construction Year (2024). For all roads, calculations are made at a reference distance of 5m from the road edge.

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

- Traffic noise levels have been calculated along the modelled roads within a 1km study area of the Proposed Scheme;
- Noise levels have been calculated for the Do Minimum scenario for the assessed Construction Year (2024);
- Noise levels have been calculated for the Do Something scenario for the assessed Construction Year (2024); and
- The change in traffic noise levels between the Do Minimum and Do Something scenarios for the Construction Year (2024) has been calculated and the associated magnitude of change (Table 9.13) and noise level range (Table 9.15) defined.

For the majority of the 1km study area, traffic noise impacts are determined to be positive, imperceptible, and temporary impact to negative, slight to moderate and temporary impact due to the negligible to low volume of additional traffic along the road network during the Construction Phase scenario.

There are a small number of roads in the overall study area where there are potential for initial significant impacts as a result of traffic redistribution onto the surrounding road network due to temporary traffic management measures. These are defined as roads with a traffic noise level above a daytime noise level of 55 dB $L_{Aeq,16hr}$ and an increase in noise level greater than 3 dB (Reference Table 9.16).

One road was identified to trigger this potential significance threshold. Further analysis was undertaken, which involved the following:

- For the road section where traffic noise levels were calculated above the potential significance thresholds, the location or presence of noise sensitive buildings was identified and the distance from the road confirmed;
- The corrected traffic noise level at the closest NSL was calculated, where required; and
- The overall significance rating was determined taking account of the change in noise level using the DMRB Noise and Vibration (UKHA 2020) 'short-term' magnitude of change (Table 9.13) and the noise level range, taking account of any distance corrections.

The specific construction traffic noise impacts for the identified road are summarised in Table 9.41.

Table 9.41: Summary of Potential Construction Phase Traffic Impacts – Year (2024)

Road	Increase above Do Minimum Scenario, dB	Magnitude of Impact	Calculated Road Traffic Noise at Closest NSL	Noise Level Category	Overall Significance Rating	Potential Impact
Old Lucan Road	+4.7	Moderate	62	Medium	Moderate	Negative, Moderate, Temporary

During the assessed Construction Year 2024, the highest potential noise impacts are calculated along Old Lucan Road. The change in traffic noise is defined as moderate with traffic noise level calculated at the closest NSLs along this road categorised as medium. The overall impact is determined to be negative, moderate and temporary.

As noted above, the construction traffic volumes used in the assessment is based on the reasonable worst case peak scenario which reflects a 'worst case day' under which the construction of multiple work sections are taking place concurrently. The impacts described in Table 9.41.

Table 9.41 therefore reflect a potential worst case period over the full Construction Phase duration. During all other periods with lower construction traffic volumes or during periods with minimal traffic management measures, traffic noise impacts will be lower than those assessed.

For all other roads across the study area, a Positive, Slight and Temporary to Negative, Slight to Moderate, and Temporary impact is calculated. Slight to Moderate impacts are identified along roads in the study area where a minor change in noise level (1 dB increase) is calculated and the noise level category is medium – high, resulting in a combined significance rating of slight to moderate.

The overall construction traffic noise impacts across the full study area are presented in Figure 9.3 in Volume 3 of this EIAR.

9.4.3.5 Summary of Potential Construction Noise Impacts

It should be noted that the calculations set out in Section 9.4.3.2 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 9.5.1.1.

The pre-mitigation construction noise significance ratings across the Proposed Scheme are summarised in Table 9.42. In line with Table 9.9Table 9.9:, the significance ratings are defined taking account of the prevailing baseline noise environment and the calculated 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. Given this level of detail cannot be accurately determined at EIAR stage for construction activities at any one location, the pre-mitigation construction noise significance ratings discussed in Table 9.42 assume all activities will occur over periods equal to or greater than the durations discussed above. In reality, the majority of activities assessed will not occur for durations exceeding those noted above at individual NSLs due to the intermittent and linear type of works involved, e.g. a boundary wall replacement will be completed over a number of days, thus significantly reducing the overall impact experienced.

For ease of reference, where activities have comparable average plant noise levels (e.g. road works and urban realm landscaping), their impacts are discussed under one heading to reflect that the range of noise levels are comparable at the same distances.

Table 9.42: Summary of Potential Construction Phase Noise Impacts

Assessment Topic	Period over which Criterion Applies	Potential Impacts
General Road Works	Monday to Friday: Daytime (07:00 – 19:00hrs)	• Negative, moderate to significant and temporary in the absence of noise mitigation at NSLs within 15m distance from the proposed works. • Negative, Slight to moderate and temporary at NSLs at distances between 15m to 25m from the proposed works. • Negative, Not significant at NSLs at distances greater than 25m from the proposed works. All impacts noted above are in the absence of noise mitigation. Refer to Section 9.5.1.1 for the range of noise mitigation measures which will be adopted at specific working areas to reduce noise impacts at NSLs.
	Monday to Friday: Evening: (19:00 – 23:00hrs) or Saturdays (08:00 – 16:30hrs)	• Negative, significant to very significant and temporary at NSLs within 25m distance from the proposed works. • Negative, Moderate to significant and temporary at NSLs at distances between 25m and 35m from the proposed works. • Not significant at NSLs at distances greater than 35m from the proposed works. All impacts noted above are in the absence of noise mitigation. Refer to Section 9.5.1.1 for the range of noise mitigation measures which will be 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)	• Negative, significant to very significant and temporary at NSLs within 10m of the proposed works. • Negative, Moderate to significant and temporary at NSLs between 15m to 25m of the proposed works. • Negative, Slight to moderate and temporary at NSLs at distances between 25m to 40m from the proposed works. • Negative, Not significant at NSLs at distances greater than 40m from the proposed works. All impacts noted above are in the absence of noise mitigation. Refer to Section 9.5.1.1 for the range of noise mitigation measures which will be adopted at specific working areas to reduce noise impacts at NSLs.
	Monday to Friday: Evening: (19:00 – 23:00hrs) or Saturdays (08:00 – 16:30hrs)	• Negative, significant to very significant and temporary at NSLs within 40m of the proposed works. • Negative, Moderate to significant and temporary at NSLs within 40m to 50m of the proposed works. • Negative, Not significant at NSLs at distances greater than 50m from the proposed works. All impacts noted above are in the absence of noise mitigation. Refer to Section 9.5.1.1 for the range of noise mitigation measures which will be adopted at specific working areas to reduce noise impacts at NSLs.
Boundary Wall, Bored Piling and Additional Construction Works	Monday to Friday: Daytime (07:00 – 19:00hrs)	• Negative, moderate to significant and temporary at NSLs within 15m of the proposed works. • Negative, Slight to moderate and temporary at NSLs between 20m to 30m of the proposed works. • Negative, Not significant at distances greater than 30m from the proposed works. All impacts noted above are in the absence of noise mitigation. Refer to Section 9.5.1.1 for the range of noise mitigation measures which will be adopted at specific working areas to reduce noise impacts at NSLs.
	Monday to Friday: Evening: (19:00 – 23:00hrs) or Saturdays (08:00 – 16:30hrs)	• Negative, significant to very significant and temporary to short-term at NSLs within 25m of the proposed works. • Negative, Moderate to significant and temporary at NSLs between 25m to 30m of the proposed works. • Negative, Not significant at distances greater than 30m from the proposed works. All impacts noted above are in the absence of noise mitigation.
Construction Compound	Monday to Friday: Daytime (07:00 – 19:00hrs)	• Negative, not significant and temporary at closest NSLs to construction compounds (LU1a LU2 and LU3).

Assessment Topic	Period over which Criterion Applies	Potential Impacts
		• Negative, slight to moderate and temporary at closest NSLs to the construction compound LU1b,
	Monday to Friday: Evening: (19:00 – 23:00hrs) or Saturdays (08:00 – 16:30hrs)	• Negative, significant to very significant and temporary at closest NSLs from proposed construction site compound LU1b • Negative, moderate to significant and temporary at closest NSLs from the proposed construction site compound LU1a with crusher in operation. • Negative, Moderate to significant at the closest NSL at LU2 • Negative, Not significant at the closest NSL at LU3 • Negative, Not significant at the closest NSL at LU3 All impacts noted above are in the absence of noise mitigation. Refer to Section 9.5.1.1 for the range of noise mitigation measures which will be 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.
Retaining Wall Construction Works	Monday to Friday: Daytime (07:00 – 19:00hrs)	• Negative, significant to very significant and temporary at NSLs within 10m of the proposed works. • Negative, Moderate to significant at NSLs at distances between 10m to 15m from the proposed works. • Negative, Slight to moderate at NSLs at distances between 20m to 30m from the proposed works. • Negative, Not significant at NSLs at distances greater than 30m from the proposed works. All impacts noted above are in the absence of noise mitigation. Refer to Section 9.5.1.1 for the range of noise mitigation measures which will be adopted at specific working areas to reduce noise impacts at NSLs.
	Monday to Friday: Evening: (19:00 – 23:00hrs) or Saturdays (08:00 – 16:30hrs)	• Negative, significant to very significant and temporary to short-term at NSLs within 30m of the proposed works. • Negative, Moderate to significant and temporary at NSLs between 30m to 40m of the proposed works. • Negative, Not significant at NSLs at distances greater than 40m from the proposed works. All impacts noted above are in the absence of noise mitigation. Refer to Section 9.5.1.1 for the range of noise mitigation measures which will be adopted at specific working areas to reduce noise impacts at NSLs.
Construction vibration from general road works & construction activities including bored piling	All Construction work periods	• 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	• Negative, slight to moderate and temporary
Construction Traffic – within 1km study area	Peak construction work periods	• Positive, slight and temporary to negative, moderate and temporary

9.4.4 Operational Phase

9.4.4.1 Operational Noise Impact Assessment

9.4.4.1.1 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 an extensive study area across the Dublin Region 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 levels changes. The noise impact assessment has focused on all modelled roads within 1km of the Proposed Scheme red line boundary to assess the potential noise impacts on the surrounding road network. Review of the traffic modelling outputs confirmed that a 1km zone was sufficient to capture all roads with potential noise impacts resulting from the operation of the Proposed Scheme.

There are two key assessment zones within the 1km study area, the specific core bus corridor (i.e. the Proposed Scheme) and the surrounding road network extending out to a 1km zone. In both instances, changes in traffic volumes and changes in fleet composition (i.e. car, bus, LGV, HGV etc.) is a key consideration when determining the change to the traffic noise environment.

9.4.4.1.1.1 Traffic Flow Data

Detailed traffic data have been provided for each modelled road within the 1km study area for the Proposed Scheme. For each road, traffic flows are provided in terms of AADT with a percentage breakdown of cars, buses, LGVs and HGVs for each road.

Traffic flow data was provided for the Opening Year (2028) and the Design Year (2043). Review of traffic volumes associated with the Opening Year (2028) are determined to be higher than those associated with Design Year (2043) for the majority of roads within the study area. This is predominately due to the modal shift towards public transport through the introduction of other committed public transport projects within the National Transport Authority (NTA) Transport Strategy for the Greater Dublin Area 2016 – 2035 (NTA 2016) document under the future design year scenario.

A diurnal profile for the study area was prepared for two key road types, those roads within the inner city cordon and those within the outer city cordon. This information was used to calculate traffic noise levels over the 16 hour daytime period (07:00hrs to 23:00hrs) and 8 hour night-time period (23:00hrs to 07:00hrs) for each road depending on the area in which it is located (i.e. inner or outer city cordon).

Further analysis of traffic flows during night-time periods was undertaken to understand the level of congestion or over-capacity queuing during this period on the road network in the study area (refer to Chapter 6 (Traffic & Transport). Traffic in the night-time periods is approximately 10% of the total daily (24hr) flow and represents a fraction of the peak daytime hours where congestion is modelled to occur. The analysis concluded that due to the significantly lower traffic volumes during this period, compared to those during the day, in tandem with the higher levels of junction capacity for vehicle movements, the effects of traffic redistribution due to the Proposed Scheme will be Imperceptible or Negligible during the night-time period. Further comment on this analysis is included in Chapter 6 (Traffic & Transport). On this basis, traffic noise analysis has focused on the daytime period where the greatest potential impacts will occur in terms of overall traffic volumes along the Proposed Scheme and traffic redistribution off the Proposed Scheme due to congestion.

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

9.4.4.1.1.2 Potential Noise Impacts Along Proposed Scheme

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

- Increased bus fleet and an associated reduction in private traffic;
- Alternations 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.

9.4.4.1.1.3 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 9.4.4.1.1.1, 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.

9.4.4.1.1.4 Source Noise Levels

The approach adopted for both study areas involves the calculation of noise emission levels associated with the key fleet composition types along the road (i.e., buses, cars, LGVs and HGVs). The calculated noise levels are then summed to obtain a total daytime ($L_{Aeq,16hr}$) value along each road within the study area. This approach allows for a sufficient sensitive analysis of fleet and road alignment changes which is specifically relevant along the Proposed Scheme including along individual bus lanes.

Noise levels associated with a passing event such as road traffic may be expressed in terms of its Sound Exposure Level (L_{AX}). The Sound Exposure Level can be used to calculate the contribution of an event or series of events to the overall noise level in a given period using the following formulae:

$$L_{Aeq,T} = L_{AX} + 10\log10(N) – 10\log10(T)\ dB$$

where:

- $L_{Aeq,T}$ is the equivalent continuous sound level over the time period T (in seconds);
- L_{AX} is the “A-weighted” Sound Exposure Level of the event considered (dB); and
- N is the number of events over the course of time period T.

The Sound Exposure Level (L_{AX}) reference values used for the assessment are those discussed in Section 9.4.3.4.

The L_{AX} values relate to fleet with internal combustion engines (ICEs). 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 30km/hr (kilometres per hour), noise from light 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 30km/hr to 60km/hr).

During the proposed Opening Year (2028), the percentage of vehicles with combustion engines will be reduced compared to the existing scenario. The NTA forecast for the year 2028 is for 94% of the city bus fleet to be electric vehicles (Evs) or hybrid electric vehicles (HEVs). For the Design Year (2043), the city bus fleet is forecast to be 100% electric.

The reference noise levels included within this study are therefore worst-case and reflect a full fleet of ICE vehicles. Due to the absence of reliable published sound emission data relating to Evs and 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 relevant change in noise levels between these scenarios will remain unchanged irrespective of the fleet type used. Further comment on specific noise levels is discussed in Section 9.4.4.1.1.6.

Proposed Scheme

Using the calculation approach discussed above, the daytime $L_{Aeq,16hr}$ traffic noise level was calculated along each road modelled as part of the traffic impact assessment (refer to Chapter 6 (Traffic & Transport)) within the Proposed Scheme boundary for the Do Minimum and Do Something scenarios. All calculations are made at a reference distance of 5m 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 (i.e. the Do Minimum scenario). 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.

Surrounding Road Network

For each modelled road within the surrounding road network outside of the Proposed Scheme red line boundary, the associated daytime $L_{Aeq,16hr}$ 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.

9.4.4.1.1.5 Traffic Noise Impacts

Opening Year (2028)

As noted above, traffic volumes associated with the Design Year (2043) of the Proposed Scheme are determined to be lower than those associated with the Opening Year (2028) for the majority of modelled roads within the study area. Traffic noise levels and associated impacts are therefore largely worst-case for the Opening Year (2028). For the purposes of assessing and describing potential noise impacts, opening year traffic is assumed to be representative from the Opening Year (2028) to the Design Year (2043) (i.e. for a 15 year period). The 'short-term' magnitude of change ratings from the DMRB (UKHA 2020) (Table 9.13) are therefore used to assess potential noise impacts associated with the Opening Year (2028) up to the Design Year (2043). 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 a 1km study area of the Proposed Scheme;
- Noise levels have been calculated for the Do Minimum scenario for the Opening Year (2028);
- Noise levels have been calculated for the Do Something scenario for the Opening Year (2028); and
- The change in traffic noise levels between the Do Minimum and Do Something scenarios for the Opening Year (2028) has been calculated, and the associated magnitude of change (Table 9.13) and noise level range (Table 9.15).

Along the Proposed Scheme, a Direct, Positive, Imperceptible, Short to Medium Impact to Negative, Slight, Short To Medium Term impact is calculated. This is as a result of a 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, cycle lanes and footpaths.

Along the majority of roads off the Proposed Scheme within the 1km study area, impacts as a result of traffic redistribution are determined to be Indirect, Positive, Imperceptible, Short To Medium Term to Indirect, Negative, Slight, Short to Medium Term once the Proposed Scheme becomes operational.

There are no roads in the overall study area where there are potential significant impacts, i.e. there are no roads with a traffic noise level increase of 3 dB or greater. Noise level increases calculated for the majority of roads in the study area outside of the Proposed Scheme are less than 1 dB resulting in an imperceptible change in traffic noise levels. There are a small number of roads where noise levels are increased by 1 to 2 dB, categorised as a minor change and would be just perceptible.

Similar to the daytime $L_{Aeq,16hr}$ parameter, the difference in the L_{den} parameter between the Do Minimum and Do Something scenario is positive or not significant along the Proposed Scheme and the surrounding road network (a change in L_{den} of less than or equal to 1 dB). Highest increases are 1 to 1.5 dB resulting in a minor change which would just be perceptible. No increase in night-time noise levels is calculated along these roads which is accounted for the L_{den} noise levels.

A full suite of calculated noise levels along roads within the study area is included in Appendix A9.2 in Volume 4 of this EIAR.

The 2028 operational traffic noise impacts across the full study area are presented in Figure 9.4 in Volume 3 of this EIAR.

Design Year (2043)

For the Design Year (2043), the assessment of potential traffic noise impacts has been undertaken using the following approach:

- Traffic noise levels have been calculated along each road within a 1km study area of the Proposed Scheme;
- Noise levels have been calculated for the Do Minimum scenario for the Opening Year (2028);
- Noise levels have been calculated for the Do Something scenario for the Design Year (2043);
- The non-project noise change has been calculated between the Do Minimum Design Year (2043) and the Do Minimum Opening Year (2028), to account for other projects and transport strategies between these assessment years; and
- The change in traffic noise levels between the 2028 Do Minimum and the Do Something scenario for the Design Year (2043) has been calculated, accounting for any variation in Do Minimum traffic flows between the Opening Year (2028) and the Design Year (2043). The associated magnitude of change (Table 9.14) and noise level range (Table 9.15) has been defined.

Along the Proposed Scheme, a Direct, Positive, Imperceptible, Long-Term Impact to Negative, Not Significant To Slight, Long-Term impact is calculated (Reference Table 9.16). Along the roads outside of the Proposed Scheme, an Indirect, Positive, Imperceptible, Long-Term Impact to Negative, Not Significant To Slight, Long-Term impact is determined due to the negligible to low volume of additional traffic added once the Proposed Scheme becomes operational.

There are no roads in the overall study area where there are potential significant impacts, i.e. there are no roads with a traffic noise level increase of 5 dB or greater during the design year. Noise level increases calculated for the majority of roads in the study area outside of the Proposed Scheme are less than 1 dB resulting in an imperceptible change in traffic noise levels. There are a small number of roads where noise levels are increased by 1 to 2 dB, categorised as a negligible change. Given this change is calculated between the year of opening and the design year (+15 yeas post opening), this magnitude of change is considered to be neutral over this time period.

Similar to the daytime $L_{Aeq,16hr}$ parameter, the difference in the L_{den} parameter between the Do Minimum and Do Something scenario is positive or not significant along the Proposed Scheme and the surrounding road network (a change in L_{den} of less than or equal to 1 dB). Highest increases are 1 to 1.5 dB resulting in a minor change which would just be perceptible. No increase in night-time noise levels is calculated along these roads which is accounted for the L_{den} noise levels.

The overall operational noise impacts across the full study area for the design year, 2043, are presented in Figure 9.5 in Volume 3 of this EIAR.

9.4.4.1.1.6 Comment on Future EV Fleet

For the roads outside of the Proposed Scheme along the surrounding road network, 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 30km/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 analysis and to be worst-case.

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 positive along the Proposed Scheme for both the Opening Year (2028) and the Design Year (2043) due to reduced overall traffic volumes. Given the same fleet 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 type.

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.

9.4.4.2 Operational Vibration Impact Assessment

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 monitoring results in Table 9.22 and Table 9.23, confirms that vibration levels associated with passing buses and other vehicular traffic at distances of 2.5m to 10m 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 582 over the 16 hour daytime period. Using this number and the highest VDV event measured during a bus pass at a reference distance of 5m from the road edge (0.0033 $m/s^{1.75}$), the daytime $VDV_{,b,day}$ value is calculated as 0.016 $m/s^{1.75}$. Reference to Table 9.17 confirms this value is orders of magnitude below those associated with a low probability of adverse comment. The overall impact is Neutral, Not Significant and Long Term.

9.4.4.3 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 perceptibly 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 or will be reconfigured and upgraded as part of the overall scheme works with no change in noise environment as a result. A small number of new bus stops will be installed as part of the Proposed Scheme.

A Review of the proposed new bus stop locations indicates that those adjacent to retail and commercial areas which are not noise sensitive areas will not pose any significant noise impacts. Additional locations for new stops are sited along the road edge and are separated from the closest noise sensitive properties by a boundary wall (typically 2 to 2.5m in height) which will provide a high level of screening from noise sources associated with bus engines.

There are two locations identified where new bus stops are proposed with noise sensitive locations in proximity. These are located at the following locations:

- Chainage A2+150 - A2+200, N4 Lucan Road north, relocated bus stop approximately 150m west of existing location; and
- Chainage A5+560, Chapelizod Bypass east.

The closest noise sensitive locations to the new bus stop location along the N4 at Chainage A2+150 – A2+200 are residential properties located approximately 30m north along the old Lucan Road. The prevailing noise environment is dominated by road traffic from the N4 Lucan Road and Old Lucan Road. Existing traffic noise levels are typically between 65 and 69dB $L_{Aeq,16hr}$ which will dominate noise levels at these locations. An existing boundary wall separates the N4 from the old Lucan Road in addition to the boundary walls fronting the closest properties. The relocated bus stop is therefore located along an existing heavily trafficked road and will be screened by the existing walls in place. The construction of the Liffey Valley Pedestrian Bridge will require the construction of a retaining wall on the south side of the bridge. The relocated bus stop at this location will therefore have a negligible impact over and above the prevailing noise environment at this location.

The closest noise sensitive locations to the new bus stop along the Chapelizod Bypass at Chainage A+560 are residential properties along Chapelizod Hill Road. The new bus stop at this location have been designed to reduce

noise impacts through the incorporation of a solid wall along the top of the ramp will be a minimum height of 1.2m. In addition, the existing noise barriers along the Chapelizod Bypass will be retained or replaced in proximity to the new bus stop.

As discussed in Section 9.4.4.1.1.4, during the proposed Opening Year (2028), the NTA forecast is for 94% of the city bus fleet to be EVs or HEVs. For the Design Year (2043), the city bus fleet is forecast to be 100% electric. The operation of electric and hybrid buses will eliminate ICE noise from buses accelerating, decelerating and idling at bus stops which is the dominant noise source. In addition, the characteristic of noise from EVs is subjectively less intrusive compared to those with ICE's and is masked to a much greater extent by surrounding road traffic.

It is noted the bus stops along the Proposed Scheme will be used by other bus operators which may not transition to EV and HEVs over the same period as the city bus fleet. The volume of these buses along the Proposed Scheme will, however, be significantly less than the city bus fleet and hence, noise levels associated with these areas will not generate significant noise levels over the prevailing noise environment.

Taking into consideration the screening between the nearest NSL and the proposed bus stops in addition to the lower noise emissions from the proposed future bus fleet, the overall impact is determined to be negative, not significant and long term.

9.4.4.4 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 Proposed Scheme). 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 9.4.3.2.1.

9.4.4.5 Assessment Summary

The Operational Phase noise impacts associated with the Proposed Scheme are summarised in Table 9.43

Table 9.43: Summary of Potential Operational Phase Impacts

Assessment Topic	Potential Impact
Opening Year (2028) traffic noise – Proposed Scheme	Direct, Positive, Imperceptible, Short to Medium Term, to Negative, Slight, Short to Medium Term
Opening Year (2028) traffic noise – Surrounding road network	Direct, Positive, Imperceptible, Short to Medium Term, to Negative, Slight, Short to Medium Term
Design Year (2043) traffic noise – Proposed Scheme	Direct, Positive, Imperceptible, Long-Term to Negative, Not Significant to Slight, Long-term
Design Year (2043) traffic noise – Surrounding road network	Indirect, Positive, Imperceptible, Long-Term to Negative, Not Significant to Slight, long-term
Operational Phase Vibration	Neutral, Imperceptible, Long-term
New Bus stops	Negative, Not Significant, Long-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 and comply with the recommendations of BS 5228–1 (BSI 2014a) and S.I. No. 241/2006 - European Communities (Noise Emissions by Equipment for Use Outdoors) (Amendment) Regulations 2006. The mitigation measures outlined below for the Construction Phase have also been included in the Construction and Environmental Management Plan (CEMP) in Appendix A5.1 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 means practicable, including proper maintenance of plant and equipment, will be employed to minimise the noise produced by on-site operations.

BS 5228–1 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 appointed 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 9.8: and Table 9.11). Reference to Table 9.42 indicates that intrusive works occurring within 50m of NSLs will need specific noise control measures to reduce impacts depending on time period over which they will occur (i.e. daytime or evening).

9.5.1.1.1 Selection of Quiet Plant

The potential for any item of plant to result in exceedance of construction noise thresholds will be assessed prior to the item being brought onto the site. The least noisy item of plant will be selected wherever practicable (e.g. plant items with sound attenuation incorporated). Should a particular item of plant already on the site be found to exceed the construction noise thresholds, the first action will be to identify whether the item can be replaced with a quieter alternative.

The appointed contractor will evaluate the choice of excavation, breaking or other working method taking into account various ground conditions and site constraints. Where alternative lower noise generating equipment are available that will provide equivalent structural / excavation / breaking results, these will be selected to control noise within the relevant thresholds, where it is practicable to do so.

The decision regarding the type of excavation technique or other construction activity to be used on a site will normally be governed by a range of engineering and environmental constraints. In these instances, it may not be possible for technical reasons to replace an item of plant with a quieter alternative. In some instances, the adoption of a quieter method may prolong the overall process, with the net result being that the overall disturbance to the community will not necessarily be reduced.

9.5.1.1.2 Noise Control at Source

The following measures will be implemented, if required, by the appointed contractor to control noise at source in order to remain below the threshold values for noise set out in Table 9.8:, 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 a muffler or sound reducing equipment to the breaker ‘tool’ and ensuring any leaks in the air lines are sealed;
- The Construction Compounds are in close proximity to NSLs (refer to Table 9.30Table 9.30) and a strict noise control policy relating to materials handling will be applied. 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 the 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 the application of damping compounds, while other noise nuisance can be controlled by fixing resilient materials in between the surfaces in contact.

9.5.1.1.3 Screening

Screening is an effective method of reducing CNLs 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 in operation in proximity to NSL boundaries with the potential to exceed the construction noise thresholds. Annex B of BS 5228–1 (Figures B1, B2 and B3) provide 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 dB(A).

The appointed contractor will provide a site hoarding of 2.4m 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 10kg/m^2 (kilogrammes per metre squared) will give adequate sound insulation performance. The use of a standard 2.4m high construction site hoarding will provide a sufficient level of noise screening once it is installed at a suitable position between the source and receiver.

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.

9.5.1.1.4 Hours of Work

It is envisaged that generally construction working hours will be between 07:00hrs and 23:00hrs on weekdays, and between 08:00hrs and 16.30hrs on Saturdays. Night-time and Sunday working will be required during certain periods to facilitate street works that cannot be undertaken under daytime / evening time conditions. The planning of such works will take consideration of sensitive receptors, in particular any nearby residential areas.

Construction activities will be scheduled in a manner that reflects the location of the site and the nature of neighbouring properties. 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. 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 9.42), other construction activities will be scheduled to not result in significant cumulative noise levels.

9.5.1.1.5 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 and other high noise or vibration activities 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.

The NTA will establish clear forms of communication that will involve the appointed 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 9.8: and Table 9.11.

9.5.1.1.6 Monitoring

During the Construction Phase the appointed contractor will carry out noise monitoring 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, construction activities along the Proposed Scheme will 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 9.11 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 9.11.

In the case of vibration levels giving rise to human discomfort, in order to minimise such impacts, the following measures shall be implemented during the Construction Phase:

- A clear communication programme will be established by the NTA 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 9.12**.** 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 9.12) 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.

9.5.1.3 Summary of Impacts

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

At the closest properties impacted by the works (typically between 10m to 30m), the prevailing daytime baseline noise level is assumed as 70 dB $L_{Aeq,12\ hr}$ and evening baseline noise level is 68 dB $L_{Aeq,4hr}$. As discussed in Section 9.3.2.4, baseline noise levels measured as part of the baseline study are potentially 1 dB 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.

Table 9.44 presents the predicted Construction Phase impacts following the implementation of mitigation and monitoring measures and assumes that the construction activities are occurring 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 six 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 9.4.3.2.

Table 9.44: Summary of Predicted Construction Phase Impacts Following the Implementation of Mitigation and Monitoring Measures

Assessment Topic	Period over which Criterion Applies	Potential Impacts (Pre-Mitigation and Monitoring)	Predicted Impact (Post Mitigation and Monitoring)
General Road Works	Monday to Friday: Daytime (07:00 – 19:00hrs)	• Negative, moderate to significant and temporary in the absence of noise mitigation at NSLs within 15m distance from the proposed works. • Negative, Slight to moderate and temporary at NSLs at distances between 15m to 25m from the proposed works. • Negative, Not significant at NSLs at distances greater than 25m from the proposed works.	• Negative, slight to moderate and temporary at NSLs within 10m distance from the proposed works. • Negative, not significant and temporary at NSLs at distances greater than 10m from the proposed works.
	Monday to Friday: Evening: (19:00 – 23:00hrs) or Saturdays (08:00 – 16:30hrs)	• Negative, significant to very significant and temporary at NSLs within 25m distance from the proposed works. • Negative, Moderate to significant and temporary at NSLs at distances between 25m and 35m from the proposed works. • Negative, Not significant at NSLs at distances greater than 35m from the proposed works.	• Negative, moderate to significant and temporary at NSLs within 10m from the proposed works. • Negative, not significant and temporary at NSLs at distances greater than 10m from the proposed works.
Road Widening / and Utility Diversion Works	Monday to Friday: Daytime (07:00 – 19:00hrs)	• Negative, significant to very significant and temporary at NSLs within 10m of the proposed works. • Negative, Moderate to significant and temporary at NSLs between 15m to 25m of the proposed works. • Negative, Slight to moderate and temporary at NSLs at distances between 25m to 40m from the proposed works. • Negative, Not significant at NSLs at distances greater than 40m from the proposed works.	• Negative, slight to moderate and temporary at NSLs within 10m distance from the proposed works. • Negative, not significant and temporary at NSLs at distances greater than 10m from the proposed works.
	Monday to Friday: Evening: (19:00 – 23:00hrs) or Saturdays (08:00 – 16:30hrs)	• Negative, significant to very significant and temporary at NSLs within 40m of the proposed works. • Negative Moderate to significant and temporary at NSLs within 40m to 50m of the proposed works. • Negative Not significant at NSLs at distances greater than 50m from the proposed works.	• Negative, significant to very significant and temporary at NSLs within 10m from the proposed works. • Negative, moderate to significant and temporary at NSLs within 10m to 15m from the proposed works. • Negative, not significant and temporary at NSLs at distances greater than 15m from the proposed works.
Boundary Wall, Bored Piling and Additional Construction Works	Monday to Friday: Daytime (07:00 – 19:00hrs)	• Negative, moderate to significant and temporary at NSLs within 15m of the proposed works. • Negative Slight to moderate and temporary at NSLs at distances between 20m to 30m from the proposed works. • Negative Not significant at NSLs at distances greater than 30m from the proposed works in the absence of noise mitigation.	• Negative, not significant and temporary at NSLs at distances greater than 10m from the proposed works.
	Monday to Friday: Evening: (19:00 – 23:00hrs) or Saturdays (08:00 – 16:30hrs)	• Negative, significant to very significant and temporary in the at NSLs within 25m of the proposed works. • Negative Moderate to significant and temporary at NSLs between 25m and 30m from the proposed works.	• Negative, moderate to significant and temporary at NSLs within 10m from the proposed works. • Negative, not significant and temporary at NSLs at distances greater than 10m from the proposed works.

Assessment Topic	Period over which Criterion Applies	Potential Impacts (Pre-Mitigation and Monitoring)	Predicted Impact (Post Mitigation and Monitoring)
		• Negative Not significant at NSLs at distances greater than 30m from the proposed works.	
Construction Compound	Monday to Friday: Daytime (07:00 – 19:00hrs)	• Negative, not significant and temporary at closest NSLs to construction compounds (LU1a LU2 and LU3). • Negative, slight to moderate and temporary at closest NSLs to the construction compound LU1b.	• Not significant and temporary at distances greater than 10m from all three construction site compounds.
	Monday to Friday: Evening: (19:00 – 23:00hrs) or Saturdays (08:00 – 16:30hrs)	• Negative, significant to very significant and temporary at closest NSLs from proposed construction site compound LU1b • Negative, moderate to significant and temporary at closest NSLs from the proposed construction site compound LU1a with crusher in operation. • Negative, Moderate to significant at the closest NSL at LU2 • Negative, Not significant at the closest NSL at LU3 • Negative, Not significant at the closest NSL at LU3	• Not significant and temporary at distances greater than 10m from all three construction compounds.
Retaining Wall Construction Works	Monday to Friday: Daytime (07:00 – 19:00hrs)	• Negative, significant to very significant and temporary within 10m of the proposed works. • Negative, moderate to significant and temporary between 10m to 15m of the proposed works. • Negative Slight to moderate and temporary at NSLs within 20m to 30m of the proposed works. • Negative Not significant at distances greater than 30m from the proposed works.	• Negative, slight to moderate and temporary at NSLs within 10m distance from the proposed works. • Negative, not significant and temporary at NSLs at distances greater than 10m from the proposed works.
	Monday to Friday: Evening: (19:0000hrs – 23:00hrs) or Saturdays (08:00hrs – 16:30hrs)	• Negative, significant to very significant and temporary at NSLs within 30m of the proposed works. • Negative Moderate to significant and temporary at NSLs between 30m to 40m of the proposed works. • Negative Not significant at distances greater than 40m from the proposed works.	• Negative, significant to very significant and temporary at NSLs within 10m of the proposed works. • Negative, not significant and temporary at NSLs at distances greater than 10m from the proposed works.
Construction vibration from general road works and construction activities including bored piling	All Construction work periods	• Negative, imperceptible to not significant and temporary	• 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	• Negative, slight to moderate and temporary	• Negative, slight and temporary
Construction Traffic – within 1km study area	Peak construction work periods	• Positive, slight and temporary to negative, moderate and temporary	• Positive, slight and temporary to negative, moderate and temporary

9.5.2 Operational Phase

9.5.2.1 Change in Road Traffic Noise

The impact assessment has determined that traffic noise impacts across the study area for the Proposed Scheme results in a positive to neutral imperceptible short and long-term direct impacts along the Proposed Scheme and negative imperceptible to slight 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.

9.5.2.2 Bus Stops

The impact assessment has determined that noise impacts associated with the provision of relocated or new bus stop locations will be negative, not significant and long term taking account of the expected transition to electric and hybrid for the city bus Fleet between the year of opening and the Design Year (2043). No further noise mitigation measures are proposed.

9.5.2.3 Road Maintenance

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

9.5.2.4 Impact Overview

The predicted Operational Phase impacts associated within the Proposed Scheme are summarised in Table 9.45**.**

Table 9.45: Summary of Predicted Operational Phase Impacts Following the Implementation of Mitigation and Monitoring Measures

Assessment Topic	Potential Impact (Pre-Mitigation and Monitoring)	Predicted Impact (Post Mitigation and Monitoring)
Opening year (2028) traffic noise – Proposed Scheme	Direct, Positive, Imperceptible, Short to Medium Term, to Negative, Slight, Short to Medium Term	Direct, Positive, Imperceptible, Short to Medium Term, to Negative, Slight, Short to Medium Term
Opening year (2028) traffic noise – Surrounding road network	Direct, Positive, Imperceptible, Short to Medium Term, to Negative, Slight, Short to Medium Term	Direct, Positive, Imperceptible, Short to Medium Term, to Negative, Slight, Short to Medium Term
Design year (2043) traffic noise – Proposed Scheme	Direct, Positive, Imperceptible, Long-Term to Negative, Not Significant to Slight, Long-term	Direct, Positive, Imperceptible, Long-Term to Negative, Not Significant to Slight, Long-term
Design year (2043) traffic noise – Surrounding road network	Indirect, Positive, Imperceptible, Long-Term to Negative, Not Significant to Slight, long-term	Indirect, Positive, Imperceptible, Long-Term to Negative, Not Significant to Slight, long-term
Operational Vibration	Neutral, Imperceptible, Long-term	Neutral, Imperceptible, Long-term
Bus stops – new locations	Negative, Not Significant, Long-term	Negative, Not Significant, 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 the 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. The most appropriate noise mitigation measures for each work area will be determined taking account of the various control measures included within Section 9.5.1.1 and the CEMP in Appendix A5.1 in Volume 4 of the EIAR and Chapter 5 (Construction). The various mitigation measures will be selected in order to control CNLs to within the limit values included in Table 9.8 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 Moderate, and Temporary during all key construction phases during daytime periods.

During evening periods, noise impacts associated with the Construction Phase will be Negative, Not Significant to Significant and Temporary within 20m of the works depending on the specific activities. 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 will be followed, where feasible, to reduce overall significance effects (i.e. scheduling works to occur for periods of less than 10 days / nights over 15 consecutive day / night 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, all key Construction Phase residual noise levels will be Not Significant, whilst meeting the scheme objectives set out in Chapter 1 (Introduction).

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).

9.6.2 Operational Phase

Once operational, there will be a Positive to Neutral impact along the Proposed Scheme due to a reduction in traffic volumes during both the Opening Year (2028) and the Design Year (2043).

During the Opening Year (2028), an Indirect, Positive, Imperceptible, Short To Medium Term to, Negative, Slight, Short To Medium Term change in traffic noise levels will occur along the surrounding road network outside of the Proposed Scheme. Whilst an element of traffic re-distribution will occur during daytime periods, the resultant noise impacts are negative, slight and short to medium term.

During the Design Year (2043), an Indirect, Positive, Imperceptible, Long Term to Negative, Not Significant to Slight, Long Term change in traffic noise levels will occur along the surrounding road network outside of the Proposed Scheme. Whilst an element of traffic re-distribution will occur during daytime periods, the resultant noise impacts are Negative, Not Significant to Slight and Long Term.

The Proposed Scheme aligns with the policy objectives of The Dublin Agglomeration NAP 2018 – 2023 (DCC; FCC; SDCC; DLRCC 2018) to reduce traffic noise exposure to populations across the city through the incorporation of improved public transport, increasing bus, train and bicycle journeys and the replacement of diesel fleet to electric and natural gas fleet. 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 Proposed Scheme where highest existing traffic noise levels are experienced. 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.

There are no significant residual Operational Phase noise or vibration impacts associated with the Proposed Scheme, whilst meeting the scheme objectives set out in Chapter 1 (Introduction).

9.7 References

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